# AGING RESEARCH AND PRACTICES IN MALAYSIA

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# AGING RESEARCH AND PRACTICES IN MALAYSIA

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EDITORIAL
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# Editorial: Aging Research and Practices in Malaysia

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**Keywords: aging, healthy aging, wellbeing, best practices, technology**

## Editorial on the Research Topic

## Aging Research and Practices in Malaysia

Malaysia is a rapidly aging upper middle-income nation with the population aged 65 years and over expected to increase 3-fold within the next 20 years. With its universities rapidly ascending international rankings, the research output within this country is also increasing at an unprecedented rate. As a result, our Research Topic on "*Aging Research and Practices in Malaysia*" has generated a great deal of interest and boasts 22 articles in total. The articles provide a good representation of the types of research ongoing in Malaysia to address the pressing issue of population aging.

The clinical research areas covered within this Research Topic included cognitive frailty, stroke, osteoarthritis (OA) and infection. Contributors included a team from the Universiti Kebangsaan Malaysia which published their protocol on multimodal intervention for cognitive frailty -WE-RISE (Murukesu et al.). Mohamad Fuad et al. conducted a controlled study using serial cognitive assessments after stroke confirming the high risk of cognitive decline after stroke. Controversially, Mat et al. found that the presence of OA symptoms was protective against falls after muscle strength is accounted for. The perspectives of older persons with OA toward the Enabling Self-management and Coping with Arthritic Pain using Exercise (ESCAPE-Pain) interventional programme were evaluated with positive responses recorded (Hasan et al.). Akhtar et al. found that treatment outcome in urinary tract infection is influenced by gender, polypharmacy and comorbidities. The above series of articles demonstrates a wide spectrum of research methods ranging from qualitative to quantitative design, observational to interventional and cross-sectional to prospective now being utilized in clinical studies in older adults.

Falls related research was heavily represented within this issue. The studies focused on home hazards among stroke survivors (Ainuddin et al.), falls risk in older persons (Ashari et al.), fear of falls (FOF) (Romli et al.), falls incidence recording in research (Romli et al.) and ankle muscle function in older persons (Perera et al.). Generally, the findings showed that there is a lack of research pertaining to home environment risk assessment and intervention in stroke survivors. Factors associated with FOF include limitations in daily functional activities but not home hazards. Instability during turning, visual impairment and back pain were the highlighted falls risk factors in Malaysian older adults. In addition, decreased toe clearance with limited knee flexion and ankle dorsiflexion was established using gait analysis in a simulated study in older persons with falls. In a pilot study testing community-based strengthening exercises for older persons with frailty

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demonstrated improvement in both upper and lower limb muscles post-intervention (Raja Adnan et al.). Lastly, one of the novel recommendations from this issue was to consider both retrospective recall and prospective recording of falls incidence using falls calendars in research.

Psychological research covered in this topic comprises prospective memory training and knowledge, attitude and practices on salt intake whereas socio-economic research is based on social factors such as dependency ratio, social networks and dementia caregiving. The study by Haron et al. highlighted the importance of knowledge on salt intake along with the aptitude to learn within one's social context to reduce hypertension among older persons. Multicomponent prospective memory training, which is tailored to older people, is emphasized by Farzin et al. as a strategy to promote independence and wellbeing. Hamid et al. found that social networks may have a stronger influence on older adults' mental health compared to their living arrangements. Goodson et al. stressed the importance of dementia awareness and caregiver training highlighting the issues surrounding the dementia care system which is difficult to navigate. Active aging and labor force participation is proposed by Mohd et al. as strategies to mitigate the negative impact of the old-age dependency ratio on economic growth. Psychological studies underscore the role of learning theories in behavior modification and healthy aging. The authors' contributions demonstrate the importance of psychological and socio-economic factors to older people's health and wellbeing.

In this Research Topic, how technology could support various health issues related to aging has been covered. Falls are related to instability either permanent or transient and to have a better understanding of physical limitations and visual issues among older persons, research using aging simulation suits could enhance health advocacy among health practitioners (Lee and Teh). Perception and expectations analysis toward the use of fall detection devices have shown definite interest in using these devices with user friendly, affordable, and accurate features (Rahman et al.). Research on muscles affecting minimum toe clearance during gait could also reduce risk of falls, as with aging the muscles would weaken and stiffen, coupled with reduced motion join range (Perera et al.). The findings of a scoping review concluded that the technological interventions in stroke rehabilitation had a positive impact on stroke rehabilitation (Selamat et al.).

Ng et al. has implemented a Health Care of Elderly course to public university students to look at their attitude, self-perceived competence and interest toward geriatric medicine as a career and found there are positive interests after the course. They also highlighted the importance to increase preparedness in managing frail older adults with multimorbidities. To address issues of limited health screening resources for older persons, Alex et al. has conducted a self-administered online survey in urban community dwelling to screen geriatric syndromes and conclude it is feasible to do it online.

The explosion of aging research in Malaysia has been apparent over the past 5 years. This Research Topic showcases the breadth of aging research in Malaysia associated with its rapid population aging that affects individuals, families and society. The published articles also demonstrated extensive inter-disciplinary collaborations within health, economy, social and technology areas. Through this topic, an understanding about aging Malaysia: research and practice has no doubt been enhanced.

## AUTHOR CONTRIBUTIONS

PT has prepared the initial draft of the Editorial. SA has compiled the article and was reviewed by all authors again, before approving the final version. All authors have made substantial contributions in this writing.

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# "Suiting Up" to Enhance Empathy Toward Aging: A Randomized Controlled Study

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**Background:** Healthcare professionals who have a positive attitude and who are more empathetic toward older adults are in a better position to deliver quality healthcare. This study examines the impact of using an aging simulation suit on undergraduate pharmacy students' empathy levels.

**Methods:** One hundred and twenty first-year students enrolled in the Bachelor of Pharmacy course were randomized to either a medication review polypharmacy workshop (control) or an immersive aging simulation suit and medication review polypharmacy workshop (intervention). Intervention participants donned the aging suit and performed a series of tasks, including walking up a flight of stairs and filling up a form to simulate the physical limitations experienced by an older adult. The workshop was delivered at week 10 of semester. Both groups also completed a medication review polypharmacy workshop at week 12 of semester. The primary outcome was a measurement of change on the Jefferson Empathy Scale-Healthcare Professional Questionnaire among both groups at week 12 of semester. Secondary outcomes include the longitudinal impact of intervention after 3 months of the workshop and perceptions on learning.

**Results:** The use of a simulation suit did not increase participants' self-rated empathy compared to control. However, the suit enhanced the ability of participants to understand the physical limitations and visual issues associated with aging. Participants also felt that it enhanced their health advocacy, as it taught them the importance of listening, patience and respect for older adults.

**Conclusion:** The use of an immersive aging suit can be a useful adjunctive tool to help enhance students' understanding of the physical limitations and visual limitations of aging. Further research is needed to understand how these limitations affect other healthcare students.

**Trial Registration:** ClinicalTrials.gov identifier: NCT04133727.

**Keywords: aging suit, simulation, pharmacy, empathy, polypharmacy, aging**

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## INTRODUCTION

The world's population is rapidly aging—nearly one in every five individuals will be 60 years old and above by 2050, translating to ∼2.1 billion people worldwide (1). As a result, many countries worldwide are finding the consequent demand on healthcare systems to be a challenge. In the context of this growing need for healthcare, the World Health Organization has recommended that the care of older adults should be centered around their own concerns and priorities (2). Medical and health science-related schools have now made it their educational mission to make compassionate person-centered care a core value of their curriculum (3–6). However, the skills aspects of training have traditionally received less attention, and most studies (7, 8) have shown that there is a decline in the empathy levels of students that persists beyond training.

Empathy is a predominantly cognitive attribute which involves learning and understanding the experiences, perspective, and concerns of a patient, combined with the ability to resonate with the patient and communicate this perspective to them (9). Such an attribute is an essential skill that is of paramount importance to all individuals, especially to healthcare professionals. Studies have shown that empathetic interactions often lead to increased patient satisfaction, better patient compliance, and better quality of life among patients (10, 11). Unfortunately, research suggests that empathy levels among students decline over time, with increased patient contact (7, 12). For this reason, it is imperative that the pharmacist–patient relationship be enhanced to provide safe and high quality care. In light of this finding, several authors have developed educational exercises that aim to improve empathy levels among pharmacy students (13, 14).

Simulation has been suggested as a novel educational approach to teach healthcare students empathy for older adults (15, 16). Simulation suits, such as GERontologic Test suit (17) and Age Gain Now Empathy System (18) were recently introduced, and offer the opportunity for younger people to experience the impairments experienced by older adults. The simulation suit usually consists of a pair of specially designed glasses which simulates opacity of the eye lens and narrowing of visual field; a pair of gloves which simulates decreased sensitivity and grip ability; a weighted vest which increases weight and mimics spinal deformities; elbow and knee wraps which result in restricted mobility and flexibility; and sand bags which are worn on the wrists and ankles to simulate slow movement as well as a pair of unevenly weighted sandals to simulate decreased flexibility and loss of gait (**Figure 1**).

The use of an immersive aging suit has been examined among nursing students, aimed at enhancing the students' appreciation of the physical and sensory difficulties among older adults. Bennett and colleagues examined how the use of an aging suit impacted health students as to the functional loss and social isolation among older adults (16). In the study, the authors noted that students gained a better understanding of the functional issues and social isolation that are associated with aging after using the aging suit. Lavallière et al. similarly examined the use of an aging suit among younger adults (19) and found that they could relate better to the physical limitations and reduced performance associated with aging.

Pharmacists are trained traditionally to focus on patient counseling especially on medication-related issues, which are commonly seen among older adults who may have to move from independent living circumstances to long-term care (11, 20–22). Nevertheless, this process is often considered as ticking a checklist rather than as a two-way communication that involves the empathy needed for delivery of patient-centered care (23). Cognizant of this limitation, the Bachelor of Pharmacy course at Monash University was redeveloped recently to establish early and regular patient contact and by ensuring that communication and clinical skills courses are co-taught from the very beginning. First-year pharmacy students in the Bachelor of Pharmacy course are taught communication skills in different settings, including communication with older adults, since this is crucial for the students' personal growth, development, and critical reasoning.

To the best of our knowledge, no study has yet evaluated whether using both a simulation exercise and an aging suit will improve pharmacy students' empathy levels, their ability to respond, and to use these skills in patient interactions. This mixed-method open-label randomized controlled study investigated the hypothesis that students' empathy can be enhanced by integrating an aging simulation exercise with a polypharmacy workshop. We hypothesized that students would improve their empathy after using the aging simulation suit compared to those who do not use the suit during their studies.

## METHODS

### Study Design and Setting

This study was a randomized, parallel-group, open-label study conducted at Monash University Malaysia between March 2018 and September 2018. The study was registered with ClinicalTrials.gov (NCT04133727).

### Participants and Allocation

All Year 1 Bachelor of Pharmacy students who were enrolled at Monash University Malaysia in 2018 were invited to participate in this study. The program is a 4-years course identical to the course offered at Monash University in Australia. Participants were recruited if they were (1) first-year pharmacy students; (2) enrolled in the Professional Practice I (PHR1011) unit; and (3) were in self-reported good health. Participants who had any current experience of dizziness or numbness in the limbs were excluded from the study.

### Randomization and Masking

Participants were randomized 1:1 to receive either intervention or control using a computer-generated random number table, 2 weeks before the polypharmacy workshop. However, due to the nature of the study, it was not feasible to blind the participants or researchers to intervention allocation upon randomization. The study was approved by the Monash University Human Research Ethics Committee (2017-11714-14826).


**FIGURE 1 |** The full setup of aging suit.

**TABLE 1 |** Areas of aging experienced by students and tasks performed.

| Areas examined | Task performed |
|---|---|
| Visual limitation associated with ocular diseases | The participant was asked to complete a standard demographic questionnaire which was prepared on a clipboard with a pen. After a minute has passed, the participant was requested to pass the form back. |
| Restricted physical strength including gait, movement and strength | Participants were asked to don the full suit on and walk for 100 m and sit down on a sofa. The participant was then asked to stand up and sit on another stool. Participants were also provided with a comb and asked to comb their hair using their non-dominant hand. |
| Grip strength and sense of touch | Participants were provided with a piece of paper, which was deliberately dropped and asked to pick it up. This activity was repeated using a 10 cent coin (diameter 1.5 cm) |
| Balance | Participants were requested to sit down on a high stool and walk up a flight of stairs. |

## Intervention

Participants randomized to the intervention group were required to wear an aging simulation suit (Nagoya, Japan: Yagami Inc.) and to perform a range of activities that aim to simulate some of the physical disabilities and challenges an older adult may experience in their daily tasks (**Table 1**). Activities performed include sitting down and getting up from a chair and sofa, reading and filling out a form during a healthcare clinic visit, as well as picking up an object from the floor. These activities were performed in the classroom a week prior to the polypharmacy workshop and took ∼10 min to complete per participant. All participants performed the task only once.

## Polypharmacy Workshop (Control)

As part of the Bachelor of Pharmacy curriculum, all students were required to participate in a polypharmacy workshop with older adults, arranged at week 12 (final week of curriculum) on campus. The session aims to outline the occurrence of polypharmacy among older adults and identify challenges that may arise from managing polypharmacy. The session also provided students with the opportunity to learn effective communication with older adults. For the session, older adults aged 60 years and above from the local community were recruited by the school administrative staff. This age limit was chosen as it is the typical retirement age in Malaysia. These older adults were required to be taking at least five or more medications (average medications per older adult in Malaysia: 6.2 medications) and were willing share their experiences with students during the workshop.

The workshop consisted of a 60-min session with four participants assigned to speak to two older adults. During the session, participants were required to assess and determine the older adults' health literacy; discuss their medicine use; discuss the difficulties they may have been facing in relation to medicine use; and complete a medication list and convey this information to each of the older adults that they had interviewed, with a copy of their list. Academic staff members who were facilitating the session provided a debriefing to students, concentrating on the medication-related issues.

## Data Collection and Evaluation

We collected the participants' demographic characteristics and scores on the Jefferson Scale of Empathy–Health Profession Student (JSE-HPS) (24), at the beginning of their course at week 1 (baseline, **Figure 2**). JSE-HPS was measured on a seven-point Likert scale which can be summed to generate a total score of between 20 and 140, with a higher score indicative of greater empathy during provider patient encounters. The tool has been validated for use among pharmacy and nursing students to measure empathy (25–27) with good reliability and validity (25).

At the end of the workshop at week 12, all participants completed a three-part questionnaire. The first section assessed the participant's self-perceived impact of the activity toward their attitude, empathy, and understanding of older adults using a 5-point Likert scale with 1 representing none at all to 5 representing a great deal. The second section comprised the JSE-HPS questionnaire, while in the third section, participants were asked to complete an open-ended questionnaire to describe how the task affected their feelings and perceptions toward older adults (refer to **Supplementary Materials** for list of questions). Participants also completed the JSE-HPS questionnaire again, 3 months after the workshop (week 24).

## Outcomes

The primary outcome of interest was the change in JSE-HPS scores from baseline to the end of the workshop (week 12). Secondary outcomes included the longitudinal impact of the intervention, 3 months after the workshop, and perceived changes in attitude, empathy toward and understanding of older adults.

## Statistical Analyses

Assuming that the intervention would improve participants' empathy scores by 10%, we needed a minimum of 108 participants. This sample size has a 90% power to detect an $\alpha$ of 0.05 between each group, factoring a 20% dropout rate.

Participants' baseline characteristics were summarized using descriptive statistics and presented as mean (standard deviation) for continuous variables and total number (percentages) for categorical variables. The characteristics were compared across groups using the analysis of variance for continuous variables or the $\chi^2$ test for categorical variables. Following an intention-to-treat protocol, we analyzed the primary outcome with their estimates based upon their randomization allocation using a multivariate general linear model, which controlled for the age and gender, since these variables have been previously suggested as possible confounders (28). The model predicted from the treatment group as well as time interaction, using all available data from baseline and follow-up time points. To consider the potential impact of missing data, we imputed missing outcome data, assuming that data were missing at random. We performed sensitivity analyses for the primary outcome by repeating the analysis including only participants who had completed the survey. All analyses were performed using the IBM SPSS Statistics, version 25.0 (Armonk, NY: IBM Corp).

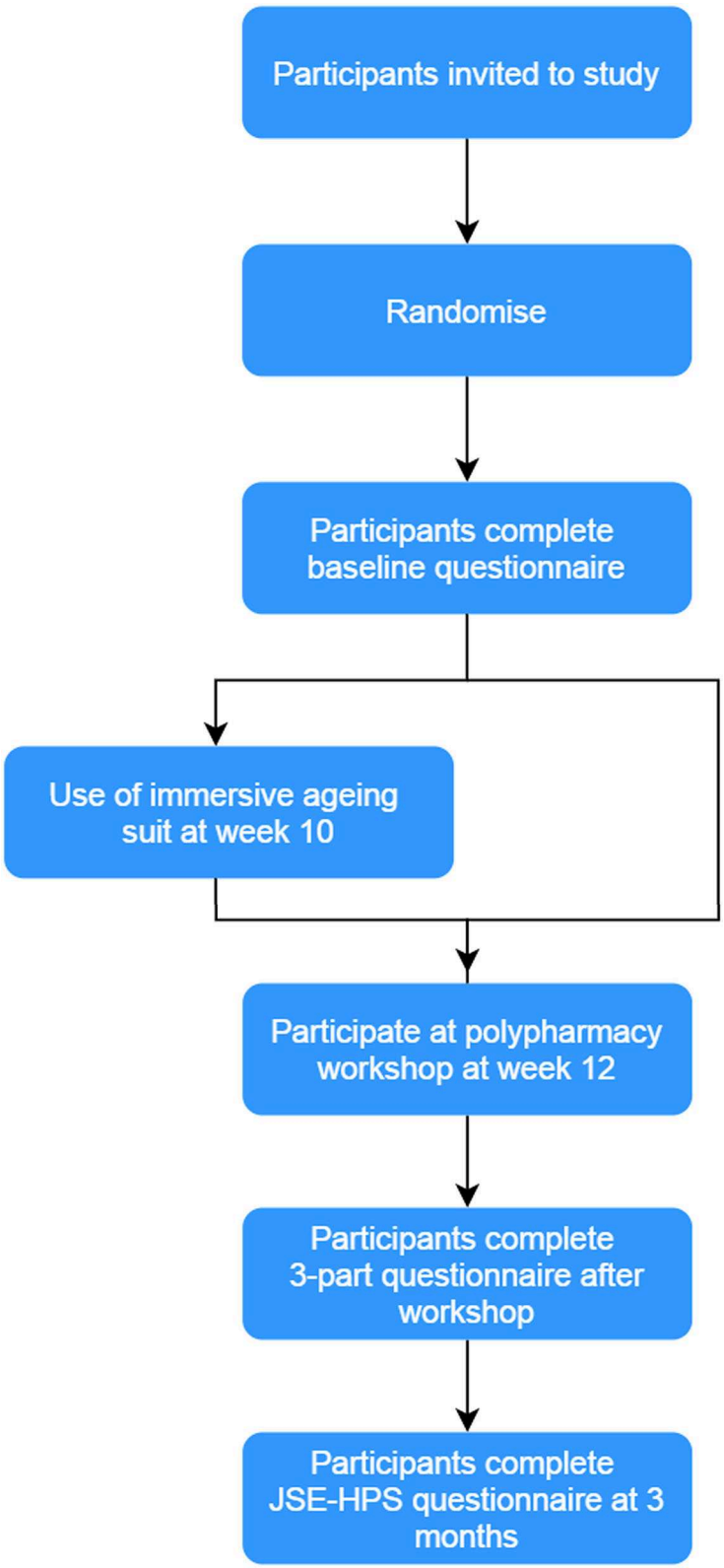


**FIGURE 2 |** Overview of study. Participants who agreed to the study were randomized 1:1 to either an immersive aging simulation suit and medication review polypharmacy workshop or medication review polypharmacy workshop (control). All participants completed a baseline questionnaire at week 0 and post-workshop questionnaire at weeks 12 and 24.

All open-ended responses were coded into themes following the principles of Miles et al. (29). Using this method, the texts were coded into nodes, based upon questions posed to participants. The codes were generated independently by two authors (SWHL and PLT). Coding was done on paper using a coding matrix developed by the researchers on Microsoft Word. A discussion was held between both researchers and conclusions were drawn by identifying for category clusters that led to the development of overarching themes and sub-themes. In cases of disagreement, both authors discussed the matter until a consensus was achieved.

## RESULTS

Of the 135 participants approached, 133 participants were randomized into the study (**Figure 3**). A total of 65 participants were randomized to intervention and 68 to control. Of these, 13 participants randomized to intervention were excluded as they did not take part in the aging suit activity. Thus, the analyses included 68 participants randomized to control and 52 to intervention. Participants had a mean age of 19.5 (0.7) years and were mostly female (77.5%, $n = 93$). The demographics of both groups were similar at baseline (**Table 2**).

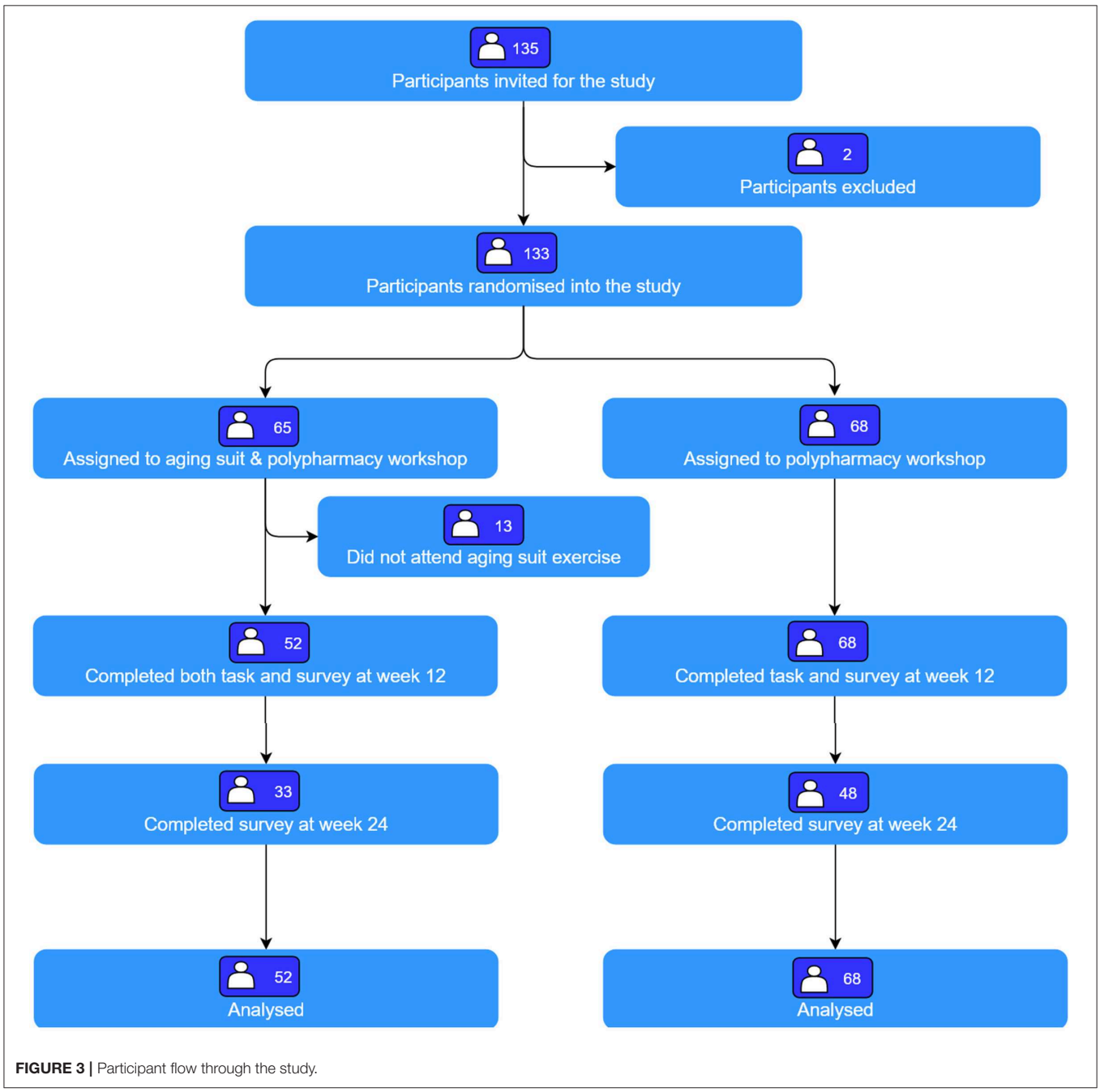


**FIGURE 3 |** Participant flow through the study.

**TABLE 2 |** Demographic characteristics of participants in the study.

| Characteristics | Aging suit with workshop ($n = 52$) | Workshop only ($n = 68$) | Overall ($n = 120$) | $p$-value |
|---|---|---|---|---|
| Mean (SD) age (years) | 19.5 (0.7) | 19.5 (0.8) | 19.5 (0.8) | 0.81 |
| Gender, *n* (%)* | | | | 0.57 |
| Male | 13 (25.0) | 14 (20.6) | 27 (22.5) | |
| Female | 39 (75.0) | 54 (79.4) | 93 (77.5) | |
| Pre-university entry qualification, *n* (%)* | | | | 0.21 |
| Foundation studies | 31 (59.6) | 34 (50.0) | 65 (54.2) | |
| GCSE A-level or equivalent | 19 (36.5) | 23 (33.8) | 42 (35.0) | |
| Matriculation or equivalent | 1 (1.9) | 8 (11.8) | 9 (7.5) | |
| Unified examination certificate | 1 (1.9) | 3 (4.4) | 4 (3.3) | |
| Mean (SD) JSE-HPS | 111.5 (13.6) | 111.9 (11.3) | 111.8 (12.2) | 0.86 |

**Chi-square test was used to determine significance, defined as $p < 0.05$.*
*JSE-HPS, Jefferson Scale of Empathy-Health Profession Student Version.*

## Primary Outcome

In the pre-specified intention-to-treat analysis, both groups reported improvements in JSE-HPS scores from baseline, with a mean improvement of 1.7 (14.5) points in the intervention group compared to 1.2 (9.4) points in the control group, but this did not reach statistical significance. No significant differences between participants' JSE-HPS scores were noted between those randomized to intervention and control (mean difference: −0.5 points; 95% confidence interval: −3.83 to 4.83; $p = 0.81$).

## Secondary Outcomes

Three months after the workshop activity, the JSE-HPS scores fell back to baseline levels in the intervention and control groups. No significant difference were noted in JSE-HPS scores between both groups (mean difference:-0.3; 95% CI: −5.16 to 5.76, $p = 0.30$; **Figure 4A**). The analysis of participants who completed the study (per-protocol analysis) showed no significant differences between both groups after the intervention at week 12 and 24 (**Figure 4B**). At the end of the workshop, participants' self-rated knowledge and understanding on the physical limitations of aging were similar between both groups ($p = 0.79$). No difference in self-reported attitudes about the importance of empathy ($p = 0.70$) as well as ability to support older adults ($p = 0.34$) between groups were also noted (**Figure 5**).

## Qualitative Data

Open-ended responses from 105 participants (87.5%) identified several common themes that spanned across both groups. These were: (1) "Lending an ear"; (2) A sense of respect; and (3) Understanding the emotions. We also identified an additional theme in the intervention group; namely a more realistic view of aging (**Table 3**).

## "Lending an Ear"

Participants' from both groups described the importance of taking time to listen to an older adult. Participants described how the polypharmacy workshop had provided them with an opportunity for a practical interaction with older adults and that it had revealed the importance of active listening. They described how each older adult they spoke with had their own story to tell and how a rushed and hurried patient-provider interaction was detrimental to their understanding of what would be needed to provide better patient care.

Participants also described the importance of having good communication skills and the importance of using open-ended questions during an interaction with older adults. Some participants also reflected upon the importance of learning other languages and dialects to improve their interactions with older adults.

## A Sense of Respect

The activities also evoked a sense of respect among participants toward older adults. Participants from both groups described that the activities made them realize that older adults face many challenges in their lives, especially in relation to medication usage. Participants also mentioned how these older adults had shared their life experiences and noted how they should always remember to take into consideration patients' feelings during any interactions.

## Understanding the Emotions

Participants mentioned that the activity provided them with a practical interaction and helped them understand the importance of empathy in healthcare. The activity gave them a unique opportunity to speak to older adults and understand the emotions that these older adults experience. Through the activity, participants mentioned that they could relate to using different communication techniques, including verbal and non-verbal communication as being essential skills for healthcare providers. Participants also reflected on how the activity would affect their future communication with older adults, such as speaking more slowly, using a suitable volume, and using appropriate tones.

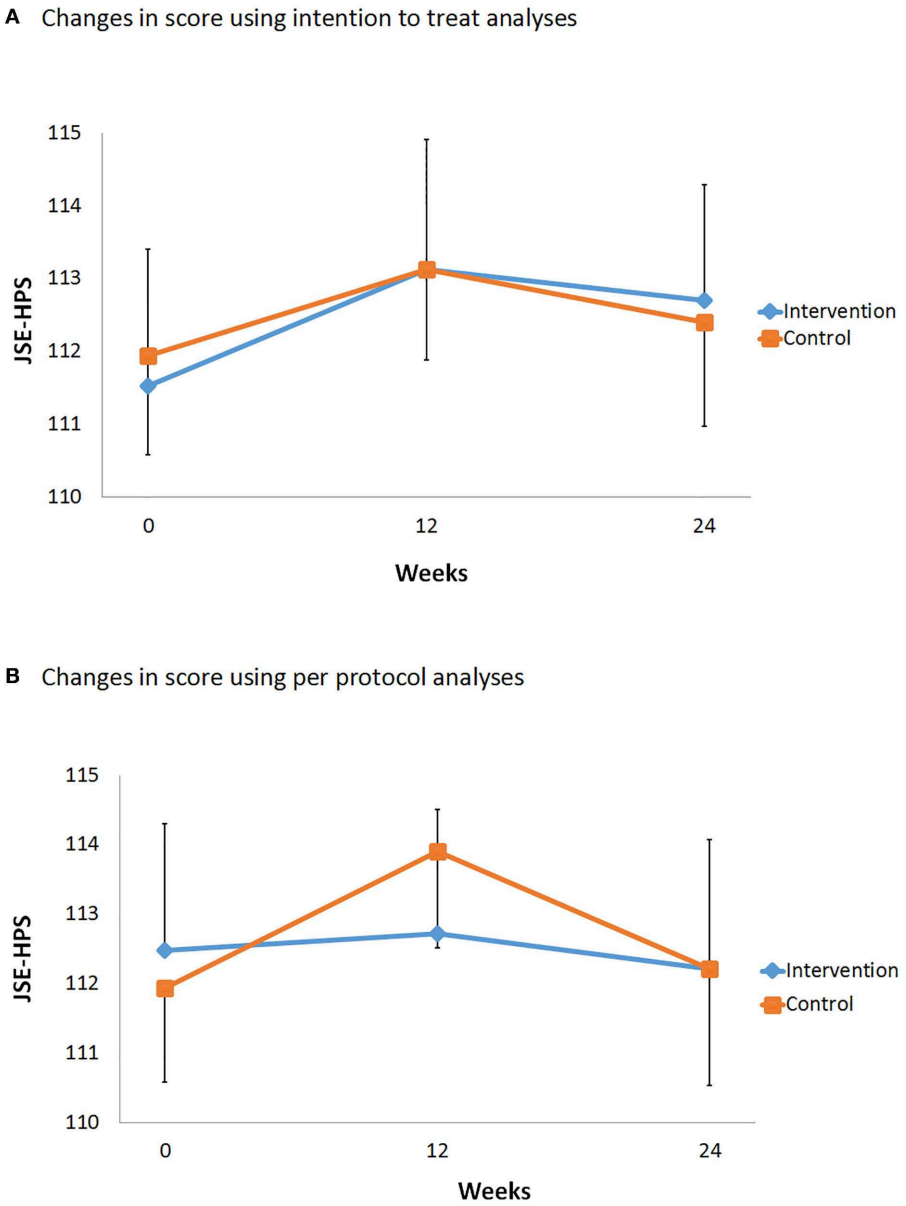


**FIGURE 4 |** Comparison of Jefferson Scale of Empathy–Health Profession Student score over time. The intervals represent standard error for each group. **(A)** Intention-to-treat analysis. **(B)** Per-protocol analysis.

## Realistic View of Aging

Participants in the intervention group described how the simulation suit exercise provided them with a deeper insight into both physical and emotional issues related to older adults. Nearly all participants described how the suit made them realize why older adults had mobility issues, especially related to walking. Other changes reported included physical limitations resulting in difficulty in getting up from a sofa, walking more slowly, as well an inability to read product information that uses small print. Some participants also reflected upon this and how it related to their interactions with their own grandparents.

Participants also described the loss of sensory feedback they felt when they wore the suit and could relate the difficulty they experienced especially when holding a pen and trying to fill in a form. Participants lamented about the difficulty with vision caused by changes to their eyesight during their experience and had great admiration and respect for older adults who could drive and read despite these limitations. Some participants mentioned that in the future, they would make changes to their practice as a pharmacist including writing in larger fonts, speaking clearly, and smiling at older adults.

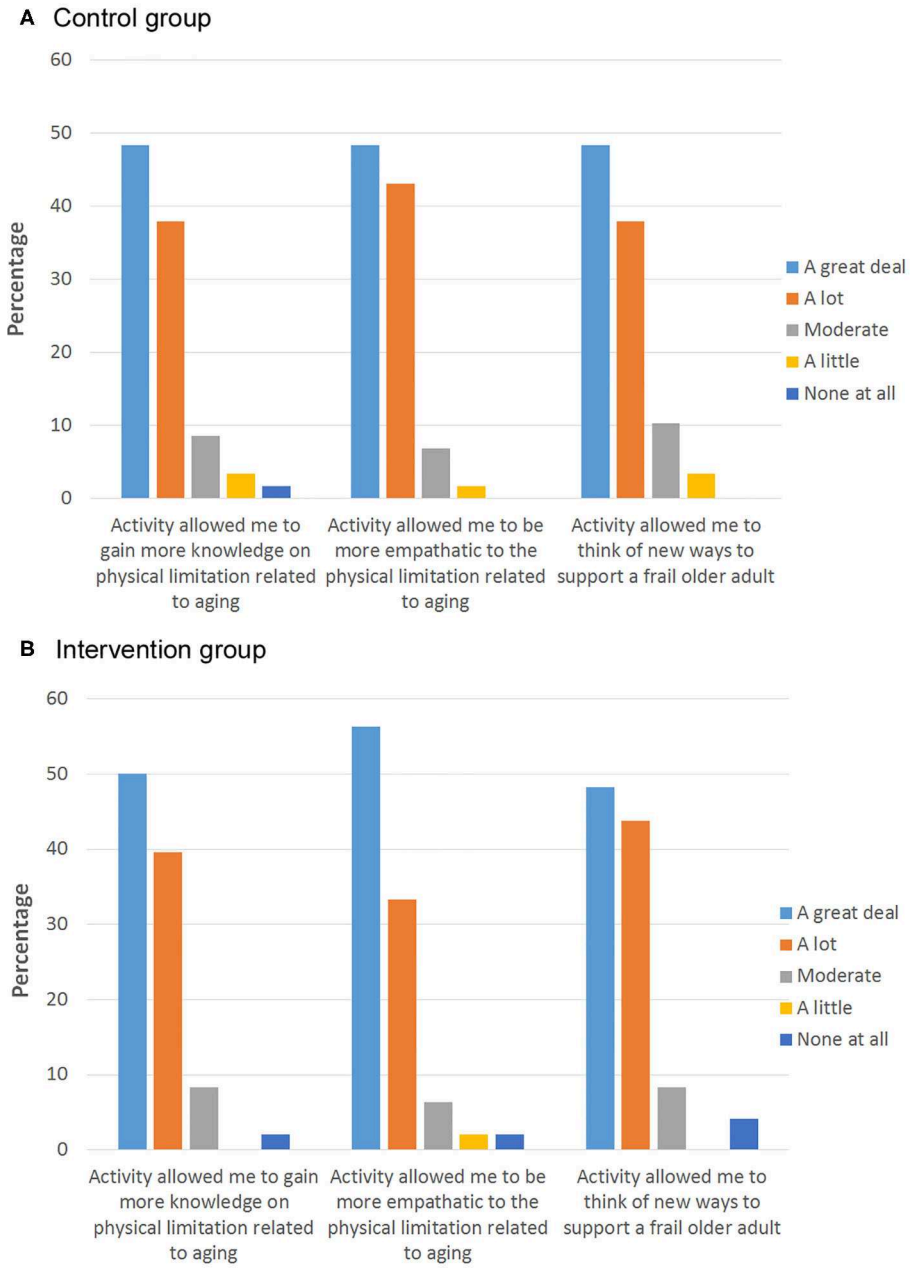


**FIGURE 5 |** Participants' reported change in attitude, empathy level, and understanding of older adult in the **(A)** control group and **(B)** intervention group after the activity. Bar chart represents the percentage of participants.

## DISCUSSION

The concept of using simulation suits is relatively new and is increasingly being examined as a learning tool for healthcare students (15, 16, 19), but use of simulation suits had not been studied in a randomized controlled cohort of pharmacy students. Our study found that the immersive aging simulation suit did not significantly improve participants' self-rated empathy levels compared to a polypharmacy workshop only. This may be due to the self-reported measure using JSE-HPS which we had utilized. Riess et al. have previously examined how empathy training could be improved in a cohort of resident physicians assigned to an augmented empathy training protocol, compared with control (30). They found no difference in the self-reported JSE scores in their cohort, but patient-rated empathy scores were significantly higher in the intervention group, suggesting that patient and self-assessment may not measure the same phenomenon (31). In our study, we noted similarly that results from our qualitative results are in contrast to those from the JSE-HPS scores. However, we believe that this is only one part of a larger puzzle as the open-ended responses of participants in the intervention showed

**TABLE 3 |** Key themes identified in the current study.

| Main themes | Exemplar quotes |
|---|---|
| Lending an ear | • *"Patients' trust can be established if we are willing to empathize with them. Hence, we need to accept their feelings and frustrations, and come up with a solution within [the] permitted time"* Student 10, Control<br>• *"…[I feel the need to] learn more languages to avoid communication barrier"* Student 61, Intervention |
| A sense of respect | • *"… but rather a sense of inferiority and humility, knowing that the experience and skills that I have now are incomparable to what [of] theirs, it motivates me to learn humbly from those who are ahead in age and experience of me. Also I would like to behave like them when I am approaching their age, still as motivated and optimistic in spite of their past experience"* Student 10, Control<br>• *"… and respect them as someone who has been through life more than I did and someone that I [can] look up to and have a great deal of respect"* Student 98, Intervention |
| Understanding the emotions | • *"I used to lack the patience when dealing with older adults but are more willing and more patient to listen and talk to them"* Student 61, Control<br>• *"I feel sentiment not only because the physical illness of the elderlies but also their emotions. One of the ladies is a divorcee and she had to take care of herself alone. The other lady had endometriosis which makes her infertile. Their stories make me feel sad because of the hard times and suffering they've gone through"* Student 115, Control |
| Realistic view of aging | • *"[I] felt a lot of limitation [which] I had never felt before. These limitations are something you are cannot control. You feel weak and helpless because you cannot change or alter [these limitations]"* Student 59, Intervention<br>• *"My ability to see and feel was significantly worsened [by wearing the suit] and it felt very difficult to do things. The thing that surprised me most is that every old person is experiencing this and there are still people that don't understand how difficult it is for elderly people to do things"* Student 66, Intervention<br>• "*I had blurred vision and had less sensitivity in my palms. I was most surprised I could not really feel much using my palms and it was hard to do simple things like picking up a coin"* Student 67, Intervention |

improvements in a more important component that is rarely examined: personal growth.

Students expressed that it is sometimes difficult to relate the decreased physical function and sensory feedback experienced by an older adult (32). While the experimental tasks in this study were not a perfect replica of actual aging, the study showed that participants who wore the suit experienced changes in task performance, consistent with those associated with aging. The impact of the suit was most pronounced for the tasks related to flexibility, which was not experienced by the control group who had only interacted with older adults. In addition, we observed an increased awareness among participants in the intervention of some of the changes that are associated with aging, such as the changes in vision.

## Implications for Future Research

The use of simulation as an educational methodology for teaching empathy is being examined increasingly by researchers (33). Our study suggests that the use of the immersive simulation suit can be a valuable adjunctive learning modality to enhance the understanding of pharmacy students of the physical limitations experienced by older adults. The use of the suit may have resulted in some students experiencing role reversal which students felt as though they were really older and, thus, could be an important mechanism in enhancing the empathy levels among students and should thus be explored further in the future. We believe that this activity also provides students with a personal and professional learning opportunity to think about their attitude toward older adults. The richness from our mixed-method study helped to clarify a range of factors that can improve or impede students' empathy levels. Students expressed that they had a more positive experience with the use of the simulation suit as suggested in our open-ended questionnaire responses received.

This technique can easily be replicable and adopted by the other medical professions, such as doctors, dentists, and nurses to improve the understanding of the potential physical limitations of an older adult. This practice can be advantageous for all healthcare professionals, since they are more likely to receive positive feedback from patients, which can be rewarding. Moreover, improved communication and trust in clinical settings can also have tangible effects, such as better patient compliance with treatment regimens and higher patient satisfaction (34).

## Limitations

Our study has some important limitations which need to be acknowledged. Firstly, the age simulation suit does not attempt to simulate any cognitive changes associated with aging, such as dementia. In addition, we did not control for other confounders which may affect the overall experience of students, such as the level of fitness of each student. The suit was only worn for a very short period of time (∼10 min), and each of the tasks was only performed once, which may not allow for each participant to experience fully the physical decline that an older adult experiences in his/her daily life. As such, future studies should ideally examine the impact of using an aging suit over an extended period of time, similar to how medical students would wear a cast for weeks to simulate a broken arm (35). This could be supplemented with a self-reflective writing exercise, which helps the observer to become more aware of his/her own emotion and subsequently improve his/her ability to be more empathetic toward another individual (36).

Some of the student participants could be living with older adults, which was not taken into consideration for the analysis. Future iterations of this activity would also take into account the students' lived experience with older adults. Our study may also be underpowered to detect the changes we had anticipated because of the small sample size that we had recruited. The study was also conducted among first-year pharmacy students and thus cannot be generalized to students from other year levels. Finally, our study assessed only empathy using a first person rating using the JSE-HPS scale, which may have resulted in the lack of significant findings reported in this study.

In summary, with an increasing population of older adults, we feel that it is of great benefit that healthcare students can appreciate what it feels like to be an older adult. The immersive aging suit can be a useful adjunctive measure for teaching students about the physical challenges faced by older

adults. However, a larger study on various healthcare students' personalized patient care and overall health outcomes should be conducted in the future.

## DATA AVAILABILITY STATEMENT

All datasets generated for this study are included in the article/**Supplementary Material**.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Monash University Human Research Ethics Committee (2017-11714-14826). The patients/participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual for the publication of any potentially identifiable images or data included in this article.

## AUTHOR CONTRIBUTIONS

SL designed the study and conducted data analysis. SL and P-LT assisted in the data analysis and drafting of the manuscript. All authors approved the final version of the manuscript.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2020.00376/full#supplementary-material

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METHODS
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# A Multi-Domain Intervention Protocol for the Potential Reversal of Cognitive Frailty: "WE-RISE" Randomized Controlled Trial

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Following the rapid increase of the aging population, health promotion and prevention of physical disability and dementia in older persons are essential for healthy aging. For example, there may be a potential to prevent or reverse cognitive frailty, the co-existence of both physical frailty and cognitive impairment in older persons. However, evidence-based interventions targeting the prevention or potential reversibility of cognitive frailty among community dwelling older adults are scarce. In this paper, we described the rationale, development and delivery of a multi-domain intervention comprising multi-component physical exercise prescription, cognitive training, dietary counseling and promotion of psychosocial support, called the WE-RISE trial. The aim of WE-RISE intervention is to potentially reverse cognitive frailty. This is a two-armed, single blinded, randomized controlled trial conducted over a duration of 6 months, at senior citizen activity centers within the Klang Valley, Malaysia. Ambulating, community dwelling older adults aged 60 years and above with cognitive frailty are randomized into two groups; (1) intervention group: which receives an instructor based "WE-RISE" intervention for the first 3 months, and then a home-based "WE-RISE at Home" intervention for the following 3 months; (2) control group: usual care with no modifications to their daily routine. Primary outcome is cognitive frailty status and secondary outcome include physical function, cognitive performance, nutritional status, psychosocial status and quality of life which are obtained during baseline screening and subsequent follow ups at 3rd and 6th month. Description of the intervention is done using the template for intervention description and replication (TIDieR) checklist. This trial protocol has received approval from Research Ethics Committee of Universiti Kebangsaan Malaysia (UKM PPI/111/8/JEP-2018-558) and the Department of Social Welfare Malaysia (MyResearch Reference: JKMM 100/12/5/2: 2018/405). Trial registration number: ACTRN12619001055190.

**Keywords: cognitive frailty, frailty, cognitive impairment, multi-domain intervention, community dwelling, older adults**

## INTRODUCTION

The average lifespan of an individual has globally increased. Malaysia is expected to be labeled as an "aged nation" by the year 2035 with 15% of its' country comprising of older persons (1) Older persons remain predisposed to adverse health outcomes resulting in reduced quality of life and increased cost of healthcare (2). Frailty and cognitive impairment have been enlisted as two of the four modern "giants of geriatrics," followed by sarcopenia and anorexia of aging (3).

Physical frailty, a prevalent clinical syndrome is manifested due to age-related degeneration of multiple systems leading to rapid health decline in older persons (4, 5). Older persons with frailty are more vulnerable and are susceptible to events such as falls, physical disability, disruption of functional independence, prolonged hospitalization, institutionalization, and fatality (5, 6). Recognized as an intermediate stage between robust and disability among older persons, frailty can be identified with the presence of unintentional weight loss, fatigue, weakness, slow motor performance, and physical inactivity as outlined in the Cardiovascular Health Study (CHS) (6).

While, mild cognitive impairment (MCI) is a symptomatic, pre-dementia phase, characterized by self-reported clinical concern, and objective memory deficits, but without functional decline (7). The occurrence of cognitive decline has been associated with vascular disease, metabolic disorder, trauma, infectious diseases, depression and polypharmacy (8). Marked changes in cognitive function may commence as early as between 3 and 7 years preceding the diagnosis of MCI (9). Hence MCI, a prodromal symptom of dementia is a primary target for early intervention to prevent or delay the progression into an irreversible state of cognitive impairment (10).

Amongst the Malaysian community dwelling older population, the prevalence of frailty and pre-frailty was reported to be 8.9 and 61.7%, respectively (11), whereas MCI is prevalent at 16% (12). Prevalence of frailty and pre-frailty has been reported to be much higher amongst institutionalized older persons at 40.7 and 56.6%, respectively, with cognitive impairment as a predictor (13). The stark contrast in prevalence between community dwelling and the more vulnerable institutionalized population is attributed to poorer health outcomes; mainly severe physical and cognitive impairments (14). There is a cyclic relationship between physical frailty and cognitive impairment, whereby the disintegration of one construct is likely to result in the consequent declination of the other (15, 16). Aimed at coalescing both constructs, the "cognitive frailty" syndrome among older adults was established in 2013 (17). Cognitive frailty is defined as a "heterogeneous clinical manifestation characterized by the simultaneous presence of physical frailty and diagnosis of cognitive impairment excluding the presence of concurrent Alzheimer's disease (AD) or other dementias" (17).

Prevalence of cognitive pre-frailty and cognitive frailty among community dwelling Malaysian older population was reported at 37.4 and 2.2%, respectively (18). Results from a longitudinal study reported the incidence rate of cognitive frailty in Malaysia at 7.1 per 100 person-years among older adults who were non-cognitively frail at baseline (19). The rate of incidence increased with increasing age among older adults aged 75 years and above, whereby it doubles every 10 years; estimated at 13.34 per 100 person-years (19). Research concerning cognitive frailty in the Malaysian context is a recent development and there is currently no available local intervention addressing this prevalent condition.

At present, physical frailty and cognitive impairment are often separately studied and addressed, despite the evidence that both are correlated (17). Although, cognitive frailty has been deduced to be "potentially reversible," a specific intervention targeted at addressing this condition in the community and home based setting remains unestablished (20). Thus, we aim to examine the effectiveness of a newly developed multi-domain intervention for possible reversal of cognitive frailty among Malaysian community dwelling older persons.

## METHODS AND MATERIALS

### Rationale for the Development of a Multi-Domain Intervention

The rationale for the development of this intervention is to address the multi-factorial predictors of cognitive frailty. This include poor physical fitness, functional dependence, depression, lack of social support, and nutritional deficiency (18, 19). There is substantial evidence advocating for the development of an intervention employing a multi-domain approach in the attempt to delay or reverse this condition; rather than a singular approach (21).

Older persons living with lower socioeconomic status are at higher risk of being frail and care dependent due to malnutrition, poor physical health practices, inevitably subjecting them to disability, and mortality (22). Moreover, these older adults are more inclined to have decreased cognitive function possibly due to lower education levels (22). Within the community-based rehabilitation settings, there is yet to be a complimentary, self-sustaining, low cost intervention for these older persons. Hence, the development of this multi-domain intervention aims to bridge this existing gap.

### Components of the Multi-Domain Intervention

Evidence of the effectiveness of a multi-domain intervention in addressing cognitive frailty is currently unavailable. However, multi-domain intervention approach has been utilized with positive outcomes for physical frailty and cognitive impairment separately. For example, in the study by Ng et al. (23), a multidomain approach combining nutritional, physical and cognitive interventions significantly reduced frailty among pre-frail and frail older adults. Similar intervention has also been aimed at delaying cognitive impairment among older persons at risk of cognitive decline in the 2-year Finnish Geriatric Intervention Study to Prevent Cognitive Impairment and Disability (FINGER) trial which consisted of nutritional guidance, exercise, cognitive training and social stimulation as well as monitoring metabolic and vascular risk factors

(24). It is noteworthy that these interventions were client-tailored and not community-based. Inclusion of physical activity, cognitive training, nutritional and dietary guidance, emotional recovery, and social support via a multi-faceted approach are the recommendations for potential reversibility of the cognitive frailty status (20, 25). These evidence and recommendations served as the foundation for the development of our current multi-domain intervention for reversible of cognitive frailty.

Exercise training has been demonstrated to be beneficial in improving frailty symptoms and cognitive function, in addition to being cost effective (26, 27). The evidence corroborates with the existing notion that exercise has the potential to reverse frailty by improving physical function (28). Similarly, exercise, specifically aerobic training was concluded to be effective in sustaining cognitive function and may delay the occurrence of cognitive decline in a systematic review (27).

While, cognitive training is beneficial in training or re-training relatively well-defined cognitive abilities such as information processing, attention, memory or problem solving via the concept of neuroplasticity (29). Taking this concept into consideration, cognitive based exercises involving guided practice structured tasks have been incorporated into interventions to enhance cognitive function (29, 30). Although, lacking high impact evidence, cognitive training has been used in combination with other domains of intervention (physical activity, socialization or healthy diet) to reduce the risk of cognitive decline and progression into dementia (29, 31).

In regard to nutritional interventions, it is important in addressing cognitive frailty as malnutrition is a contributor to the onset and progressive worsening of cognitive frailty and other related co-morbidities (25). Deficiency of protein, vitamin D, vitamin B12, inadequate calorie intake or even over-eating in middle age have been enlisted as several factors leading to sarcopenia, weight loss, fatigue and cognitive decline among older adults (18, 25, 32). There is evidence to suggest that nutritional interventions promoting a continuous practice of balanced dietary patterns, could delay cognitive frailty (25). Additionally, combination intervention such as exercise and nutrition is strongly recommended as compared to nutritional intervention alone among frail and cognitively impaired older adults (33).

Generally, healthy or successful aging include physical, mental, and psychosocial well-being (34). Factors such as positive self-esteem, self-achievement, self-worth, and self-efficacy are associated with positive health outcomes among older persons (34). An association between poor psychosocial status, cognitive impairment, and physical frailty has been established (21). Notably, incorporating elements of fun, social inclusion, and enjoyment in older persons with frailty resulted in improved frailty scores, delaying functional decline, improved quality of life as well as psychosocial well-being (35). Promotion of social interaction via group-based interventions have also shown favorable outcomes amongst older persons with cognitive impairment and frailty (21, 36).

## Development and Selection of Specific Intervention

An evidence-based exercise program for older adults with cognitive frailty is not available. Thus, we developed a multi-component exercise program based on the combination of the available evidence. Firstly, the components of aerobic exercise, progressive resistance training, balance and flexibility were selected as it addresses the frailty criterion of weakness, slow motor performance, low physical activity, and fatigability (26, 37). Next, we benchmarked the evidence in an umbrella systematic review of systematic reviews (total of 58 RCTs) evaluating the effectiveness of exercise-based interventions among those with pre-frailty and frailty (26). In this review, it was concluded that multi-component exercise training was the most effective form of exercise-based intervention among pre-frail and frail older persons as it improved physical performance, specifically muscle strength, gait speed, and balance (26). The proposed outline of a multi-component exercise program targeting older persons with frailty should encompass progressive resistance training, aerobic, balance, and flexibility training. The frequency of exercise sessions was suggested up to thrice weekly for a duration of between 45 and 60 min per session at moderate to high intensity. Effective exercise program should be carried out for at least 10 weeks or more (26).

This population is also vulnerable to a plethora of unfavorable health outcomes, including the risk of falls (6). So, we adapted the design and progression of exercise prescription of the Otago Exercise Program (OEP) (38) in respect to progressive strengthening and balance exercises. OEP is an evidence-based falls prevention program targeting community dwelling older adults which has yielded positive outcomes in overall improvement in physical function and a 35% decrease in falls among older persons with frailty (39). Further modifications of balance exercises were made to cater for functional training. These included improving performance in task accomplishment which often require multi-tasking when carrying out activities of daily living. The aim is to improve specific balance related ability such as regaining postural stability following perturbation, reaching upwards or downwards multiple times to collect household objects or even the ability to avoid obstacles while walking and talking (40). Lastly, the exercises were adjusted in accordance to the ACSM consensus recommendations for physical activity among older adults (41).

As for cognitive intervention, it is commonly delivered via technology such as computer-based training software or more recently commercialized packages for the use on smart devices (42). However, a non-technological and more traditional method of interactive cognitive training has also been shown to improve attention and memory among older Singapore population with frailty (23). We believed that this approach of cognitive training may be more sustainable and feasible as a low cost, community-based intervention for the purpose of our present study. Moreover, the targeted older persons for the present intervention expressed that they were not in favor of using technological gadgets in our needs assessment discussion.

The domains of cognition namely short-term memory, attention, information processing skills, perceptual organizational tasks, reasoning and logic, and problem-solving abilities were selected for cognitive training in our present intervention. This selection was based on the existing literature among older adults with cognitive impairment (23, 31, 43). We included "Pen to Paper" tasks such as "spot the difference," mazes, matrix reasoning, and jigsaw puzzles. These tasks have been included as cognitive training resulting in enhanced cognitive function as it tackles multiple domains of cognition (visual perception, orientation perceptual reasoning, cognitive speed), and promotes an increase of brain reserve whilst preventing emotional distress which negatively impacts cognitive aging (23, 44). We deduce that this hands-on approach of cognitive training is not only effective in improving cognitive function but also beneficial in promoting social engagement as an activity of leisure.

For nutritional intervention, the existing interventions to address cognitive impairment or frailty consist of a wide range including a variety of supplementation, specialized diet and single or multi-nutrient intervention (33, 45, 46). As an alternative, dietary counseling, an inexpensive, and straightforward intervention and has been found to substantially reduce the risk of malnutrition among older adults (33). Hence, dietary counseling with education on healthy eating habits was opted as the nutritional intervention in our present study to allow older persons to sustain their healthy eating patterns as it is personalized to locally available and affordable produce.

Group directed intervention was the choice for the delivery of our present multi-domain intervention. This is because it is known to promote social participation, besides improving adherence to physical activity, psychological factors and social relationships; which further advocates that group-based intervention is key as a means of incorporating psychosocial well-being among older adults (47).

## Description of the WE-RISE Intervention (TiDieR Checklist)

### Brief Name

The "WE-RISE" intervention stands for: Warga Emas - Resilient mInd and muScle Exercise. "Warga Emas" translates to Senior Citizens in the Malay language. The terms "resilient mind and muscle" was selected as we aim to reverse impaired physical and cognitive status of the older persons with respect to cognitive frailty.

### Where: Intervention Location

Targeting community dwelling older adult population, we screened and recruited registered members of the Activity Centers for Older Persons; known locally as "Pusat Aktiviti Warga Emas" (PAWE) for the present study. PAWEs has been set up across the nation under the Malaysian Department of Social Welfare (48). These activity centers provide a social space promoting active participation and involvement of older persons within the community (48).

### Intervention Providers

The exercise, cognitive and psychosocial component of the intervention was administered by a qualified physiotherapist with geriatric rehabilitation background (primary research coordinator). The physiotherapist in charge underwent training which included background to the adversity of cognitive frailty, rationale of the intervention, practical session of the intervention and participant safety moderated by Physiotherapist and Clinical Psychologist lecturers (research team members). The dietary component of the intervention was administered by a trained

**TABLE 1 |** Classification of cognitive frailty groups.

| | Criteria | Categorization | | |
|---|---|---|---|---|
| | | Robust | Cognitive pre-frailty | Cognitive frailty |
| **Frailty**<br>Fried et al. (6) | *Shrinking*:<br>Unintentional weight loss of more than 5 kgs<br>*Weakness*:<br>Assessed with hand grip strength and adjusted for gender and body mass index against original cut-off points.<br>*Slowness*:<br>Assessed with 5-meter gait speed test, adjusted for gender and height against original cut off points.<br>*Exhaustion*:<br>Identified with two items from the CES-D scale.<br>*Low physical activity*:<br>Identified by low scores of the PASE. | 0 | 1–2 Criteria | ≥3 Criteria |
| **Cognitive impairment**<br>Kelaiditi et al. (17) | Clinical Dementia Rating Scale score | 0 | 0.5 | 0.5 |

*CES-D, Center for Epidemiologic Studies Depression Scale; PASE, Physical Activity Scale for Elderly.*

clinical dietician under the supervision of a Professor in Nutrition and Dietetics (research team member).

## Procedure and Materials

In this randomized controlled study, participants were screened at baseline via face to face interview using a structured questionnaire for sociodemographic and clinical characteristics, psychosocial and functional status, cognitive function, quality of life and dietary intake. Anthropometry and physical performance measurements were objectively assessed. All assessments were conducted by qualified research assistants who were trained together. Inclusion criteria of this study were: Malaysian, community dwelling, aged 60 years and above, able to ambulate independently and classified to have cognitive pre-frailty or cognitive frailty. Older persons who were physically robust, diagnosed with terminal illnesses, major psychiatric illnesses, classified to have mild to moderate dementia, unable/refused to participate in the intervention, or already participating in other programs or on-going trial were excluded from the present study. The primary and secondary outcomes are as outlined.

### *Primary outcome: cognitive frailty*

This study operationalized cognitive frailty as proposed by Kelaiditi et al. (17) using Fried's criteria as outlined in the Cardiovascular Health Study to define physical frailty and the Clinical Dementia Rating Scale (CDR) to define objective cognitive impairment. The presence of one or two of the Fried's criteria was defined as pre-frailty, whilst the presence of three or more was defined as frail and a score of 0.5 on the CDR is defined as mild cognitive impairment (MCI) (17). Collectively, participants who had a combination of pre-frailty/frailty and MCI were categorized as cognitive frailty (**Table 1**).

### *Secondary outcomes*

Sociodemographic information, Clinical Characteristics and Lifestyle: Sociodemographic and lifestyle variables included age,

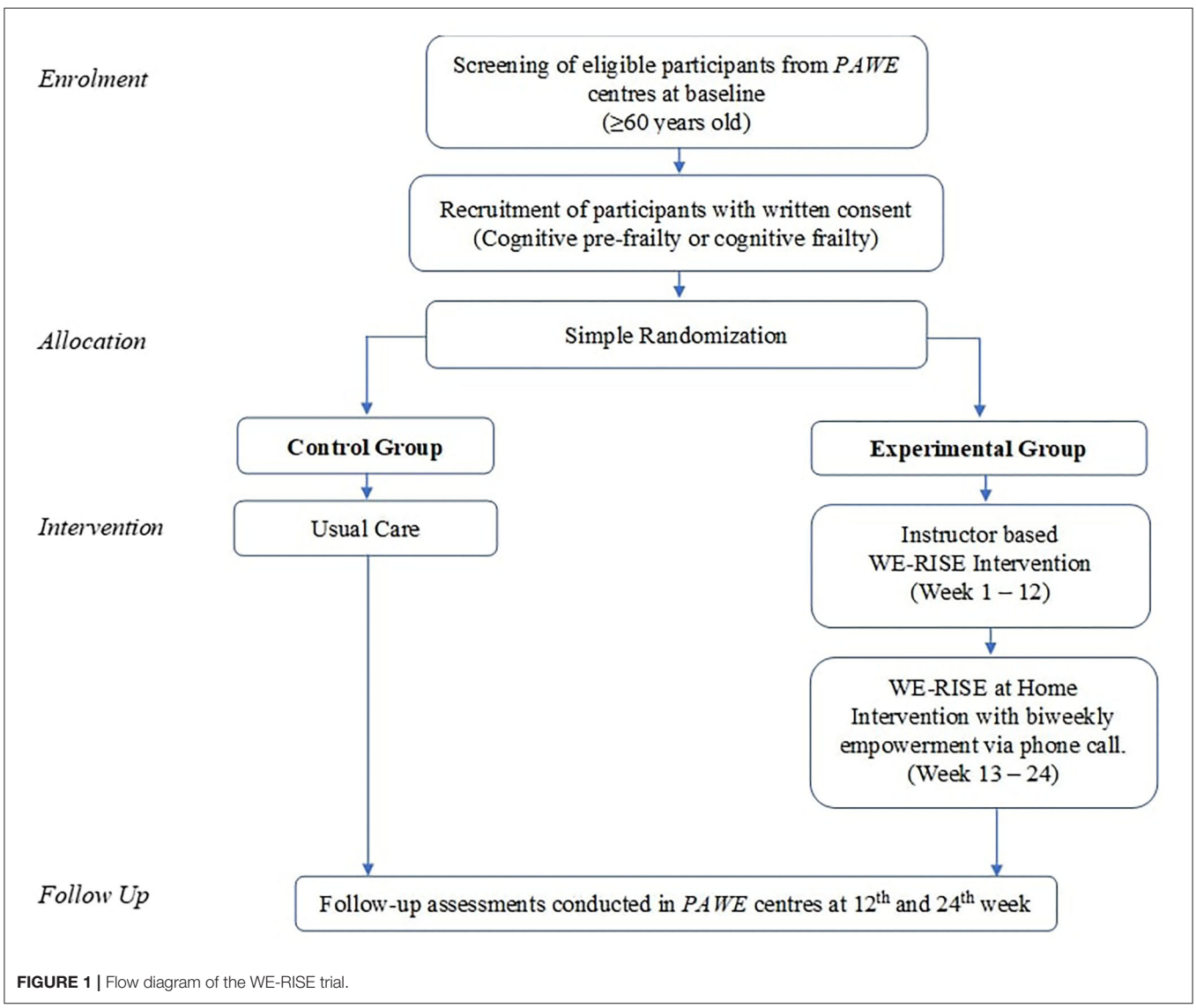


**FIGURE 1 |** Flow diagram of the WE-RISE trial.

gender, level of education, ethnicity, marital status, status of employment, income status, alcohol consumption and smoking history. Clinical characteristics included history of falls, family history of dementia and history of chronic diseases.

Physical Fitness and Functional Status: The senior fitness test by (49) was used to measure physical fitness. Thirty-Second Chair Stand test for lower body strength assessment; Back Scratch test for upper body flexibility assessment; Sit-and-Reach test for lower body flexibility; Timed Up and Go test for mobility and balance; 6-meter Gait Speed test for gait speed; and the 2-Min Step test to assess cardiovascular fitness and endurance. Functional status was assessed by level of independence based on the Instrumental Activities of Daily Living (IADL) (50).

Cognitive Function: The Mini Mental Examination State (MMSE) was used to assess global cognition (51). The Rey Auditory Verbal Learning Test (RAVLT) was used to detect short-term verbal memory, working memory, verbal learning and declarative memory (52). The Digit Span test, originally a test from Weschler Adult Intelligence Scale (WAIS) assessed memory, attention and concentration (53). The Trails Making Test (TMT) was used to assess processing speed and mental flexibility (54).

Nutritional Status: Anthropometric measurements and body composition were used as indicators of nutritional status. Length of arm demi-span, mid-upper arm circumference, waist circumference, hip circumference, and calf circumference were measured using the Lufkin® W606PM Anthropometric Tape Measure. Body composition including body mass index, metabolic age, fat percentage (%), fat mass (kg), fat free mass (kg), and muscle mass (kg) was measured using the Tanita® TBF-400 Total Body Composition Analyzer.

Dietary Intake: Dietary intake was assessed using the Dietary Habits Questionnaire (DHQ) to estimate the overall dietary intake, usual dietary habits and the mean intake of various types of nutrients (55). The food intake will be analyzed using Nutritionist-Pro software to estimate the total calories, macronutrients and micronutrients intake.

Psychosocial Status: The Geriatric Depression Scale-15 (GDS) was used to detect symptoms of depression (56). Domains of functioning and disability was assessed using the WHODAS 2.0 (57).

Quality of Life: The 15-D was used as a measure of health-related quality of life (HRQoL). It describes the participants' self-perception of the following domains: mobility, vision, hearing, breathing, sleeping, eating, speech, excretion, usual activities, mental function, discomfort and symptoms, depression, distress, vitality, and sexual health (58).

### *Randomization*

Participants with cognitive pre-frailty or cognitive frailty were randomized into intervention and control groups. Simple randomization was executed using the Research Randomizer© computer program by the primary research coordinator (59). The trial flow is as illustrated in **Figure 1**. In this single blinded study, research assistants involved in data collection for the baseline and follow up outcome measures to prevent bias were blinded of the groups. Primary research coordinator was not involved in data collection. In order to minimize contamination between the intervention and control groups, an arrangement was made with the participating PAWEs to allow private and scheduled use of the facility on days that are not open for member activities.

### *Intervention*

*Experimental Group* The 24-week (6 months) intervention was divided into two phases. Phase 1 comprised of the first 12 weeks whereby an instructor guided group-based intervention was conducted at PAWE centers twice a week for a duration of 90 min per session. Phase 2 comprised of the following 12 weeks whereby the "WE-RISE at Home" is independently carried out by the participants as a home-based intervention.

At the commencement of the WE-RISE intervention, the therapist explained each component of the intervention and what was expected during each intervention session. The 12 weeks of intervention was divided into 3 parts: Level 1 – week 1 – 4, Level 2 - week 5 to 8 and Level 3 – week 9 to 12 with increasing level of intensity for the exercises and cognitive training.

*Multi-component exercise training.* The frequency, intensity, time and type (FITT) principle for this study was established based on best available recommendation for effective exercise interventions among community dwelling older persons with frailty (26). The FITT framework also corroborates with the gold standard guidelines established by the American College of Sports Medicine (ACSM) for exercise prescription in older persons (41). The exercise regime of this intervention is as outlined in detail in **Tables 2–5**. The exercise training begins and ends with flexibility training consisting of mobility and dynamic stretching of major joints as a warm-up and cool down. This component of the exercise program remains unchanged throughout Level 1–3 (**Table 2**). Aerobic training is administered through dance aerobic sessions. The dance aerobics will largely

**TABLE 2 |** Flexibility training program.

| | Level 1 | Level 2 | Level 3 |
|---|---|---|---|
| *Flexibility: joint mobility & dynamic stretching* | Duration of exercise:10 min | | |
| Head and Neck<br>Shoulder and Arm, Trunk | Repetition: 8 counts for each plane of motion for mobility | | |
| Hip and Knee, Ankle | Stretching: Each stretch sustained for 8 s in each plane of motion | | |

**TABLE 3 |** Aerobic training program.

| | Level 1 | Level 2 | Level 3 |
|---|---|---|---|
| *Aerobic training* | Duration of Exercise: 15 min | | |
| | Type: Dance Aerobics | | |
| | Intensity: RPE 3–5; moderate intensity | | Intensity: RPE 6–8; vigorous intensity. |

*RPE, Rate of Perceived Exertion.*

**TABLE 4 |** Progressive resistance training program.

| | Level 1 | Level 2 | Level 3 |
|---|---|---|---|
| *Progressive resistance training* | Duration of exercise: 30–40 min<br>Number of muscle groups: 8–10 | | |
| Upper body strength<br>Shoulder press<br>Lateral shoulder raise<br>Front shoulder raise<br>Triceps extension<br>Bicep curl | Repetition: 8<br>Number of sets: 3<br>Weight cuff: 0.5 kg around wrist. | Repetition: 10<br>Number of sets: 3<br>Weight cuff: 1.0 kg around wrist. | Repetition: 12<br>Number of sets: 3<br>Weight cuff: 2.0 kg around wrist. |
| Lower body strength<br>Seated knee raise<br>Seated knee extension<br>Standing hamstring curl<br>Standing lateral leg lift<br>Calf raises<br>Heel raises | Repetition: 8<br>Number of sets: 3<br>Weight cuff: 0.5 kg around ankle. | Repetition: 10<br>Number of sets: 3<br>Weight cuff: 1.0 kg around ankle. | Repetition: 12<br>Number of sets: 3<br>Weight cuff: 2.0 kg around ankle. |
| Sit to stand<br>Half-squat (with support) | Repetition: 8<br>Number of sets: 3<br>Weight cuff: 0.5 kg around wrist. | Repetition: 10<br>Number of sets: 3<br>Weight cuff: 1.0 kg around wrist. | Repetition: 12<br>Number of sets: 3<br>Weight cuff: 2.0 kg around wrist. |

comprise of active movements such as stationary march, front and backward march, side walking with a turn, toe steps, in combination with upper and lower limb movements (**Table 3**). Progressive resistance training targeted upper limb, lower limb and body weight exercises to improve overall muscle strength. The exercises carried out from level 1 to level 3 are maintained throughout with variation in level of resistance and repetitions per set for each exercise. Resistance in this intervention is provided with the usage of weight cuffs (**Table 4**). The balance and coordination training include multi-task exercises which recruit not just postural control and strength muscles, but also requires cognitive processing (**Table 5**). A PVC elastic ball is used for part of the balance exercises.

There may be a risk of injury involved while participating in physical activity. Older adults are susceptible to injuries such as sprains, repetitive strain, falls, muscle fatigue, muscle cramps or may be hesitant due to fear of injury (60). To overcome these adverse outcomes, safety is ensured at all times by carrying out the activity in the presence of support (chair or wall). Intermittent breaks are provided throughout the exercise regime and hydration is a priority. Participants are arranged in a manner whereby each individual is in the view of the instructor and vice versa. Participants will be briefed that they may experience some form of delayed onset muscle soreness (DOMS) due to muscle adaptation to exercise which is normal and will cease (61). Participants are also advised to rest should they feel pain, discomfort or intolerance to the exercises.

*Cognitive training.* The activities in the intervention will include "paper and pencil tasks," puzzle activities, memory games, "spot the difference," coloring activities, matrix reasoning, maze activities and sorting activities as outlined in **Table 6**. Materials for the cognitive training include, stationary, cognitive challenge worksheets, jigsaw puzzle, memory cards, colored ice cream sticks and colored toothpicks. The level of difficulty will be increased each month to further challenge the participants' cognitive function.

*Dietary Counseling.* A qualified clinical dietitian conducts a one-off group dietary counseling session which includes the distribution of a dietary information pamphlet to promote physical and cognitive well-being. The pamphlet includes meal by meal guidance and healthy eating habits to be practiced pre- and post- exercise. Participants are encouraged to contact the dietician via phone call should they have any queries.

*Psychosocial support.* Intervention is conducted as a group-based activity which are enjoyable and interesting with constant facilitation. Elements of group-based sessions encompass friendly interaction, support based communication and the establishment of a non-threatening environment to ensure adherence to intervention and improve self-esteem (62). It should be noted that, all activities in the multi-domain intervention excludes competitive components.

*Home based program – "WE-RISE at home".* Following the completion of the 12-week center based WE-RISE program, the participants were instructed to carry out the intervention in the comfort of their home independently twice a week for 12 weeks. A "WE-RISE at Home" packet containing an activity manual, dietary guideline, 12 sheets of cognitive training activities, 2 sets of jigsaw puzzle, a ball, a pair of 2 kg weight cuffs and stationery, is given to each participant. The manual contains illustrated and written, step-by-step instructions on how to carry out the exercises while ensuring safety at all times. Each participant was provided with a calendar in the manual with scheduled dates to carry out the home program and they were asked to tick the date boxes after completing each session which served as a log for record keeping. Although participants were to stick to the exercises and cognitive activity included in the "WE-RISE at Home"; they were given the autonomy to decide the type of aerobic exercise they preferred to carry out (a choice of: dance aerobics, brisk walking, stationary or mobile jogging, stationary march). They were also able to select which cognitive activity they felt like tackling for each session. Empowerment strategies have been found to play a vital role in bringing forth positive health outcomes and making informed health decisions (63). Participants were contacted every 2 weeks via phone call as an empowerment method aimed to provide social support, motivation, promote positive health behaviors and create awareness of self-efficacy. In addition, it also enabled monitoring of the participants' compliance to the intervention and their health status as the intervention progressed.

*Control group.* The control group in this study received usual care and participate in PAWE weekly conducted community activities such as cooking classes, karaoke, arts and craft, chair exercises, with no changes made to their habitual routine of daily life.

**TABLE 5 |** Balance and coordination training program.

| | Level 1 | Level 2 | Level 3 |
|---|---|---|---|
| Weight shifting | Side to side, frontward to backwards, 8 reps, with support. | Side to side, frontward to backwards, 10 reps, no support. | Side to side, frontward to backwards, 12 reps, no support. |
| Single leg stand | 10 s each leg, with support. | 10 s each leg, without support. | 10 s each leg, without support. |
| Semi-tandem stand | 10 s, eyes open, with support | 10 s, eyes open/closed, with support. | 10 s, eyes open/closed, without support. |
| Tandem stand | 10 s, eyes open, with support | 10 s, eyes open/closed, with support. | 10 s, eyes open/closed, without support. |
| Sideways walking | 10 steps, 4 reps, with support. | 10 steps, 4 reps, without support. | 10 steps, 4 reps, without support. |
| Backward walking | 10 steps, 4 reps, with support. | 10 steps, 4 reps, without support. | 10 steps, 4 reps, without support. |
| Walking with a turn | Walk and turn in the figure 8 | Walk and turn in the figure 8 | Walk and turn in the figure 8 |
| Heel walking | 10 steps, 4 reps, with support. | 10 steps, 4 reps, without support. | 10 steps, 4 reps, without support. |
| Toe walking | 10 steps, 4 reps, with support. | 10 steps, 4 reps, without support. | 10 steps, 4 reps, without support. |
| Ball activity | Ball dribbling and throwing upwards & single direction ball throwing with partner. | Ball dribbling and throwing upwards with one hand; ball throwing/catching in different directions in a stationary circle. | Ball dribbling and throwing upwards with one hand; throwing/catching ball in different directions while rotating in circle. |
| Tandem walk | 10 steps, 4 reps, with support. | 10 steps, 4 reps, with support. | 10 steps, 4 reps, without support. |
| Slalom walking | Slalom walk around stationary obstacles. | Slalom walk around stationary obstacles in haphazard directions. | Slalom walk around while picking up stationary obstacles in haphazard directions. |
| Coordination training | Hand eye coordination training | | |

### Tailoring

This was a standardized group targeted program, with no individual tailoring.

### Adherence/Fidelity

To ensure the intervention is conveyed as per the protocol, the physiotherapist in charge was observed and assessed by researchers of physiotherapy and clinical psychology background. The factors taken into assessment were appropriate exercise prescription for older persons with cognitively frailty, safety of the intervention delivery, manner of intervention delivery and adherence to the specified protocol. Fidelity of participants to the intervention was monitored by attendance logs of each participant for each intervention session. For the WE-RISE at Home, the number of completed session is self-reported by the participants over the biweekly phone calls with therapist as well as marked in the calendar within the activity manual. Additionally, elements of motivation, psychological and practical support, goal setting and focus on independence are incorporated as adherence measures older adults with frailty and cognitive impairment (64, 65).

### Data Analysis

All statistical analyses will be carried out using the Statistical Package for Social Sciences (SPSS) software, version 23.0. An alpha level of (0.05) was considered for all the statistical tests used in the study. Two-sided $p$ values of (0.05) and (80%) power will be statistically significant. Results of the randomized controlled trial will be analyzed using repeated measures analysis of variance for pre-test (Baseline Scores) and post-test (3rd month, $6^{th}$ month) for experimental and active control group. *Post-hoc* analysis will be conducted using Benferonni correction. Analysis will include nutritional assessment, cognitive frailty outcome measures, cognitive assessments, physical function assessments and quality of life.

## DISCUSSION

To the best of our knowledge, this multi-domain intervention incorporating cognitive, physical, nutritional and psychosocial domains specifically targeting the potential reversibility of cognitive frailty will be the first of its kind in Malaysia, as compared to existing interventions which address physical frailty and cognitive impairment separately among community dwelling older adults. The description of the WE-RISE intervention was reported using the TIDieR (66) to enable smooth replication into practice should it be found to be effective in addressing cognitive frailty.

We employed strategies that were found to be effective in the management of physical frailty and cognitive impairment in the hopes that the same outcomes will be obtained when the conditions co-exist simultaneously. There is an apparent gap in evidence regarding the existence of interventions in the 'real-world' setting (67). The novelty of this intervention is that the multiple domains of the intervention are tackled in a single session and it is executed in a "real-world" setting. This form of delivery overcomes the challenges faced when disseminating evidence-based interventions that are usually conducted in controlled and optimum environments to practice (67). The WE-RISE intervention is designed to adapt to the local setting, hence the translation to real-world practice is anticipated to be less challenging and sustainable. Likewise, the intervention is progressive in nature and is simple to comprehend and adhere to. The WE-RISE at Home program strongly promotes the continuation of self-management following the instructed sessions at the comforts of their own home. The

**TABLE 6 |** Outline and description of cognitive training program.

| Activity | Domain of Cognition | Description of Activity | Levels of Difficulty |
|---|---|---|---|
| "Getting 'jiggy' with it"<br>- Jigsaw puzzle | Visuospatial reasoning & working memory | Assembling jigsaw puzzle. | Level 1: 6 Piece puzzle<br>Level 2: 6 Piece & 9 Piece puzzle.<br>Level 3: 6,9- and 12-piece puzzle. |
| "Let's get it sorted"<br>- Sorting game | Executive function & cognitive flexibility | Sorting different objects by color first and then progressing to sorting by name of color. | Level 1: Ice cream stick and sort only 2 colors.<br>Level 2: Ice cream Stick sort but color of stick or tub.<br>Level 3: Matchstick sort by color of stick and color of tub. |
| "It's not the same!"<br>- Spot the difference | Attention & processing speed | Two similar pictures are printed on a single sheet. Participants are to spot and circle 10 differences between the two. | Increasing level of complexity of the worksheets provided. |
| "Get out!"<br>- Maze Activity | Problem solving skills & reaction time | Maze activities printed on paper. Participants are to find their way out of the maze with a pencil. | Increasing level of complexity of the mazes provided. |
| "What did you see?"<br>- Recall activity | Short term memory | Show a picture for 30 s, remember all the objects within the picture and list as many as possible. | Level 1: 5 objects<br>Level 2: 10 objects<br>Level 3: 15 objects |
| "Jog that memory"<br>- Memory games with cards. | Reaction time, attention & processing speed | This is a card-based memory game. A deck of cards containing paired pictures is used to play memory-based games such as "snap" or quick pairing. | Level 1: 2 players, 1 deck of cards<br>Level 2: 4 players, 2 deck of cards<br>Level 3: All participants together, combination of 3 different decks. |
| "Color codes" | Concentration & matrix reasoning | These games are a combination of colors and shapes on paper.<br>Simple sudoku type activity will be given, instead of numbers with shapes of different colors. | Level 1: Only 1 empty spot in each row.<br>Level 2: 2 empty spots in each row.<br>Level 3: Multiple missing spots to be filled. |

elements of social engagement via phone call with instructor, autonomy to select the activities of choice at home and setting targets to achieve for each session are promising components that heighten motivation to carry out activities independently (65).

The WE-RISE intervention hopes to provide easier accessibility whilst enabling "age-friendly" health care delivery. If the intervention is found to be effective, the community-based nature of the intervention delivery may also be of lower cost as compared to the process of obtaining standard healthcare. Furthermore, it is not specific to the subset of older persons from lower socioeconomics but can also be applied amongst all walks of life and be practiced as a preventative strategy. The effectiveness and cost effectiveness of the WE-RISE intervention as compared to usual care on the reversal of cognitive frailty status among community dwelling older adults will be reported at the end of the trial. It is hoped that WE-RISE which is a multi-component and domain intervention will not only be beneficial in addressing cognitive frailty but also physical activity and general health in older persons.

In conclusion, we hope the address the need for a comprehensive and feasible intervention which is also sustainable in terms of delivery and cost for the well-being of older persons with cognitive frailty. The WE-RISE is versatile and can be administered within the community as well as a hospital or nursing home setting by most exercise instructors or primary healthcare practitioners with training.

## TRIAL REGISTRATION

This trial was registered in the Australian New Zealand Clinical Trials Registry (ANZCTR) on the 29th of July 2019. Registration number: ACTRN12619001055190.

## DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary materials, further inquiries can be directed to the corresponding author/s.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Research Ethics Committee of Universiti Kebangsaan Malaysia (UKM PPI/111/8/JEP-2018-558) Department of Social Welfare Malaysia (MyResearch Reference: JKMM 100/12/5/2: 2018/405). The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

RM: conceptualization, methodology, project administration, resources, and writing – original draft. DS: conceptualization, methodology, project administration, resources, supervision, writing – review & editing, and funding acquisition. SS: project

administration, resources, supervision, writing – review & editing, and funding acquisition. PS: methodology, supervision, and writing – review & editing. All authors contributed to the article and approved the submitted version.

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# Impact of Knee Pain on Fear of Falling, Changes in Instrumental Activities of Daily Living, and Falls Among Malaysians Age 55 Years and Above

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**Objectives:** To determine the temporal relationship between the presence of knee pain and knee pain severity identified at baseline with fall risk, fear of falling and changes in instrumental activity of daily living at 12-months follow-up.

**Methods:** This was a prospective study from the Malaysian Elders Longitudinal Research (MELoR) study involving community dwelling older persons aged 55 years and older. The presence of one fall in the preceding 12 months, knee pain, and functional capacity were determined at baseline (2013–2015) and follow-up (2015–2016). Function was determined as loss of at least one of seven instrumental activities of daily living (IADL). Physical performance was evaluated at baseline using the timed-up-and-go (TUG) test. Fear of falling (FoF) was determined using the single question "Are you afraid of falling?"

**Results:** Data were available for 605 participants, mean (*SD*) age = 69.10 (7.24) years. Knee pain was present in 30.2% at baseline. Neither the presence of knee pain nor knee pain severity at baseline were associated with falls at 1-year follow-up. Knee pain was significantly associated with FoF at follow-up [aRR (95%CI) = 1.76 (1.02–3.04)] but not changes in IADL. Among individuals with no falls at baseline, the presence of knee pain was protective of falls at follow-up after adjustment for baseline physical performance [adjusted rate ratio, aRR (95% confidence interval, CI) = 0.35 (0.13–0.97)].

**Conclusion:** Knee pain is associated with increased FoF at 1.5 years' follow-up within a multi-ethnic population aged 55 years, residing in an urban location in a middle-income South East Asian nation. Interestingly, after differences in muscle strength was accounted for, knee pain was protective against falls at follow-up. Our findings challenge previous assumptions on joint pain and falls and highlights the importance of large prospective studies and further mechanistic research incorporating psychological factors in this area of increasing prominence.

**Keywords: aged, knee pain, prospective falls, accidental falls, activity of daily living**

# INTRODUCTION

Knee pain due to osteoarthritis (OA) is the most common type of joint pain complaint among older persons (1). The prevalence of knee pain, however, varies according to geographical location and culture with a higher prevalence reported among older Asians. One in three Malaysians age 55 years and above experience knee pain (2), while symptomatic knee OA has been reported in 16% of older individuals living the US (3). The presence of low grade, chronic pain in the knee due to OA, may negatively influence the older persons psychological state and overall quality of life.

Falls and fear-of-falling (FoF) are a debilitating conditions associated with poorer health status and functional decline among older adults (4–6). The consequences of falls includes fatal and non-fatal injuries (7), with serious injuries found in 20% of falls in older adults (8). In a recent systematic review, which included 39 studies, joint pain is associated with poorer static, dynamic, multicomponent, and reactive balance which may increase the risk of falls in older persons (9). The presence of balance impairment or instability resulting from joint pain may lead to FoF with the presence of actual fall events (10). It has been suggested that pain stimulates fear avoidance, (11) which leads to fear of movement and activity avoidance. The presence of knee pain may also lead to impairment in activities of daily living which may in turn lead to further increased FoF and other negative psychological sequelae (9).

Few studies have evaluated the relationship between knee pain with falls, FoF and functional status. The establishment of the temporal relationship between these key variables will informing the development of strategies to reduce the burden of disease associated with knee OA. Our previous work demonstrated a positive association between knee pain and retrospective recall of falls in the preceding year, in a cross-sectional analysis of 1,212 older Malaysian aged 55 years and above from the Malaysian Elderly Longitudinal Research (MELOR) cohort (12). With the subsequent availability of longitudinal follow-up data, we were able to examine the relationship between knee pain and falls in a time-dependent fashion. In addition, the effect of knee pain on FoF and changes functional status in measured with instrumental of activity daily living (IADL) were also studied.

# METHODS

## Study Design and Population

First and second wave data were obtained from the Malaysian Elders Longitudinal Research (MELoR) study. The MELoR cohort was recruited between November 2013 to October 2015 from the electoral rolls of the Parliamentary constituencies of Petaling Jaya North, Petaling Jaya South, and Lembah Pantai which were located in Greater Kuala Lumpur. The recruitment strategies for MELoR have been explained in greater detail elsewhere (13). Individuals aged 55 years and above were selected through simple random sampling stratified by age deciles and ethnicity. Second wave data were obtained from 2015 to 2016. This study was approved by the University of Malaya Medical Centre Medical Ethics Committee (Ref: 925.4) and complied with the Helsinki Declaration of 1975, revised in 1983. Written informed consent was obtained from all study participants prior to their inclusion. Participants with communication difficulties, including cognitive impairment, affecting their ability to respond to the questionnaire were excluded.

## Baseline Interview

Participants were recruited through door-to-door visits. Data on demographics, socioeconomic started, home environment, media use, psychological status, functional status, falls history, medical history, medication use, healthcare utilization, and opinions on the end of life were obtained through computer-assisted interviews during this initial visit. Medical history was established through self-reported physical diagnosis of medical conditions identified on a list using commonly used terminology. The occurrence of falls was determined by asking participants during their home-based interviews whether they had at least one fall in the past 12 months. The presence of FoF was also established at baseline during this visit. This initial survey interview took around 2 h. The survey questionnaire was development through a series of face-to-face meetings and electronic communications by an expert panel comprising researchers in geriatrics, primary care, public health, economics, built environment, sports science, media studies, education, law, and computer science. Interviews were conducted by trained researchers blinded to the actual research questions. Participants were then requested to attend a hospital-based health check during which anthropometric and physical performance measurements were collected.

## Case Definition

The presence of pain was determined with the single question "Are you often troubled with pain?" Those who responded "yes" to the above question were then asked, "Do you have pain in any of the following parts of your body." They were then required to select any appropriate responses from a list of seven options, which included: head, back, hip, knees, feet, mouth/teeth, and "all over." With the assistance of the interviewer, participants then filled in a table requiring then to identify whether the pain affected the right, left, or both knees and to rate the severity of pain as "1 = mild," "2 = moderate," and "3 = severe." This question was adopted from The Health and Retirement Study (HRS), a nationally representative survey of community-living older adults in the United States (14).

## Physical Performance

Physical performance in our participants was determined by hand grip strength (HGS) and the timed-up-and-go (TUG) test.

*Hand grip strength* was measured using a Jamar digital smart hand dynamometer (Pattersons Medical®/Samsons Preston®, USA). Participants' hand dominance was first determined. The researcher then first demonstrated the correct procedure to the participant, while instructing the participant to sit upright on

a standard chair with back support and arms, and to start with the dominant arm. Participants were then instructed to hold their arms flexed at 90°, with the forearm resting on the arm of the chair, and to grip the dynamometer with their maximal strength. They were told they had three attempts with each arm. The researcher would then pass the instrument to the participant and instruct the participant to sit down on the chair and check the participant's position. Participants were encouraged to perform as well as they could using a standard squeezing phrase "Squeeze……harder, harder…and stop squeezing." Three measurements (in kg) for each hand, alternating sides were recorded.

*The Timed Up and Go test* was first demonstrated to the participant, followed by one trial run, before taking a second measurement which was recorded. Shoes were kept on for this test. The time taken for the participant to complete a three-meter continuous walk from and back to a seated position on a standardized chair, 46 cm in height, with arms and a back rest was recorded. Participants were instructed to walk independently at their natural pace and were allowed to use a walking aid if they normally required one. Completion time of longer than 13.5 s (s) indicated impaired lower limb function (15).

## Follow-Up

Follow-up data were obtained during wave two interviews conducted between September 2015 to January 2016. Only home-based computer-assisted interviews were conducted during this second wave.

## Outcomes

### Falls

Participants were again asked if they had the question, "Have you fallen in the last 12 months?" during the second wave. Those who provided an affirmative response were subsequently asked to report the number of falls they experienced.

### Fear of Falling

Participants were asked, "Are you afraid of falling?" Those who answered "yes" to this question were considered to have FoF. Previous studies have found the single question to be comparable to falls efficacy scales in the determination of the presence of FoF in population-based studies (6, 16).

### Changes in Instrumental Activities of Daily Living

Seven out of eight items of the Lawton-Brody IADL were included in the home-based interview questions (ability to use telephone, going out, shopping, food preparation, doing housework, taking own medication, and ability to handle finances). The item on managing own laundry as it was felt by the expert panel that it did not appropriately measure activities of daily living in the Malaysian culture where tasks are commonly delegated to younger female in the family regardless of the older person's ability to perform such tasks. A score of "1" was assigned to each item if they responded positively to "answering phone calls," "using transportation with assistance," "shopping independently," "preparing meals independently," "doing housework with help," "managing their own medications," and "managing everyday finances with help with banking and major transactions," or "0" if they rated their function were below the above stipulated levels for each item (17). The maximal score was therefore "7," with a lower score indicating poorer function. Changes in IADL (cIADL) at follow-up were determined by subtracting the wave two IADL score from the wave one IADL score ($cIADL = IADL_{baseline} - IADL_{follow-up}$). The score was then dichotomised with those with a score of one or greater categorized as reduced IADL and 0 and below as no change or improved IADL.

## Statistical Analysis

Data analyses were conducted using the SPSS Version 20 (IBM, Armonk, NY, USA). Descriptive statistics were first presented as means with standard deviations for continuous data and frequencies with percentages for categorical data. The independent *t*-test was applied for continuous variables and chi-squared test for nominal variables in bivariate analyses. Subsequently, the rate ratios (RR) with 95% confidence intervals (CI) were determined for falls at wave 2, for all participants and the sub-group of non-fallers at baseline. In addition, similar comparisons were made for severity of knee pain using logistic regression with dummy variables. Uncertain responses and missing values were removed in the association analysis. Multiple logistic regressions analyses were performed to assess the association between knee pain as well as knee pain severity and falls following adjustments for demographic differences and baseline physical performance. We first included falls in the year prior to baseline as a covariate in multivariable models. As the presence of falls at baseline was a strong predictor of subsequent falls, a subgroup comprising only non-fallers as baseline was created by excluding those with baseline falls. Analyses were repeated by substituting fear of falling and reduced IADL as the outcomes. Baseline IADL was not included as covariate in the multivariable analysis in order to avoid multicollinearity effects. Potential confounders were selected based on differences in baseline characteristics and clinical relevance. The theoretical framework by which this analysis strategy was drawn is further illustrated in **Figure 1**.

# RESULTS

## Baseline Characteristics

The initial recruitment figures for the MELoR cohort comprised 1,614 individuals at wave one home-based computer assisted interviews. Subsequently 1,419 attended hospital-based health checks. Wave two interviews were abruptly stopped after 770 participants were re-interviewed due to withdrawal of study funding in 2016 resulting from sudden, catastrophic economic circumstances. Data on knee pain, falls, physical performance and follow-up falls were available for a total of 605 (79.5%) participants, mean (SD) age 69.10 (7.24) years. The mean time to follow-up between wave one and wave two was 494.1 days. **Table 1** displays participant characteristics at baseline according to knee pain status. Participants with knee pain were more likely

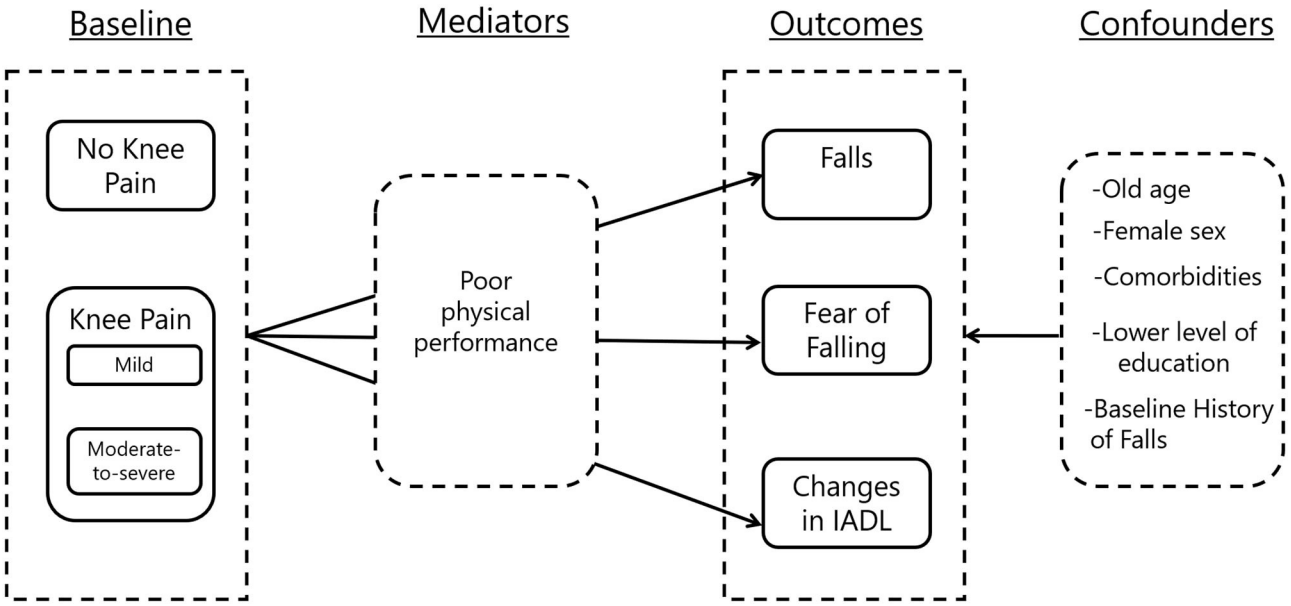


**FIGURE 1 |** Theoretical framework on the relationship between knee pain, falls, fear of falling, and changes in instrumental activity of daily living. IADL, instrumental activities of daily living.

to be women with lower educational attainment, and increased likelihood of self-reported physician-diagnosed hypertension and diabetes mellitus. Individuals with knee pain also had higher body mass index (BMI), poorer physical performance measured by TUG and HGS and lower IADL scores. Individuals with knee pain were also more likely to have reported the occurrence of at least one fall in the preceding 12 months and FoF at enrolment to the study (**Table 1**).

## Knee Pain and Prospective Falls

The association between knee pain and prospective falls was determined for the overall cohort as well as those who had no falls at baseline according to the presence of knee pain and severity of knee pain. In other words, logistic regression analyses were conducted for all participants, as well as non-fallers at baseline (no falls in the past 12 months at wave 1). Prospective falls (falls in past 12 months at wave 2) was considered the dependent variable while knee pain or moderate or severe knee pain were independent variables. **Table 2** documents the crude and adjusted associations between knee pain and knee pain severity with falls in all subjects and subjects without falls at baseline. The presence of knee pain or moderate to severe knee pain at baseline was not associated with prospective falls at follow-up. In the sub-group analysis, those without history of falls showed similar results where the presence of knee pain was not associated with prospective falls. However, following adjustment for baseline physical performance which either HGS or TUG score, presence of knee pain or moderate-to-severe knee pain were protective of prospective falls (adjusted rate ratio, aRR = 0.35; 95% confidence interval, CI = 0.13–0.97). This suggests the presence of knee pain protected individuals who had no previous history of falls from any subsequent falls once differences in sociodemographic, comorbidities, and physical performance or muscle strength were accounted for statistically (**Table 2**).

## Knee Pain and Fear-Of-Falling at Follow-Up

**Table 3** summarizes the multiple logistic regression analyses using the presence of FoF at wave 2 follow-up as the dependent variable, with either the presence of knee pain or knee pain severity as independent variables. Analyses were conducted first with the overall cohort then with individuals with no falls at baseline (participants with at least one fall in preceding 12 months at recruitment excluded). Both crude unadjusted RR with 95% CI as well as aRR with 95%CI after adjustment first for age, sex, education, hypertension, diabetes, and BMI, followed by further adjustments with HGS are presented here. Unadjusted analyses found significant associations between presence of knee pain and FoF at follow-up for the overall cohort (RR = 2.66; 95% CI = 1.62–4.36) as well as baseline the non-faller (RR = 3.36; 95% CI = 1.28–6.26) subgroup. For the overall cohort the presence of knee pain remains significantly associated with FoF at follow-up after the first adjustment for potential confounders (aRR = 1.76; 95% CI = 1.02–3.04), but the relationship was no longer significant following additional adjustment for HGS (aRR = 1.71; 95% CI = 0.99–2.98). In the non-fallers at baseline subpopulation, the relationship between presence of knee pain and FoF remained significant after adjustment for all potential known confounders. When knee pain severity was considered, crude and adjusted analyses for identical confounders and potential mediators found that individuals with moderate to severe baseline knee pain were significantly more likely to have FoF at follow-up than those without baseline knee

**TABLE 1 |** Baseline characteristic for participants with and without knee pain.

| | Without knee pain ($n = 422$) | With knee pain ($n = 183$) | *p*-value |
|---|---|---|---|
| Age (*y*), mean (*SD*) | 68.90 (7.00) | 69.55 (7.76) | 0.312 |
| **Sex, *n* (%)** | | | |
| Female | 211 (50.0) | 133 (72.7) | <0.001* |
| **Education Level, *n* (%)** | | | |
| Primary and lower | 66 (15.7) | 62 (33.9) | <0.001* |
| **Comorbidities, *n* (%)** | | | |
| Hypertension | 197 (46.7) | 107 (58.5) | 0.008* |
| Diabetes mellitus | 102 (24.2) | 60 (32.8) | 0.028* |
| Stroke | 8 (1.9) | 2 (1.1) | 0.477 |
| Heart attack | 27 (6.4) | 17 (9.3) | 0.208 |
| Asthma | 30 (7.1) | 11 (6.0) | 0.622 |
| Parkinsonism | 2 (0.5) | 0 (0.0) | 0.351 |
| Visual problem | 163 (38.6) | 83 (45.4) | 0.122 |
| Ischemic heart disease | 62 (14.7) | 17 (9.3) | 0.070 |
| BMI (kg/m$^2$), *mean (SD)* | 24.81 (4.35) | 26.28 (4.56) | <0.001* |
| Medication ≥5, *n* (%) | 158 (37.5) | 82 (45.1) | 0.083 |
| TUG score, *mean (SD)* | 11.73 (2.95) | 13.39 (4.74) | <0.001* |
| Grip strength, *mean (SD)* | 24.59 (7.97) | 20.70 (6.64) | <0.001* |
| IADL score, *mean (SD)* | 6.68 (0.76) | 6.45 (0.99) | 0.002* |
| Fear of falling, *n* (%) | 290 (68.9) | 158 (86.8) | <0.001* |
| History of falls, *n* (%) | 84 (19.9) | 62 (33.9) | <0.001* |

*SD, Standard deviation; BMI, Body mass index; TUG, timed-up-and-go; IADL, instrumental activities of daily living. *p < 0.05.*

pain for the overall cohort as well as the baseline non-faller subgroup (**Table 3**).

## Knee Pain and Change in Instrumental Activities of Daily Living

**Table 4** summarizes the logistic regression analysis findings using cIADL as the dependent variable and either presence of knee pain or knee pain severity as independent variable. In the unadjusted analysis, having knee pain or moderate-to-severe knee pain was associated with reduced IADL (crude RR = 2.00; 95% CI = 1.29–3.11). This association was, however, attenuated following adjustment of age, comorbidities, BMI, and demographic differences. Similar findings were observed when we compared mild knee pain and moderate-to-severe knee pain with absence of knee pain. Among baseline non-fallers, no significant association was found in all models (**Table 4**).

# DISCUSSION

The temporal relationships between knee pain and falls, fear of falling and changes in function are evaluated in this study. By examining the prospective relationship between the presence of knee pain and the severity of knee pain with falls at follow-up, FoF at follow-up and cIADL, we were able to tease out the potential influence of knee pain on physical, psychological and functional outcomes in residents aged 55 years at recruitment in an urban location in Malaysia, a multi-ethnic, upper-middle income country in South-East Asia. The presence of knee pain at baseline is not associated with increased risk of falling at one-and-a-half-year follow-up but was conversely protective of follow-up falls once those who fell at baseline were excluded once differences in muscle strength were adjusted for. The presence of knee pain at baseline, was, however, associated with the presence of FoF at follow-up. Changes in IADL over the follow-up period associated with baseline knee pain was found attributable to differences in age, sex, level of education and comorbidities.

Few studies have obtained data on fall occurrence prospectively in relationship to knee pain (18). A study by Dore et al. suggested that the presence of lower limb OA in one site led to a 53% increase the risk of future falls in 12 months (19). In contrast, our finding was more in line with a recent study by the European Project on OSteoArthritis (EPOSA) which found that the presence of clinically-diagnosed knee OA, was not associated with one or more falls at 1-year follow up. Instead, this study found significant associations between clinical OA and recurrent falls with pain medication as potential mediators (20). Our study, therefore, complements the findings of the EPOSA study by further determining whether FoF or functional status was affected prospectively by the presence and severity of knee pain.

As neither the presence of knee pain or knee pain severity led to falls over 12 months over a mean follow-up duration of 1.5 years, we went on explore this relationship using statistical methods, in an attempt to explain this unexpected finding, despite the expected presence of poorer muscle strength, gait and balance scores and IADL performance among those with knee pain. Individuals who had reported at least one fall in the preceding 12 months at enrolment were excluded from our exploratory analyses since a previous history of falls is a strong risk factor for subsequent falls (21–23) and may have confounded our findings. Following adjustments for differences in comorbidities, age, gender, education and muscle strength or gait and balance between those with and without knee pain, the presence of knee pain appeared to confer a protective effect on falls occurrence at follow up. This protective effect appeared to apply in those with moderate to severe knee pain over those with no knee pain. While such exploratory analyses ought to be interpreted with caution, it has revealed a potential mechanistic explanation for why the presence of knee pain may not necessarily lead to falls. It is to be expected that knee pain is associated with increasing age, female gender, reduced muscle strength and increased BMI which are associated with increased risk of falls (24), the effect of pain may conversely balance out the increased risk from the above through a mechanism which remains unclear. Plausible explanations may include, increased vigilance, compensatory strategies and reduced physical activity (25, 26). This could have important implications on treatment strategies, which have thus far concentrated primary on pain relief. Removal of the sensation of pain may paradoxically lead to increased risk of falls, as highlighted by the EPOSA study.

Despite the lack of association of knee pain with fall occurrence at follow-up, FoF appeared to be independently associated with presence of knee pain, with the relationship relevant for those with moderate to severe knee pain rather

**TABLE 2 |** Associations between baseline knee pain and prospective falls.

| Prospective Falls, *n* (%) | Knee pain | | Knee pain severity | | |
|---|---|---|---|---|---|
| | No knee pain | With knee pain | No pain | Mild | Moderate-to-severe |
| **All participants (*N* = 605)** | | | | | |
| Unadjusted RR (95% CI) | 1 | 1.03 (0.67–1.60) | 1 | 0.88 (0.41–1.88) | 1.01 (0.61–1.67) |
| Adjusted RR (95% CI)[a] | 1 | 0.91 (0.57–1.48) | 1 | 0.88 (0.40–1.94) | 0.85 (0.49–1.48) |
| Adjusted RR (95% CI)[b] | 1 | 0.84 (0.51–1.36) | 1 | 0.80 (0.36–1.77) | 0.78 (0.44–1.37) |
| Adjusted RR (95% CI)[c] | 1 | 0.65 (0.89–0.97) | 1 | 0.66 (0.28–1.54) | 0.56 (0.30–1.02) |
| **Baseline no falls (*N* = 459)** | | | | | |
| Unadjusted RR (95% CI) | 1 | 0.56 (0.27–1.14) | 1 | 0.55 (0.16–1.85) | 0.55 (0.16–1.85) |
| Adjusted RR (95% CI)[a] | 1 | 0.50 (0.23–1.09) | 1 | 0.52 (0.15–1.80) | 0.40 (0.15–1.08) |
| Adjusted RR (95% CI)[b] | 1 | 0.45 (0.20–0.99)* | 1 | 0.49 (0.14–1.71) | 0.35 (0.13–0.97)* |

*RR, rate ratio; CI, confidence interval.*
*[a]Model adjusted with age, sex, education, hypertension, diabetes and BMI.*
*[b]Model further adjusted with muscle strength (grip strength), adjustment for TUG produced similar result.*
*[c]Model further adjusted with baseline history of falls.*
**Significant at $p < 0.05$.*

**TABLE 3 |** Presence and severity of knee pain at baseline and fear of falling at follow-up.

| Fear of falling | Knee pain | | Knee pain severity | | |
|---|---|---|---|---|---|
| | No knee pain | With knee pain | No pain | Mild | Moderate-to-severe |
| **All participants (*N* = 605)** | | | | | |
| Crude RR (95% CI) | 1 | 2.66 (1.62–4.36)* | 1 | 1.75 (0.83–3.70) | 3.24 (1.75–5.97)** |
| Adjusted RR (95% CI)[a] | 1 | 1.76 (1.02–3.04)* | 1 | 1.20 (0.54–2.67) | 2.21 (1.12–4.37)* |
| Adjusted RR (95% CI)[b] | 1 | 1.71 (0.99–2.98) | 1 | 1.16 (0.52–2.60) | 2.12 (1.07–4.19)* |
| Adjusted RR (95% CI)[c] | 1 | 1.69 (0.97–2.94) | 1 | 1.14 (0.51–2.56) | 2.07 (1.04–4.10)* |
| **Baseline no falls (*N* = 459)** | | | | | |
| Crude RR (95% CI) | 1 | 3.36 (1.81–6.26)** | 1 | 2.62 (0.99–6.90) | 3.78 (1.76–8.13)* |
| Adjusted RR (95% CI)[a] | 1 | 2.53 (1.28–5.03)** | 1 | 1.82 (0.66–5.03) | 3.04 (1.29–7.20)* |
| Adjusted RR (95% CI)[b] | 1 | 2.52 (1.26–5.03)** | 1 | 1.83 (0.66–5.07) | 3.02 (1.27–7.19)* |

*RR, rate ratio; CI, confidence interval.*
*[a]Model adjusted with age, sex, education, hypertension, diabetes and BMI.*
*[b]Model further adjusted with muscle strength (grip strength), adjustment for TUG score produced similar result.*
*[c]Model further adjusted with baseline history of falls.*
**Significant at $p < 0.05$.*
***Significant at $p < 0.01$.*

than those with mild knee pain. The relationship was unchanged after baseline fallers were excluded. The implication of FoF is not explained in this study as FoF was considered an outcome, and the relationship between FoF and falls and other potential physical and psychological sequelae was not explored. Previous studies have considered FoF as a psychological condition with greater negative consequences than falls alone, with established relationships between FoF and activity avoidance and impaired functional status (4, 27).

While significant associations between knee pain at baseline and deterioration in IADL was found initially, this was confounded by advanced age, increased BMI, comorbidities, and demographic differences. Knee pain did not lead to any change in IADL among baseline non-fallers. A previous study by the Osteoarthritis Initiative showed over 7 years' follow-up, out of 1,055 adult aged 45 to 79 years, with or at high risk of knee OA who had no limitation at baseline, 25% had slow and steady decline and another 5% had fast and progressive decline (28). Thus, it is possible that, the real impact of having knee pain on IADL can only be demonstrated over a longer follow-up duration.

## Limitations

Fall occurrence at follow-up was dependent on retrospective recall. However, given the resource limitations for following up this cohort, which also led to incomplete follow-up of the cohort, prospective diary exercises were not within our grasp. Potential recall bias may, therefore, lead to inaccuracies in

**TABLE 4 |** Knee pain and knee pain severity at baseline and reduction in instrumental activities of daily living.

| Reduction in IADL | Knee pain | | Knee pain severity | | |
|---|---|---|---|---|---|
| | No knee pain | With knee pain | No pain | Mild | Moderate-to-severe |
| **All participants (*N* = 605)** | | | | | |
| Crude RR (95% CI) | 1 | 2.00 (1.29–3.11)* | 1 | 2.08 (1.05–4.12)* | 2.03 (1.24–3.32)** |
| Adjusted RR (95% CI)[a] | 1 | 1.62 (0.98–2.68) | 1 | 1.83 (0.86–3.89) | 1.59 (0.90–2.80) |
| Adjusted RR (95% CI)[b] | 1 | 1.65 (0.99–2.74) | 1 | 1.85 (0.87–3.96) | 1.62 (0.92–2.87) |
| Adjusted RR (95% CI)[c] | 1 | 1.65 (0.98–2.78) | 1 | 1.89 (0.87–3.97) | 1.64 (0.92–2.91) |
| **Baseline no falls (*N* = 459)** | | | | | |
| Crude RR (95% CI) | 1 | 1.91 (1.11–3.28) | 1 | 2.18 (0.97–4.94) | 1.83 (0.98–3.42) |
| Adjusted RR (95% CI)[a] | 1 | 1.45 (0.79–2.65) | 1 | 1.90 (0.80–4.53) | 1.26 (0.62–2.58) |
| Adjusted RR (95% CI)[b] | 1 | 1.46 (0.79–2.69) | 1 | 1.91 (0.80–4.55) | 1.27 (0.62–2.62) |

*RR, rateratio; CI, confidence interval.*

[a]*Model adjusted with age, sex, education, Hypertension, diabetes and BMI.*

[b]*Model further adjusted with physical performance (Grip strength), adjustment for TUG score produced similar result.*

[c]*Model further adjusted with baseline history of falls.*

**Significant at $p < 0.05$.*

***Significant at $p < 0.01$.*

our findings, and which may have influenced the lack of any significant relationship between knee pain and falls in our cohort. Funding issues commonly affect cohort studies, which is also a major reason why cohort studies from developing countries remain limited. The presence of knee pain was only identified through the lead-in question, "are you often troubled by pain." The duration of the pain had not been provided here with the word "often" being a subjective term, therefore further adding to the potential inaccuracies. No confirmatory diagnosis of osteoarthritis with clinical assessments or radiographical methods was possible. Our study nevertheless has highlighted the need to conduct further studies which may further unwrap the potential protective effect of pain on fall occurrence as well as to examine psychological and economic implications, which this study was unable to address as it addressed psychological, functional and fall outcomes concurrently, and did not examine the interplay between these three outcomes.

This study highlighted the complexity of the relationship between knee pain with falls and other fall related outcomes. By concurrently examining the effect of knee pain on falls, fear of falling and functional capacity prospectively, we found that knee pain at baseline did not increase the risk of falls in the preceding 12 months over a mean follow-up period of 1.5 years. The relationship between knee pain and FoF was, however, apparent, but not changes in functional ability. Future studies should consider evaluating the potential protective effect of knee pain which could be due to increased vigilance and activity avoidance from fear of falling.

## DATA AVAILABILITY STATEMENT

Due to concerns about loss of fidelity of personal identifiable data the MELoR data set is currently not available publicly. However, parts of the data set will be release anonymized through written requests submitted to the corresponding author.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Malaya Medical Centre Medical Ethics Committee (Ref: 925.4). The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

SM, SK, and MT: conceptualization, investigation, and methodology. SM and MT: formal analysis. SK, A-VC, and MT: funding acquisition. All authors: contributed to the article and approved the submitted version.

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BRIEF RESEARCH REPORT
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# Frequency of Cognitive Impairment Among Malaysian Elderly Patients Following First Ischaemic Stroke—A Case Control Study

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**Background:** Stroke is highly prevalent globally and is an important cause of cognitive impairment and dementia.

**Aims:** We determined the frequency of post-stroke cognitive impairment (PSCI) at 1, 3, and 6 months among patients with first clinical ischemic stroke compared to risk and age-matched controls.

**Methods:** This study involved 32 cases and 32 controls, and was conducted over 6 months. Cases were inpatients aged >60 with first clinical ischemic stroke. Controls were age-matched subjects without prior stroke. Montreal Cognitive Assessment (MoCA) was performed in all patients at 1, 3, and 6 month post stroke. A MoCA score of <26 was used for mild PSCI and <22 for moderate PSCI (post stroke dementia).

**Results:** Post-stroke dementia was detected in 12 patients (37.5%) at 1st month, in 13 (40.6%) at 3rd month and 15 (48.4%) at 6th months. Mild PSCI was present in 7 patients (21.6%) at 1 month, 16 patients (50%) at 3 months, and 15 patients (48%) at 6 months. The odds ratio (OR) for post-stroke dementia was 3.2 (95%CI 0.98–10.68; $p = 0.05$) at 1 month; 3.69(95% CI 1.13–12.11; $p = 0.031$) at 3 months, and 4.88 (95% CI 1.49–15.99; $p = 0.009$) at 6 months. Years of education was an independent predictor for dementia (OR 0.60; $p = 0.046$). The OR for post-stroke dementia at 6th month was 7.23 with education level adjusted (95%CI 1.46–35.86, $p = 0.015$).

**Conclusion:** The frequency of PSCI was high as early as 1 month after stroke. Stroke alone conferred a 7.2 times risk for post-stroke dementia compared to controls.

**Keywords: stroke, cognitive impairment, post-stroke dementia, post-stroke cognitive impairment, ischaemic stroke**

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## INTRODUCTION

Stroke is an important cause of cognitive impairment (1, 2). The Oxford Vascular Study, a large prospective study evaluating incidence of vascular events among participants living in Oxfordshire reported that the incidence dementia after a major stroke was 50 times higher than in the general population, in the year after a stroke (2). A systematic review on post stroke dementia yielded

varying prevalence depending on the population studied and the number of strokes. A pooled prevalence of 7.4% (4.8–10) was obtained from population-based studies, whereas hospital-based studies had a higher prevalence of 41.3% (29.6–53.1) when recurrent strokes and pre-stroke dementia were not excluded (1).

The Malaysian National Stroke Registry had reported an increase in stroke incidence and prevalence from 2010 to 2014 most likely due to an increase in the prevalence of vascular risk factors (3). The Global Burden of Disease Study 2016 reported an increase in the burden of stroke worldwide, particularly in the low to middle income countries such as Malaysia (4). This increasing burden of stroke has a significant impact on the incidence and prevalence of post stroke cognitive impairment (PSCI) (5). Cognitive impairment and/ or dementia, when present is associated increased rates of institutionalization, mortality, and poor quality of life (6).

While there are some studies on the prevalence of dementia among Malaysians (7–9), data on post-stroke cognitive impairment is still lacking except for one study which evaluated the presence of post stroke cognitive impairment among stroke survivors in the community (10). Additionally, although cognitive impairment may become established from as early as 1-month post stroke, there are no national guidelines or recommendations on when to screen for cognitive impairment following an incident stroke. As there is increasing evidence for early cognitive rehabilitative interventions for improving cognition post stroke (11), it is therefore imperative to determine the incidence and prevalence of cognitive impairment after an incident stroke, and to understand the contributory risk factors so that treatment can be instituted appropriately.

This study was therefore conducted to determine the incidence and trajectory of cognitive impairment among patients with first-ever ischemic stroke compared to age-matched high risk controls over 6 months. We also determined independent risk factors which contributed toward the development of post-stroke dementia.

# MATERIALS AND METHODS

## Study Design

This was a single-center prospective observational case-control study. Patients were recruited from the stroke unit, general medical wards, and from stroke registry of Hospital Canselor Tuanku Muhriz, Kuala Lumpur. Inclusion criteria for cases were: elderly patients aged ≥60 years, who were admitted with a first clinical ischaemic stroke to the medical wards or stroke care unit. Controls were age, gender and risk-factor matched, non-stroke patients attending the cardiology outpatient clinic or patients admitted to general medical wards, with a diagnosis other than stroke. Patients were excluded if they had previous strokes, a haemorrhagic stroke, diagnosis of dementia, or other neurodegenerative diseases such as Parkinson's disease, Alzheimer's disease. Ethics approval was obtained prior study conduct with an approval code. Informed consent was obtained prior to enrolment.

## Study Assessments

Patients were assessed by a single investigator. Baseline data which included demographics, level of education, and risk factors (hypertension, diabetes mellitus, dyslipidaemia, ischemic heart disease, and smoking) were collected into a semi-structured questionnaire. Patients and family members were questioned regarding any forgetfulness prior to the stroke to determine if there was a possibility of undiagnosed dementia or cognitive impairment.

Stroke was classified according to Oxfordshire Community project Classification (OCSP) as lacunar stroke (LaCI), posterior circulation stroke(PoCI), partial anterior circulation stroke(PACI), and total anterior circulation stroke (TACI) (12). The presence of white matter changes and old lacunar infarcts on computed tomography (CT) imaging were recorded.

The Montreal Cognitive Assessment (MoCA) was used to screen for the presence of cognitive impairment or dementia (13). A cut off score of <26 was used for mild cognitive impairment, a score of <22 was used for dementia (14, 15). All assessments were performed at 1, 3, and 6 months post-stroke by a single interviewer.

In the post-stroke patients, probable post stroke dementia was diagnosed using the NINDS AIREN criteria, which requires the presence of dementia by clinical history and examination, and documented by neuropsychological testing (MoCA <22); evidence of cerebrovascular disease by either history, clinical examination, or brain imaging; and the first 2 criteria to be reasonably related (16).

## Statistical Analysis

The sample size required for each arm, based on previous study (17) with study power set to 80% with 5% level of significance was 36. Statistical analyses were performed using IBM Statistical Package for Social Sciences (SPSS) version 21.0. Non-parametric tests were used as the data were not normally distributed. Categorical variables were analyzed using Fisher's exact test and Pearson Chi-square test where appropriate. The continuous variables were analyzed using Mann–Whitney *U*-test. Repeated Measurement Analysis using Friedman ANOVA test was done to determine change of MoCA over time between two groups. Kaplan-Meier Survival Analysis was done to estimate dementia free survival comparing two groups. Univariate followed by multivariate logistic regression was performed to determine the independent predictors for post-stroke dementia. Binary logistic regression analysis was performed to calculate the odds ratio for dementia between two groups of subjects. A $p < 0.05$ was considered statistically significant.

# RESULTS

## Baseline Characteristics

A total of 64 subjects were finally recruited (32 stroke subjects and 32 control subjects). Of 41 patients with stroke initially recruited, only 32 completed the study. One patient died at home due to unknown cause and 8 patients withdrew from the study. One patient from the stroke group and one patient from the control group were unable to complete the 6$^{th}$ month

**TABLE 1 |** Baseline sociodemographic data of the subjects.

| | Cases ($n = 32$) | Control ($n = 32$) | $p$-value |
|---|---|---|---|
| Age (years)*** | | | |
| Median (IQR) | 66.50 (65.00–71.75) | 67.00 (63.00–70.00) | 0.803 |
| **Sex *n* (%)*** | | | |
| Male | 23 (35.9) | 25 (39.1) | |
| Female | 9 (14.1) | 7 (10.9) | 0.774 |
| **Race *n* (%)**** | | | |
| Malay | 9 (14.1) | 10 (15.6) | |
| Chinese | 20 (31.3) | 21 (32.8) | |
| Indian | 3 (4.7) | 1 (1.6) | 0.584 |
| **Smoking *n* (%)*** | | | |
| Smoker | 12 (18.8) | 15 (23.4) | |
| Non-smoker | 20 (31.3) | 17 (26.6) | 0.613 |
| **Education years***** | | | |
| Median (IQR) | 7 (3–9.25) | 7 (3.5–10) | 0.254 |
| Hypertension *n* (%)** | 30 (50) | 30 (50) | 1.00 |
| DM *n* (%)* | 14 (21.9) | 19 (27.1) | 0.317 |
| Dyslipidemia *n* (%)** | 29 (90.6) | 30 (93.8) | 0.641 |
| IHD *n* (%)** | 12 (18.8) | 23 (35.9) | 0.011 |

*Analysis performed using Fisher's exact test.*
*Analysis performed using Pearson Chi-Square test.*
***Analysis performed using Mann–Whitney U-test.*
*DM, Diabetes Mellitus; IHD, Ischemic Heart Disease.*

assessment. Both cases and controls were age and sex-matched. The median age among cases was 66.50 years (IQR 65.00–71.75) while among controls was 67.00 years (IQR 63.00–70.00). Baseline sociodemographic and the presence of underlying risk factors were comparable for cases and controls (**Table 1**).

Among the stroke subjects 65% had lacunar stroke and 35% had non-lacunar stroke. As per OCSP classification, the majority of the patients had LaCI (59.4%), followed by PACI (21.9%) and PoCI (18.8%). None of the patients had a TACI perhaps since aphasic patients were excluded. In the stroke group, 50% had either white matter changes or old lacunar infarcts on the brain imaging.

## Post-stroke Dementia and MCI

At 1-month post stroke, 12 (37.5%) patients had PSD, while only 5 (15.6%) patients in the control group fulfilled the MoCA cut-off for dementia ($p = 0.04$). By the 3$^{rd}$ month, 3 (40.6%) patients had developed dementia in the stroke group while the number remained unchanged in the control group ($p = 0.025$). By the 6$^{th}$ month, a total of 15 (48.4%) had developed dementia in the stroke group, whereas the control group remained unchanged (**Table 2**).

At 1 month, 7 (21.9%) patients in the stroke group had mild PSCI (scored MoCA <26) while 3 (9.4%) patients in the control group had mild cognitive impairment (MCI) ($p = 0.151$). By the 3$^{rd}$ month, 16 (50%) patients in the stroke group had developed mild PSCI (MoCA <26), while only 4 (12.5) in the control group had MCI ($p = 0.003$). At 6$^{th}$ month, 15 (48.4%) patients had MCI in the stroke group, as one patient had progressed to dementia, while 2 new patients in the control group had developed MCI making a total of 6 (22.2%) ($p = 0.031$; **Table 2**).

**TABLE 2 |** Frequency of PSCI (MCI and dementia) among stroke subjects and controls.

| | Stroke % | Controls % | *$P$-value |
|---|---|---|---|
| **1st month** | | | |
| Normal | 13 (40.6) | 24(75.0) | |
| MCI | 7 (21.6) | 3 (9.4) | 0.151 |
| Dementia | 12 (37.5) | 5 (15.6) | 0.044 |
| **3$^{rd}$ month** | | | |
| Normal | 3 (9.4) | 23 (71.9) | |
| MCI | 16 (50.0) | 4 (12.5) | 0.003 |
| Dementia | 13 (40.6) | 5 (15.6) | 0.025 |
| **6$^{th}$ month** | | | |
| Normal | 1 (3.2) | 21 (65.6) | |
| MCI | 15 (48.4) | 6 (18.8) | 0.031 |
| Dementia | 15 (48.4) | 5 (15.6) | 0.007 |

*Fisher's exact test.*
*MCI, Mild Cognitive Impairment.*

## Risk Factors for Dementia

Years of education ($p$=0.020, OR 0.75, 95% CI 0.64-0.99) and non-lacunar stroke ($p$=0.024, OR 1.6, 95% CI 0.09-7.82) were significantly associated with dementia in the stroke group using univariate analysis (**Table 3**). The presence of diabetes, hypertension, dyslipidaemia, white matter changes and old lacunar infarcts on brain imaging were not significant risk factors for post-stroke dementia. Using multivariate regression, only years of education was found to be an independent predictor for developing post-stroke dementia (OR 0.60, 95%CI 0.36–0.99, $p = 0.046$; **Table 4**).

## Post-stroke Dementia Risk and Progression of Cognitive Impairment

Patients with stroke had significantly increased risk of developing cognitive impairment at 1 month compared to controls with an odds ratio (OR) of 3.2 (95%CI 05.98; $p = 0.05$). This increased to 3.69 at 3 months (95% CI 1.13–12.11; $p = 0.031$) and 4.88 at 6 months (CI 1.49–15.99; $p = 0.009$). After adjusting for educational level at 6$^{th}$ month, the OR increased to 7.23 (95%CI 1.46–35.86, $p = 0.015$).

Of the 7 patients with who had mild PSCI by MoCA score at 1 month, 3 progressed to post-stroke dementia at 6 months, and the rest remained as mild PSCI, with a conversion rate of 42.8%. None of the patients in the control group with MCI converted to dementia. A non-parametric repeated measurement analysis using Friedman ANOVA test to determine change over time for MoCA in 2 groups showed a greater rate of decline in the stroke group (chi-square 38.49, $p < 0.001$). Based on survival analysis, 50% of stroke patients remained dementia-free by the 6th month, whereas in the control group 85% were dementia free by the 6$^{th}$ month. The mean estimate 6-month dementia-free

**TABLE 3 |** Univariate logistic regression for risk factors for dementia at 6th month.

| | OR | 95% Confidence interval | *p*-value |
|---|---|---|---|
| Age | 1.08 | 0.947–1.24 | 0.245 |
| Sex (female) | 0.6 | 0.119–3.03 | 0.537 |
| Years of education | 0.75 | 0.64–0.99 | 0.020 |
| DM | 1.07 | 0.256–4.49 | 0.925 |
| Hba1C | 1.21 | 0.80–1.84 | 0.373 |
| Hypertension | 6.18 | 0.26–146.7 | 0.260 |
| IHD | 0.98 | 0.227–4.25 | 0.981 |
| Smoking | 1.71 | 0.396–7.42 | 0.471 |
| Depression | 0.27 | 0.025–2.90 | 0.278 |
| Type of stroke (non-lacunar) | 1.6 | 0.09–7.82 | 0.024 |
| Site of stroke (Left) | 5.0 | 0.82–30.46 | 0.08 |
| Presence of white matter changes or old lacunar infarct on CT brain | 0.33 | 0.68–1.62 | 0.174 |
| **OCSP classification** | | | |
| LaCI | 0.90 | 0.129–0.16 | 0.908 |
| PoCI | 3.75 | 0.331–42.46 | 0.286 |

*DM, Diabetes Mellitus; IHD, Ischemic Heart Disease; OCSP, Oxfordshire Community Stroke Project; LaCI, Lacunar stroke; PoCI, Posterior circulation stroke; PACI, partial anterior circulation stroke.*

**TABLE 4 |** Multivariate logistic regression for risk factors of dementia at 6th month.

| | OR | 95%Confidence interval | *p*-value |
|---|---|---|---|
| Age | 1.22 | 0.85–1.76 | 0.281 |
| Sex (female) | 3.83 | 0.18–81.56 | 0.389 |
| Years of education | 0.60 | 0.36–0.99 | 0.046 |
| DM | 0.10 | 0.03–3.02 | 0.184 |
| Dyslipidemia | 8.56 | 0.009–7,974.42 | 0.538 |
| IHD | 1.98 | 0.13–29.79 | 0.621 |
| Type of stroke (non-lacunar) | 0.44 | 0.36–6.54 | 0.560 |
| Presence of white matter changes or old lacunar infarct on CT brain | 0.49 | 0.29–487.5 | 0.588 |

*DM, Diabetes Mellitus; IHD, Ischemic heart Disease.*

survival was 3.6 in the test group and 5.2 in the control group, $p = 0.007$ (**Figure 1**).

## DISCUSSION

Stroke leads to global cognition impairment in 44% of patients and impairment in individual domains in 30–35% of patients within 2–6 months of an index event (18). A recent meta-analysis of hospital-based studies which harmonized data on post stroke cognitive impairment (PSCI), assessed at ≥1 month, from stroke onset showed that the pooled prevalence of post stroke neurocognitive disorder (NCD) was 53.4%; with mild NCD (MCI) in 36.4% and major NCD (PSD) in 16.5% of patients (19). International guidelines have recommended screening for PSCI as early as 3–6 months, so that appropriate treatment can be instituted. In this study, we evaluated the frequency of post stroke mild cognitive impairment and moderate cognitive impairment at three time points (1, 3, and 6 month), to determine the trajectory of post stroke cognitive changes over time, and compared this against age, gender, and disease-matched controls.

As expected, our study showed a significantly higher prevalence of moderate PSCI (PSD) among our ischaemic stroke patients at all the three time points compared to age-matched controls. In addition, there was a steady rise in the prevalence of PSD over the 6-month period, from 37.5% at 1st month, to 40.6% at the 3rd month, and to 48.4% at the 6th month. Similar to that observed with PSD, the prevalence mild PSCI among the stroke survivors was significantly higher compared to controls at 3 and 6 months. The prevalence of mild PSCI also increased steadily from 21.9% in the first month to 50% at 3 and 6 months. Taken together, the prevalence of cognitive impairment (mild and moderate) after an incident stroke in our study was 98.4%, which is alarmingly high. In contrast, a study, similar to ours, which screened for PSCI, at 2 and 6 months, in 325 subjects, using a MOCA cut off score of <26, reported that the prevalence of PSCI was highest at 2 months (66.4%), which declined slightly to 59.1% at 6 months (20). Most published studies have used single point assessments at either 3 or 6 months for the evaluation of dementia post stroke, thus yielding differing prevalence.

The progression of mild PSCI to PSD over the 6-month period was rather high in our study. Three out of 7 (42.8%) patients progressed from mild PSCI to PSD by the 6th month. No changes in MoCA scores were observed in the control group. The risk of developing post stroke dementia at 6 months following a first clinical stroke was 7.2 times higher than that for someone of the same age, gender, educational level, and disease risks. This is perhaps one of the highest reported in the literature. On the other hand, a population-based study, involving 212 patients and 1,060 controls reported a 2.4 times risk of developing dementia after a first stroke (21).

Based on survival analysis, only 50% of stroke patients had MoCA scores ≥22 by the 6th month, compared to 85% in the control group. Educational level was the only independent predictor for post stroke dementia from our study. Patients with longer years of education had significantly lower risk of developing post stroke dementia. Other risk factors including age, depression, type of stroke and the presence of white matter disease were not significantly associated with dementia in our study. In addition, the progression to moderate cognitive impairment was most significant in the first 3 months of stroke, although the MoCA scores continued to decline from 3 to 6-month post-stroke. Our findings are supported by another study which showed that although the probability of incident dementia declined over time following stroke, it was highest within the first 90 days following a stroke (22).

Studies on post stroke cognitive impairment in Malaysia are limited despite an increasing prevalence and mortality associated with stroke. To our knowledge, only one study had evaluated the prevalence of post-stroke cognitive impairment, and it was conducted in the community. In that study, 50 patients with single or recurrent strokes, attending day-care centers in Klang Valley, Malaysia were screened using the Addenbrooke's Cognitive Examination-Revised instrument (10). It was reported from that study that 76% of patients had

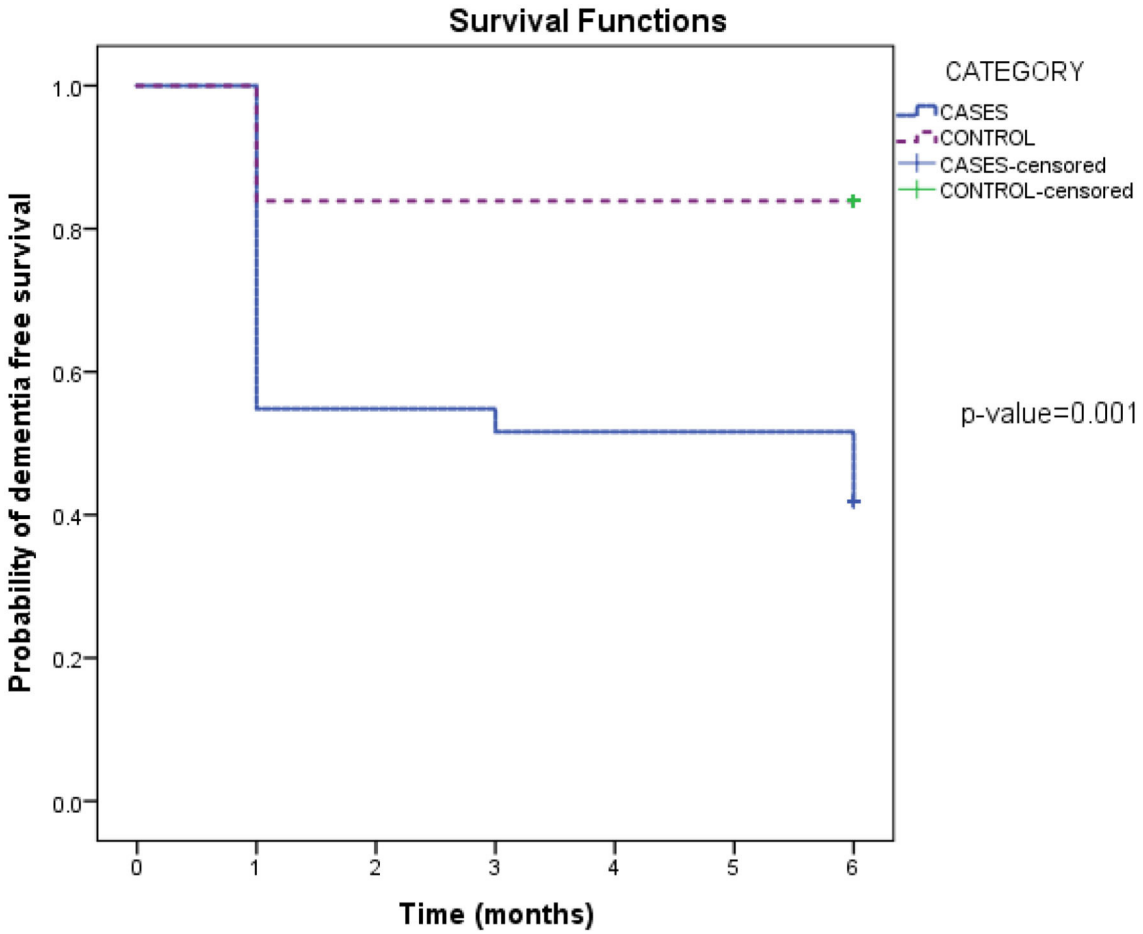


**FIGURE 1 |** Estimate of survival free of dementia over 6 months between cases and controls.

post stroke cognitive impairment (10) Among the risk factors evaluated, only education level and age were found to be independent predictors of cognitive dysfunction in that study (10). Despite the methodological differences, the prevalence of PSD was high in our study and the above study; although in the latter, the prevalence was perhaps higher due to the inclusion of recurrent strokes. This could be partly due to the fact that post stroke rehabilitative management in Malaysia are primarily focused on improving physical mobility and speech with insufficient emphasis on cognitive rehabilitation therapy, which could have accounted for the high prevalence of PSD among Malaysians. Given the high progression of mild to PSD in our study, there is a pressing need to screen and treat cognitive impairment post stroke, as early as possible, to prevent progression.

There are several limitations in this study. Firstly, being a hospital-based study, we may have missed patients with mild stroke who did not seek medical attention. Secondly, we only included patients with ischaemic stroke and thus unable to determine the prevalence of PSCI in patients with haemorrhagic strokes. Thirdly, as this study was meant to determine the trajectory of cognitive decline, we did not evaluate the functional impairment associated with PSD, using the Barthel Index and hence unable to correlate the presence of PSD with functional activity. Finally, although MoCA is most valid and clinically feasible tool to screen for cognitive impairment post stroke (23), a cut off score of <26 for may have led to an overestimation of cases with PSCI. Finally, our sample size was relatively small compared to other studies. Nevertheless, findings from this study could be used to design larger clinical trials or studies to assess PSCI in the Malaysian population.

However, we believe our study has a number of strengths. This was the first study to report the trajectory of cognitive decline following an incident stroke among Malaysians. Being a prospective study, we were able to detect the development of new dementia among our patients more accurately. We had also utilized a lower MoCA cut score of <22 matched for years of education, for the diagnosis of dementia, to ensure that we did not overestimate the presence of dementia in our patients. This was based on previous validation studies conducted among Malaysians, and in Hong Kong, as both populations had similar years of education to our current cohort

(14, 15). Additionally, our cases and controls were matched by age and sex as well as for other predisposing risk factors for vascular dementia, which allowed us to determine the true effect of the first stroke on the development of dementia in these patients.

In conclusion, our study showed that a first incident ischaemic stroke led to PSD in 48% of patients at 6 months, and conferred a 7.2 times risk for PSD compared to age- and risk-matched controls. These alarming rates strongly emphasize the need to institute cognitive rehabilitative strategies as part of stroke rehabilitative protocol in Malaysia. Future longitudinal studies, with longer follow up are warranted to understand the risks and burden of post-stroke dementia in our population, considering the increasing prevalence of stroke in Malaysia.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Secretariat of Research and Innovation, Faculty of Medicine, Universiti Kebangsaan Malaysia. Approval Code - FF-2016-435. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR'S NOTE

Apart from detrimental effects on functional abilities, stroke is a major contributing factor for dementia. Data on post-stroke cognitive impairment and dementia following first ischaemic stroke in Malaysia is lacking. Post-stroke cognitive impairment has a significant impact on overall prognosis independent of physical disability. This study showed that years of education was a significant factor for developing post-stroke dementia. These rates are quite alarming and suggest that patients with stroke should be screened and received early cognitive rehabilitation regardless of their baseline status given the high conversion rate to MCI and dementia over the 6-month period. Additionally, early treatment for those with MCI could potentially prevent progression to dementia.

## AUTHOR CONTRIBUTIONS

ZMF contributed to writing proposal, data collection, analysis, and writing first draft. HM contributed to study conception and review of manuscript. SZSZ contributed to study design and statistical analysis. NMI contributed to initial study conception and design, data analysis, and critical review of the manuscript.

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BRIEF RESEARCH REPORT
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# Home Hazards With Fear of Falling: Findings From the Baseline Study of the Malaysian Elders Longitudinal Research (MELoR)

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**Background:** Fear of falling (FoF) is a common issue among older people, impacting on psychological health, functional performance and mortality. Many factors associated with fear of falling have been investigated but little is known about the role of home hazards. Home hazards can be due to unsafe environmental and functional features. This study is aims to evaluate the association between home hazards with fear of falling among community-dwelling individuals aged 55 years and over.

**Methods:** Baseline data with 1,489 older individuals from the Malaysian Elders Longitudinal Research (MELoR) study were analyzed. Home visits for interview and observations in the home were conducted with the participants. FoF was established with a single-item question and home hazards with the Home Falls and Accidents Screening Tool (HOME FAST).

**Results:** The majority (76.4%) of older participants experienced FoF. The history of falls was not associated with FoF ($p = 0.868$), but FoF was associated with participants limiting their daily activities ($p < 0.001$). Home hazards were less likely ($p = 0.023$) and functional issues were more likely ($p < 0.001$) to be associated with a high degree of FoF. However, both home hazards domains were not associated with activity restriction due to FoF.

**Conclusions:** Education about home hazards from the perspective of person-environment interaction may encourage home hazards management and reduce FoF which should be evaluated in future studies.

**Keywords: accidental fall, aged, fear of falling (FOF), home safety, fall-related psychological concern**

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## INTRODUCTION

Falls are known as a major issue for older people. Falls are common among community-dwelling older populations (1–4). However, the impact from falls can be catastrophic such as psychological disturbance, injuries (i.e., fractures, pain, oedema), loss of functions (physical, social, activities of daily living), morbidity, and mortality (5).

More than 400 risk factors associated with falls have been identified and these can be classified into two major domains; intrinsic and extrinsic (3, 6). While intrinsic factors may include biological, behavior and socioeconomic factors, extrinsic factors are predominantly environmental factors (3, 6). Home hazards are a factor which has received much attention in falls investigations with older people.

Investigating the association between home hazards, falls and risk of falling is difficult and challenging. One review study on the intervention of home hazards management found this to be effective in reducing falls among older people (7). However, observational studies face difficulty proving the association exists. In a review by Letts et al. (8) summarized cross-sectional studies failed to find any significant association, while cohort studies found mixed findings; significant associations were only found in high quality studies. These findings are again replicated in a recent study by Romli et al. (9, 10) that found no significant association between a home hazards score and history of falls. The interaction is complex as either the hazards have been eliminated after the older person had a fall, thus making the prior hazards undetectable, or the hazards appear after a fall due to reduced functionality and daily performance as consequences from the fall. These factors are unstable and there are limitations in investigating these associations through cross-sectional designs.

Fear of falling is considered as an alternative avenue of investigation to understand falls. Fear of falling is the psychological manifestation of falls (11, 12). Previous falls predict the existence of fear of falling in older people and the fear of falling will become a predictor for falls occurrence during the following year (11). In addition, fear of falling has been recognized as a risk factor for falls among older people (13, 14). However, fear of falling is also a factor independent from falls; it is a condition where an older person fears a fall among those who fall and even among those who never fallen (14–16). Fear of falling is worth investigating as more than half of the older population experiences it with potentially serious consequences; psychological impact such as depression, functional and activity restriction, impaired quality of life and increased risk of mortality (16, 17). Using fear of falling as an outcome variable is important as it is persistent over time. Compared to a fall that is only an event at one-point in time, fear of falling is consistent for a period of time and is less likely to be diminished if there is no intervention.

A systematic review found that factors associated with fear of falling include female gender, performance and physical function, the use of a walking aid, history of falls and poor self-rated health. Inconclusive factors were psychological issues (i.e., depression and anxiety) and medication (18). Interventions specifically designed to reduce fear of falling have been found to be effective (19), and these include housing adaptation (20). Identified factors and interventions addressing fear of falling were found to be similar to factors related to falls and interventions for falls prevention (18, 19, 21, 22). This suggests that fall prevention efforts may be transferable to fear of falling. However, home hazards have not been investigated as a factor associated with fear of falling. Only two studies were found and both were from Iran. A study found home hazards to be positively and significantly associated with fear of falling (23). However, the study did not use any standardized instrument specifically to measure home hazards and focused only on three simple items of physical environmental hazard (i.e., present of extra objects, slippery floor or none). Another study found a significant association between higher home hazards and greater fear of falling (24). However, the study utilized the Home Safety Checklist where the instrument was criticized for having poor psychometric properties (9, 10). In addition, the study investigated home hazards as the outcome for fear of falling.

The definition of home hazards has evolved in the past two decades. Home hazards are not merely the presence of danger or deficits in the physical environment but also involve the observation of functional capability of an older person when interacting with the home environment (9, 10, 25, 26). For home hazards, the functional capability of the older person in their home environment might not be determined on the functional independence of older people in general (26). For example, an older person who is independent in activities of daily living and having good balance and mobility may still have a hazard when climbing a narrow flight of stairs or upsetting his or her balance when reaching high objects in the kitchen cabinet. Therefore, there is a need to investigate the role of home hazards on fear of falling among community-dwelling older people in a robust manner.

## MATERIALS AND METHODS

A cross-sectional study design utilizing data from the first wave of the Malaysian Elders Longitudinal Research (MELoR) project was used in the current study. The first wave data for MELoR serves as the baseline data for a longitudinal cohort study in which the outcomes will inform future government policies and scientific research. Registered voters aged 55 years and over were recruited through simple random sampling stratified by the three major ethnicities (i.e., Malay, Chinese and Indian) in Malaysia and age deciles. Participants were identified through the electoral rolls of three adjacent parliamentary constituencies within the Federal Territory Kuala Lumpur and the Petaling District of the state of Selangor. The recruitment procedures for the project are described elsewhere (27).

### Data Collection

Participants providing informed consent were visited at their home by a trained MELoR researcher using a computer-aided method to administer a set of questionnaires consisting of survey items and validated assessments related to falls. The data were collected through interviews based on the participant's response and via interview-with-observation for the home hazards assessment. The survey captured sociodemographic information, and housing status (i.e., property type, home ownership). The detail of the procedure is reported elsewhere (9, 10).

### Fear of Falling

Fear of falling was evaluated using a single-item question by asking participants, "Are you afraid of falling?" with a dichotomous answer of "yes" or "no." If the participants answered "yes" to the initial questions, subsequent questions were then administered, first on the degree of fear by asking, "Do you feel somewhat afraid or very much afraid of falling?" with two answer choices of "somewhat" or "very much," and second on activity restriction by asking, "Do you limit your activities because you are afraid of falling?" with the selection of answers either "yes" or "no." The single-item question on fear of falling is widely used and considered a gold standard evaluation due to its simple structure and ease of administration even among people with cognitive impairment (28, 29). It demonstrates acceptable psychometric properties with good discriminant validity compared to the modified Fall Efficacy Scale ($p < 0.001$) and Fall Efficacy Scale–International (FES-I) ($r = 0.71$; $p < 0.05$), as well as good test-retest reliability over a 2-week period ($k = 0.72$) (29).

### Home Falls and Accidents Screening Tool (HOME FAST)

The HOME FAST is an instrument to screen for home hazards associated with increased risk of falls among older people. Comprising 25 items evaluating seven key areas of hazards on flooring, furniture, lighting, bathroom, storage, stairways and mobility. Physical environment aspects of the HOME FAST comprise 14 items (i.e., item 1,2,3,4,7,8,9,13,14,15,18,19,21, and 23) and functional aspects comprise 11 items (i.e., item 5,6,10,11,12,16,17,20,22,24, and 25) (26). The HOME FAST has been developed considering the influence of the person-environment interaction on the older person's functional performance within the home environment (26). Each item on the HOME FAST is scored "yes" or "no." With certain items, an additional answer choice of "not applicable" was made available. Only a "no" answer is assigned a 1 mark to indicate the presence of that hazard. The total score ranges from 0 to 25 where higher scores indicate more hazards. The HOME FAST has good face and content validity, strong internal consistency ($\alpha = 0.95$) good inter-rater ($k = 0.62$–$0.85$) and excellent test-retest reliability (ICC = 0.77–0.92), and strong predictive validity for falls (OR: 1.016, $p = 0.006$) and responsive (1–2%; OR: 0.984, $p = 0.02$) (1, 2, 9, 10). The HOME FAST has been translated into several languages such as Brazilian-Portuguese, Persian, Mandarin, Malay, and Tamil (9, 10, 30, 31). A brief sample of the HOME FAST is shown in **Table 1**.

## Data Analysis

Missing data in the HOME FAST items (incomplete) were treated by assigning a score of 0 while samples with missing HOME FAST data (no data on all items) were removed. Data on the HOME FAST score were tested for normality and parametric tests were selected. Missing data on the fear of falling question were minimal, treated by using dummy variables and included in the final analysis. The HOME FAST score was the independent variable and was categorized into three types of hazard score: (1) overall score, (2) HOME FAST physical environment score (HF–environment), and (3) HOME FAST functional aspect scores (HF–function). Binary and multinomial logistic regression analyses were conducted depending on the nature of the dependent variable of the fear of falling–two or three categories respectively.

# RESULTS

Initial data were available for 1,489 older participants. The majority of the participants were married (73.6%), living with others (93.9%) and either living in multi-story housing (53.3%) or in owned or spouse-owned houses (75.9%). The majority of older people were afraid of falling (76.4%). Other characteristics were relatively balanced as presented in **Table 2**. Chi-square analyses found that a history of falls in the previous month was not associated with fear of falling either on falls combined inside and outside the home ($X_2 = 0.028$; $p = 0.868$) or falls inside home only ($X_2 = 1.434$; $p = 0.231$). However, the presence of fear of falling was strongly associated with the perception of limitations of daily activities ($X_2 = 1{,}351.97$; $p < 0.001$). The mean number of hazards in the participants' home as recorded by the HOME FAST was 5.23 (95%CI = 5.10–5.37). Detailed types of hazards as measured by the HOME FAST can be referred to in another publication (9, 10).

## Association Between Home Hazards and Fear of Falling

Due to missing data on the HOME FAST, only data from 1,374 participants were included in the final analysis. Binary logistic regression analysis on the total score of the HOME FAST was found to have no significant association with fear of falling [Exp(β) = 1.010; $p = 0.694$]. Further analysis was conducted through binary logistic regression according to the HOME FAST subscales which found that fear of falling was associated with lower HF-environmental scores [Exp(β) = 0.919; $p = 0.029$] and higher of HF-functional scores [Exp(β) = 1.193; $p = 0.003$].

Additional findings from the multinomial logistic analysis revealed that home hazard scores were not associated with fear of falling among older participants who were 'somewhat' fearful compared to those with no fear either on HF-environment ($p = 0.566$) or HF-function ($p = 0.963$). However, the rating of 'very much' fearful of falling was associated with reduced HF-environment ($p = 0.023$) score and but increased HF-function score ($p < 0.001$) when compared to individuals with no fear (see **Table 3**).

Among those who were fearful of falling ($n = 1{,}039$), binary logistic regression yielded no significant association of home hazards with whether or not the participants limited or did not limit their daily activities due to fear of falling on both HOME FAST subscales; HF-environment ($p = 0.205$) or HF-function ($p = 0.105$).

# DISCUSSION

This study indicates those with a high level of fear of falling were less likely to have environmental home hazards but were more

**TABLE 1 |** Example of HOME FAST.

| No | Item | Y | N | N/A |
|---|---|---|---|---|
| 1 | Are walkways free of cords and other clutter? | | | |
| 2 | Are floor coverings in good condition? | | | |
| 3 | Are floor surfaces non slip? | | | |
| 4 | Are loose mats securely fixed to the floor? | | | |
| 5 | Can the person get in and out of bed easily and safely? | | | |
| 6 | Can the person get up from their lounge chair easily? | | | |
| 7 | Are all the lights bright enough for the person to see clearly? | | | |
| 8 | Can the person switch a light on easily from their bed? | | | |
| 9 | Are the outside paths, steps and entrances well lit at night? | | | |
| 10 | Is the person able to get on and off the toilet easily and safely? | | | |
| 11 | Is the person able to get in and out of the bath easily and safely? | | | |
| 12 | Is the person able to walk in and out of the shower recess easily and safely? | | | |
| 13 | Is there an accessible/sturdy grab rail/s in the shower or beside the bath? | | | |
| 14 | Are slip resistant mats / strips used in the bath/bathroom/shower recess? | | | |
| 15 | Is the toilet in close proximity to the bedroom? | | | |
| 16 | Can the person easily reach items in the kitchen that are used regularly without climbing bending or upsetting his or her balance? | | | |
| 17 | Can the person carry meals easily and safely from the kitchen to the dining area? | | | |
| 18 | Do the indoor steps/stairs have an accessible/sturdy grab rail extending along the full length of the steps/stairs? | | | |
| 19 | Do the outdoor steps/stairs have an accessible/sturdy grab rail extending along the full length of the steps/stairs? | | | |
| 20 | Can the person easily and safely go up and down the steps/stairs inside or outside the house? | | | |
| 21 | Are the edges of the steps/stairs (both inside and outside the house) easily identified? | | | |
| 22 | Can the person use the entrance door/s safely and easily? | | | |
| 23 | Are paths around the house in good repair, and free of clutter? | | | |
| 24 | Is the person currently wearing well fitting slippers or shoes? | | | |
| 25 | If there are pets – can the person care for them without bending or being at risk of falling over? | | | |

*Y = YES (No hazards).*
*N = NO (Hazardous).*
*N/A = Not Applicable.*

likely to have functional home hazards compared to individuals with no fear of falling. When all home hazards are evaluated together we found no association with presence fear of falling or level of fear of falling. Environmental home hazards may have been reduced when individuals develop fear of falling; these individuals may be more vigilant (17) and hence may have taken active steps to reduce environmental hazards. Conversely, the presence of functional home hazards may have precipitated fear of falling as these individuals with functional home hazards are more likely to experience challenges in maintaining stability while performing daily tasks and are more likely to perceive the threat of falls. Previous studies had, however, found an association between home hazards and fear of falling (23, 24). However, the method of identifying home hazards was not described (23). The presence of home hazards also did not involve the use of a checklist through direct observation (24). Therefore, this study where the home hazards were evaluated via observation and interview provides stronger confidence in the outcome.

The fear avoidance model indicates that an individual may rectify any problem or avoid an activity that may cause a fall (32). Fear of falling is influenced by balance problems and falls, and cognitive issues–particularly attention and processing of sensory information–which may elicit the fear (32). Older people who are afraid may become meticulous in subconsciously identifying any hazards in their environment. The older person or family members may have rectified any physical hazards available. This makes the environment safer and reduces the perception of risk of falling (33). Meanwhile, older people who are not afraid may not be attentive to any physical hazards present and therefore do not eliminate or modify them. If the fear of falling is low there may not be sufficient motivation to correct the hazards (34). However, the fear-avoidance model may also negatively affect an older people doing functional tasks which may then cause the older person to be less competent in functional performance to overcome the hazards. Any effort to eliminate hazards might also be limited due to lack of knowledge and limited resources (e.g., financial, material) as these actions are self-driven. Identification and management of home hazards may be limited without appropriate health professional input (i.e., occupational therapist) and only simple modifications may be done due to cost (33, 35).

**TABLE 2 |** Demographic characteristics of the participants.

| Demographic | | *N* (total valid) | *n* (%) |
|---|---|---|---|
| Age [mean (95%CI)] | | 1,453 | 68.71 (68.32–69.09) |
| Gender | Male | 1,486 | 649 (43.7) |
| | Female | | 837 (56.3) |
| Ethnicity | Malay | 1,483 | 507 (34.2) |
| | Chinese | | 480 (32.4) |
| | Indian | | 488 (32.9) |
| | Others | | 8 (0.5) |
| Religion | Islam | 1,469 | 518 (35.3) |
| | Christian | | 272 (18.5) |
| | Buddhist | | 255 (17.4) |
| | Hindu | | 377 (25.7) |
| | Others | | 47 (3.2) |
| Marital status | Single/never married | 1,479 | 83 (5.6) |
| | Married | | 1,089 (73.6) |
| | Divorced/separated/widowed | | 307 (20.8) |
| Household | Alone | 1,484 | 91 (6.1) |
| | With others | | 1,393 (93.9) |
| Education | None or primary | 1,481 | 421 (28.4) |
| | Secondary | | 619 (41.8) |
| | Tertiary | | 441 (29.8) |
| Type of property | Landed single-story house | 147 | 434 (29.4) |
| | Landed multi-story house | | 788 (53.3) |
| | Apartment-like | | 217 (14.7) |
| | Traditional house | | 39 (2.6) |
| Home ownership | Own or spouse owned | 1,480 | 1,123 (75.9) |
| | Not own | | 357 (24.1) |
| Years living in their home, years [mean (95%CI)] | | 1,453 | 29.95 (29.25–30.64) |
| Falls in past 12 months | No | 1,464 | 1,132 (77.3) |
| | Yes | | 332 (22.7) |
| | Falls not at home | 332 | 150 (45.2) |
| | Falls at home | | 182 (54.8) |
| Fear of falling | No | 1,459 | 345 (23.6) |
| | Yes | | 1,114 (76.4) |
| | Somewhat | 1,109 | 506 (45.6) |
| | Very much | | 603 (54.4) |
| | Not limit activities | 1,104 | 590 (53.4) |
| | Limit activities | | 514 (46.6) |
| HOME FAST [mean (95%CI)] | | 1,489 | 5.23 (95% CI = 5.10–5.37) |

A higher risk of home hazards was found to not restrict the older participants from doing their activities of daily living. One reason is the number of hazards in this study is considered low. A study in Australia considered a cut-off point of 9 and above while a study in Asia considered the cut-off point at 6 and above as having a high risk level of home hazards (36, 37). The HOME FAST is a screening tool which is brief and aims to identify individuals at risk of having significant home hazards. However, the limited number of items may not be able to identify hazards comprehensively compared to other assessment tools (9, 10, 38). This has reduced the ability of the HOME FAST to detect older people who are truly at risk of having home hazards that limit daily function. Therefore, future study should utilize comprehensive home hazards assessment such as Westmead Home Safety Assessment (WeHSA) for a thorough evaluation and detailed outcome.

Although reduced functional performance *per se* is considered an established risk factor for falls and fear of falling among older people, the definition of functional performance inherent in the assessment of home hazards is different. Hazardous functioning as part of a home hazard happens only when an older person is performing an unsafe activity due to an unsafe environment or the presence of hazardous environments on the risk of falling, while another assessment may consider that independence in functions are intact. For example, if the older person needs to stand on tip-toes when reaching high items in the kitchen cabinet, this may be considered a hazardous activity in terms of falls risk even though the person may have good balance and mobility skills. Our study is unique in that we have identified that the interaction between the older person and the home environment is related to fear of falling; although the participants in this study were relatively independent in basic and instrumental activities of daily living as previously reported in Romli et al. (9, 10). This finding supports the hypothesis by Iwarsson et al. (25) where the interaction between the person and their hazardous environment increases the risk of falling. This indicates that a safer home environment is important to facilitate the prevention of falls.

The limitation of this study is that some of the home hazards might be unsuccessfully identified by the MELoR researchers who are not occupational therapists as they have limited knowledge on human body structure and functions, and occupational science. The concept of person-environment fit is complex. Dynamic variability on how older adults navigate their home environment in ways that either reduce or increase their risk of falls is difficult to capture (39). The functional aspects may involve underlying contributions such as cognitive, vision and mobility problems that may be difficult for non-health or non-occupational therapy trained individuals to interpret when conducting the assessment (1, 2, 31). Another limitation is the cross-sectional design where any causal-and-effect relationship is unable to be determined (40) however prospective data is not yet available. There is no study that thoroughly investigated fear of falling in Malaysia and this MELoR project is the pioneer for such research while older Malaysians do not recognize fear of falling and its impact (41). Moreover, stroke is a major issue with older people and combined with falls has made the issue significant (42). Stroke survivors have been reported with a higher level of fear of falling compared to the general population in Malaysia (43). Hence, with the absence of studies in Malaysia on fear of falling, this study is valuable.

**TABLE 3 |** Association between fear of falling and home hazards using multinomial logistic regression.

| HF subscale | Fear of falling | HF score mean (95%CI) | Exp (B) | Wald | S.E. | *P*-value |
|---|---|---|---|---|---|---|
| Environment | Very much[†] | 3.77 (3.61–3.92) | 0.909 | 5.139 | 0.042 | 0.023* |
| | Somewhat[†] | 3.78 (3.63–3.93) | 0.976 | 0.330 | 0.043 | 0.566 |
| | No fear | 3.86 (3.66–4.06) | *reference* | | | |
| Function | Very much[†] | 1.63 (1.51–1.75) | 1.282 | 16.256 | 0.062 | <0.001** |
| | Somewhat[†] | 1.30 (1.20–1.40) | 1.003 | 0.002 | 0.067 | 0.963 |
| | No fear | 1.31 (1.19–1.43) | *reference* | | | |

[†]*Compared with no fear.* $^{*}p \leq 0.05$, $^{**}p \leq 0.01$.

Management of the physical environment is important to reduce environmental hazards and functional hazards. However, this action is under-appreciated by older people as they view that home modification has few benefits and falls usually happen due to their own incapacity (41). Older people mostly had high fear of falling when performing activities at home (13). Fear of falling is common among community-dwelling older people and is independent of whether or not a person experiences a fall. Fear of falling is influenced by an older person's perception of their own physical or functional capability to mediate their surroundings (13). Learning from other older people who fell and the consequences from the fall may elevate the fear on falls among older people (44). Fear of falls can reduce the functional capacity of older people because they may limit their daily activities as a consequence of the fear. However, well-managed home hazards can reduce falls and fear of falling (7, 20). Public education on home hazards conducted from the person-environment interaction perspective should, therefore, be explored as a potential solution to reducing fear of falling among older adults. As fear of falling is not associated with falls, future studies should also consider evaluating the relationship between fear of falling and quality of life and health outcomes in this population.

## DATA AVAILABILITY STATEMENT

The data analyzed in this study is subject to the following licenses/restrictions: The dataset can be requested to the AGELESS Longitudinal Study of Ageing. Requests to access these datasets should be directed to ageless@um.edu.my.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Malaya Research Ethics Committee (MEC Ref No: 943.6). The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

MHR has major contribution on initiating the original idea and writing the manuscript conducting the systematic searching. MHR, LM, ML, LC, and MPT have equal contribution on disseminating, critical analyzing, and synthesizing the findings. MPT was one of the principal investigators for MELoR project back then and currently the head of principal investigator for AGELESS Longitudinal Study for Ageing. All authors approved the final version of the manuscript.

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# Online Multi-Domain Geriatric Health Screening in Urban Community Dwelling Older Malaysians: A Pilot Study

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**Introduction:** With a rapidly aging population, the Malaysian health care system needs to develop solutions to address the lack of resources that are required for the assessment of the older person. The complex nature of geriatric syndromes coupled with the occurrence of multiple comorbid illnesses with aging, make geriatric assessment a resource intensive process. Digital health solutions could play an important role in supporting existing health care systems, especially in low and middle income countries, with limited speciality services in geriatrics.

**Objective:** This is a pilot study aimed at screening for geriatric syndromes through self-administered online surveys in urban community dwelling older Malaysians and assessing the pattern of geriatric syndromes in relation to the frailty status of the study participants.

**Methods:** This is a cross-sectional pilot study conducted between July-September 2020. Community dwelling adults aged 60 years and over were invited to take part in an online survey. Information on sociodemographic variables, comorbidities, and the self-reported results of geriatric syndromes (frailty, sarcopenia, anorexia of aging, urinary incontinence, falls, and cognitive impairment), were collected through the survey.

**Results:** Data was collected for 162 participants over a period of 2 months. The mean (SD) age of the respondents was 66.42 (5.25) years with 64.9% females. Majority of the respondents were of Chinese ethnic origin (67.9%) and had tertiary level of education (75.9%). The average time taken by participants to complete the survey was 16.86 min. Urinary incontinence was the highest reported geriatric syndrome (55.1%) followed by falls (37.6%), anorexia of aging (32.8%), cognitive impairment (27.8%), and sarcopenia (8.3%). Frailty was detected in 4.5% of the study population. Loss of weight in the previous year was the highest reported component of the frailty assessment tool. The presence of sarcopenia, anorexia of aging, poor/fair self-rated health, urinary incontinence, and multimorbidity were significantly higher in older adults who were frail or prefrail.

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**Conclusion:** Screening for geriatric syndromes through online surveys is a feasible approach to identify older adults in the community who are likely to benefit from geriatric assessment. However, the demographic profile of the older population that are accessible through such digital platforms is limited.

**Keywords: older population, Asia, online, frail, geriatric syndromes**

## INTRODUCTION

Geriatric syndromes are multifactorial conditions that are common in older adults. They are distinct from organ specific disease conditions due to their complex pathogenesis, presence of multiple risk factors and atypical clinical presentation (1). Geriatric syndromes include but are not limited to dementia, delirium, falls, incontinence, pressure ulcers, malnutrition, frailty, and sarcopenia. Frailty is one of the newer geriatric giants and is characterized by decreased ability of the body's physiologic response to maintain homeostasis during periods of stress (2). Frailty is not only associated with poor health outcomes such as increased dependency, hospitalizations, and mortality but is also a major cause of economic burden (3, 4). Frailty along with other geriatric syndromes are best identified through a Comprehensive Geriatric Assessment (CGA). Comprehensive geriatric assessment (CGA) is a multidimensional process which identifies the medical, social, and functional needs of older adults, for the development of a coordinated care plan to meet those needs (5). CGA conducted in a clinical setting takes 1–2 h on an average (6). It is usually undertaken by an interdisciplinary team comprising clinicians, nurses, occupational, and physical therapists. The Rapid Geriatric Assessment (RGA) is a tool developed in order to conduct a quick screening of four geriatric syndromes which include frailty, sarcopenia, anorexia of aging, and cognitive impairment (7).

In Malaysia, the aging population is rapidly increasing while trained geriatricians are still limited in number (8). Geriatric training was recently included as a core component of the undergraduate medical curriculum (9). Therefore, primary care clinicians have limited knowledge on the detection and management of geriatric problems. Older adults who do access geriatric units are by way of referral and are mostly those who require acute care with complex care needs. The role of early detection and prevention of the geriatric giants such as frailty and dementia are heavily emphasized in developed countries where older adults comprise a significant proportion of the overall population (10). As of 2020, 7% of the Malaysian population are aged 65 years (11) and above, and this is expected to double by 2035 (12).

A study in older urban community dwelling Malaysians found that 67.7% of the study population were pre-frail and 5.7% were frail (13). As a frailty is a potentially reversible condition if identified early, the high prevalence of pre-frailty in the Malaysian population indicates an urgent need to address the factors contributing to its development at an early stage. The occurrence of geriatric syndromes can have a major impact on the quality of life for older adults (14). However, in the current health care system, majority of these conditions are identified and managed during hospitalization of older adults, by which time most of them are already dependent for care. Therefore, it is crucial to set up systems and solutions that support screening and early detection of geriatric syndromes at a community level (15). This will enable the identification of those individuals who can benefit from targeted geriatric assessment and management.

Current healthcare approaches are primarily disease centered rather than person centered (16). Time per patient is a critical component as current healthcare settings are geared toward seeing more patients in a limited period of time. This approach is not well-suited for the aging population due to the presence of multiple comorbidities, increasing complexity, and atypical presentation of disease. Gathering information from an older patient or caregiver requires a substantial amount of time due to the reasons mentioned and takes up a significant portion of the clinical visit. One potential solution to this problem is to allow patients to provide their information prior to the actual visit, that can be utilized by the clinician as a valuable source of information for clinical decision making and management. Data provided by patients through an online platform, which is accessible to the healthcare provider, will also assist the clinician to focus on areas of priority for the older individual while using consult time more efficiently.

There is limited data on the awareness and use of digital health tools among the older Malaysian population. Studies suggest that social media is widely used by older Malaysians, primarily for the purpose of communication with friends and family, and majority of them use smartphones to access social media (17). The use of online platforms for the purpose of health screening and assessments in older adults have been studied in developed nations, but there is limited evidence from Asian countries (18). Therefore, a pilot study was conducted to screen for geriatric syndromes through self-administered online surveys in urban community dwelling older Malaysians and to assess the patterns of geriatric syndromes in relation to the frailty status of the study participants.

## METHODS

This was a pilot cross-sectional study conducted through an online survey from July–September 2020. Participants for the study were recruited by convenience sampling. The inclusion criteria for the study were Malaysians citizens aged 60 years and above who were willing to participate in the online survey. Individuals aged 59 years and below were excluded from the study. Recruitment posters were circulated in closed social media

community groups for older Malaysians in the Klang valley, which is an urban conglomeration in Malaysia that includes Kuala Lumpur and the adjoining state of Selangor. Information about the study was disseminated to seven organizations for older adults including non-profit organizations and healthcare organizations for senior citizens. Respondents were directed to an online link with the explanatory statement and a consent form. Those who consented were then directed to the online survey. The survey questionnaire was generated using Qualtrics software, Version [September, 2020] Copyright © [2020] (19). The study was approved by the Monash University Human Research Ethics Committee 2020-21334-45510.

The survey collected data on sociodemographic factors, comorbid illnesses, medications and geriatric syndromes. Information on geriatric syndromes such as frailty, sarcopenia, nutrition and cognition, falls, urinary incontinence, and sensory impairments was collected through the online questionnaire.

## Frailty

Frailty was assessed using the FRAIL scale. It consists of 5 items: fatigue, unable to climb 1 flight of stairs, unable to walk 1 block, presence of 5 or more chronic illnesses and loss of weight of more than 5% in the past 1 year (20). Loss of weight was calculated as the difference between self-reported weight 1 year ago and current self-reported weight. A score of 3 or above over 5 indicates the presence of frailty. A score of 1–2 over 5 indicates pre-frailty and absence of any of the items indicates a robust state.

## Sarcopenia

Sarcopenia was assessed using the SARC-F tool and consists of 5 components: strength, assistance in walking, rise from a chair, climbing stairs, and falls in the past 1 year (21). The scores range from 0 to 10 and a score of 4 or higher indicates sarcopenia.

## Nutritional Status

The Simplified Nutritional Appetite Questionnaire (SNAQ) was used to assess appetite. It has 4 items: appetite, food taste, feeling of satiety, and number of meals consumed in a day (22). Possible scores range from 4 to 20. A score of $\leq$14 over 20 is indicative of anorexia and is predictive of at least 5% weight loss in the following 6 months.

## Cognition

Cognitive impairment was assessed using the Alzheimer's Dementia Screening Interview (AD8). The AD8 comprises of 8 questions that test for memory, orientation, judgment, and function and can be self-administered. The participant rated AD8 has been validated for use in an Asian population (23).

## Falls

The presence of a fall in the preceding 1 year was ascertained by the question, "Have you fallen in the past 12 months?" The number of falls over the past 1 year is a component of the SARC-F tool. A fall was defined as unintentionally coming to rest on the ground, floor, or lower level (24). Further data on falls requiring hospitalization, and fear of falling was captured in the questionnaire.

## Urinary Incontinence

The presence of urinary incontinence was identified by inquiring about symptoms of stress and urge incontinence through the questions "Do you ever wet yourself when you cough or strain?" and "Do you ever wet yourself before you reach the toilet?" respectively. The presence of symptoms of either stress or urge incontinence or both were considered as the presence of urinary incontinence.

## Multimorbidity

The number of comorbid illnesses was summed and calculated from a total of 13 self-reported medical conditions including hypertension, diabetes mellitus, dyslipidemia, heart disease, arrhythmias, arthritis, cancer, Parkinson's disease, stroke, chronic lung disease, cirrhosis, osteoporosis, and thyroid disease. Multimorbidity was defined as the presence of 5 or more chronic illnesses.

## Self-Rated Health

Response options for self-rated health ranged from "excellent" to "poor." Self-rated health was then classified into 2 categories, those with poor/fair self-rated health and those with good to excellent self-rated health.

## Sensory Impairment

Vision and hearing impairments were assessed by self-reported impairments in vision and hearing, respectively.

Data analysis was carried out using SPSS software (v.24) (25). Continuous variables were presented as mean (standard deviation) while categorical variables were presented as frequencies (percentages). All variables were calculated as categorical data except for age which was taken as a continuous variable. Bivariate analysis was performed using the Chi-square test for categorical variables and the Mann-Whitney *U*-test for continuous variables with non-normal distribution. A $p < 0.05$ was taken as statistically significant.

# RESULTS

A total of 162 participants answered the online survey. Fifteen duplicate responses, two potential bot responses (detected by the Qualtrics software program), seven incomplete responses and four participants who were non-eligible on the basis of age, were excluded from final data analysis. Complete data was available on 134 participants. Participants took an average time of 16.86 min to complete the survey. The mean (SD) age of the respondents was 66.42 (5.25) years. The demographic characteristics of the study participants can be found in **Table 1**. The major proportion of the study participants belonged to the age group 60–70 years (82.9%). Majority of the respondents were female, had tertiary level of education and were of Chinese ethnic origin. Twenty respondents (15%) were living alone and 103 respondents (77%) were retired or unemployed.

**Figure 1** shows the distribution of geriatric syndromes reported in the study population. Frailty was detected in six participants (4.5%), 41 participants (30.6%) were pre-frail and 87 respondents (64.9%) were robust older adults. Sarcopenia

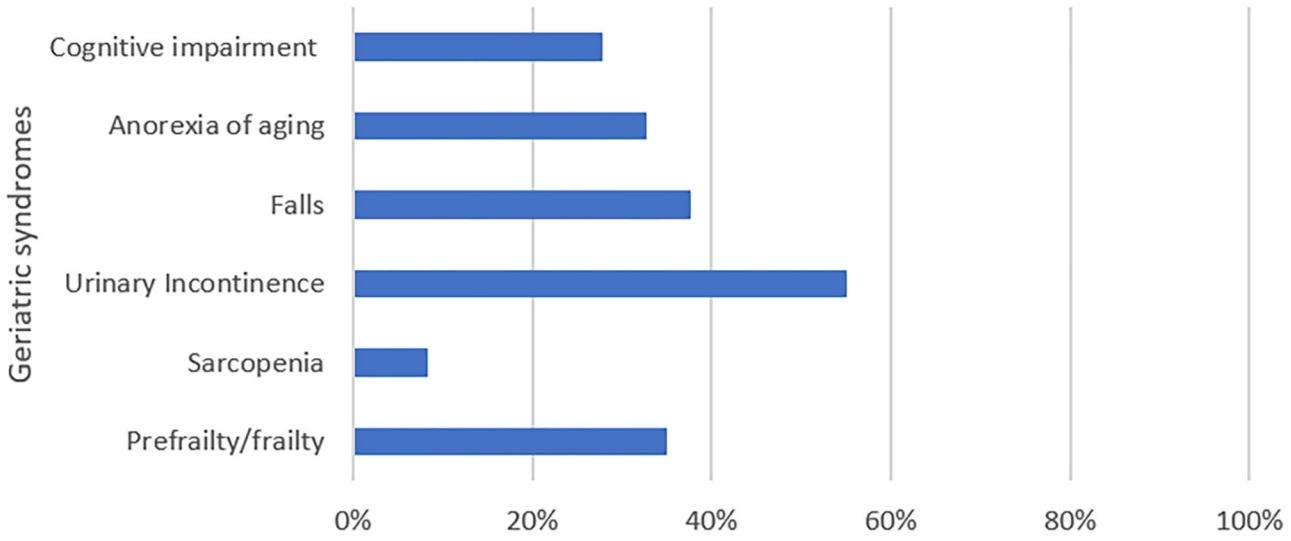


**FIGURE 1 |** Geriatric syndromes reported in study population.

**TABLE 1 |** Baseline characteristics of participants.

| No | Variable | Frequency, (percentage) |
|---|---|---|
| 1 | **Age groups** | |
| | 60–65 | 66 (49.3) |
| | 65–70 | 45 (33.6) |
| | 70–75 | 13 (9.7) |
| | >=75 | 10 (7.5) |
| 2 | **Gender** | |
| | Male | 47 (35.1) |
| | Female | 87 (64.9) |
| 3 | **Ethnicity** | |
| | Chinese | 91 (67.9) |
| | Malay | 23 (17.2) |
| | Indian | 17 (12.7) |
| | Others | 3 (2.2) |
| 3 | **Education** | |
| | Primary | 7 (5.2) |
| | Secondary | 32 (23.9) |
| | Tertiary | 95 (75.9) |
| 4 | **Employment status** | |
| | Working, part time or full time | 31 (23.1) |
| | Retired/Unemployed | 103 (76.9) |
| 5 | **Marital status** | |
| | Married | 93 (69.4) |
| | Divorced/Single/Widowed | 41 (30.6) |
| 6 | **Living alone** | |
| | No | 114 (85.1) |
| | Yes | 20 (14.9) |
| 7 | **Smoker/Ex-smokers** | 19 (14.2) |
| 8 | **Alcohol use** | 29 (21.6) |

was detected in 11 respondents (8.3%). Anorexia of aging was found in 44 participants (32.8%) while cognitive impairment was reported by 37 participants (27.8%). Fifty participants (37.6%) had experienced at least 1 fall in the past year. Fear of falls was reported by 101 (79.5%) participants. Out of 118 respondents (88.1%) who responded to questions on urinary incontinence, 65 (55.1%) were found to have symptoms of stress or urge incontinence or both. Vision impairment was reported by 63 participants (48.8%) while hearing impairment was reported by 27 respondents (22%). **Table 2** shows the sociodemographic distribution of geriatric syndromes according to age and gender.

The presence of frailty, sarcopenia, incontinence, anorexia of aging, and cognitive impairment is higher among older adults aged 75 years and above, in comparison to other age groups. The pattern of the geriatric syndromes was analyzed across various strata of frailty. **Table 3** shows this comparison.

The presence of sarcopenia, anorexia of aging, poor/fair self-rated health, urinary incontinence, and multimorbidity were significantly higher in older adults who were frail or prefrail. The FRAIL scale was used for the detection of frailty in this study. **Figure 2** shows the distribution of the individual components of FRAIL tool. Loss of weight of >5% was the highest reported component of the FRAIL scale.

## DISCUSSION

Conducting a pilot study on screening for geriatric syndromes through an online survey in Malaysia has brought out several important findings. The study was conducted over a period of 2 months, over which we received 162 respondents in the first 40 days of the study. Complete data on outcomes of interest was available in 90% of the responses. The average duration to complete the online survey was 16.86 min. This indicates that

**TABLE 2 |** Geriatric syndromes according to age and gender distribution.

| | | Age categories* | | | | | Gender categories* | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 60–65 years | 65–70 years | 70–75 years | ≥75 years | *p*-value | Male | Female | *p*-value |
| 1 | Pre-frailty/Frailty | 23 (34.8) | 13 (28.9) | 6 (46.2) | 5 (50) | 0.487 | 16 (34) | 31 (35.6) | 1.00 |
| 2 | Sarcopenia | 4 (6.2) | 4 (8.9) | 1 (7.7) | 2 (20) | 0.527 | 1 (2.1) | 10 (11.6) | 0.096 |
| 3 | Urinary Incontinence | 32 (53.3) | 24 (58.5) | 5 (41.7) | 4 (80) | 0.494 | 19 (50) | 46 (57.5) | 0.553 |
| 4 | Falls | 26 (40) | 18 (40) | 4 (30.8) | 2 (20) | 0.604 | 17 (36.2) | 33 (38.4) | 0.853 |
| 5 | Anorexia of aging | 20 (30.3) | 16 (35.6) | 3 (23.1) | 5 (50) | 0.524 | 16 (34) | 28 (32.2) | 0.849 |
| 6 | Cognitive impairment | 16 (24.6) | 14 (31.1) | 2 (15.4) | 5 (50) | 0.259 | 14 (29.8) | 23 (26.7) | 0.840 |

**Frequency (Percentage)/p-value derived by chi square.*

**TABLE 3 |** Comparison between categories of frailty.

| No | Variable | Robust | Pre-frail/frail | *p*-value |
|---|---|---|---|---|
| 1 | Age (median, IQR) | 66, 6 | 66, 7 | 0.486[a] |
| 2 | Female gender | 56 (64.4) | 31 (66) | 1.00[b] |
| 3 | Self-rated health (Poor/fair) | 15 (17.2) | 21 (45.7) | 0.001[b] |
| 4 | Multimorbidity | 0 (0) | 4 (8.5) | 0.014[b] |
| 5 | Vision impairment | 40 (47.6) | 23 (51.1) | 0.716[b] |
| 6 | Hearing impairment | 17 (22.1) | 10 (21.7) | 1.00[b] |
| 7 | Sarcopenia | 3 (27.3) | 8 (72.7) | 0.016[b] |
| 8 | Reported falls in past 1 year | 28 (32.6) | 22(46.8) | 0.134[b] |
| 9 | Presence of fear of falls | 61 (76.3) | 40 (85.1) | 0.263[b] |
| 10 | Presence of incontinence | 36 (46.2) | 29 (72.5) | 0.011[b] |
| 11 | Presence of cognitive impairment | 21 (24.4) | 16 (34) | 0.311[b] |
| 12 | Anorexia of aging | 21 (24.1) | 23 (48.9) | 0.007[b] |

[a]*Mann Whitney-U-test for continuous variables.*
[b]*Chi-square test for categorical variables.*

it is feasible to carry out data collection through an online platform over a stipulated period of time. Respondents have undertaken self-reported online surveys for the purpose of geriatric screening, from the comfort of their own environments, which could provide valuable information for the clinician.

Majority of the study participants were those with tertiary level of education and predominantly were of ethnic Chinese origin. This may be indicative of the segment of the population that actively access community groups through social media and online platforms. This is also a limiting factor of our study, as there is no external validity and therefore, our findings cannot be extrapolated to the general population. The organizations that were approached for this study were mainly community groups for older adults with an online presence. Some of the groups had regular activities and forums conducted online and face to face. Other online platforms were primarily used for information dissemination meant for older Malaysians. Digital tools and interventions developed for older adults in Malaysia need to be designed considering the demographic profile of the target population. At the same time, future interventions to improve use and access to such digital tools need to include those older adults who have limited exposure to such platforms.

Frailty is a state of increased vulnerability to stressors due to an accumulation of deficits across multiple physiologic systems (26). Frail older adults are at an increased risk of negative health outcomes such as falls, physical limitation, hospitalization, and mortality (27). There are multiple instruments to detect frailty such as the Physical Frailty phenotype and the accumulation deficit index etc. (28). Yet, this condition is often overlooked by clinicians and is seldom addressed at an early stage. This could be because of its complex nature of presentation and also due to lack of awareness in the treating physician. Frailty is a continuum that is categorized into 3 stages: robust, pre-frail and frail. The FRAIL scale is a simple screening questionnaire to detect frailty which has the added advantage of a management algorithm for each of its individual components (29). Using the FRAIL tool, 4.5% of our study population screened positive for frailty and 30.6% were found to be pre-frail. Among the individual components of the FRAIL scale, loss of weight in the past 1 year was the highest reported by our study participants. Interestingly, about one third of our study population were found to have poor appetite and at risk for future loss of weight through the Simplified Nutritional Appetite Questionnaire. Anorexia of aging is common in the geriatric population but it is often attributed to the normal aging process (30). It is a risk factor for the development of frailty. This indicates that anorexia of aging is a significant problem in older Malaysians and it requires regular screening and appropriate interventions. However, our study design was cross-sectional and therefore follow up data was not available for the participants. This is an interesting finding that can contribute to the development of appropriate interventions for frailty prevention for older adults in Malaysia. While physical exercise has been proven to play a pivotal role in frailty management, nutritional interventions are currently an area of active research (31). Further research is required to understand the nutritional component of frailty and how it can play a role in frailty prevention and management.

Sarcopenia is defined as the progressive loss of muscle mass and function (32). It is one of the newer geriatric syndromes and is associated with adverse health outcomes such as falls, fractures, hospitalizations and increased mortality (33). The SARC-F is considered to be a suitable tool for screening for sarcopenia in the community (21). Sarcopenia was found to be significantly higher among the pre-frail/frail study participants. This is similar to findings from other studies as sarcopenia is considered to a

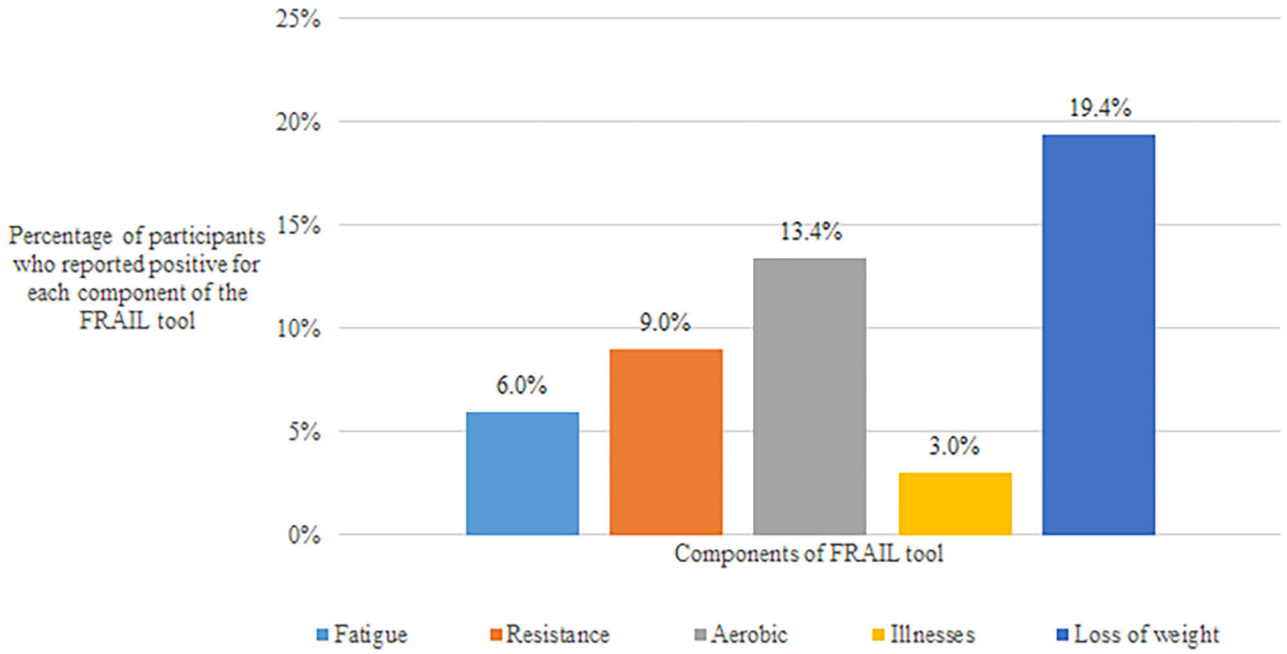


**FIGURE 2 |** Distribution of components of FRAIL tool in the study population.

key component of physical frailty. Participants of Malay ethnicity and females were found to have higher rates of sarcopenia when compared to their counterparts but these findings were not significant. This could be due to the low power of the study due to small sample size. Falls is one of the components of the SARC-F. 37.3% of the study participants reported that they had at least 1 fall over the past 1 year. Fear of falling was detected in 79.5% of the respondents. Women were found to have significantly higher levels of fear of falling when compared to men. There was no significant difference between fallers and non-fallers with respect to the fear of falling.

Cognitive impairment was assessed using the Alzheimer's Dementia Screening Inventory (AD8) that was self-administered. 27.8% respondents were found to have cognitive impairment. The participant rated AD8 is useful to gain a preliminary understanding of an individual's cognitive status (23). Considering the fact that our study participants are able to access and answer questions through an online survey, the findings suggest that these might be individuals with early cognitive changes but are functionally independent. Those detected to have cognitive impairment might be candidates for formal cognitive assessment and close follow up in the future. On the other hand, it would be highly unlikely for individuals with severe cognitive impairment to access such online surveys. Therefore, the role of screening through online platforms is better applicable for the early detection of cognitive impairment in older individuals.

Urinary incontinence is a frequently under-reported and undermanaged problem in the geriatric population. This could be due to social embarrassment or cultural barriers to discuss such issues with the healthcare provider. Out of those who agreed to answer questions on incontinence, 55% of the study population reported the presence of stress or urge incontinence which is much higher than the prevalence of urinary incontinence of 30.8% reported in an urban population in Malaysia (34). Answering sensitive questions through a survey may have prompted patients to be more open about their symptoms. Frail and prefrail older adults were more likely to report urinary incontinence when compared to robust older adults. Timely monitoring and effective management of this condition could have a role in delaying frailty and its consequences in older Malaysians.

Self-rated health is a simple measure of the overall subjective health status of an individual. It has been found to be useful in identifying vulnerable groups of older people who can benefit from targeted interventions (35). Self-rated health has also been shown to be useful in predicting institutionalization in community dwelling elderly in longitudinal studies (36). Our study findings show that self-rated health reported as "poor" or "fair" is significantly higher in pre-frail/frail individuals when compared to individuals in the robust category. Self-rated health is a simple measurable tool which has been demonstrated to be a valid predictor of chronic morbidity and mortality (37). Such findings are useful to inform resource planning and care delivery services in health care systems of developing countries such as Malaysia.

Our study has a few limitations. As data was self-reported and collected through an online tool, there could be errors in data reporting that could affect the accuracy of data. However, every effort was made to minimize false data reporting by enabling

multiple error proofing options that are available through the Qualtrics software. Furthermore, responses that were flagged as duplicate responses or bot responses were excluded from the final data analysis. Information on follow up outcomes were not available due to the cross-sectional design of the study. As the screening was based on self-reported data through an online platform, it will have to validated against clinician delivered geriatric assessments. Moreover, the tools included in the questionnaire require validation for use through an online survey. The current study may not have been successful in reaching out to a significant proportion of frail older adults who are dependent and have complex care needs due to limited access or inability to use digital platforms. The respondents of the online survey in our study are likely to be older adults who have the physical and cognitive abilities to use digital gadgets such as computers and handphones which indicates a reasonably good state of overall health. As depression was not assessed, this could have led to a possible bias in the other assessments reported in the study. Yet, geriatric syndromes reported in our study population were high which suggests that the actual magnitude of the problem could be much larger in the general population. Lessons learnt from this study can be used to inform the development of future digital health interventions for the older population.

The development of digital tools for health care are all the more relevant in the wake of the Covid-19 pandemic. Older citizens are increasingly concerned about visiting medical facilities for the management and follow up of their pre-existing ailments. Due to national lockdowns, there have been physical restrictions to travel to health facilities. Moreover, as the aging population are highly vulnerable to infections in the current situation, there is a conscious or unconscious delay in getting to hospitals, especially for detection and diagnosis of new medical conditions. This can be detrimental to the overall health of older people. Frail older adults are the most affected in times of global crisis such as the Covid-19 pandemic (38) and recognizing geriatric syndromes early has never been more relevant. The study has highlighted that there is an urgent need for researchers and policy makers to identify effective methods for early detection of geriatric syndromes in older Malaysians.

## CONCLUSION

This study has shown that screening for geriatric syndromes through self-administered online surveys is feasible to a certain extent, in urban Malaysian settings. Clinically valuable information can be collected using such tools that can be utilized by healthcare providers for better diagnosis and management. Future studies will be required to validate the use of online surveys for geriatric screening against clinical assessments. This method of screening older adults online can substantially reduce the burden on the health care system by more efficient use of existing resources. The study showed that the main challenge in using online tools for healthcare screening is to ensure accessibility and effective use by all segments of the older population.

## DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because due to concerns about loss of fidelity of personally identifiable data, the dataset is currently not available publicly. However, parts of the dataset will be released anonymised through written requests submitted to the corresponding author. Requests to access the datasets should be directed to Deepa Alex, deepa.alex@monash.edu.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Monash University Human Research Ethics Committee (2020-21334-45510). The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

DA and DM designed the study and contributed to writing of the manuscript. DA and AF were responsible for the conduct of the study and carried out the data analysis. All authors reviewed and approved the final submitted version.

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# Perspectives of ESCAPE-Pain Programme for Older People With Knee Osteoarthritis in the Community Setting

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**Background:** Functional limitationscommonly affect patients with knee osteoarthritis (OA) which reduces quality of life. The Enabling Self-management and Coping with Arthritic Pain using Exercise (ESCAPE-pain) is an evidence-based programme identified to be suitable for adaptation for the Malaysian health care system. It is important to understand the acceptance from a sociocultural context of the ESCAPE-pain programme from the perspectives of patients with knee OA and healthcare professionals. This qualitative study aims to explore the perspectives of stakeholders to inform the adaptation of the ESCAPE-pain programme into the Malaysian health care system.

**Method:** Semi-structured interviews using interview guides were conducted with 18 patients with knee OA and 14 healthcare professionals including nurses, physiotherapists, occupational therapists, medical doctors, and orthopedic surgeons. The data were transcribed and analyzed using framework analysis.

**Results:** The findings show that patients and healthcare professionals positively accept the programme into their daily living activities and recommend some modifications related to the Malaysian context. This study also highlights strategies to adopt when providing ESCAPE-pain to patients with knee OA.

**Conclusion:** The findings reveal how sociocultural considerations could facilitate uptake and engagement with the ESCAPE-pain programme for home exercise among patients with knee osteoarthritis. These findings may benefit t patients with knee OA in the Malaysian healthcare system, although future research is recommended.

**Keywords: osteoarthritis, exercise, self-management, primary care, community**

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## INTRODUCTION

Over the last 20 years, symptomatic knee OA has increased globally and it is anticipated that it will continue to increase due to growing levels of obesity and population survival into older age (1, 2). This requires healthcare professionals to prepare for the increased demand for services to treat OA (3). A study on the global burden of disease in 2012 estimated that 250 million people are affected by knee OA, with rates in females being almost double that in males worldwide (3, 4).

In Malaysia, the Arthritis Foundation of Malaysia (AFM) estimates that around one in ten older people aged 60 and above have OA, with the most common form being OA of the knee (5). Although there are no precise data for patients with knee OA currently in Malaysia, the Community Orientated Program for Control of Rheumatic Diseases (COPCORD) study on musculoskeletal pain concluded that the knee was responsible for the majority of all reported complaints of joint pain during the study, and on further examination more than half of those with knee pain had OA (6).

Current clinical practice guidelines (CPG) provided by the Malaysian Ministry of Health (MOH) for managing patients with knee OA focus on hospital-based care, which involves multidisciplinary approaches with pharmacological treatment and surgery alongside health education (7). It is recommended that patients with OA are educated about the diagnosis, weight reduction (for obese patients), range of motion exercise, strengthening, and aerobic exercise (7). Little is known about the strategies and delivery system used to ensure that the patients adhere to their prescribed treatment in Malaysia. It is also observed that no community or home-based programme for patients with knee OA are offered or implemented in the country as an alternative if they are unable to afford hospital treatment.

In order to explore how patients with OA can benefit from a self-management programme, we systematically searched the most feasible, evidence-based programme for OA. The ESCAPE-pain programme has been shown to be safe and cost-effective for individuals with either knee or hip OA (8–10). ESCAPE-pain is a rehabilitation programme that integrates educational self-management and coping strategies for people with joint pain with an individualized exercise regimen for each participant. The programme is available online at www.escape-pain.org to facilitate wider clinical implementation to benefit more people (11). In brief, the programme comprises two components, which are education and exercise. The education component aims to educate people to understand pain, physical activity, healthy eating, drug management and simple ways to cope through self-management. Meanwhile, the exercise regimen is a progressive exercise programme and tailored according to the individual's abilities and needs including strength, balance, coordination, control and function. It is delivered twice a week for 6 weeks in small groups of 8-12 people (12 classes) (9, 10).

It is important to consider how the programme fits in with current practice and its acceptability and feasibility. This information is needed to inform future implementation if the trial demonstrates that the programme is effective for patients with knee OA. Thus, we conducted semi-structured interviews with patients with knee OA and their associated healthcare professionals. The goal of this study was to understand how OA is currently treated in primary care setting and to explore the perspectives of healthcare professionals and patients on the acceptability and feasibility of a structured self–management programme that involves community approach.

# METHODS

## Design

A pragmatic qualitative approach was chosen for the study, whereby it does not adhere to any specific methodological approach, but is concerned with the real-world issues related to the stakeholder's perspectives of the ESCAPE-Pain programme, it, therefore, takes a more general approach to the area of study (12). The aim was to explore the beliefs and attitudes of healthcare professionals and patients with knee OA toward the ESCAPE-pain programme, including their perspectives of the current management of knee OA. The findings will inform the adaptation of ESCAPE-pain programme for implementation in the Malaysian healthcare context.

Face-to-face individual semi-structured interviews were undertaken to explore the overall opinions of the participants concerning their current management of knee OA and their perspectives of the ESCAPE-pain programme. The programme consists of education and exercise components were thoroughly explained to healthcare professionals and patients with knee OA by providing the programme booklet and exercise diagram. For the education component, they were asked about simple education, self-management, coping strategies, and exercise regimen. While the exercise components, they were asked about each exercises mode such as using static bike, bench, boards, theraband, and other physical movements. Interviews were chosen to obtain personal opinions that participants may not have been comfortable with sharing in the presence of other people, such as with focus groups (13). Interview guides for both healthcare professionals and patients were developed based on a review of the literature, the study context and the experience and knowledge of the author in the field (**Table 1**). This included questions considered relevant for eliciting pertinent information about how participants might engage with the programme. The interview guides were initially written in English and translated into Malay. The translated documents were piloted among Malay native speakers to check for understanding and clarity of the language. The semi-structured interviews were guided but at the same time, the interviewees were open to what participants say by conducting the interviews conversationally. The style of the conversation provided flexibility to probe or ask follow-up questions based on interviewees' responses (14). The ESCAPE-pain programme was introduced to the participants after asking about their experience of managing their knee OA.

## Participant Information

Participants were recruited from two selected hospitals in Malaysia. Healthcare professionals were included if they were one of the orthopedic surgeons, medical doctors, nurses, physiotherapists and occupational therapists with at least six months' working experience in orthopedics rehabilitation or with related qualifications such as Advanced Diploma in Orthopedics or equivalent; and directly involved in the management of patients with knee OA. A total of 14 healthcare professionals (eight men, six women) were approached and interviewed comprising two orthopedic surgeons, two medical officers, three

**TABLE 1 |** Example of interview guide for healthcare professionals.

| Topic | Specific objective | Example |
|---|---|---|
| **Healthcare Professionals** | | |
| Current management for patients with knee OA including support, facilities, effectiveness, role, barriers and influential factors. | To explore healthcare professionals' experiences, concerns and needs in the management of knee OA. | Could you explain about the support or facilities provided in this hospital to help patients in managing their knee OA? |
| Views on the suitability of education component and exercise regimen interventions from ESCAPE-pain programme. | To explore healthcare professionals' cultural and religious beliefs as regards the ESCAPE-pain programme. | Do you think that simple education will work for patients with knee OA? Why?<br>Do you think that an exercise regimen for an individual will work for patients with knee OA? Why? |
| Recommendations of other relevant strategies, interventions and tools for consideration. | To consider how the ESCAPE-pain programme could be integrated into the care pathway in the Malaysian healthcare system. | Which other strategies, interventions or tools would you consider including as one of the elements? Please explain. |
| **Patients With Knee OA** | | |
| Experience of self-management of knee OA. | To gain insight into patients' views regarding management of knee OA. | What is your opinion of the effectiveness of the service provided in helping you to manage your OA? |
| Views on treatment, facilities, effectiveness, barriers and influential factors of the hospital/healthcare. | To explore patients' experiences, concerns and needs in the management of knee OA. | What are the barriers/influential factors when receiving treatment from the hospital? |
| Views on the suitability of education components and exercise regimen interventions from the ESCAPE-pain programme. | To explore patients' cultural and religious beliefs about the ESCAPE-pain programme. | Do you think that simple education will work for you? Why?<br>Do you think that a personalized exercise regimen will work for you? Why? |
| Recommendations of other relevant strategies, interventions and tools for consideration. | To consider how the ESCAPE-pain programme could be integrated into the care pathway in the Malaysian healthcare system. | Which other strategies, interventions or tools would you consider being one of the elements? Please explain. |

**TABLE 2 |** Demographic data of healthcare professionals.

| Respondent | Gender | Age | Occupation (Highest qualification) | Work Experience in years |
|---|---|---|---|---|
| HCP01 | Male | 32 | Nurse (Masters) | 8 |
| HCP02 | Female | 36 | Nurse (Advanced Diploma) | 10 |
| HCP03 | Male | 29 | Physiotherapist (Diploma) | 8 |
| HCP04 | Female | 29 | Physiotherapist (Diploma) | 7 |
| HCP05 | Female | 32 | Occupational Therapist (Diploma) | 10 |
| HCP06 | Female | 33 | Occupational Therapist (Diploma) | 11 |
| HCP07 | Male | 35 | Occupational Therapist (Bachelor's Degree) | 12 |
| HCP08 | Female | 37 | Nurse (Bachelor's Degree) | 14 |
| HCP09 | Male | 46 | Assistant Medical Officer (Diploma) | 19 |
| HCP10 | Male | 33 | Physiotherapist (Bachelor's Degree) | 5 |
| HCP11 | Female | 29 | Medical Officer (Bachelor's Degree) | 5 |
| HCP12 | Male | 45 | Consultant Orthopedic Surgeon (Masters) | 25 |
| HCP13 | Male | 29 | Medical Officer (Bachelor's Degree) | 5 |
| HCP14 | Male | 34 | Orthopedic Surgeon (Masters) | 9 |

nurses, three physiotherapists, three occupational therapists and one assistant medical officer (**Table 2**).

Patients were included if Diagnosed with OA affecting the knee by a medical officer based on CPG MOH (7), and mentally capable of giving informed consent; Aged 50 or above, the minimum requirement for the diagnosis of knee OA based on CPG MOH (7). Twenty patients were approached via clinic appointments and 18 completed the interview sessions. Two patients withdrew due to lack of interest and time constraints. The group consisted of both genders (male $n = 5$; female, $n = 15$) and ages ranged from 51 to 81 years old. The participants were from various ethnicities and cultural backgrounds (Malay, $n = 9$; Chinese, $n = 8$; Indian, $n = 3$). Seven participants had literacy problems and the rest had various levels of education; three were still working as civil servants at the date of the interview. The time since diagnosis with knee OA varied from 1 to 30 years (**Table 3**). Participants were excluded if they were unable to understand the Malay language.

## Procedure

This study obtained approval from the University of Manchester Research Ethics Committee (Ref:16451) and

**TABLE 3 |** Demographic of patients with knee OA.

| Respondent | Gender | Age | Ethnicity | Level of educational background | Duration of knee OA in years |
|---|---|---|---|---|---|
| P01 | Female | 68 | Malay | No formal education | 20 |
| P02* | Female | 71 | Malay | No formal education | 6 |
| P03* | Female | 70 | Malay | No formal education | 10 |
| P04 | Female | 80 | Chinese | No formal education | 30 |
| P05 | Female | 64 | Malay | No formal education | 6 |
| P06 | Female | 61 | Malay | MCE | 4 |
| P07 | Male | 56 | Malay | Master's Degree** | 7 |
| P08 | Female | 74 | Chinese | No formal education | 12 |
| P09 | Female | 61 | Chinese | MCE | 7 |
| P10 | Male | 51 | Chinese | MCE | 3 |
| P11 | Female | 64 | Chinese | MCE | 9 |
| P12 | Female | 56 | Malay | Diploma** | 5 |
| P13 | Female | 55 | Chinese | LCE | 5 |
| P14 | Female | 69 | Chinese | MCE | 8 |
| P15 | Male | 62 | Malay | MCE | 16 |
| P16 | Female | 64 | Indian | Standard Three, PS | 25 |
| P17 | Female | 64 | Indian | LCE | 4 |
| P18 | Female | 70 | Indian | Standard Six, PS | 1 |
| P19 | Male | 60 | Malay | MCE | 10 |
| P20 | Male | 53 | Chinese | Bachelor's degree** | 1 |

**Incomplete interview and withdrawn from the study. **Still working. MCE, Malaysian Certificate of Education; LCE, Lower Certificate of Education; PS, Primary School.*

the Medical Research Ethics Committee (MREC), Malaysia [Ref: (10)KKM/NIHSEC/P16-1552]. Hospital OA teams were identified to acquaint them with the aims and details of the study, and to solicit their authorization and co-operation.

Information was obtained about the members of the OA healthcare professionals' teams including representatives from primary care medicine, rheumatology, nursing, and physiotherapy staff such as gender, age, profession, and number of years in service. Healthcare professionals were purposively sampled by years of experience, age, and gender to reflect the diversity of the different healthcare professionals who support patients with OA. Purposive sampling provides rich information with diverse perspectives of the exploration of phenomena (15).

Meanwhile, patients diagnosed with knee OA were identified from their attendance at an outpatient clinic appointment, from outpatient clinic census or hospital records. A meeting was conducted with the members of the clinical staff regarding the study and criteria for patients. Patients were asked by the member of clinical staff if they were willing to be approached by the researcher. Potential healthcare professionals and patients were approached, provided with verbal information about the aim of the study, how the data would be conducted, what participation was required of them and the time needed for the interview before consent obtained. The interview sessions were audio-recorded and lasted between 60 and 90 min. All interviews were conducted in Malay language by the same researcher. The participants were informed about their right to withdraw from the study and confidentiality of the data.

## Analysis

The interviews were analyzed in Malay using QSR NVivo version 12 (16), to preserve the implicit and contextual semantics, and then translated into English. Issues of bilingualism were overcome by checking and re-checking the audio against the written transcriptions to ensure consistency. The process of transcription, anonymisation, and analysis using the framework approach generates themes through step-by-step contrasting and comparing across the data which produces highly structured findings (17). Framework analysis is beneficial by clearly tracking the movement of data (18, 19). It also follows well-defined procedures and provides the possibility of reconsideration and reworking ideas which enables collaborative analysis (19). Thus, the analytical stages lead to the final interpretation of the research findings (20).

Based on the transcripts, initial categories were developed. Then the initial themes were identified, and the connections between themes were analyzed to identify the main themes and subthemes. This process involves intuitive and logical thinking to judge the meaning and examine the links, to fully address the research questions (21). The initial themes were constructed based on the issues informed by the research objectives, and healthcare professionals' and patients' perspectives on the transcripts. This familiarization process continued until the information had been fully understood and all transcripts reviewed. Meetings with the research team were conducted to discuss the dataset and develop consensus of coding and interpretations.

# RESULTS

Overall, the data reflect the healthcare professionals' experience in relation to the management of patients with knee OA, their explanations of how they cared for patients with knee OA, their perspectives of the ESCAPE-pain programme, and potential modifications that they think might be helpful for patients with knee OA in Malaysia. Both healthcare professionals and patients were positive toward the implementation of the ESCAPE-pain programme among the community. Positive views of the ESCAPE-pain programme were reported, with patients preferences and their understanding of the commitment required. The findings are summarized under three key themes: eagerness to know about ESCAPE-pain; coping with knee OA, and desired care. The main themes and subthemes that emerged from the data are outlined in **Table 4**.

## Healthcare Professionals

### Positive Views of the ESCAPE-Pain Programme

#### *Current Challenges Create Future Opportunity*

The healthcare professionals described their management of patients with knee OA and the provided services for these patients. The healthcare professionals understood their role in providing the best available treatment to patients with knee OA. Healthcare professionals described that in providing the services to patients with knee OA, they encountered many challenges such as shortages of staff, overcrowding of patients and high workload.

> At the hospital, we have limited manpower to provide the best care to all patients… We try to educate them, but for various reasons, we cannot deliver the best… We don't even call them to ask about progress… The only thing is, we ask them during the next appointment visit… That's all… If you run education in a group like this programme (ESCAPE-pain), they will be happy… Meeting people could also make them happy… (HCP04)
>
> We have time constraints looking after the patients while they're attending their appointments… Running the clinic effectively is added to this difficulty… It's everyday business, many patients… Every day… If you mentioned the programme could be conducted at home, that would be better… (HCP08)

These challenges were routinely observed in current practice. The ESCAPE-pain programme was described as being able to potentially facilitate the process of delivering healthcare services to patients with knee OA without requiring a visit to the hospital. The healthcare professionals agreed that recruitment to the ESCAPE-pain programme should be based on the availability of the patients and what the instructor considers to be a manageable number to support.

#### *Enabling the Understanding of Intervention Through Education*

The healthcare professionals described the component of education as a valuable addition to increase understanding regarding self-management of knee OA. They agreed to most of the content of the programme as described by the interviewer. They noted that in Malaysia there are different ethnic groups, different beliefs and different cultures. This understanding of the complexity of the Malaysian people is important as it may influence the implementation of a new programme and its acceptance. The healthcare professionals highlighted that the educational component in ESCAPE-pain could facilitate the understanding of the intervention among the Malaysian people.

> When we teach them, we demonstrate the real thing for them; they would accept it… So far, they are tolerant… Through effective education, they will know what to do… (HCP03)
>
> We should reinforce the programme with pamphlets, videos or a related website for their reference… I understand that those are emphasized in the ESCAPE-pain programme… Just check whether the patients involved have the access to those technologies mentioned… (HCP07)

All components in the ESCAPE-pain programme were viewed by the healthcare professionals as helpful for patients with knee OA. In addition to that, all of them spoke positively about the implementation of the ESCAPE-pain programme in Malaysia.

> Implementing this (programme) will be very good. Most of the patients agree with getting health education from us. We tell them what to do based on their ability. They have no objection to doing it. The only thing is they might complain of pain. No excessive movement is what they prefer... (HCP02)
>
> This (ESCAPE-pain programme) is good. We can give it a try. Call up a few patients who will agree to come to this session. It might help them… (HCP11)

The educational component of ESCAPE-pain consists of relevant topics that could facilitate the understanding of the intervention in the Malaysian context. The healthcare professionals highlighted that, in the context of Malaysian people, some older people attending hospital for treatment had not received formal education in their youth due to the political and economic difficulties during their childhood. Some of them had low levels of literacy but were keen on the use of step-by-step pictures (such as photos or illustrations) and numbering.

> Some of them do not know the Malay language, we talk to their daughters… Some also do not know how to read: we provide them with illustrations… But sometimes, we don't have the resources to give to the patients… (HCP01)
>
> Many of my patients attending for treatment do not know how to read the Malay language… And some of them cannot read at all… But they know numbers… Simple instructions might work… (HCP06)

A simpler version with more pictures was suggested, but the full version was found to be helpful for the family members and friends in understanding in advance the support needed.

#### *Concerns About the Exercise Component*

Referring to the exercise components in the ESCAPE-pain programme, the healthcare professionals tended to state that any equipment involved (particularly the static bike) may not be acceptable for the patients. Among the reasons were safety issues and the economic background of people suffering from knee OA in Malaysia. The exercises could be modified or replaced with another related activity, based on the capability of the patients.

**TABLE 4 |** Themes and subthemes from interview data.

| Participants | Themes | Sub-themes |
|---|---|---|
| Healthcare professionals | Positive views of the ESCAPE-pain programme | Current challenges create future opportunity |
| | | Enabling the understanding of intervention through education |
| | | Concerns about the exercise component |
| | Anticipating the preference of the patients | Possibility of participation |
| | | Post-intervention |
| | | Cultural aspects and beliefs |
| | Understanding of commitment | Family and social support |
| | | Ability to adhere |
| | | Motivational status |
| Patients with knee OA | Eagerness to know about ESCAPE-pain | Excited about the programme |
| | | Ability to exercise |
| | Coping with knee OA | Difficulties of OA |
| | | Complementary therapy in a cultural context |
| | | Anxiety |
| | Desired care | |
| | | Effective communication |
| | | Continuous support |

> Usually, we will advise the patients to use a water bottle (as a weight) to replace the quadriceps bench… There are different types of (muscle) movement, put the weight on a different side… (HCP03)
>
> If they don't have a bike at home, we could advise them to walk if our aim is for cardio (endurance). If our aim is for their range of movement, we may advise them to cycle their legs while lying down… Just imagine how you pedal a bike… Or if they have very limited range, just swing the leg… If they have improved, they may continue on to a heel slide… (HCP04)

The alternative approaches provided by the healthcare professionals are not contradictory to the exercise regime in the ESCAPE-pain programme. This was checked with the originators of the ESCAPE-pain programme. Modifications can be made depending on the objective of the exercises either for endurance, strength, balance or flexibility. Meanwhile, the healthcare professionals perceived that some of the exercise types may not be suitable for older patients with knee OA as they could increase their risk of a fall. They suggested that a safety assessment must always be conducted.

> Usually, we don't advise the patient to do a wall squat in the 90-degree position. That is dangerous. We need to stand by with a cushion or mattress (on the floor), just in case… They might fall (HCP07)
>
> If the patient wants to try the boards, we must supervise. I am afraid they will fall. It will put pressure on the knee. The wall squat is also risky, putting an extra load on the knee… (HCP10)

Although exercises without sophisticated equipment are offered in the ESCAPE-pain, the main aim is to encourage the participants to engage with the exercise based on their capability, regardless of the type of exercise. Modifications must be true enough to the original ESCAPE-pain programme without jeopardizing the core components of the programme.

## Anticipating the Preference of the Patients

### *Possibility of Participation*

Although the components of ESCAPE-pain are relevant to the context, the healthcare professionals reported that there may be possible barriers to participation. The healthcare professionals gave an example of current treatments provided by the hospital. Some patients were reported to have a lack of motivation to follow the prescribed treatment. These patients are seen as not prioritizing their health due to other possible commitments such as being the main financial provider for the family.

> For those who are doing business for a living, the only thing we can provide is education. For sure they have no time to do other things. They will be focusing more on their daily business. Different for a housewife: she might do this (exercise) while watching TV. At least she does… (HCP04)
>
> Patients might default on the treatment if they feel that it is difficult for them to attend… As healthcare professionals, we want to see them, to look after them… They will only come to the hospital if they encounter any problems… (HCP14)

Some healthcare professionals perceived that some barriers to participation may be due to age-related factors that may affect the ability of some patients to perform the tasks related to the treatment. Some also reported that the patients' sedentary lifestyle had become a norm already, and thus difficult to change.

> I think because they are old, the older people, they don't even have any desire to move. Sometimes OK, sometimes unmotivated (Malay: malas)… (to move)… They might not participate effectively… (HCP04)
>
> They are old already to me. In addition, they have had no formal education before; they might be able to understand simple instruction only… It might be difficult to perform an effective intervention for them… (HCP11)

Other factors were pointed out by the healthcare professionals as a reason for the ineffectiveness of current treatment. Three main aspects were highlighted: long waiting lists, time constraints and oversubscribed services.

> The gym (physiotherapy) is small, packed; the patients frustrated when they come. Also, it's difficult to park, the distance between one appointment to another is long… There's nobody around to bring them and fetch them from hospital… It's a logistics issue (HCP08)
>
> If we have time to educate the patients during free clinic time, we will. The fact is that we have limited staff, so we must refer them to physiotherapy… We hope they may have time to do it… (HCP13)

Thus, understanding the difficulties of delivery of treatment to patients with knee OA may facilitate the understanding of possible participation in the ESCAPE-pain programme. ESCAPE-pain was seen as best implemented in the community or home setting due to current difficulties faced by both healthcare

professionals and patients with knee OA in getting the best treatment at the hospital.

### Post-intervention

Another theme highlighted by the healthcare professionals was the continuous engagement after the completion of the programme. Assessing the capability of the patients and understanding the socio-demographic differences were seen as important for post-intervention. Apart from different cultures, the Malaysian community also has differences in economic status and geographically different areas such as urban, suburban and rural areas. These factors may influence patients in terms of access to healthcare facilities, recreational and daily needs. Pre-assessment of patients' backgrounds may help to identify the best strategies for an individualized exercise provision.

> We immediately educate them about home exercise… Every appointment, we will teach the patient some home exercise… We will tell them what they can do, what they cannot do… What they should do… What to be cautious of… (HCP10)
>
> The patients might not be able to afford to buy the equipment. Those attending the government hospital are usually low to middle income people (HCP13)

The healthcare professionals expressed that different ethnic groups also practice different daily living activities based on their health perceptions. It was observed that some ethnic groups may practice better physical activities than others.

> Malay especially, and the older females, are not keen to do exercise: they see it as something strange to them… (HCP02)
>
> To me, the Chinese are more disciplined in terms of performing the exercises; they have Tai Chi, even group dancing for example, but not Malay… (HCP03)

Therefore, understanding the differences between the ethnicities may be helpful when considering how to present or implement the programme. The healthcare professionals also perceived that the patients may require continuous support with good communication skills in order to help them to feel positive about the programme in the home setting.

> Some patients are willing to buy home exercise equipment such as a static bike… They will use it initially… Toward the end, they might not do it again… The home environment is sometimes not encouraging… If they are really enthusiastic, yes, they will do it… Otherwise, they won't do it… Home-based exercise should be encouraged… (HCP03)

The delivery of the programme could be modified according to the patients' beliefs and daily living activities. This may help the patients continue to engage with the programme after completion of the intervention.

#### *Cultural Aspects and Belief*

The majority of Malaysian people embrace religious beliefs which they practice as part of their activities of daily living. They perform rituals or prayers based on their faith and these fulfill the needs of a follower. Therefore, if they have difficulty in performing these activities, they may seek help by searching for any available treatment to solve their problems. This was also highlighted by the healthcare professionals: that the patients who come to hospital need treatment to improve their daily living activities including performing their religious activities.

> When they pray, they will have a problem. So they come to get our advice. If they are not confident in us, we will get the religious officer to teach them how to pray while sitting. They still can do it even though they feel that it is not perfect (HCP05)
>
> We advise the Muslims particularly to pray sitting… However, there is not much difference… Before attending hospital they also prayed sitting… The only thing is that they will feel more confident when the healthcare professionals advise them according to their beliefs… (HCP11)

Thus, restrictions in performing religious activities appeared to be a potential motivator for the patients to seek available treatment. An alternative method of treatment for symptoms may be perceived as a positive alternative by older people. When providing education, simple instructions were seen as helpful for older people. In these circumstances, the delivery of the programme is illustration based, with active group discussion and follow-up strategies to enhance understanding.

Other than undertaking physical activities, the healthcare professionals perceived that the patients with knee OA may have their way of managing their symptoms through traditional practices. The healthcare professionals reported having no problem with the patients' traditional approach as long as it did not worsen the patients' symptoms.

> Sometimes they will see a "bomoh" (traditional healer) first, and they will only come to us if it does not work with them… We advise them to come to us first, but then that is their belief, we cannot force them (to come to the hospital) … (HCP06)
>
> Many of them will go for massage, hot compress using hot stones (Malay: bertungku), but… Hmmm… We cannot prevent them because it is a norm here… If you have pain you go for a massage, or hot compress… (HCP13)

While reading through the ESCAPE-pain programme, the healthcare professionals highlighted the need to comply with the local context for some of the contents. They believed that this would not change the main content of the programme.

> In my experience, most people… Particularly the older people… Are sensitive to cultures in many ways… The food, the lifestyle, the relationships and so on… (HCP09)
>
> I would recommend that the programme uses local photos or pictures, portraying our way of life, which could be practical for (the older) people to follow… (HCP14)

Therefore, incorporating cultural aspects and beliefs may facilitate the understanding of the preferences of patients with knee OA. This cultural knowledge may facilitate the process of adapting the programme into the Malaysian context. The recommendations of the healthcare professionals regarding the culturally sensitive content were used for the adaptation of the ESCAPE-pain programme in this study.

### Understanding of Commitment

#### *Family and Social Support*

The healthcare professionals indicated that there may be some positive factors that may facilitate concordance with treatment. The influence of caregivers including family members and their level of education contributed to positive reinforcement. The healthcare professionals also emphasized that caregivers may also influence the decisions made by the patients regarding treatment.

> We try to use the motivational interview in our care… We ask them to describe what they would do with the family if they were healthy… We try to motivate the family as well to care for the patients… (HCP07)
>
> We have to see them with the caregiver, the spouse, son or daughter; they can be involved together (HCP05)

So, the opportunity for healthcare professionals to involve family members or caregivers in treatment was perceived to be important. This factor may assist with the acceptance of the programme by patients. Social support was reported to be important in increasing engagement with any treatment. The patients seemed to have good peer support when socializing with other patients with similar conditions.

> Usually, the patients will be anxious at the beginning… However, when other patients explain the management and care to them, it influences them … Supporting each other is seen to be effective… They need to socialize at the beginning of the treatment… (HCP06)
>
> When we conducted the sharing session, we found the patients' self-esteem was better if they managed themselves… Unlike previously, they feel loneliness… They know that other people also have similar problems to them… We noticed that they tend to attend appointments… Because of other people similar to them… Better adherence, I believe… (HCP07)

Thus, for patients with knee OA, being supported by relatives and other patients with similar conditions appears to facilitate the acceptance of treatment or intervention of care.

#### *Ability to Adhere*

Another concern of the healthcare professionals was the ability of prospective participants in the programme to adhere to the twice-weekly schedule for 6 weeks. They highlighted that good communication, continuous reminders and building good rapport may be important to promote adherence to treatment.

> If we provide the patients with systematic health education, I think they will follow it… It helps patients… Any types of diseases or problems, we provide health education… The most important thing is effective health education… (HCP01)
>
> The patients will do the exercise intervention… But we need to remind them of those exercises… Follow-up calls are very helpful… We call the patients or their family or relatives just in case if they have any difficulties or problems… (HCP02)

The healthcare professionals added that the patients may also adhere if the programme suited their daily activities, though effective communication and gentle reminders were recommended.

> I think we must keep telling (reminding) the older (people) generation… Only then will they keep following it (the content) … But… It depends on their acceptance as well… (HCP11)
>
> Usually, when we advise them, we should follow it up (for effective education) … It sounds additional effort to do… But sometimes we have no time… Although we know it is essential to track the progress (HCP13)

The healthcare professionals added that, in their experience, regular reminders may help the implementation to be effective in terms of adherence to the programme. Thus, follow-up sessions were one of the important reported strategies that may assist with continuing engagement.

#### *Motivational Status*

According to the healthcare professionals, the educational status of the patients may also influence the acceptance of treatment or health-related education as the majority of the patients receiving treatment in the general hospital are people from low to middle socioeconomic class. Also, people from different ethnic groups may not fully comprehend the official language of Malaysia due to limited use of their own language, such as Mandarin, Cantonese, Tamil, or local dialects. These aspects could influence their motivational status in receiving care.

> To me, education and practice, it depends on the level of education. If low, they will listen but not do. If they are educated people, they will listen and follow instructions (HCP06)
>
> There are patients who are highly motivated to come to do exercise… This type of patient could support the other patients to do it together… The enthusiasm is really good to encourage other people (to do exercise)… (HCP08)

Motivational status was perceived to be one of the factors to consider to ensure a good outcome for the programme. Motivational levels could increase or decrease, but the most important was to keep motivating the patients through different methods.

## Patients With Knee OA

### Eagerness to Know About ESCAPE-Pain

#### *Excited About the Programme*

While the ESCAPE-pain programme was being explained to patients with knee OA during the interviews, most of the patients expressed positive attitudes toward the programme. They were interested in getting further information about the programme and wished to be able to join the programme once implemented. They were excited about socializing with other people during the group discussion of the educational components.

> I would seriously consider joining the programme. At least I can socialize with people with the same thing in common… (P08)
>
> I have to take care of myself. I am not only living with knee pain, but also I am a breast cancer survivor. I do not want to be free (to have free time). I always tell myself, I will mark the

calendar if I want to do something, and I think I can manage myself (P11)

They appeared to be pleased about the possibility of joining the programme. They perceived that the two components in the ESCAPE-pain programme may benefit them in managing their knee OA. They were also excited about self-managing their symptoms.

### *Ability to Exercise*

The patients felt that most of the exercises in the ESCAPE-pain programme would be easy to perform and require little guidance for implementation. Some of the patients said that they would perform physical activities as part of their daily lives.

Sometimes when I lie down alone, I raise my leg… In supine position, I feel good. If I feel pain, I stop. If I sit on a chair, I will raise my leg up to 50 (times). I stop. I feel light (better) for a while… (P06)

I just walk every day. I just do hand movements, like this, like that, up and down. Sometimes I move my leg like this. I exercise myself. Nobody taught me… (P14)

The patients also mentioned that an exercise bike may not be affordable for them, while some exercises in the regime may also not be suitable for them as they had specific difficulties.

I feel nervous when I step down. Very painful (step down). A higher step is more painful. To step forward is very painful… It is very exhausting… I can't even run. Only walk… I can walk halfway and stop… (P07)

Squatting is very painful … If I want to stand, it is very painful… It is very stiff… I have to hold on to something to get up from squatting or sitting … (P09)

Thus, the exercise may need to be based on the participants' functional abilities as recommended in the ESCAPE-pain programme. Any activities which are painful for a given participant are discouraged in the programme. Only the equipment which is available for the participant is encouraged, if there is no equipment, the participants may complete other exercises. Some patients added that their daily practice of spiritual activities may also have a positive impact on them. This may help the patients engage with physical activities.

Usually, after morning prayer (subuh), I will do some exercises. The daily practice of prayer reminds me to do exercise. In the afternoon, if I have nothing to do, I will do exercise too… (P05)

In those days I went for exercise, did qigong, very active… Now, I wake up at 5 am, do some prayer, then I do yoga. Every day… I just started… Due to the knee pain. Now I can fold the leg. If I don't exercise, I am afraid it will jam… (P17)

Therefore, participants may need to be asked about the best time for them to practice exercise. Spiritual or religious practice may be part of the assessment as it may be considered the best time to include the exercise regime.

## Coping With Knee OA

### Difficulties of OA

The patients revealed that they were having problems undertaking prescribed treatment by the hospitals for reasons such as family matters, time constraints, economic factors and lack of motivational support.

I have to wait for 2 to 3 h. Moreover, I am having difficulty communicating in good Malay language with the others. I feel so quiet… (P08)

If I go to the hospital, I will get free service. If I want to buy it, it is not affordable. It (the equipment) is very expensive (P16)

Usually, the treatment in the hospital is once a week. I think it is inadequate; otherwise, I have my own equipment. Meanwhile, I think that they (healthcare professionals) do not provide individualized treatment… That's my comment (P20)

However, they required treatment to manage their symptoms, which many Muslim patients mentioned affected their religious practice. They reported certain limitations.

If I want to pray, I must sit for a long period first then can only walk to the bathroom If it's morning prayer (subuh), it is not too bad to pray although I have to move my leg first before getting up. The reason for not going to the mosque is knee pain. If nobody takes me, I don't go. (P05)

I am having difficulty praying. I should sit on the chair to pray. I feel that it is not the perfect way of praying. I hope God will accept my prayer. (P06)

Participants reported that they wanted to overcome their symptoms in order to make themselves feel like better people through being able to perform religious activities. This factor appeared to be a good motivator for the participant to take part in an exercise programme. Either they had to go to the hospital, or they had to find alternative ways. They perceived that through education and exercise, they could perform the exercises by themselves.

The patients with knee OA also revealed that they faced lots of difficulties in daily life due to the disease. They believed that biological factors (age) were predetermined and therefore inevitable. However, the psychological factors (fear of exercise, low self-esteem) could be considered and controlled as a means of overcoming the destructive emotions if the treatment was suitable.

Everything is stiffening already. I am too shy to start doing exercises, I am too old. There's nothing much we can do (P08)

If I were having extreme knee pain, I wouldn't look for this (exercise) equipment. I have to accept that, it is from God. The time has come, the number of age has increased… (P12)

The patients expressed feelings of shame and inconvenience about doing exercises. They were afraid of what people around might think, they were not motivated, and also feared the risk of falling.

If I go to exercise, it is only because of knee pain. We are afraid that another illness will come. Maybe a fall. So, I think if safety

precautions are taken to prevent any injuries, for me this will be better... (P12)

First thing, it is unmotivated (Malay: malas), the second thing is it is an inconvenience. Otherwise, if there are not too many types (of exercises) then it might be OK. I prefer cycling… So I am seriously thinking of going to the gym (gymnasium). (P20)

Recognizing the difficulties of knee OA and its consequences may enable facilitators to plan future interventions by using the facilitators and including activities that may decrease or overcome the barriers. Motivational interviewing as in the ESCAPE-pain programme seems to be a good activity to conduct during a group discussion in order to encourage behavioral changes among older people.

### *Complementary Therapy in a Cultural Context*

The patients revealed that restriction of activities and constant pain are part of their difficulties of living with knee OA. They said that one of the strategies for managing symptoms of knee OA is the use of alternative or complementary treatment. Many different approaches were reported to minimize or decrease the burdensome symptoms, including Islamic traditional healing, massage, traditional Chinese medicine and thermal bed.

I have tried almost everything… Massaging… Few times I tried… After massaging I feel better… Sometimes I use hot stone compress (Malay: bertungku)… Like a postnatal mother… I also have tried the Islamic healing treatment (Alternative treatment using religious beliefs of practitioners: such as the use of the holy verses of the Quran and pray. The practitioners acknowledge that any diseases and healing processes are from the Creator. No pharmacological component)… (P15)

Initially, I felt very strong pain, I went for massage… For 2 weeks of massage… Because I want to cook, nobody would cook for me… Massaging also never heals… I have tried the free promotional Ceragem (automatic therapeutic thermal massage beds) for almost one and a half months already now (P16)

Sometimes I go for a massage…I have tried a Chinese traditional practitioner (Malay: Tabib cina), acupuncture… almost everything - whatever people said... (P19)

The interviews revealed that the patients received treatment at the hospital as well as trying different traditional and complementary therapies to improve their conditions. The ESCAPE-pain programme offers few alternatives to exercise for the patients to decrease the symptoms and promote wellbeing.

### *Anxiety*

The patients also highlighted that they were worried about their current condition. They appeared to have a low level of understanding of how to cope with anxiety. Their activities of daily living had also changed due to the knee OA. Some of the patients were unable to read or write, including the education materials. Unlike patients with a good educational background, they appeared less able to find ways of coping with their concerns.

I just keep quiet when the healthcare professionals talk, I can't read. Do not read the book (Al-quran), anything—cannot read. I have been working from a young age… You demonstrate to us first, then we can do it. Provide us with instructions using pictures and numbers, we will follow… (P05)

I cannot read at all. If you provide me with a picture and number, I think I could… (P01)

I will only do whatever I think good… Other people do not suggest anything to me… probably I don't ask them (laugh)… I will search for further information if I want to know… (P20)

Although they reported that healthcare professionals had given them education pertaining to the care of knee OA, they stated that they just kept quiet if they did not understand. However, some of the patients suggested that using numbering methods with a picture or step-by-step diagram may help.

## Desired Care

### *Effective Communication and Approach*

The patients appeared to prefer the healthcare professionals to talk to them by giving advice including strategies to manage their symptoms. Two-way communication in educating people with knee OA was suggested for better understanding and acceptance.

Sometimes I fell asleep when the nurse was giving health education (feeling bored). Sometimes, I will tell the nurse whom I know, that if everybody follows the advice, nobody will go for surgery (knee)… (P06)

Healthcare professionals should say something advisory. They must communicate with the patients at every session attended. It will improve the acceptance of information given… I received the information about doing this and that… But I was not asked whether I could do that or not… (P20)

Thus, two-way communication was repeatedly suggested to encourage patients to actively participate during group discussion. It might help them accept the content to practice in their daily activities. Patients preferred polite communication such as simply asking about their condition.

I don't want people (healthcare professionals) to ask so many questions… Just ask "how are you?"…"Do you feel better today?"… Or "Is it good for you?"… Things like that… Nothing more is expected from me… (P08)

I prefer staff that can communicate with me… To show they're compassionate about me… Communication is very good. If they could do that, I would feel happy… (P11)

Patients requested that every person should be treated individually based on their condition. Every person may have a different problem and ability. The way healthcare professionals approached them was deemed important.

We are old already, thus we tend to be sensitive… Although something simple also, we take it seriously… We become too bad… It's sensitive (P01)

If people gently talk about the management of care, we tend to accept it… Sometimes when we are also not in a good mood, it changes because of the way people communicate and approach us… (P15)

The patients appeared very positive about accepting any information related to the management of care based on the way people communicated and approached them.

***Continuous Support***

Although some patients appeared aware that their motivational levels may decrease with the implementation of a self-management programme, they suggested a few things to maintain engagement with the programme. Most of the patients were excited that the ESCAPE-pain programme includes group discussion. They believed that by socializing with other people, their motivation level would increase. With the support of a facilitator, they thought that they may follow the flow of the programme.

> If we have friends, we will see other people with the same fate, we will be motivated; we might not need a constant guide, and friends also can help (boost motivation)… If a nurse or a doctor said to me, I would follow. We may need someone to tell us what to do, what the consequences are. If we do it ourselves, we do not know what will happen… (P07)
>
> If I do it myself, I will do something that I know. I can't do all the exercises. I need guidance from people (healthcare professionals) to do it… (P17)

As the programme is aimed at patients with knee OA, it is important to consider their suggestions. A few areas were suggested for integration into the programme, including effective communication and motivational support. Motivation to be involved in treatment or any related programme relies on several factors. The patients informed that they were much unmotivated to exercise.

> It takes time… That makes things difficult. If I need to, only then I will do it. If not, I won't do it. I will bear (Malay: tahan) the consequences (of the disease) until it becomes severe enough to look for treatment. I believe our attitude must change… (P07)
>
> After that, I feel unmotivated (Malay: malas), too much work to do. If there is no work, it would be fine. Put it in front of the TV (the exercise equipment), just temporarily use the equipment for exercise. Furthermore, we are getting older, unmotivated (Malay: malas); the most important thing is that we're unmotivated (Malay: malas) … (P12)

Some of the patients also reported that they needed attention or continuous guidance from healthcare professionals to do the exercises or follow the treatment regimen.

> In case we miss the session, call for follow-up. The staff (healthcare professionals) should do this I think… We are the countryside people (Malay: orang kampung). If we don't tell them, they won't. People like me may think, if we have guidance, we will do it; if motivated, we do; if not, we don't. (P07)
>
> If someone guides me in doing all those things it would be better. Sometimes, if we want to do it, it might be wrong. Maybe if a doctor or nurse could correct it, it would be better. (P09)

Some of the patients also revealed that they felt very positive about continuing any treatment or programme or exercise if it made them feel better. They believed that by completing exercise, they may get some benefit.

> If I feel better, I will continue to do it. If there are no changes (or it becomes worse), I will stop doing it (P08)
>
> My father was a yoga master… I do yoga every day… Just started because of the leg (knee)… I practice it, now I can bend the knee… If no exercise, I am afraid it will be jammed (stiff)… (P17)

Some patients mentioned that if family members supported them, it may influence the way they practice at home.

> I live alone. So will be unmotivated (Malay: malas) to do it. If my children are around, I feel different. Let them observe what we are doing. My children like anything related to health. They always remind me, like 'have you done it?'… If they are not around, I feel unmotivated. They remind me because they know I am in pain. (P06)
>
> I don't know how to do it. I feel unmotivated (Malay: malas) at home, cannot do it… (laughing) Someone has to force me: only then it's OK. (P13)

These findings suggest that many factors may influence patients' motivation, including healthcare professionals, family members and activity-related outcomes. Each patient may have different motivational factors that may help them adhere to the programme. Taking these factors into consideration may be very important.

# DISCUSSION

This study aimed to explore the perspectives of healthcare professionals and patients with knee OA in managing knee OA and the ESCAPE-pain programme. The findings could be used to inform cultural modifications to the ESCAPE-pain programme. Some considerations were identified from both groups: views of current management; experience, concern and needs; cultural influences; attitudes toward the ESCAPE-pain programme.

## Views of the Current Management of Knee OA

Both healthcare professionals and patients with knee OA agreed that current management of knee OA in the hospital is good but access is problematic due lack of staff, overcrowding, long waiting lists, personal matters and time constraints. The distance of the facilities from their homes, transportation issues, and the cost of traveling were also considered burdensome. These problems are also reported in other parts of the world (22, 23). Thus the difficulties faced by both parties may require an effective self-management intervention outside the healthcare facilities, possibly in a community setting (24).

Furthermore, communication barriers were also reported by healthcare professionals and patients. Lack of two-way communication and difficulties in understanding instructions were among the issues (25). In another study, some patients were reported to be reluctant to discuss any therapy undertaken with their healthcare professionals (26). They may not have been comfortable discussing these issues with their healthcare

professionals. The interviewees suggested that interactions between the patients and healthcare professionals could improve adherence to the treatment and keep the patients engaged with the programme (27).

Some of the patients also reported having literacy problems which could interfere with receiving effective treatment when using reading materials related to the treatment. Although the healthcare professionals mentioned that home exercise was prescribed for the patients, it was not beneficial for some of the patients, possibly due to these reasons. It possibly shows that a breakdown of communication had occurred. Thus, an improvement in communication skills between the healthcare professionals and patients is needed, which could create a positive effect on the process of rehabilitation including improving the quality of patients' life (28).

An alternative that is suggested is motivational interviewing during group discussion; it is used as a platform to encourage a behavioral change in older people (29). Through discussion, it provides the opportunity for the participants to share their views with other participants, promoting two-way communication. Personnel providing rehabilitation services also could include strategies to cope with the intervention programme, for instance, individualized strategies for self-managing the symptoms (30), as expected by the patients (31). The descriptions of current management have identified barriers to managing patients with knee OA. Thus, possible solutions were identified before adapting the programme to the context for implementation.

## Experiences, Concerns, and Needs

The patients said their experience of having knee OA has restricted their daily activities. Patients also stated that their pain worsened sometimes in the day when doing activities or even small movements. They also reported problems with being able to squat. This could lead to stressful situations and impact their quality of life (30).

Lack of motivation is another contributing factor highlighted by both groups of participants. The participants reported that they are already too old to do exercise (32, 33), accepting the societal norm of having a sedentary lifestyle. They also felt fear of doing exercises, shame, and fear of making a bad impression on their community and family. Motivation was very important if patients are to participate in the programme. Some of the patients also believed they were quite powerless to do anything other than what they actually did, in a fatalistic way (34). Some of them also accepted the cause of pain, without complaining about it, and were afraid to do further exercise for fear of causing pain (35). These factors could contribute to their low levels of motivation.

The patients also needed support from healthcare professionals, family, and society in terms of an understanding of the differences in sociodemographics, activities of daily living, and the practice of different ethnic groups' living activities. The success of an intervention programme seemed to be determined by continuous support from the family and community (36). The patients required continuous support from the family members, friends, or other people with the same problem as them. Continuously supporting the patients was seen to be important, through various techniques including education, advice, counseling, and guidance (37). Continuous encouragement from the staff and the involvement of family members and friends may have kept the patients engaged with the programme. Increased engagement provided opportunities for patients to ask questions about health promotion and disease prevention (38). Healthcare professionals needed to personalize the advice, including support for the individual's needs, according to their current symptoms and their consequences on their activities of daily living (39). Understanding the patients' experience, concern and needs may have increased the acceptability of the programme within the context.

## Cultural Influences

Culture is the platform that we engage with in everyday life, and is not a concrete thing (40). It includes the language, relationships, behaviors, and shared values of the way we live. Culture could influence how patients with knee OA perceive disease and could provide the opportunity for them to look for treatment if they have difficulties in fulfilling their cultural needs. Patients reported that they have problems practicing their religion in daily life. The healthcare professionals agreed when the patients asked them for advice related to cultural needs.

Both types of participant also reported that various techniques were used to alleviate the symptoms of knee OA, particularly pain, using locally commonplace alternative and complementary therapies. Massage, herbal and cultural-based treatments (such as Islamic medical treatment, and traditional Chinese healers) were among the options. In another study, it was reported that the use of chiropractors, massage and dietary supplements were among the most widely used complementary or alternative modalities (26). Besides, herbs and topical ointments were also found to be commonly used traditional medicine among the Malaysian population (41). Within the ethnic groups also, people use traditional medicine, reflecting various cultural practices across the community (42). They believe that traditional medicine containing natural materials from plants is less harmful and probably more effective than conventional medicine (41). These approaches may be worth integrating into the discussion to relate to their daily living activities. It may be worthwhile for healthcare professionals to be familiarized with the common traditional and complementary medicines taken by the patients (41). The instructor for the ESCAPE-pain programme may also make a further assessment of the traditional remedies options before guiding the patients regarding the use of a traditional or complementary approach based on current knowledge.

Meanwhile, patients reported that they were concerned about their spiritual needs. The majority of Malaysian people embrace one religion, which is in line with findings that more than 80% of the world's population associate themselves with a type of religion (43). Patients reported that while praying, whatever the religion, they could be in a state of relaxation. The relationship between religions and effects in life are variously reported and happen throughout people's lives (44). Although it is a personal issue in someone's life, it also has something to do with daily living activities. Patients value it for empowerment, peace, hope, and their faith (45). Difficulties in fulfilling spiritual needs may be a good motivator to look for an alternative treatment, which

requires strong faith to create positive change. For some people, the perceptions of diseases have been influenced by their belief in life after death, consequently affecting their decisions about their condition (46). Thus, it is worth discussing the strength of their faith to create a positive change toward better management of knee OA.

Another related cultural difference in the programme is between dietary intake in the UK (western) and local foods. In Malaysia, as a Muslim dominated country, alcohol is not commonly used by the majority of people. However, it is taken by followers of some other religions. In practice, the healthcare professionals generally advise patients against alcohol consumption (7). Understanding a culturally sensitive diet has proven to be important for an intervention programme (36). The selection of food behavior is also strongly linked with the culture around good physical health (47). Meanwhile, other daily activities of older people in Malaysia could be different from other parts of the world. Some patients felt that undertaking exercise was strange to them at their later stage of life, but this was viewed differently in other parts of the world (48). Thus, understanding cultural activities in the society could tailor specific action goals to promote the acceptability of the programme.

### Attitude Toward ESCAPE-Pain Programme

Both healthcare professionals and patients with knee OA have positive attitudes toward the ESCAPE-pain programme, both education and exercise components equally. The programme was also reported by the patients as being a platform for them to socialize with other people, which had been reduced due to their knee OA (34). The education component was perceived to be a comprehensive package for people with knee OA. However, some of the older people in Malaysia have literacy issues, and illustration-based information is suggested for better understanding. Using pictures in educating the participants was reported to increase their attention, ability, ease of remembering and tendency to adhere to the education programme (49, 50).

The list of exercises in the exercise component was seen as appropriate to practice, similar to other studies findings regarding exercise for OA (34, 35). However, exercises using any equipment such as static bike may not be feasible due to financial constraints. Using a recreation or exercise bike is hardly seen among the elder people in Malaysia. Those who could afford to buy equipment were encouraged to do so. Some of the healthcare professionals and patients had negative attitudes toward the use of rocker boards, wobble boards and wall squats due to safety reasons, but the majority agreed that they could be used with the recommended safety measures.

To increase safety while performing a wall squat, adding a ball between the wall and the patient was suggested. One-leg standing was suggested as an alternative to board exercises (51). Safety is the utmost priority, particularly when dealing with older people. There are many risks, such as falling and injury. Therefore, the healthcare professionals advised that rocker boards and wobble boards should not be used in this study and they were replaced with one-leg standing. Meanwhile, the ability to perform a wall squat should be assessed for all participants with the highest safety consideration. Thus, modifications of the exercise programme based on patients' ability and acceptance of the context were encouraged in the ESCAPE-pain programme, to promote engagement with the exercise.

As for the delivery of the programme, it may be worth looking at the barriers faced by the healthcare professionals and patients with knee OA, provided with possible solutions in the delivery of the programme in the context. To keep people engaged in the exercises, assessment of their daily routine may help to identify the best time to perform the exercises. Based on the flexibility of the participants' and the instructor's time, sessions were arranged to suit the best time for both parties. The success of the intervention appeared to be facilitated by support from family and social, cultural sensitivity, and the appropriate level of literacy among the participants (36). The findings from both healthcare professionals and patients with knee OA concerning the possible integration of ESCAPE-pain will be modified into the ESCAPE-pain programme.

The strengths of this study include the use of appropriate design; translated interview guide was piloted; approaching two hospitals; patients were from various cultural backgrounds; recorded interviews and conducted by a native speaker. The qualitative approach was designed to gain perspectives on the ESCAPE-pain programme is seen as a valuable introduction to the healthcare professionals and patients with knee OA before adapting and testing the ESCAPE-pain programme. The reliability of this qualitative approach was also ensured through audio-recording, saturation and reflexivity (52). However, the limitation of this study could be the opposite gender of the interviewer may influence participants from sharing their experiences.

In conclusion, the present study aimed to elicit healthcare professionals' and patients' views about the ESCAPE-pain programme for implementation among the Malaysian population. The findings would be the platform for integrating and incorporating the ESCAPE-pain programme into the context with modification. Overall, the ESCAPE-pain was perceived as feasible and acceptable for implementation in Malaysian health care context. The integration of education and exercise components may be influenced by the community and the available resources. Possible modifications included: providing close contact with the older people with knee OA; approachable healthcare professionals; comprehensible modules; translations of language and lifestyle. Other techniques of programme delivery were suggested to engage patients, introduce the intervention and illustrate its proposed mechanisms more clearly during the next stage.

## DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary materials, further inquiries can be directed to the corresponding author/s.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Manchester Research Ethics Committee (Ref:16451) and the Medical Research Ethics

Committee (MREC), Malaysia (Ref: (10)KKM/NIHSEC/P16-1552). The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

All three authors involved in the design, developmental, analysis, and discussion of the study. The corresponding author involved in data collection.

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# Knowledge, Attitude and Practice (KAP) of Malay Elderly on Salt Intake and Its Relationship With Blood Pressure

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Hypertension is a worldwide problem and a major global health burden with high salt intake as one of the factors often related to it. Public exposure to a high salt diet has contributed to the increase in prevalence of hypertension among the Malaysian population. Improving the knowledge, attitudes and practices (KAP) related to salt intake is a key component of effective blood pressure control. Therefore, this study was aimed to determine the association of KAP of healthy salt intake toward blood pressure among the elderly residing in a semi urban area of Klang Valley Malaysia. A cross-sectional study using convenience sampling was conducted among Malay elderly, aged 60–81 years old residing in Bandar Baru Bangi. Subjects were required to answer the questionnaire via face to face interview regarding KAP of Salt Intake, together with sociodemographic and health profiles. Anthropometry parameters and blood pressure were measured. A total of 94 elderly [57.5% women with mean Body Mass Index (BMI) of 26. 46 ± 4.16, 42.5% men with mean BMI of 27.31 ± 5.19] have participated in the study. Results indicated that the overall KAP score was average (57.4%). However, majority showed a positive attitude toward reducing the salt intake. BMI was found to have significant correlation with blood pressure ($r = 0.278$, $p < 0.05$). Higher education level was significantly ($p < 0.05$) associated with good knowledge scores while younger subjects have a positive attitude toward healthy intake of salt ($p < 0.05$). Subjects with higher knowledge scores were also observed to have the more controlled blood pressure compared to those who scored less. Attitude and practices score showed no significance difference ($p > 0.05$) with blood pressure. Younger age, higher level of education and living partner or elderly was significantly ($p < 0.05$) associated with lower systolic and diastolic blood pressure. Overall, this study showed that knowledge toward healthy salt intake, BMI, education level, and living with others were significantly associated with the blood pressure among the elderly. Further education and intervention is required to improve knowledge on healthy salt intake among elderly as part of the prevention from hypertension.

**Keywords: elderly, salt, hypertension, awareness, blood pressure**

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## INTRODUCTION

A recent study by NCD Risk Factor Collaboration (2017) (1) revealed that Asian countries, especially industrial countries are facing a threat for a hypertension epidemic. The World Health Organization (WHO) predicted that 1.56 billion (29.2% of the world population) will develop hypertension by 2025. The prevalence of hypertension in Malaysia (i.e., 22.9%) is reported to be higher than its neighboring countries, i.e., Singapore (14.6%) and Thailand (22.3%) (2). Prevalence of hypertension increases with age and most are asymptomatic at least until the early stage. More than half of the population aged 65 years old and above in Malaysia has hypertension (3). Previous analysis based on the National Health Morbidity Survey (NHMS) 2018 by The Institute for Public Health (IKU) (4) showed that the prevalence of hypertension among pre-elderly in Malaysia was 32.7% with 77.3% pre-elderly reportedly had hypertension screening in the past 12 months (4). Despite the alarming prevalence, the awareness toward hypertension and factors related to it is still low (5).

Risk factors of hypertension included Body Mass Index (BMI), smoking, arterial stiffness and resistance, and high dietary salt or sodium intake (6). A significant contributor to the daily intake of sodium in Malaysia was found to be in sauces and cooked food (7, 8). Previous study by Suzana et al. reported poor hypertensive control among Malaysians with hypertension was related to high salt diet eating habits (9). The high sodium consumption among Malaysians were reported to be a result of poor knowledge and practice toward reducing salt intake (8). Although it is found that poor knowledge contributes to higher salt consumption, the reason behind such result is unknown. Another study by Apidechkul (10) toward elderly in the rural area of Thailand revealed that high salt intake was the factor causing hypertension. Excessive dietary sodium intake is associated with an increased risk of hypertension, which in turn may be a major risk factor of stroke, cardiovascular diseases (CVDs), and kidney diseases (11). Apart from that, an increase in body weight and blood level glucose, triglycerides, and albumin too enhanced the risk of high blood pressure in Malaysian elderly (12). Thus, effective strategies should be implemented to prevent further increase of hypertension. According to WHO (2), some population-level strategies that can be applied includes awareness campaigns on salt-reduction, education on food labeling and reformulation of processed foods.

Previous study by Norimah et al. (13) reported nutrition knowledge was poor among elderlies in Malaysia. Other prior studies also revealed that elderly with poor salt-related knowledge had poorer salt-related practices. Those with poor knowledge and lower risk perception regarding hypertension are the most potential to be exposed to this health problem and other health effects related to hypertension (14). A study in China also reported that elderly with poor knowledge and awareness toward hypertension contribute to the increase in hypertension cases in the country (15). Furthermore, poor awareness toward hypertension may increases the risk of the onset of other complications related to hypertension especially in older population (16).

Since hypertension is an arising global problem, collection of epidemiology data and assessing knowledge, attitude and practice related to healthy salt intake in a population is important in the construction of effective salt-reduction strategies (17, 18). To the best of our knowledge, there was no study that have reported on salt awareness among the elderly in Malaysia. Not only that, available researches on KAP does not state the reason behind such scores. Therefore, this study aimed to understand and assess the factors affecting the knowledge, attitude and practice on salt intake among the elderly in Bangi.

## MATERIALS AND METHODS

### Study Design

This is a cross-sectional study aimed to determine the Knowledge, Attitude and Practice (KAP) on salt intake and its relationship with blood pressure among Malay elderly residing in a semi urban area of Klang Valley in Malaysia, i.e., Bandar Baru Bangi, Selangor, Malaysia. Sample size calculation was done using the Cochran (1977) (19) formula. The expected population proportion of 61.3% was taken from previous MySalt 2015 study (20).

$$n = \frac{(Z_{\alpha/2})^2 p(1-p)}{\Delta^2} \quad (1)$$

Where by,
$n$ = sample size 0.91134661
($Z_{\infty/2}$) = confidence level of 95% (standard deviation 1.96)
P = population = 61.3% = 0.613 (expected proportion of population based on MySalt 2015 study)
$\Delta$ = accuracy level = 10% (0.10)
Therefore,

$$n = \frac{(1.96^2)(0.613)(1-0.613)}{0.1^2} \quad (2)$$

= 91 subjects
Considering drop-out factors to be 10%, the real sample size is calculated as following:
Sample size ($n$) = 91 + (10% x 91)
= 100

A total of 94 elderly subjects comprising of 40 males and 54 females were recruited through convenience sampling. Convenience sampling is described as non-probability sampling in which people are sampled because they are the easiest to reach. In this study, sampling was carried out in mosques as the community there were the easiest to communicate and contact with. Prior day of data collection, posters promoting the study was disseminated around the mosque and via Whatsapp (done by Head of Mosque). Data collection day was scheduled on the same day as mosque's religion class as a way to gain more elderlies to be approached after. Subjects selected are Malaysian, aged 60–81 years old, able to understand Malay or English and residing in Bandar Baru Bangi. Ethics approval was obtained from Universiti Kebangsaan Malaysia (UKM) Research Ethics Committee (reference number: UKM.PPI.800-1/1/5/JEP-2019-525).

## Data collection

This study was initially planned to involve multi-ethic population whereby data will be collected at community centers in the area. However, due to time constraint (3 months for data collection), we were not able to obtain the permission from the respective Municipal Council on time (up to months for approval). We then decided to approach the board in churches, temples and mosques in the area to join the study, but only the Muslim or majority Malay community allowed us to collect data and were able to accommodate our needs (space to collect data, tables, and chairs) while others were either not interested or was not able to accommodate due to already scheduled events.

Thus, data were collected from a sample of 100 Bangi residents aged 60 and over at the time of the study. The study was conducted by interview administered questionnaire in Masjid Al-Umm and Masjid Al-Hasanah in Bandar Baru Bangi by six students from Nutrition background in July 2019 to October 2019. Subjects were invited to take part in the research via text blasts and mosque announcements. A few stations were set up for the collection of sociodemographic, anthropometric and KAP data. After excluding incomplete data, there were 94 eligible subjects to participate in the survey. Willingness to participate in the survey was taken to imply consent. Survey was conducted in Malay and English.

## Sociodemographic and Health Profiles

Subjects were required to fill in forms regarding sociodemographic information and health history at designated stations. Sociodemographic information includes gender, race, age category (60–69, 70–79, and over 80 years old), marital status, education level, living alone or with family or partner, smoking history, sleep schedule and alcohol intake. For health profiles, subjects were required to jot down related health history and medications taken for it. Only the most prominent health diseases were chosen i.e., Hypertension, Diabetes, and Hypercholestrolemia.

## Knowledge, Attitude and Practice (KAP) Questionnaire

This questionnaire was adapted from previous studies by Institute of Public Health (20) (Module C) and modified to meet objectives of the study. The Knowledge, Attitude and Practice (KAP) Questionnaire comprises of three modules: Module A, Module B, and Module C. Module A includes sociodemographic and personal information of subjects such as name, gender, race, and education level. Module B consists of subject's health history whereas Module C consists of 18 questions that assess knowledge, attitude, and practice of salt intake. Practice of salt intake was assessed using the adopted and modified MySalt 2015 Knowledge, Attitude and Practice (KAP) questionnaire (20). In this questionnaire, questions related to salt intake practices were included as the following: Do you add extra soy sauce or sauce into food when you eat? How much salt is used when preparing food at home? Do you request for less salt when eating out? How much salt do you think you take every day? Is controlling salt intake your daily routine? If yes, how do you control it?

Each answer in Module C was scored in order to classify subject based on scoring by Bakaman et al. (1996) (21) as follows:

| Score | Knowledge | Attitude | Practice | Total KAP |
|---|---|---|---|---|
| <60 | Poor | Negative | Inadequate | Poor |
| 60–70 | Fair | Neutral | Adequate | Fair |
| >70 | Good | Positive | Good | Good |

Subjects who scored more than 70 for each part were classified as having a good and satisfying knowledge, attitude, and practice on salt intake. The questionnaire was validated through a pilot study among 80 subjects in Selangor and Kuala Lumpur. Findings from the pilot study were analyzed using Cronbach Alpha to determine the reliability of the questionnaire. A value of 0.7 Cronbach Alpha was obtained, proving that this questionnaire is indeed reliable (22). A dual language version of this questionnaire was also created to ensure subjects have a better understanding of each of the questions.

## Anthropometric Measurement

Anthropometric measurement of subject is conducted according to International Society for the Advancement of Kinanthropometry (ISAK) protocol (23). Measurements consist of height, weight, body fat percentage, hip and waist circumference and blood pressure. SECA Bodymeter 213 (SECA, Germany) was used to measure height with accuracy nearest to 0.1 cm. For weight, a SECA 880 Digital Weighing Scale was used with accuracy nearest to 0.1 kg. The instrument used to measure body fat percentage is Omron HBF-306 (hand-held BIA). Waist and hip circumference were measured using Lufkin tape with accuracy nearest to 0.1 cm whereas Omron HEM-7120 was used to measure blood pressure. Classification of blood pressure is adopted from Malaysia's Clinical Practice Guidelines: Management of Hypertension 2018 (24).

## Statistical Analysis

Statistical analysis was performed using IBM SPSS version 23.0. The significance level in this study was set to 0.05, any $P < 0.05$ was denoted as statistically significant. Descriptive analysis was used to determine sociodemographic characteristics of subjects. Data with normal distribution are tested with parametric test (Independent *T*-Test, Pearson's Chi-Square) whereas data that are not normally distributed are tested with non-parametric test (Spearman's Rho). Independent *T*-Test was used to determine on anthropometric and blood pressure measurements on male and female subjects. Pearson's Chi Square was used to determine the relationship between KAP scores on sociodemographic factors and blood pressure. Spearman's Rho was used on sociodemographic and anthropometric measurement of elderlies on blood pressure.

# RESULTS

**Table 1** shows the sociodemographic data of the subjects. Majority of the subject in this study were females (57.5%). This

**TABLE 1 |** Sociodemographic data of subjects.

| Characteristics | Total ($n = 94$) | Percentage (%) |
|---|---|---|
| **Gender** | | |
| Male | 40 | 42.5 |
| Female | 54 | 57.5 |
| **Age** | | |
| 60–69 years old | 83 | 88.3 |
| 70–79 years old | 10 | 10.6 |
| 80 years old and above | 1 | 1.1 |
| **Race** | | |
| Malay | 94 | 100 |
| **Marital status** | | |
| Married | 83 | 88.3 |
| Divorced | 9 | 9.7 |
| Widower/ Widow | 2 | 2 |
| **Education level** | | |
| Secondary education | 37 | 39.4 |
| Tertiary education | 57 | 60.6 |
| **Residence** | | |
| Alone | 3 | 3 |
| With spouse/family | 91 | 97 |
| **Smoking history** | | |
| Yes | 90 | 96 |
| No | 2 | 2 |
| | 92 | 98 |
| **Adequate sleep (7-8 hours)** | | |
| Yes | 87 | 93 |
| No | 7 | 7 |
| **Alcohol intake** | | |
| Yes | 0 | 0 |
| No | 94 | 100 |

study involved only Malays as there were no response from Chinese or Indian community centers. More than half of the subjects in this study were aged 60–69 years old (88.3%) and were married (88.3%). Majority subjects were also reported to have tertiary education level (60.6%). Most subjects were reported to live with family or spouse (97%). As for lifestyle, a greater number of subject had no smoking history (98%), claims to be not under pressure or stress (93%), gets enough sleep (93%), and abstains alcohol (100%).

**Table 2** shows the anthropometry data of subjects according to gender. There was a significant difference ($p < 0.05$) in body weight, height, body fat percentage, and waist-hip ratio between male and female subjects. Men were found to be heavier, taller, and have bigger waist-hip ratio compared women and women have relatively higher body fat percentage than men. There was no significant difference ($p > 0.05$) in Body Mass Index (BMI), waist and hip circumference and systolic and diastolic blood pressure between genders. There was no not significant difference in terms of normal BMI between men and women. However, there more overweight (34%) women compared to men (11%) and vice versa for obesity where men (14%) were found to be more obese than women (6%).

**Table 3** shows the score for each knowledge, attitude and practice (KAP) on salt intake among subjects. There was a slight difference in the number of subjects who scored fair (38%) and poor (39%) for knowledge on salt intake and the consequences of having too much salt. Majority subjects (75.5%) were reported to have positive attitude toward a healthier salt intake and believe that a lower salt intake will benefit their health in the long run. Majority of the subjects (57.4%) had average overall score of KAP. Although majority of the subjects had positive attitude toward healthy salt intake, they have poor to fair knowledge and poor practice on healthy salt intake.

The association between anthropometry measurements and KAP variables of elderly with blood pressure is shown in **Table 4**. Based on the findings, Body Mass Index (BMI) correlated significantly ($p < 0.01$) with systolic and diastolic blood pressure. For KAP scores, knowledge was significantly ($p < 0.05$) associated with systolic blood pressure.

**Table 5** shows age was significantly ($p < 0.05$) correlated with the attitude score while education level was significantly ($p < 0.05$) correlated with the knowledge score. An inverse significant association ($p < 0.01$) was observed between education level and blood pressure where elderly with higher education level (university level) had a lower and more controlled systolic and diastolic blood pressure.

## DISCUSSION

In this study, knowledge, attitude and practice (KAP) toward salt intake among Malay elderly residing in Bandar Baru Bangi and its association with blood pressure were assessed. Based on the data obtained, this study showed that the knowledge on salt among the majority of elderly in Bangi ranged from poor to moderate. Further investigation in this study found that although elderly had knowledge about the relationship of salt and hypertension, many was not aware of other diseases such as osteoporosis, kidney stones, and gastric cancer that may also develop with high dietary salt intake. The findings of this study are in accordance with previous study in China by Song et al. (10) who reported a poor knowledge on salt-related disease among the elderly, that needs to be improved. However, a study by Grimes et al. (25) revealed the opposite in which elderly in Australia were reported to be more likely aware of the link between excessive salt intakes with certain specific health conditions.

Apart from that, majority of the elderly in this study have no knowledge on the daily salt intake recommendation set by the Ministry of Health Malaysia as stated in the Recommended Nutrient Intake (RNI) Malaysia, which is 5 g/daily. Therefore, this study deduces that elderly have lack of specific knowledge on the maximum daily dietary salt intake. This may be due to health education regarding salt intake and hypertension and salt-related education are only taught on the surface (26). Based on the interview conducted in this study, elderly only had access to nutrition and health knowledge when they are referred to nutritionists or dietitians in the hospital. In Hong Kong, elderly living in Elderly Health Centers (EHC) were reported to have better health literacy than the general elderly population as they

**TABLE 2 |** Anthropometry characteristics of subjects.

| Anthropometry characteristics | Men ($n = 40$) (Average± s.d.) | Women ($n = 54$) (Average± s.d.) | Total ($n = 94$) (Average± s.d.) | *P*-value |
|---|---|---|---|---|
| Weight (kg) | 72.98 ± 16.15 | 60.93 ± 10.22 | 64.82 ± 13.38 | 0.001 |
| Height (m) | 162.46 ± 5.96 | 151.59 ± 5.19 | 155.37 ± 7.34 | 0.000 |
| Body Mass Index (kg/m$^2$) | 27.31 ± 5.19 | 26. 46 ± 4.16 | 26.71 ± 4.44 | 0.993 |
| Percentage Body Fat (%) | 26.96 ± 8.23 | 35.57 ± 6.11 | 32.76 ± 7.95 | 0.001 |
| Waist circumference (cm) | 94.77 ± 14.99 | 86.72 ± 10.09 | 89.52 ± 12.48 | 0.210 |
| Hip circumference (cm) | 102.87 ± 10.64 | 98.75 ± 8.05 | 100.13 ± 9.08 | 0.214 |
| Waist-Hip Ratio (WHR) | 0.92 ± 0.07 | 0.86 ± 0.06 | 0.88 ± 0.07 | 0.002 |
| Systolic Blood Pressure (mmHg) | 139.91 ± 17.03 | 131.28 ± 21.76 | 134.16 ± 20.11 | 0.235 |
| Diastolic Blood Pressure (mmHg) | 78.33 ± 10.76 | 73.11 ± 10.54 | 74.08 ± 10.83 | 0.520 |

*Independent T-Test was used to compare between the parameters between genders.*

**TABLE 3 |** Scores of knowledge, attitude and practice on salt intake among subjects.

| Part | Marks | Average score (mean ± s.d.) | Total ($n = 94$) | Percentage (%) |
|---|---|---|---|---|
| Knowledge | <60% (Poor) | 49.97 ± 8.58 | 37 | 39 |
| | 60–70% (Fair) | 64.52 ± 2.05 | 36 | 38 |
| | >70% (Good) | 73.47 ± 3.46 | 21 | 22 |
| Attitude | <60% (Negative) | 58 ± 0 | 3 | 3.2 |
| | 60–70% (Neutral) | 62 ± 1.77 | 20 | 21.3 |
| | >70% (Positive) | 86.15 ± 8.65 | 71 | 75.5 |
| Practice | <60% (Poor) | 52.13 ± 6.01 | 46 | 48.9 |
| | 60–70% (Adequate) | 62.28 ± 2.25 | 35 | 37.2 |
| | >70% (Good) | 73.77 ± 3.65 | 13 | 17.3 |
| Overall score for knowledge, attitude and practice | <60% (Poor) | 54.18 ± 3.46 | 11 | 11.7 |
| | 60–70% (Average) | 65.81 ± 3.29 | 54 | 57.4 |
| | >70% (Good) | 74.55 ± 3.28 | 29 | 30.9 |

had access to primary health care (27). Another study by Lee et al. (28) suggested that minority of the population in the Republic of China had worse nutritional status and poorer health as they often had limited access to health care information and centers. Thus, it is observed that nutrition and health knowledge is only accessible for the elderly if they had access to health care. This shows that there is a need to ameliorate the education and health campaigns to further improves the understanding and knowledge of the elderly especially on other salt-related diseases and salt-reduction knowledge.

In terms of attitude, majority of elderly in this study had positive attitude toward salt reduction and healthy salt intake. This study found that elderly showed effort in reducing salt intake and acknowledge the importance of consuming salt according to the recommendation. This finding is concurrent with previous studies by Zhang et al. (26) and Lee et al. (28) where elderly was reported to believe that salt reduction would indeed give positive impact to health status. However, it is important to note that a small number of the subjects in this study who were older had negative attitude toward healthy salt intake as they are used to eating salty food and believe that salt has no correlation to the onset of poor health conditions.

This study found that almost half of the study population (48.9%) had poor practice scores. It was found that majority of them do not request for salt to be reduced in the cooking when eating out as they believe it is beyond their control to request for such. Furthermore, the elderly did not read salt content on the labels when making choices during grocery shopping, as their main concern was more on the price and its halal status. In addition, some elderly in this study also did not find the need to control their salt intake as they believed that the amount of salt consumed daily is just right. This finding is similar to a study by Cheikh et al. (29) that reported a low percentage in salt intake control was due to the believe that their salt intake is within the right amount.

Although elderly had a positive attitude toward healthy salt intake, the salt-related knowledge and practice were inadequate and unsatisfying. Previous studies reported the same findings where positive attitude toward salt intake does not translate to good salt control practices (30, 31). Thus, awareness campaigns and salt-control interventions in the community need to be revised for improvements with emphasis on the elderly. One way is by improving knowledge on salt-reduction and its benefits as it will increase effectiveness of salt-reduction initiatives (26).

**TABLE 4 |** Association of anthropometric and KAP characteristics with blood pressure.

| Anthropometric characteristics | Systolic blood pressure (mmHg) | | Diastolic blood pressure (mmHg) | |
|---|---|---|---|---|
| | *r* | *p* | *r* | *p* |
| Body mass Index (BMI) | 0.278 | 0.000** | 0.202 | 0.001** |
| Weight (kg) | 0.038 | 0.769 | −0.028 | 0.838 |
| Height (cm) | 0.025 | 0.849 | −0.022 | 0.865 |
| *Waist-Hip Ratio* | 0.205 | 0.12 | 0.051 | 0.699 |
| Waist Circumference (cm) | 0.066 | 0.608 | 0.115 | 0.371 |
| Hip circumference (cm) | 0.102 | 0.424 | 0.065 | 0.61 |
| **KAP scores** | **Systolic blood pressure (mmHg)** | | **Diastolic blood pressure (mmHg)** | |
| | *p* | | *p* | |
| Knowledge | 0.037* | | 0.094 | |
| Attitude | 0.28 | | 0.936 | |
| Practice | 0.457 | | 0.234 | |
| Overall KAP | 0.069 | | 0.544 | |

*Spearman's Rho was used to test anthropometry data against blood pressure.*
**Correlation is significant at $p < 0.05$. **Correlation is significant at $p < 0.01$.*
*Chi-Square was used to test KAP scores against blood pressure. *p-value is significant at $p < 0.05$.*

**TABLE 5 |** Association of knowledge, attitude and practice scores on sociodemographic characteristics.

| Sociodemographic characteristics | Knowledge score (K) | Attitude score (A) | Practice score (P) | Overall KAP score |
|---|---|---|---|---|
| | *p* | *p* | *p* | *p* |
| Gender | 0.084 | 0.111 | 0.951 | 0.637 |
| Age | 0.201 | 0.006* | 0.795 | 0.169 |
| Marital Status | 0.986 | 0.12 | 0.276 | 0.583 |
| Education level | 0.020* | 0.313 | 0.738 | 0.826 |
| Living alone/ with company | 0.898 | 0.203 | 0.211 | 0.813 |

*Chi-Square test was used. *p-value is significant at $p < 0.05$.*

Having knowledge will influence one's behavior as behavior is determined by intention and intention is influenced by how one perceives knowledge (32). Therefore, if elderly had better knowledge on the health complications and problems related to excessive salt intake, they might be more prone to reduce dietary salt intake, thus improving their salt-related practices.

This study revealed that elderly with higher BMI regardless of gender had higher systolic and diastolic blood pressure. This finding is parallel to prior studies where mean systolic and diastolic blood pressure was higher among older subjects with elevated BMI (33–35). Based on this finding, the study can conclude that hypertension can be controlled and prevented by reducing BMI. Apart from that, knowledge and attitude scores were also to have significant relationship with certain sociodemographic variables. Subjects that obtained tertiary education such as Degree or Diploma were reported to have higher knowledge scores compared to those who obtained secondary education. Elderly aged 60–70 years old were observed to have a more positive attitude toward healthy salt intake.

This study showed that subjects with higher knowledge scores had better systolic blood pressure. Only the knowledge section of the KAP questionnaire was found to be significantly associated with lower systolic blood pressure. It can be concluded that those with better knowledge and awareness on the risk factors and related complications and of hypertension had better control of their blood pressure. This finding is comparable to findings by Zhang et al. (26) that reported that subjects that had more knowledge on risk factors and hypertension complications as well as higher awareness had better blood pressure control. Therefore, it is clear that by improving the knowledge of elderly on healthy salt intake will have better association with their blood pressure reading. The overall scores of KAP questionnaire for the elderlies were non-satisfactory. Score classifications were referred from the Journal of Family and Community Medicine (21). However, it was found that their attitudes toward healthy salt intake were mainly positive.

The limitation of this study is the unavailable data on salt intake level from diet of the studied population. Due to small sample size, a robust statistical analysis to identify associated factors of KAP level could not be done. There may also be bias to the KAP questionnaire as practices reported may not be subject's daily practice. The strength of the study is, it was

conducted among a unique population that might provide a different perspective for intervention in future studies. This study is the first in Malaysia that explores the KAP of elderlies on salt intake.

## CONCLUSION

Salt-related knowledge and practice among elderly in this study was unsatisfying despite having positive attitudes toward healthy salt intake. Higher education level was significantly associated with higher knowledge score whereas a younger age of 60–69 years old was significantly associated with higher attitude scores. Higher knowledge scores were also observed to significantly associated with controlled systolic blood pressure. Older age and living alone was significantly associated with higher blood pressure whereas higher education level was significantly associated with lower blood pressure. add limitation if this study, strength, and implication. Future study should be looking into the salt intake of the elderly through diet food record. Further education and intervention is required to improve knowledge on healthy salt intake among elderly as part of the prevention from hypertension.

## DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary files, further inquiries can be directed to the corresponding author.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by National University of Malaysia. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

HH, HY, and SS contributed conception and design of the study. NK organized the database and performed the statistical analysis. NK and HH involved in preparing the first draft of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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# The Association of Falls with Instability: An Analysis of Perceptions and Expectations toward the Use of Fall Detection Devices Among Older Adults in Malaysia

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**Background:** Falls are a significant incident among older adults affecting one in every three individuals aged 65 and over. Fall risk increases with age and other factors, namely instability. Recent studies on the use of fall detection devices in the Malaysian community are scarce, despite the necessity to use them. Therefore, this study aimed to investigate the association between the prevalence of falls with instability. This study also presents a survey that explores older adults' perceptions and expectations toward fall detection devices.

**Methods:** A cross-sectional survey was conducted involving 336 community-dwelling older adults aged 50 years and older; based on randomly selected participants. Data were analyzed using quantitative descriptive analysis. Chi-square test was conducted to investigate the associations between self-reported falls with instability, demographic and walking characteristics. Additionally, older adults' perceptions and expectations concerning the use of fall detection devices in their daily lives were explored.

**Results:** The prevalence of falls was 28.9%, where one-quarter of older adults fell at least once in the past 6 months. Participants aged 70 years and older have a higher fall percentage than other groups. The prevalence of falls was significantly associated with instability, age, and walking characteristics. Around 70% of the participants reported having instability issues, of which over half of them fell at least once within 6 months. Almost 65% of the participants have a definite interest in using a fall detection device. Survey results revealed that the most expected features for a fall detection device include: user-friendly, followed by affordably priced, and accurate.

**Conclusions:** The prevalence of falls in community-dwelling older adults is significantly associated with instability. Positive perceptions and informative expectations will be used

to develop an enhanced fall detection incorporating balance monitoring system. Our findings demonstrate the need to extend the fall detection device features aiming for fall prevention intervention.

**Keywords: older adults, fall detection, fall prevention, instability, perception, assistive technology, gerontechnology**

## INTRODUCTION

Falls are rising globally with an estimated 646,000 yearly fatal falls, where death rates among older adults aged 60 years old and above are the highest, worldwide (1). Falls are reported as the second leading cause of accidental or unintentional injury deaths worldwide after traffic injuries, and the leading cause for non-transport unintentional injury deaths (1, 2). Globally, it is reported that ∼28–35% of older adults over the age of 65 years are estimated to fall once or more frequently each year (1). Whereas, in Malaysia, according to the National Health and Morbidity Survey in 2018 for elderly health reported nearly 15% of older adults aged 60 years or older reported at least one fall in 12 months (3).

In line with the demographic transition and speed of aging, the older adults' population growth brought safety among older adults into perspective and is always associated with falls, risk of falls and the impacts of the incidents. Fall incidents are typically associated with mortality, morbidity, and higher nursing home admission rates causing pricey social and healthcare costs (4). This may result in fear of falling developed and can contribute to psychological conditions such as depression and voluntary activity avoidance (4–7). The different levels of functional capability are significantly determined by the health-related quality of life (6). Other common risks in addition to advancement in age include balance impairment, walking difficulties, lower body weakness, vitamin D deficiency, vision problems, foot pain, poor footwear and hazardous living environment (8, 9).

Identifying factors associated with falls incidents is vital in formulating fall prevention, aiming at reducing the occurrence and further complications. The specific objective of the present study was, therefore, to analyze the prevalence of falls in older adults and its association with instability along with several noteworthy variables. Previous studies that examined instability reported various findings, where Lamb et al. (10) and Hyndman and Ashburn (11) discovered that instability was a risk factor for falls, as opposed to findings of Jorgensen et al. (12). The more risk factors that a person has would elevate to higher chances of falls. Thus, one of the solutions to maintain physical functioning is the use of assistive technology. It has become a vital necessity to help those in need during their advanced years.

Previously, researchers have put various efforts in developing fall prevention technologies to enhance older adults' functional capability as well as patients with functional impairment (13–22). Use of technology in fall prevention is increasing due to the limited skilled caregivers, a slow response that could lead to fatality and also high cost incurred. As identified by Khosravi and Ghapanchi (16), switching from complete reliance on human assistance to technology is assumed to be the viable solution to alleviate the gap between the demand for aged care and supply. Habib et al. (16) in their literature review, concluded that a fall detection system is a device to assist older adults and their caregivers in avoiding the consequences of "long lie" periods by a proposed series of events; detecting fall, triggering notification alarms, sending messages and calling for help as soon as a fall occurs. The term "long lie" is identified as unwillingly remaining on the ground for an hour or more following a fall, whereby half of those who experienced it die within 6 months of falling (23–25). Concerning this matter, older adults who fell with no fatal injuries but remained on the floor for prolonged periods after the fall must be closely monitored as they are categorized as individuals with a high risk of falls (26).

Common in the industry, commercial fall detection device offers the basic function of detecting a fall and immediately alert caregivers or monitoring base unit to provide necessary actions depending on the person's condition. Unfortunately, the development of fall detection devices has been controversially reviewed by users and researchers, which leads to halting the promising technology to be commercialized. For example, robustness in terms of the sensors' sensitivity and accuracy contribute to false detection due to a variety of fast movements. Failure in detecting different types of falls caused the system to automatically cancel the alert if the sensors detect any movements after the fall, assuming the person is conscious and needs no further help (27). Most of the devices in the market are only limited to detecting falls. While the technology is mostly geared toward older adults prone to fall, instability is a complementary subject concerning fall prevention programs. Therefore, this study is the groundwork in proposing an extended version of fall detection incorporating a balance monitoring system as a fall prevention device to be implemented in the future.

Additionally, another objective of this study was to analyze the psychological part concerning older adults. The perceptions on the use of fall detection devices were investigated. The perception of fear, frustration, and unacceptance toward technological devices as well as the refusal to adopt technology were examined at the end of this study. The issue of privacy being violated or reluctant to reach for tailored training in using the new technological device were examined. Their expectations toward fall detection devices were documented to understand older adults' preferences in utilizing such devices. Williams et al. (28) verified that the essential functions of the future assistive technology device include emergency alarm systems and fall detection. However, despite the perks that the technology could offer, there are risks involving privacy, and confidentiality due to continuous monitoring of movement via sensors and Global Positioning System (GPS) hence become significant concerns

that can hinder its successful implementation (28–30). However, Malaysia-based studies of older adult's perceptions, the needs or acceptance of assistive technology remain insufficient. There was no previous study in Malaysia addressing the older adults' perceptions and expectations toward the use of fall detection devices. The particular needs and preferences of older adults in the context of the development and use of fall detection systems have not been given considerable attention (31). Malaysia's vital challenge is planning and managing the aging society, especially in providing necessary alternative for effective assistance for them.

# MATERIALS AND METHODS

## Study Design and Setting

A nationwide cross-sectional survey was conducted targeting community-dwelling older adults. The sampling technique of this study was randomized with convenient sampling. This observational study was designed to find: (a) the association between prevalence of falls with instability among older adults, (b) the association between prevalence of falls and instability with demographic and self-reported walking characteristics, and (c) the perceptions and expectations toward fall detection devices based on the response from structured questionnaires. Data collection was conducted from July 2019 to January 2020. The survey was conducted using a confidential self-administered questionnaire distributed to random sample of older adults stratified by age, gender, and geographic location; representing a population estimate of 10,994,000 older adults aged over 50 years. The targeted sample of 385 older adults was determined using the Finite Population Correction, and the response rate was 87.3% (336 respondents).

## Participants

A total of 336 community-dwelling older adults aged 50 years and older participated in the study. The only inclusion criterion for participants was age. Even though older adults in Malaysia are defined as individuals aged 60 years old, pre-elderlies aged 50 to 59 years old were included in the process of selecting the participants due to lower life expectancy compared to the Western Countries (32) and referring to the National Health and Morbidity Survey (3). Also, knowing the health conditions of the pre-elderly group is vital as early detection of one's condition that can make a difference later in life. The goal of the target population was to have a wide-ranging representative of older adults nationwide. Participants involved were from various states across Malaysia that are having high number of older population, with the highest participants were from Perak ($n$ = 160), followed by Selangor ($n$ = 96) and Kuala Lumpur ($n$ = 44). Other participants were scattered around other states (Johor, Kedah, Kelantan, Negeri Sembilan, Pulau Pinang, Putrajaya, and Terengganu). We selected the state of Perak as the main target in accordance to the population projection by the Department of Statistics Malaysia. The aging population in Perak is expected to become the oldest amongst the elderly population in Malaysia by 2020 when that group reaches 397,400 (15.8%) of the estimated 2.6 million total population (33).

## Ethical Considerations

The surveyed respondents were informed of the research's purpose, mode of participation, benefits and confidentiality. All respondents understood the objective of this research and voluntarily signed consent forms prior to the interview. Participation was entirely voluntary, and data were conducted confidentially where names and addresses were not being used in the analysis of this study. All study procedures were reviewed and approved by the Ethics Committee for Research Involving Human Subjects Review Board (JKEUPM-2017-251).

## Study Variables/Measurements

The questionnaire consisted of two self-administered parts on fall risk assessment following completion of their demography details; (i) Falls assessment and perceived walking stability and (ii) Experience using a fall detection device, perceptions, and expectations toward the use of a fall detection device. Participants were enlightend earlier on the fall definition, which was defined as an unexpected event in which the individual comes to rest on the ground, floor or lower level (1). As for the fall detection device, the basic mechanism was explained and defined as a wearable device. The advantage of using the fall detection device was enlightened. An example of an existing fall detection device was displayed to the participants upon answering the questionnaire.

In this paper, only the critical measurements mentioned below were extracted and examined to determine the contributing factors associated with fall incidents.

1. The primary outcome for this study is the prevalence of falls in the past six months, that was ascertained by questioning, "Did you experience any fall in the past six months?" prior to answering the questionnaire.
2. Walking stability was derived from a close-ended question of "Do you feel unbalance/ unstable while walking/ moving to places." Meanwhile, the answers to multiple response questions regarding their walking characteristics such as "Walking with a bit stooped, walking with shuffle foot, difficulty rising from a chair, cannot walk without assistance, not having such problems," and "Do you need a walking aid to assist you in walking/moving?" are then referred to ensure the consistency of answers. Respondents were considered as having a mobility limitation if they indicate a need for any of the listed ambulatory aids (wheelchair, cane, crutches, and/or clutching onto the furniture or anything around them to move from one place to another).
3. Perception toward fall detection devices was attained from three questions which were "What makes you refuse to use a fall detection device?", "Do you think the use of this fall detection device can increase your safety and reduce the risk of falls?", and "If you have been offered to test a fall detection device, are you interested to try it on?".
4. Lastly, participants were required to answer an open-ended question "What is your expectation of a fall detection device if you are to use one?". The answers were summarized and grouped according to the frequencies, resulting in a list of older adults' expected features in a fall detection device.

## Quantitative Data Collection and Analysis

The design of the questionnaire was adapted from the Johns Hopkins Fall Risk Assessment Tool (JHFRAT) for Home Health Care, Morse Fall Scale and Outpatient Falls Questionnaire by Abujudeh et al. (34), modified to suit the Malaysian population. Frequency and percentage were used for descriptive analysis based on the quantitative data. The strength of association was analyzed using Chi-square test for inferential statistics with 95% confidence interval. The three computed associations were: (i) between falls with instability, (ii) between falls and instability with demographic characteristics, and (iii) between falls and instability with walking characteristics. *P*-values were based on two-sided tests and were considered statistically significant at $p < 0.05$. All analyses were conducted using SPSS software (SPSS Inc., version 22.0).

# RESULTS

Quantitative results were based on data collected using questionnaires, in which 336 respondents have successfully participated in the survey. There are three distinct sections of analysis: (i) Association between falls and instability with demographic and walking characteristics, (ii) Association between falls with instability, and (iii) Perceptions and expectations toward fall detection devices. The prevalence of falls and perceived instability among respondents was compared across gender, age groups and living arrangements. Further analysis of walking characteristics among the respondents was done with regards to the use of ambulatory aids and perceived gait problems.

## Association Between Falls and Instability With Demographic and Walking Characteristics

The average age of the respondents was 63.6 years (SD: 7.2 years), with 83 individuals were <60 years old, and eight individuals above 80 years old. The majority were females (83.3%), and 85.7% of respondents co-reside with family members including spouse, children and other family members. In total, $n = 336$ respondents successfully provided data on falls and stability.

**Table 1** shows the association between falls with demographic and walking characteristics. The prevalence of falling in 6 months prior to the survey was 28.9% ($n = 336$), with 24.1% reported to fall once or twice. Men reported a 3.9% higher prevalence of falls than women as the frequency for falling three or more times was higher among male respondents. The association between the prevalence of falls with age was statistically significant as falls increases with age. Gender and living arrangement have no significant association with the prevalence of falls, although male respondents and those who lived with children showed higher prevalence compared to other groups.

Furthermore, when comparing across the variables related to walking characteristics, one out of seven respondents were using ambulatory aids to help them walking or moving around. There was a statistically high and significant association between falls and using ambulatory aids ($p < 0.001$). Respondents who depend on ambulatory aids, especially wheelchair and cane, were more likely to fall as the frequency of falls was higher.

Respondents perceived to have the listed gait problems tend to fall more, in which 101 reported walking difficulties, correspondingly having significant association with falls. The frequency of falls across respondents walking with shuffle foot was the highest, where almost 70% fell at least once in 6 months. The ones without gait problems also reported 23% falls incidents among 235 respondents. Indeed, not only respondents with gait problems were having instability issues.

A similar analysis was made across demographic and walking characteristics associated with perceived instability as presented in **Table 2**. The results were based on respondents' self-reported walking stability. Around 22% of the respondents perceived instability when moving from one place to another. Around one-third of both males and females reported having instability issues, but no significant association was found between gender and perceived instability. Similar to the prevalence of falls, there was a significant association between age and perceived instability as the frequency increases with age. However, no association between living arrangements and perceived instability was found, but respondents who lived alone reported higher instability issues percentage.

The association between perceived instability with the use of ambulatory aids and perceived gait problems were highly significant. All wheelchair and cane users were found to have instability issues. Almost 90% of the respondents who cannot walk without assistance also reported having instability while moving between places. Also, it is noted that 31 respondents with instability issues did not opt to use ambulatory aids in their daily lives.

## Association Between Falls and Instability

**Table 3** shows a statistically high and significant association between falls and perceived instability. The prevalence of falls among the respondents who perceived instability was 47.2%. Among respondents with instability issues, over one-third reported falling at least once in 6 months prior to the survey, and 12.5% reported falling three times or more. Moreover, the percentage of respondents with perceived instability issues reported to fall was directly proportional with age; 10.8, 6.6, 15.6, and 37.5% (sequence follows the age group in **Table 1**).

## Perceptions and Expectations Toward Fall Detection Devices

For this section, the respondents were initially asked whether have known or heard of a fall detection device, and 91.7% of them answered No. Nonetheless, respondents who answered Yes, stated that they refuse to use the device due to these reasons; they have never experienced falls ($n = 17$), no information on how or where to purchase the device ($n = 8$), and because the device is expensive ($n = 2$).

In addition, an equally important finding is that one respondent has experienced using a fall detection device. The respondent stopped using the device after a few months because the wearable device was mentioned to be uncomfortable.

**TABLE 1 |** The association between falls with demographic and walking characteristics.

| Variables | Total (*n*, %) | Falls in 6 months (*n*, %) | | | $X^2$ | *p*-value |
|---|---|---|---|---|---|---|
| | | 1–2 | 3 or more | None | | |
| **Total respondents (*n*, %)** | 336 (100) | 81 (24.1) | 16 (4.8) | 239 (71.1) | - | - |
| *Demographic characteristics* | | | | | | |
| **Gender** | | | | | | |
| Male | 56 (16.7) | 12 (21.4) | 6 (10.7) | 38 (67.9) | 5.301 | 0.071 |
| Female | 280 (83.3) | 69 (24.6) | 10 (3.6) | 201 (71.8) | | |
| **Age (Years)** | | | | | | |
| 50–59 | 83 (24.7) | 19 (22.9) | 4 (4.8) | 60 (72.3) | 13.922 | * |
| 60–69 | 181 (53.9) | 39 (21.6) | 4 (2.2) | 138 (76.2) | | |
| 70–79 | 64 (19) | 21 (32.8) | 7 (10.9) | 36 (56.3) | | |
| >80 | 8 (2.4) | 2 (25) | 1 (12.5) | 5 (62.5) | | |
| **Living arrangement** | | | | | | |
| Alone | 48 (14.3) | 9 (18.8) | 4 (8.3) | 35 (72.9) | 5.517 | 0.479 |
| Spouse | 121 (36) | 34 (28.1) | 3 (2.5) | 84 (69.4) | | |
| Children | 62 (18.4) | 17 (27.4) | 3 (4.9) | 42 (67.7) | | |
| Family member | 105 (31.3) | 21 (20) | 6 (5.7) | 78 (74.3) | | |
| *Walking characteristics* | | | | | | |
| **Ambulatory aid type** | | | | | | |
| Wheelchair | 4 (1.2) | 2 (50) | 1 (25) | 1 (25) | 18.378 | *** |
| Cane | 21 (6.3) | 9 (42.9) | 4 (19) | 8 (38.1) | | |
| Crutches | 3 (0.9) | 1 (33.3) | | 2 (66.7) | | |
| Clutching onto the furniture | 21 (6.3) | 7 (33.3) | 2 (9.5) | 12 (57.2) | | |
| None | 287 (85.3) | 64 (22.3) | 8 (2.8) | 215 (74.9) | | |
| **Perceived gait problem** | | | | | | |
| Walking with a bit stooped | 25 (7.4) | 5 (20) | 4 (16) | 16 (64) | 14.504 | ** |
| Walking with shuffle foot | 24 (7.1) | 12 (50) | 4 (16.7) | 8 (33.3) | | |
| Difficulty rising from a chair | 57 (17) | 19 (33.3) | 3 (5.3) | 35 (61.4) | | |
| Cannot walk without assistance | 8 (2.4) | 2 (25) | 2 (25) | 4 (50) | | |
| Not having such problems | 235 (69.9) | 47 (20) | 7 (3) | 181 (77) | | |

*$p$-value < 0.05, **$p$-value < 0.01, ***$p$-value <0.001.

However, the device was believed to provide safety and helpful in reducing the risk of falls.

Almost 99% of 336 respondents agreed that fall detection devices could help to increase safety and reduce the risk of falls, and 64% have a definite interest in using a fall detection device. In comparison, 33% answered Maybe. Referring to **Table 4**, of those who said yes, their history of falls showed higher prevalence compared to those who were not interested. Similarly, respondents perceived to have instability showed a positive interest in using the fall detection device. The percentage of interest was surprisingly high among older respondents and those living with children.

Price plays an important role when purchasing a device, especially among older adults who are generally technologically illiterate. When asked about the expected price range of a fall detection device, most of them answered the device should be <RM500, and only 2.4% of them selected RM1000–3000 (**Figure 1**).

The last question was open-ended, where expected features being anticipated in a fall detection device were inquired. The most answered feature was easy to use or user-friendly ($n = 170$) followed by affordable price ($n = 146$), accurate ($n = 63$), and effective in terms of fast response ($n = 52$). The rest of the answers are illustrated in **Figure 2**.

## DISCUSSION

This study's results highlight the association between falls with instability and their association across demographic and walking characteristics among a sample of older adults aged 50 years and above. Also, their perceptions toward the use of fall detection devices were investigated in which safety and reducing the risk of falls are the two main concerns, along with the expected features of fall detection devices. These findings identify potential enhanced features to be incorporated in a fall detection device by studying the older population's fall risk profile and may influence intervention strategies aimed at preventing falls.

Almost half of the respondents who reported falls in the past 6 months perceived they suffered instability while walking or moving to places. Since the *p*-value is less than significant level

**TABLE 2 |** The association between instability with demographic and walking characteristics.

| Variables | Perceived instability (*n*, %) | | $X^2$ | *p*-value |
|---|---|---|---|---|
| | Yes | No | | |
| **Total respondents (*n*, %)** | 72 (21.4) | 264 (78.6) | - | - |
| *Demographic characteristics* | | | | |
| **Gender** | | | | |
| Male | 15 (26.8) | 41 (73.2) | 1.145 | 0.285 |
| Female | 57 (20.4) | 223 (79.6) | | |
| **Age (Years)** | | | | |
| 50–59 | 17 (20.5) | 66 (79.5) | | |
| 60–69 | 31 (17.1) | 150 (82.9) | 17.374 | ** |
| 70–79 | 18 (28.1) | 46 (71.9) | | |
| >80 | 6 (75) | 2 (25) | | |
| **Living arrangement** | | | | |
| Alone | 13 (27.1) | 35 (72.9) | | |
| Spouse | 28 (23.1) | 93 (76.9) | 3.794 | 0.285 |
| Children | 15 (24.2) | 47 (75.8) | | |
| Family member | 16 (15.2) | 89 (84.8) | | |
| *Walking characteristics* | | | | |
| **Ambulatory aid type** | | | | |
| Wheelchair | 4 (100) | | | |
| Cane | 21 (100) | | | |
| Crutches | 2 (66.7) | 1 (33.3) | 117.879 | *** |
| Clutching onto the furniture | 16 (76.2) | 5 (23.8) | | |
| None | 31 (10.8) | 256 (89.2) | | |
| **Perceived gait problem** | | | | |
| Walking with a bit stooped | 12 (48) | 13 (52) | | |
| Walking with shuffle foot | 17 (70.8) | 7 (29.2) | | |
| Difficulty rising from a chair | 29 (50.9) | 28 (49.1) | 88.03 | *** |
| Cannot walk without assistance | 7 (87.5) | 1 (12.5) | | |
| Not having such problems | 18 (7.7) | 217 (92.3) | | |

***p-value < 0.01, ***p-value < 0.001.*

**TABLE 3 |** The association between falls with instability.

| Falls in 6 months (*n*, %) | Perceived instability (*n*, %) | | $X^2$ | *p*-value |
|---|---|---|---|---|
| | Yes | No | | |
| 1–2 | 25 (34.7) | 56 (21.2) | | |
| 3 or more | 9 (12.5) | 7 (2.7) | 20.145 | *** |
| None | 38 (52.8) | 201 (76.1) | | |

****p-value < 0.001.*

0.05, we can conclude that there is an association between falls and instability among older adults in Malaysia ($X^2 = 20.145$ and *p*-value $< 0.001$). There was an increasing trend across age group in terms of the prevalence of falls and perceived instability. The results support previous literature findings that gait difficulties or instability were associated with falls in older adults (7, 26, 35–40). Older adults tend to define a fall as a loss of balance, while health care professionals commonly address the consequence of falling, including injury and reduced quality of life (41). Hatch et al. (39) suggested that older adults who have concerns about their balance may encounter actual balance deficits. This explains why the respondents with instability issues in this study reported a high number of falls occurrences, at the same time increasing the risk of falls. Covinsky et al. (42) and Muir et al. (9) emphasized their findings that the self-reported dizziness or instability is associated with increased fall risk.

**TABLE 4 |** Interest in using fall detection devices in relation to the prevalence of falls, perceived instability and demographic characteristics among the respondents.

| Interest in using a fall detection device | Yes (*n*, %) | Maybe (*n*, %) | Not interested (*n*, %) |
|---|---|---|---|
| **Falls in 6 months** | | | |
| 1–2 | 59 (72.8) | 22 (27.2) | |
| 3 more | 12 (75) | 4 (25) | |
| None | 144 (60.2) | 85 (35.6) | 10 (4.2) |
| **Perceived instability** | | | |
| Yes | 57 (79.2) | 14 (19.4) | 1 (1.4) |
| No | 158 (59.9) | 97 (36.7) | 9 (3.4) |
| **Sex** | | | |
| Male | 34 (60.7) | 21 (37.5) | 1 (1.8) |
| Female | 181 (64.7) | 90 (32.1) | 9 (3.2) |
| **Age (Years)** | | | |
| 50–59 | 36 (43.4) | 45 (54.2) | 2 (2.4) |
| 60–69 | 122 (67.4) | 53 (29.3) | 6 (3.3) |
| 70–79 | 52 (81.3) | 10 (15.6) | 2 (3.1) |
| >80 | 5 (62.5) | 3 (37.5) | |
| **Living arrangement** | | | |
| Alone | 32 (66.7) | 14 (29.2) | 2 (4.1) |
| Spouse | 81 (66.9) | 37 (30.6) | 3 (2.5) |
| Children | 46 (74.2) | 14 (22.6) | 2 (3.2) |
| Family member | 56 (53.3) | 46 (43.8) | 3 (2.9) |

The prevalence of falls in the last 6 months prior to the survey was 28.9% ($n = 336$), consistent with a study done in institutional settings in Kuala Lumpur, with 30% ($n = 50$) prevalence (43) and 27.3% ($n = 516$) with history of falls in Melaka (44). In another study conducted in Brazil, with 400 participants aged 60 years or older, the prevalence of falls was 35.3% (45). The result was higher compared to other several studies reporting the prevalence of falls in the preceding 12 months; 4.07% ($n = 811$) by a study among community-dwelling in Perak (46), 14.1% ($n = 3{,}969$) from the National Health and Morbidity Survey 2018 (3), and 17.6% ($n = 1{,}372$) among community-dwelling older adults aged 40 and above in Germany (47). Also, a recent study of older adults living in four regions across the United States reported 18.8% ($n = 878$) prevalence in the previous 6 months (13).

The risk of falling is increasing with age as the findings found that increasing age was statistically significant, where the age group of 70 years and above were more likely to fall, mainly three or more times in the past 6 months. The findings are similar to those found in studies analyzed that advanced age is associated with a higher percentage of falls (8, 36, 45, 48–50). In contrast, Rizawati and Mas Ayu (44) found that fall occurrence was the

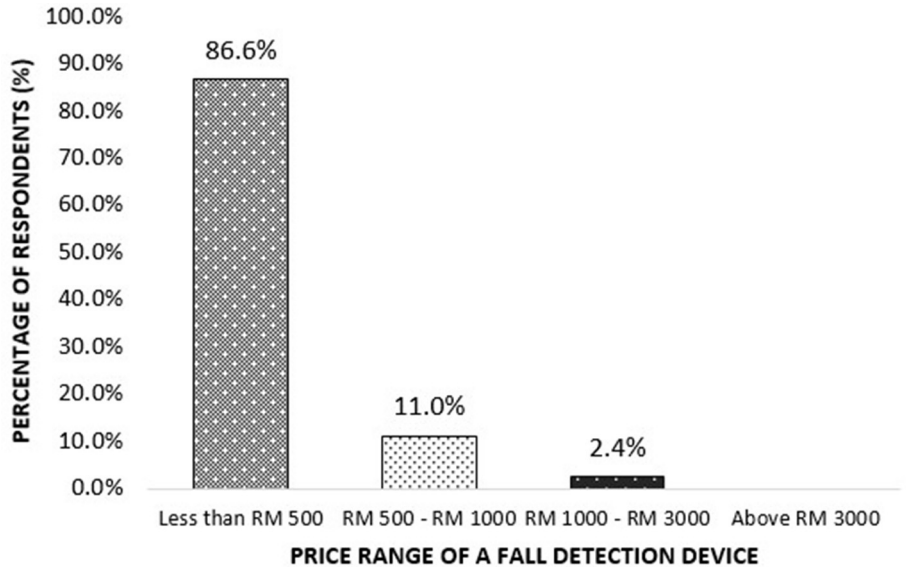


**FIGURE 1 |** Expected price range of a fall detection device by the respondents.

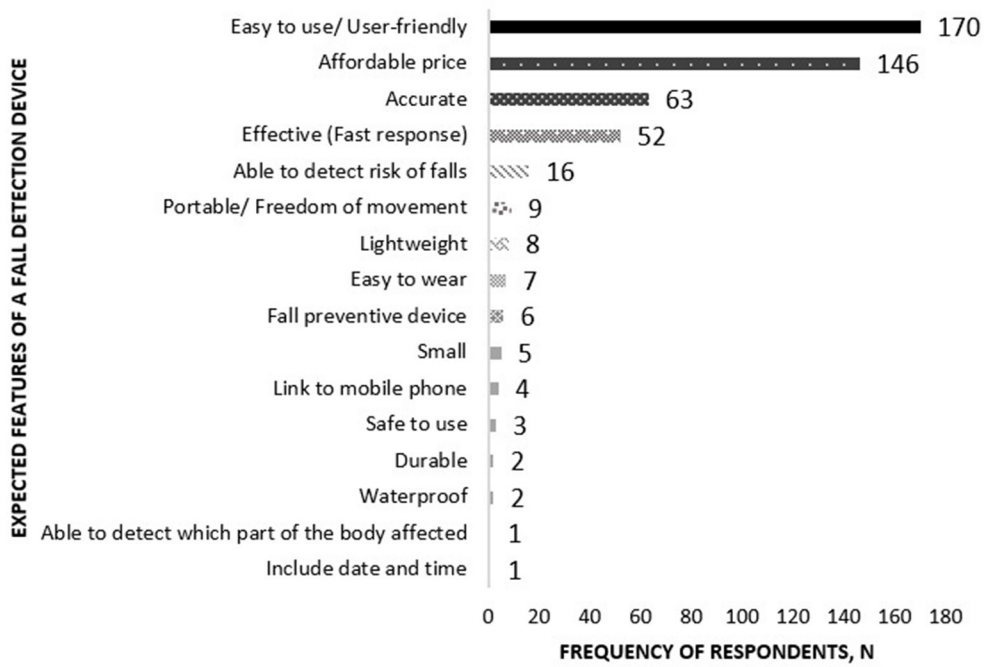


**FIGURE 2 |** Expected features of a fall detection device by the respondents.

highest in the younger group of 60 to 70 years, which accounted for 59.6% of total falls compared to age more than 70 years old (32.7%) during the past 12 months.

Although living arrangement has no significant association with the prevalence of falls and perceived instability, the ones who need serious attention are older adults who live alone, as there were 13 cases of falls reported in 6 months. Family members or designated community could remotely monitor from elsewhere if they were to use any fall detection devices to avoid long lie situation if a fall occurs and subsequently would provide immediate assistance.

More males respondents were experiencing instability. Older age group and those living alone are prone to have risk of falls, in consistence with the known relationship between falls

and instability. The analysis revealed that regardless of gender and living arrangements, there were still incidents of falls and instability among the respondents.

Reliance on ambulatory aids to move around in daily activities is identified as mobility limitation among older adults. Over a quarter of those who did not use ambulatory aids reported fall incidents. The results revealed that respondents who relied on ambulatory aids tend to fall more, contributing to the increased risk of falls among older adults. Thus, it necessitates fall detection device. The present study is consistent with the findings from previous studies reporting that respondents with a history of falls were more likely to use an assistive device (37, 51), but contradicting with the findings from Harris and colleagues (35). Also, Bogle and Newton (52) identified that the use of an assistive device was a strong predictor of performance on the Berg balance test.

Older adults are encouraged to depend on assistive devices during their advanced years to avoid accidents. The association between using assistive devices for ambulation and falls concludes that older adults require assistance from caregivers or family members, suggesting that additional training with the appropriate assistive device is necessary. The impaired balance resulting from the aging process among the respondents may require the use of ambulatory aids, as deduced from the findings that all types of ambulatory aids used were related to almost 90% of the respondents with instability issues.

The present study's findings agree with other studies that concluded respondents who fall were more likely to have gait problems; identified to be the factors in fall incidence and risk (8, 37, 45, 49, 53–56). Tinetti et al. (26) also revealed balance and gait tests, including difficulty rising from a chair, in which half of the respondents from this study reported having gait problems, to be a useful predictor in identifying recurrent fallers. Furthermore, investigating the association of instability and gait problems led to the term of fear of falling. Hatch et al. (29) stated that fear of falling was a factor of balance confidence concerning the impaired balance due to these balance limitations.

Preparing for the aging population comes with challenges. One of them is dealing with older adults themselves. Their perceptions and acceptance toward technology with rapid innovation in this day and age may affect the percentage of adoption and usage. For example, most of the respondents in this study have never heard of the fall detection device, though it is widely used in developed countries. It is unfortunate to say that older adults in Malaysia have yet to be well-literated with advanced technology. This may be because of decreasing cognitive ability making it hard to learn and use a new device with new features and buttons. Based on the survey results, 28 of the respondents who knew about the device have stated the reasons for refusal to use the fall detection device. Most stated they have not fallen before resulting in no intent of purchasing or trying to use the device. In future, a longer survey period and broader targeted samples with experience using a fall detection device may contribute to more meaningful analysis for older adults population in Malaysia.

In reality, older adults are interested in using a technological device that can assist them in their daily lives, as proven in **Table 4**. Majority of the respondents were interested in using a fall detection devices, provided they are tailored with training and assistance. Consistent with Wong (57), new technology adoption among older adults (in the study refers to mobile phone) took much longer time although it has positively changed from resistance to acceptance. In order to expedite the technology adoption, the barriers must be investigated and overcame. As identified by several studies, barriers include lacking in these matters: the knowledge of key elements of the program, the expertise to train programs concerning fall preventions, the confidence of using advanced technology, insufficient knowledge of target group, funding, public awareness, and marketing campaign regarding gerontechnology programs (18, 58–60).

A previous study agrees with the finding that older adults tend to assume that the device is expensive; therefore, they tend not to use any technological advanced device at all (61). This explains why 86.6% of the respondents chose the expected affordable and suitable price for the fall detection device to be the lowest (<RM500).

Findings also showed that most of the respondents and their community lacked information and awareness on the range of available assistive devices and other available devices that offer a quality life in their advanced years. Referring to Chen and Chan (62), the older adults' health capabilities and functional capacities affect the utilization of gerontechnology. Simultaneously, its usage is driven by outcome expectations and peer recommendation, supported by facilitators. Correspondingly, their study proved that training was the primary factor in facilitating technology use, and it will increase the chance of accepting and utilizating innovative technology (62). In-line with previous studies, training courses or workshops could boost older adult's self-confidence, stimulate positive attitudes, and surge in intention to use technology (63, 64). As such, The Cycle of Technology Acquirement by Independent-Living Seniors (C-TAILS) introduced by Peek et al. (65), older adults' problems or status quo must be investigated first before proposing new technology to them. Then, enabling mechanisms would be triggered as personal and situational moderating factors, influencing the technology acquirement, which then will be depicted by their actual experiences with the newly acquired technology.

The assessment highlights the importance of inquiring older adults' expectations regarding a future fall detection device's features. The findings can be applied as a guide strategies in designing the device and engaging the older population in preventing falls in the future.

## LIMITATIONS

The outcomes of this study have some limitations. Participants were randomly selected at convenience with the aim to have a wide-ranging older adult population. However, only healthy community-dwelling was selected due to limited access and a short data collection period. As they were recruited by convenience sampling, it cannot represent the general population and are prone to selection bias.

Secondly, incidents of falls and instability were assessed by self-report, which could lead to recall bias. As most retrospective research, the false recall may have created inaccuracies in reporting the fall history retrospectively over 6 months. The actual frequencies of falls would be greater or lesser than 28.9%. Additionally, the respondents' functional condition may not be the same at the time of the fall incidents while the respondents were evaluated.

Thirdly, there was no further assessment of falls-related factors and instability characteristics. Examples of assessments to develop more meaningful analysis are gait patterns, types of injuries caused by falls and symptoms or diseases that could cause falls (e.g., impaired vision, dizziness, vertigo, dementia, depression). Additionally, further studies on older adults' reactions to maintain balance in a time of perturbation are highly suggested.

Fourthly, findings represent by cross-sectional associations cannot be used in determining the cause. Further studies to address the causal relationship of falls, instability, gait impairments, and mobility limitations are needed.

Although the present study investigated the older adult's perceptions and the use of technology, the findings are based on cross-sectional studies that did not take into account user experiences.

## CONCLUSION

The prevalence of falls and the percentage of perceived instability conditions increases with time as the older population grows. The analysis showed that instability affects the occurrence of falls among older adults. The occurrences could be reduced with proper monitoring. The demand continues for fall prevention intervention in detection, as well as awareness and familiarization among this population.

As for the research approach, the questionnaire has been proven to be quite successful in analyzing the older adult's perception and expectation toward the use of fall detection devices in Malaysia. The questionnaire results identified a fall detection device's preferred design for older adults. In the field of innovation design for older adults, it is always important to mind our designs to be in tandem with aging competency to avoid the perception of fear, irritation, and refusal to use the technological device. Thus, the designed technology must be calibrated and developed with them instead of for them. Meanwhile, encouraging this non-users to adopt technology requires removing all barriers at personal, technological and environmental levels to ensure its effectiveness. With all variables considered, it can be concluded that the need to extend the fall detection device incorporating a balance monitoring system is highly beneficial for fall prevention intervention.

Although several variables distinguished between those who fell and those who did not, the relationship may only be an association, not causal; may vary between individuals, similar to perceived instability conditions. For example, having gait problems may cause an older adult to develop a fear of falling, loss of stability, and consequently tend to fall. Alternatively, an older adult may not have such problems and may fall, both because of the nature of aging.

The primary purpose of studying gerontechnology is to improve the quality of life among older adults. The proposed device offers older adults freedom and boosts their confidence whereby they can do daily activities without fear, hence promoting active aging. The more active an older adult is, the lesser potential of falling will it be. Technology is one of the approaches which can support older adults in their daily lives, in addition to enhancing their comfort and safety at home.

Henceforward, the well-being of older adults should be taken into consideration from now on. An enhanced fall prevention device is expected to assist caregivers or family members as real-time monitoring provides immediate alert, promoting peace of mind and reducing the burden. Correspondingly, physical therapists and clinicians can clearly understand when the person falls and circumstances surrounding it, allowing for better treatment. Finally, more profound findings and more psychological analysis are needed, which can be tailored to older user's needs and perceived to be senior-friendly and more accurate.

## DATA AVAILABILITY STATEMENT

The original contributions generated in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Committee for Research Involving Human Subjects (JKEUPM), Universiti Putra Malaysia. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

KA, SA, and CW designed the whole framework and methodology. KA conducted data collection, data analysis, and manuscript preparation. All authors were involved in the methodology development, read, review and proofread the final manuscript.

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# Stroke Rehabilitation for Falls and Risk of Falls in Southeast Asia: A Scoping Review With Stakeholders' Consultation

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**Background:** Research on rehabilitation for falls after stroke is warranted. However, published evidence on fall interventions with stroke survivors is limited and these are mainly international studies that may be less relevant for Southeast Asia.

**Objective:** This review aims to systematically identify literature related to stroke rehabilitation for falls and risk of falls in Southeast Asia.

**Methods:** A scoping review with stakeholders' consultation was implemented. An electronic search was conducted up to December 2020 on 4 databases (Medline, CINAHL, Scopus, ASEAN Citation Index). Only original studies conducted in Southeast Asia were selected.

**Results:** The initial search yielded 3,112 articles, however, only 26 were selected in the final analysis. Most of the articles focused on physical rehabilitation and implemented conventional therapies. While the literature may reflect practice in Southeast Asia, stakeholders perceived that the literature was inadequate to show true practice, was not informative and missed several aspects such as functional, cognitive, and psychological interventions in managing falls. Individual-centric interventions dominated the review while community-based and environmental-focused studies were limited. Majority of the articles were written by physiotherapists while others were from physicians, occupational therapists, and an engineer but few from other healthcare practitioners (i.e., speech therapists, psychologists) or disciplines interested in falls.

**Conclusions:** Falls prevention among stroke survivors has received a lack of attention and is perceived as an indirect goal in stroke rehabilitation in Southeast Asia. More innovative research adopted from falls research with older people is needed to advance falls prevention and intervention practice with stroke survivors.

**Keywords: aged, cerebrovascular accident, falls, rehabilitation, developing countries**

## INTRODUCTION

Southeast Asia is one of the most populous regions in the world. It consists of low, middle, and high-income countries namely Brunei, Cambodia, East Timor, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam (1). With a total population of almost 700 million, the region is rich with different ethnicities and cultures. However, it also shares similarities in terms of dietary, climate and lifestyle (1, 2). Stroke is one of the top non-communicable diseases worldwide and in Asia (3). The highest prevalence rates of both ischemic and haemorrhagic stroke occur in high-income regions of the Asia Pacific, North America, East and Southeast Asia, in those aged 50–64 years (4). The prevalence of stroke in Southeast Asia countries per 1000 people is 8.0 in Indonesia (5), 9.0 in the Philippines (6), 36.5 (for >50 years) in Singapore (7), 18.8 (for >45 years) in Thailand (8), 6.1 in Vietnam (9) and 7.0 in Malaysia (10) respectively. Stroke is the primary cause of physical impairment and disabilities in adulthood making it a major public health problem (11–13).

Studies have established the association between stroke and falls (14, 15). The consequences of falls after stroke are devastating as they could lead to reduced social participation, fear of falling, traumatic brain injury, fractures, deficits in functioning, morbidity, and even mortality (16–19). International studies reported that the prevalence of falls among stroke survivors within the first 6 months after discharge is between 36 to 73% and fall rates remain high between 40 to 58% 1 year after stroke (20–25). However, the prevalence of falls among the stroke population in Southeast Asia has not yet been determined. Furthermore, 61% of falls occurred in the first 2 months after discharge from rehabilitation and returning home after stroke (26). Most stroke survivors fall inside their home (27–29) and it was reported that walking and transfers were the most frequent activities at the time of a fall (16). Mackintosh et al. (26) also reported that less than a quarter of fallers sought health professional advice after a fall and possible reasons for this include the perception that falls are not preventable and occur because of the impairments after a stroke or an individual's age. This finding suggests there is a need to instigate more intensive falls and injury prevention strategies in the first months after discharge from rehabilitation.

Falls in stroke survivors are usually attributed to a combination of factors that may or may not be related to stroke, and stroke is just one of the many significant comorbidities affecting older adults (30). Several risk factors for falls among stroke survivors have been identified. The key risk factors for fallers among the stroke population are impaired mobility, reduced balance, use of sedative/psychotropic medications, disability in self-care, depression, cognitive impairment, and history of falls (31). Previous literature on falls in older adults (32, 33) and the stroke population (31, 34) proposed a classification of risk factors of falls into the following domains: sociodemographic, sensorimotor, cognitive, psychosocial, medical, balance and mobility, and self-care (31). Several studies have concluded that the risk factors identified for falls in stroke are similar to those of falls in the general older population (30, 35, 36). However, compared with studies among older people (37–39), research in falls and stroke is limited, particularly in aspects other than physical issues, either as a risk factor or intervention. These findings suggest a need to establish holistic and tailored falls and injury prevention strategies as an integral part of each person's stroke rehabilitation plan. Thus, by understanding falls in stroke, preventing and intervening falls needs to become a priority for stroke survivors.

Rehabilitation is a goal-oriented process that assists a person with disabilities to achieve an optimal emotional, physical, cognitive, social, and functional level (40). The professionals involved include rehabilitation physicians, occupational therapists, physiotherapists, speech therapists, rehabilitation nurses, and medical social workers. In general, the rehabilitation process can occur either as an inpatient, outpatient, in the community, and in home-based settings. Rehabilitation was found to benefit stroke and falls in general (37, 41, 42). These rehabilitation programs must be carefully evaluated based on understanding the risk factors contributing to falls (43). Stroke rehabilitation for fall prevention aims to correct factors that have contributed to the fall, assist recovery from any complications and restore confidence and activity. This process includes a falls risk assessment including fear of falling, a comprehensive home assessment to reduce falling hazards, and multifactorial interventions in the community (44). One systematic review identified several interventions for falls, including exercise, pre-discharged home visits, the use of an assistive device, and transcranial direct current stimulation. However, only single exercise interventions were found might reduce the rate of falls among stroke survivors (45).

Published evidence on interventions for stroke and falls is limited and are mainly from Western-influenced and developed countries. This signifies that the findings on stroke and falls practice from those countries' contexts may become less relevant for application in Southeast Asia (40, 41). Studies on falls and community-dwelling older people gathered from a specific region benefit the region by identifying unique findings, practicing gaps, and providing a better understanding of the field for the region (46). While stroke and falls are also a major concern in Southeast Asia, published literature in this region remains limited and difficult to access.

A scoping review's general purpose is to map key concepts that underpin a research area, especially an area that is complex or understudied (47). Thus, this review, guided by the JBI guideline for evidence synthesis (48), aims to comprehensively identify evidence on stroke rehabilitation for falls and risk of falls in Southeast Asia. The framework consists of seven consecutive stages, which include (i) developing the review question, (ii) defining inclusion and exclusion criteria, (iii) conducting a search strategy, (iv) evidence screening and study selection, (v) data extraction, (vi) data analysis, and (vii) presentation of results. Each stage is discussed in further detail below, and the Preferred Reporting Items for Systematic Reviews and Meta-analysis extension for scoping reviews (PRISMA-ScR) (49) (**Supplementary Table 1**) was adopted as a guideline for the report of the scoping review.

# METHODOLOGY

## Review Question

The study adopted the Population-Concept-Context (PCC) framework (48) to determine the research question's extent. The population is adult stroke patients, and the concepts are rehabilitation for falls and risk of falls after stroke. The context of this study focused on the Southeast Asia region. This scoping review was developed based on the question "What is the extent of published literature on rehabilitation for falls and risk of falls after stroke in Southeast Asia?"

## Defining Inclusion and Exclusion Criteria

The criteria are detailed according to the PCC framework as the following:

### Participants

This scoping review considered research studies that focused on stroke survivors, caregivers and healthcare professionals aged 21 years old and above. Stroke survivors were defined according to diagnostic criteria of the American Heart Association/American Stroke Association (50). All professionals were part of the management team for stroke patients, including rehabilitation physicians, physicians, medical social officers, occupational therapists, speech therapists, physiotherapists, engineers, and volunteers.

### Concept

This review considered all research studies that specifically addressed stroke rehabilitation for falls or risk of falls. Research that did not provide stroke rehabilitation services was excluded.

### Context

All studies need to be conducted in Southeast Asia, and interventions could be implemented either in the hospital or in the community (e.g., patients' homes). However, residential and institutionalized stroke patients were excluded from the analysis; stroke patients in institutions have severe disabilities, and the main aim of the care in these institutions is nursing rather than rehabilitative care.

### Types of Evidence Source

Studies included in this review were all types of original or primary research studies including interventional studies (randomized controlled trials, quasi-experiments, single-group pre-post), observational studies (cross-sectional, cohort, longitudinal, case series, and case reports) and qualitative studies related to rehabilitation. A scoping review aims to provide a map of understanding about a scenario; thus, it will consider various designs of original studies including articles of lower evidence such as qualitative studies and case reports (48). All full-text articles included must be in English. Gray literature (e.g., thesis, dissertation), conference abstracts, guidelines, training, process evaluations (no outcome data), non-research article (i.e., editorial, letter, commentary) and secondary data analyses (books, government reports) were excluded from the review. No restrictions were imposed on the date of the study or the study design.

## Search Strategy

The search strategy was used to locate published studies. First, keywords derived from previous systematic reviews and other reviews (30, 31, 45) were listed to get an idea of the common keywords utilized for the topic. Then, based on the PCC framework, the authors developed the main keywords for each category. Synonyms for each keyword were searched via the internet and discussions were conducted between 2 authors to select and finalize the most relevant keywords for use. The finalized keywords utilized are as the following: a combination of "stroke" and related terminology (i.e., cerebrovascular accident, CVA), "rehabilitation" (including occupational therapy, physiotherapy, speech therapy), "falls" (including falls intervention and prevention) and "Southeast Asia" (including each name of the country members). Boolean operators, parenthesis, exact and wildcards were used whenever appropriate.

Specifically, the search strings used were ("cerebrovascular accident" OR "CVA" OR "stroke") AND ("fall*" OR "fall* prevention" OR "fall* intervention" OR "accidental fall*" OR "risk of fall*" OR "fall* predictor*" OR "prevalence of fall*") AND ("rehabilitation" OR "occupational therap*" OR "physiotherapy*" OR "physical therap*" OR "speech language patholog*" OR "speech therap*") AND ("Southeast Asia" OR "Malaysia" OR "Singapore" OR "Thailand" OR "Brunei" OR "Indonesia" OR "East Timor" OR "Cambodia" OR "Myanmar" OR "Vietnam" OR "Laos" OR "Philippines") for 3 databases. However, for the ASEAN Citation Index, only the keyword "fall" was used due to the limited algorithm feature of the search engine (**Supplementary Table 2**). The keywords were inserted into electronic search engines of EBSCOHost for MEDLINE and CINAHL databases, Scopus, and ASEAN Citation Index (ACI) on 30th September 2019 and was updated up to 12th December 2020. A manual search was also conducted regarding a related review by Romli et al. (51).

## Evidence Screening and Study Selection

Two authors independently screened the titles and abstracts of studies and assessed the eligibility of the studies for inclusion against the pre-defined criteria mentioned previously. For each article, any disagreements between the 2 authors were resolved by discussion. In the first screening stage (titles plus abstracts), studies were included when any of the 2 authors agreed that they were eligible for inclusion or if there were doubts about whether to exclude them. In the second screening stage (full text), studies were included when both authors felt that they met all the inclusion criteria. A healthcare practitioner was consulted when disputed studies were identified during the full-text screening, who acted as an independent arbiter. Pre-consensus agreement on the included full-text articles between the 2 authors was calculated using percentage values. No quality evaluation was implemented as a critical appraisal of each study is not compulsory for scoping reviews (48).

## Data Extraction

The details of the studies, which included the citation, country, study objective, design, setting, instruments used, and findings,

were extracted and summarized in a matrix table (46). The data extraction was done by the first author and then verified by the other authors. The findings of the review were collated into the following research categories: observational studies, interventional studies, and qualitative studies.

The stakeholder consultation (48) was conducted as part of a study reported separately (under review). The purpose of the consultation was to explore the stakeholders' perceptions of stroke rehabilitation's current practice for falls after a stroke. Concisely, the consultation implemented a qualitative study design (52). Eighteen participants from one community-based stroke rehabilitation center were purposefully selected. All participants had given informed consent before the discussions. Three focus group discussions were conducted; 2 groups combined both stroke survivors and caregivers and 1 group of only healthcare professionals. The focus group discussions were conducted following standard practice (53, 54). The sessions were conducted in a separate meeting room to ensure privacy where the participants actively engage in the discussion while two researchers acted as moderators to facilitate the sessions. Each participant was provided with a summary of the preliminary findings from the review (up to the group discussion date) and a set of open-ended questions to guide the discussions. The participants could then discuss their views in any language convenient to them as long as they understood them. The sessions were recorded using a voice recorder and through note-taking by a research assistant. The data management and analysis of this qualitative study was guided by the Sutton and Austin framework (55). The data were transcribed verbatim and coded between two authors. This qualitative study received ethical clearance from University Putra Malaysia Ethics Committee for Research Involving Humans (JKEUPM-2019-100).

## Data Analysis and Presentation of the Results

The data were narratively summarized according to pre-defined themes on fallers' characteristics, factors associated with falling, rehabilitation interventions available for falls prevention and intervention for stroke survivors, and perceptions on stroke rehabilitation and falls. The themes were developed through discussion among authors by looking into the studies' similarities and their findings. Synthesis from the review was integrated with the stakeholders' consultation. Self-reported falls and falls-related assessment tools, including their validity and reliability in the Southeast Asia context, were also documented. The interaction between themes in this scoping review was illustrated as a mapping framework.

# RESULTS

## Study Inclusion

The initial search yielded 3,112 unique articles, and the consensus for full-text acceptance between the two authors was 69.2% ($n$ = 18/26). For disputed articles ($n$ = 11), six decisions were resolved by a discussion between the 2 authors, while another 5 articles were referred to an arbiter. Of the disputed 11 articles, seven articles were accepted, and 4 were rejected. A total of 26 articles were included in the final analysis (56–81). Reasons for the exclusion of articles during the full-text screening were provided in **Figure 1** (14, 82–92).

## Characteristics of Included Studies

Most of the included studies are from Singapore (63, 65, 66, 68, 71, 72, 76–78), followed by Malaysia (57, 61, 69, 70, 73–75, 80), Thailand (56, 60, 62, 64, 67, 79), the Philippines (58, 59) and Indonesia (81) (**Figure 2**). No articles were found from other Southeast Asia countries. The articles were published between 2006 to 2020 (**Supplementary Table 3**). Of the total 26 articles, five were observational studies (57, 62, 64, 66, 76), 17 were experimental (56, 58–61, 63, 65, 67, 69, 73–75, 77–81) and the remaining four were qualitative (68, 70–72). Meanwhile, 15 were clinical-based studies (56–59, 62–67, 70, 75, 78, 79, 81) and 11 studies were conducted in the community (60, 61, 68, 69, 71–74, 76, 77, 80). Most of the articles were authored by physiotherapists ($n = 14$) followed by physicians ($n = 6$), occupational therapists ($n = 5$), and an engineer ($n = 1$).

## Review Findings

Four studies (62, 64, 66, 76) reported the rate or incidence of falls. Three studies (62, 66, 76) specifically investigated the location and activities when the falls happened and four studies (62, 64, 66, 76) established the risk and associated factors related to falls. A total of 16 studies investigated the intervention for risk of falls for stroke survivors; three studies (67, 79, 81) were randomized controlled trials, two studies (56, 61) were a non-randomized controlled trial, 7 studies (60, 63, 65, 69, 75, 77, 78) were one-group pre-post experiment, four studies were case reports (58, 59, 73, 74) and one study was a protocol (80). The interventions identified from this review can be classified as conventional or technology-based methods. Conventional interventions were defined as commonly accepted interventions that are provided manually in the form of face-to-face sessions with patients, in contrast, technology-based interventions involved the use of sophisticated technology such as robots and digital facilities (i.e., virtual reality and tele-health) (93). Four studies explored the perceptions of stroke rehabilitation practices among stroke survivors, caregivers, and healthcare professionals (68, 70–72).

## Characteristics of Falls and Fallers

One study evaluated falls 6 months after stroke and found that 12.5% of the participants had fallen once, and 13.5% experienced repeated falls (64). Studies that followed up on stroke survivors over 12 months post-stroke reported that 24–28% of individuals fell at least once and 16% fell more than once (66, 76). Inpatient stroke rehabilitation reported that 15.9% had fallen during admission, 10.6% fell once, 5.3% fell twice or more, and the incidence rate was at 3.44/1,000 patient/day for all cases during the inpatient stroke rehabilitation (62). Only one study (64) evaluated fallers' characteristics: predominantly older, male, had an ischemic stroke, had left-sided hemiparesis, were using an assistive aid or wheelchair, had a greater stroke severity, had poorer cognition, and with poor lower extremity motor control. The fallers group showed less improvement in physical impairments,

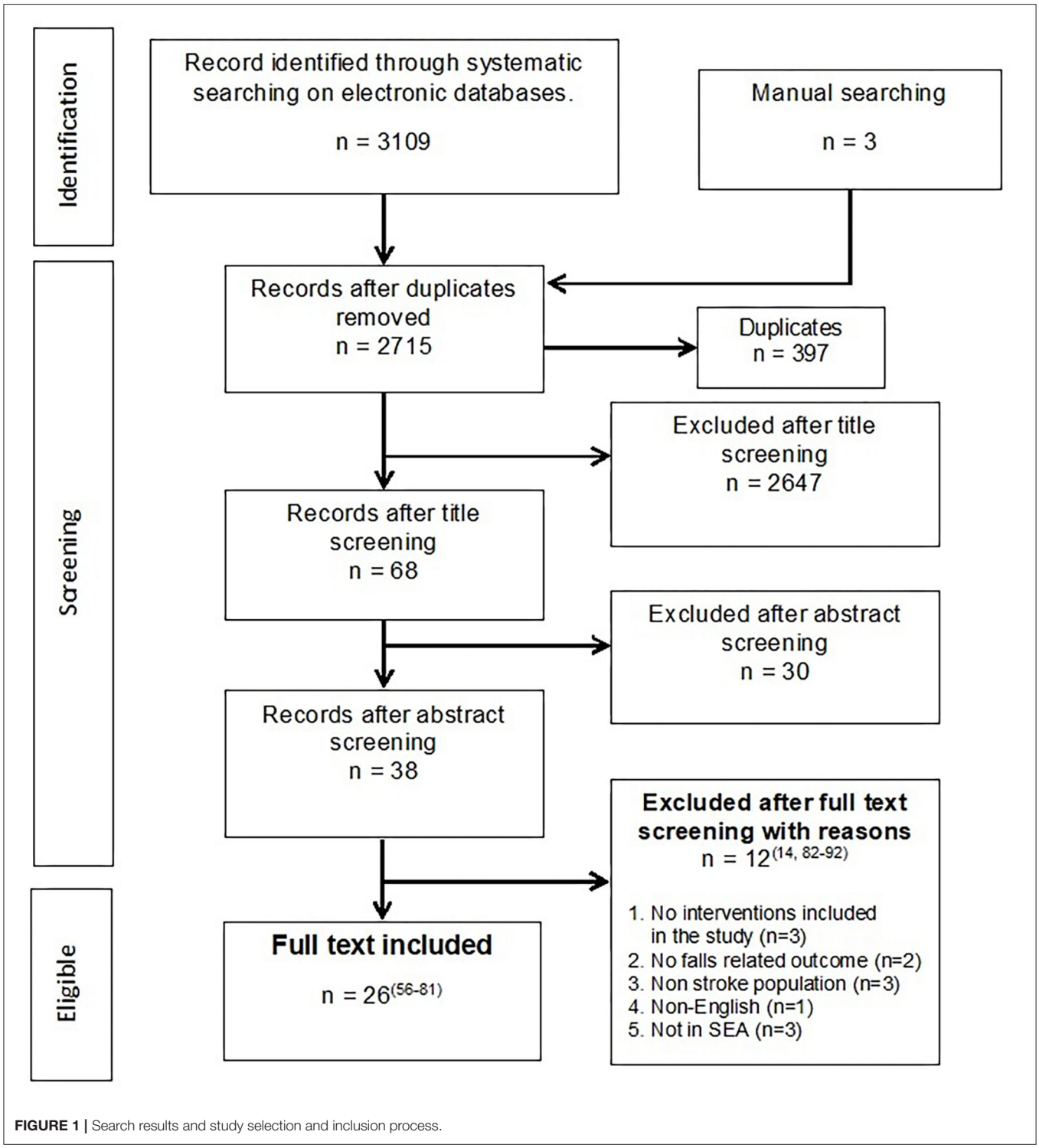


**FIGURE 1 |** Search results and study selection and inclusion process.

lower activity levels, and community participation than non-fallers (64). The fallers group also reported higher scores of falls efficacy, indicating that participants who fell had lower self-confidence and a greater fear of falling than the non-fallers (64).

## Falls Location and Activities at the Time of the Fall

Inpatient falls often happened at the bathroom (37.1%), at the bedside (22.9%), on the wheelchair (11.4%) and others (28.6%) (62). Approximately 47–86% of falls occurred at and inside

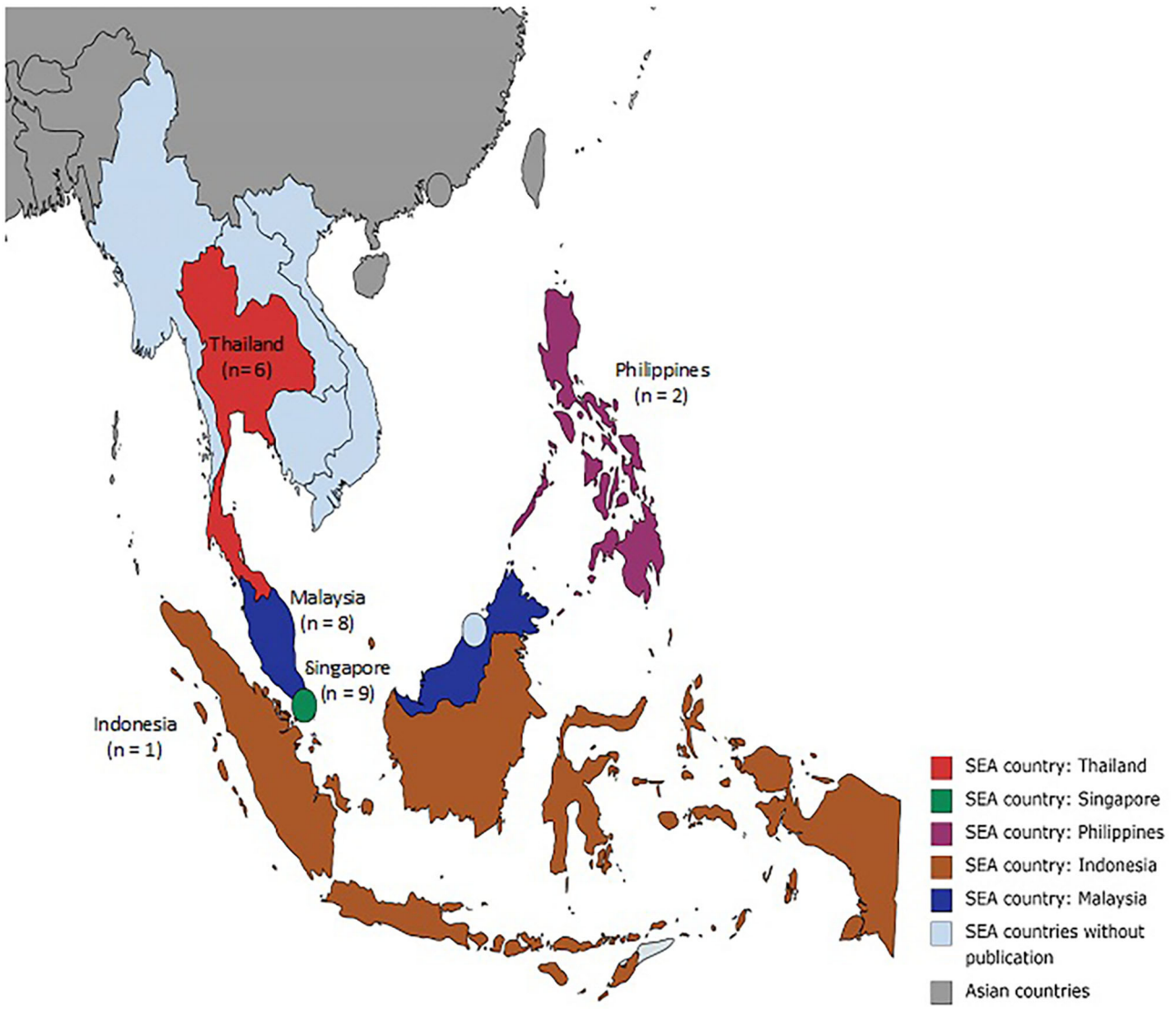


**FIGURE 2 |** Map of Southeast Asia. Source: https://mapchart.net/asia.html.

of stroke survivors' homes (66, 76). Falls at home most often occurred in the toilet (35.6%), in the bedroom (16.9%), and in the living room (3.4%) (76). Thirty-two percent of falls were related to the use of stairs (66) and 20–48% occurred during walking (62, 66, 76). In addition to that, 20–22.9% of falls happened while transferring (62, 76), and the rest included activities during reaching (14.3%), dressing (11.4%), rising to stand (11.4%), showering (5.7%), turning (5.7%), and others (8.6%) (62). The most common reasons for falls as perceived by stroke survivors were loss of balance (56%) and impulsivity (15%) (76).

## Identified Risk of Falls/Associated Risk Factors for Falls

Fallers showed less improvement in physical impairments within 6 months post-stroke (64). Fallers also demonstrated significantly smaller stride length, gait speed variability, and mediolateral and vertical pelvic displacement (66). When assessing balance, fallers had significantly lower scores on the Timed-Up and Go, Step Test (66) and Berg Balance Scale (64). The risk of falling within 6 months was double when identified by balance measurements and functioning at 3 months (64). One study revealed that the transfer domain was the only significant independent factor affecting falls (76). The stroke survivors who fell were also those with more difficulties in mobility and in reintegration to everyday living (77).

## Conventional and Technology-Based Interventions

Conventional therapy consisted of either standard protocol treatments such as Motor Imagery (MI), Proprioceptive

Neuromuscular Facilitation (PNF), Neuro-restoration (Bobath, Rood, Carr and Shepherd Method, and Constraint-induced Movement Therapy) or generic and conservative therapy such as exercise, functional training, strengthening exercise, task-specific gait training, and education. Most of the interventions benefited stroke survivors, and standard protocol interventions showed greater effectiveness in reducing falls, risk of falls, and fear of falling. In summary, the MI technique was found to be significant in improving gait symmetry and fall-efficacy compared to a generic physiotherapy regime (56). Similarly, PNF was assumed to benefit stroke survivors in managing the risk of falls, despite insufficient evidence (58, 59). A study in Thailand investigated Village Health Volunteers' training for stroke survivors' therapy via 1-h, weekly home visits. After 8 consecutive weeks, there was an improvement in stroke survivors' walking speed (60). One study examined multifactorial interventions for falls after stroke (77). The interventions included were exercises, peer support, homework, community mobility practice, and caregiver's education. Falls data were collected with 8 participants (four fallers and 4 non-fallers among stroke survivors) for a total of 8 months from baseline (77). At 1-month follow-up, stroke participants demonstrated positive changes in fall behavior, mobility, and goals. There were no changes among the family caregivers in terms of health status and strain except for a maid who's stress level had increased during post-evaluation, but her general health status improved during post-evaluation compared to the baseline assessment (77). Regarding the effectiveness of physiotherapy interventions on brain neuroplasticity, both the intervention and control group showed improvements in balance and functional performance. Furthermore, the neuro-restoration intervention group had greater effectiveness than the conventional physiotherapy intervention in terms of balance and functional performance but did not achieve a statistical difference in neuroplasticity regeneration (81).

Technology-based interventions identified from this review were Variable Automated Speed and Sensing Treadmill (VASST), virtual therapy exergame activity, multidirectional reach tool, home-based balance exercise, stepping response training using a Voluntary-induced Stepping Response (VSR), platform perturbation training using platform translation equipment (DST) and the BAL EX FOOT (61, 63, 65, 67, 73, 74, 78, 79). Although all interventions claimed to be beneficial to stroke survivors, there was limited evidence to support the effectiveness of technology-based interventions over conventional ones. The multidirectional reach tool, virtual therapy exergame activity, and the VASST were found to have the potential to be implemented. The use of the multidirectional tool among stroke survivors saw improvements in balance as it resulted in increased Limits of Stability (LoS) and weight-bearing squats as well as awareness and practice of behaviors that could potentially protect against falling (67). The virtual therapy exergame study reported that both the intervention and control groups had significant improvements in functional mobility and lower limb strength after the intervention phase, indicating that substituting a portion of the standard physiotherapy time with virtual reality games was equally effective in maintaining physical function outcomes and activities of daily living among community-dwelling stroke survivors (61). The VASST showed significant improvement in walking distance, gait speed, and balance of the stroke survivors (63, 65). Compliance with all 12 training sessions was 100% for all subjects, and there were no dropouts or serious adverse events when the VASST was used (65). Meanwhile, VSR and DST trainings improved protective stepping in stroke, and VSR could be a feasible alternative to equipment-based training but requires further study. The home-based balance exercise and the BAL EX FOOT cannot be recommended as these interventions had substantial methodological limitations, were still in the prototype phase, and required further investigation. In terms of feasibility, the virtual reality exergame had the most potential as it utilized commercial equipment and provided a feasible dosage similar to conventional sessions.

## Perceptions on Stroke Rehabilitation and Falls

A study by Nordin et al. (70) interviewed both rehabilitation professionals and stroke survivors, while Koh et al. (68) only focused on stroke survivors. For stroke rehabilitation in general, both professionals and survivors believed that the current stroke practice had improved over the past decade (70). However, the continuity of treatment for stroke survivors after a hospital discharge needs to improve as many survivors did not continue rehabilitation due to the lack of facilities and resources. Despite improved functional performance after inpatient rehabilitation, some patients were deterred from continuing rehabilitation as they did not feel that they gained much from their rehabilitation program. One participant commented that they did not see improvements after rehabilitation, whereby impairments could still cause a fall and result in difficulties in standing upright (68). Family-assisted therapy was one potential path to continued recovery despite the uncertainty of family members' commitment (70). Participants also claimed that family members can be overprotective and that this had discouraged stroke patients from performing home exercises, while other participants felt that the family of stroke patients had not given adequate support throughout the rehabilitation process. One stroke survivor quoted that whenever he does the exercises, his wife got angry because she was afraid that he could fall while doing the exercises. She was also worried about who will take care of the stroke survivor if he did fall while doing the exercises.

Two of the qualitative studies explicitly focused on rehabilitation for falls after stroke (71, 72). Stroke participants perceived intrinsic and extrinsic factors to be leading to falls. Muscle fatigue, decreased balance, and risky behavior (e.g., fast turning while walking) were intrinsic factors, while some of the extrinsic factors reported included environmental hazards and improper use of aids and equipment (e.g., walking aids, ankle-foot orthoses) (71). After their first post-stroke fall, almost all stroke participants showed an increased fear of falling and reported that the fall disrupted their normal daily activities. For others, it increased their dependency on caregivers and caused difficulty to conduct everyday tasks because of safety concerns (71). As part of the recovery phase, therapists who

had experience in caregiver training emphasized caregivers' role in helping the stroke patients during the rehabilitation process (72). These therapists also highlighted the essential role of family members and maids in preventing falls and agreed that education and caregiver training should be further improved (72).

## Outcome Measures

The outcomes from the included studies utilized a varied number of instruments; both standardized and non-standardized. Instruments established using research internationally were considered standardized, while researcher-developed instruments developed purposely for the study or instruments used that were not cited or not provided with evidence of publication were considered non-standardized. Standardized assessments identified are listed in **Supplementary Table 3**, while non-standardized assessments included self-reported falls (62, 64, 66, 76–79) weight-bearing squat, gait symmetry parameters, speed and velocity stride length, step width, mediolateral and vertical pelvic displacement, external rotation of lower limb, center of pressure and limits of stability (56, 58, 59, 66, 67, 74). The list of standardized assessments utilized in the included studies is shown in **Table 1**, with evidence of its validation in Southeast Asia.

## Stakeholders' Consultation

Eleven clients and seven healthcare professionals were recruited as participants. Half of the clients were stroke survivors ($n = 6$, 54.5%), and the remaining were spousal caregivers. For healthcare-participants, the majority were physiotherapists ($n = 5$, 71.4%), followed by an occupational therapist ($n = 1$, 14.3%) and a speech therapist ($n = 1$, 14.3%). All therapists had between 1–5 years of professional experience. The findings of the qualitative study relevant to this scoping review are summarized below.

Most client-participants admitted that multiple recurrent falls occurred, consistent with the literature (66, 76). One stroke-participant said that he fell 4 times, and another caregiver-participant reported that her husband had more than 50 falls after his stroke. However, some participants did not have any falls after being discharged from the hospital. In terms of the location of falls, this review identified that most falls occurred at and inside the homes (66, 76). This is further verified by a client-participant who mentioned that he had fallen in the toilet and when going up and down the stairs in the home. Outdoor falls were also reported in a restaurant and hospital.

Stroke-participants admitted that after a fall, they became more conscious of walking freely and without assistance. One caregiver whose husband was a faller said that falling had made him even more afraid to walk. Another stroke survivor also echoed that his number one concern after a stroke was the risk of falls after having several near misses. Furthermore, the caregivers also emphasized that they did not let their spouses do daily activities alone to avoid unwanted falls. This supports the study by Jalayondeja et al. (64) in which fallers participated less in activities and the community, had lower self-confidence and a greater fear of falling. The participants also recognized that physical impairments play a role in falls, as stated in the literature (64, 66). However, there were additional factors not identified in the literature but had a significant impact, such as the environment (e.g., uneven road), communication, and cognition. One caregiver mentioned that her husband's memory was not good, and he had difficulty distinguishing between right and left. According to the caregiver, this could have contributed to falls at home.

In terms of interventions received, all participants agreed that most of the interventions listed in the review were conducted except the technology-based interventions. However, the list was not exhaustive. Many other activities (i.e., domestic and leisure activities) were also implemented. This is because the interventions implemented in real practice targeted holistic objectives rather than only focusing on falls. This was mentioned by one healthcare-participant where preventing falls came indirectly when an improvement in other aspects was achieved. This was also agreed by client-participants where they viewed that improving their social life was more important than preventing falls after stroke. Environment and home hazards were somehow overlooked, both from gathered literature as well as by the participants. Shortage of manpower, cost, and time constraints to conduct home assessments were some of the reasons stated by healthcare-participants for the less attention to home hazards. For client-participants they perceived that home visits and modifications were not necessary, were expensive, and they did not appreciate the undesired aesthetic value (i.e., hospital-like environment) of their homes after the modifications.

## Interaction of Information in the Scoping Review

The information gathered within this scoping review is mapped to show the linkage, as illustrated in **Figure 3**. The figure presents the interaction of the combined information from the review findings, consultation outcome, and the comparison of stroke and falls literature within the international context.

# DISCUSSION

This scoping review addresses a new research area related to falls and falls risk with stroke survivors in Southeast Asia. This scoping review also provides a comprehensive understanding of this topic and identified critical gaps (48). Consultation with the stakeholders provided an added value (48, 138). The scoping review was comprehensive but inadequate to gain a realistic view of what occurs in practice in Southeast Asia compared to the feedback from the consultation group (138). Compared with international literature pertaining to falls and stroke, research in Southeast Asia was one dimensional, not comprehensive, and has yet to mature (30, 31, 45, 139). One of the reasons for this is that falls are still given less priority either in stroke rehabilitation research or practice. Hence, falls prevention is perceived as a secondary outcome for stroke rehabilitation as the other interventions received greater attention. This scoping review indicates how falls are set aside in stroke rehabilitation practice. Although stroke rehabilitation targets physical and functional improvement in general, it fails to benefit falls prevention

**TABLE 1 |** List of Standardized Assessments.

| No | Domain | Assessment | Study | Validated in SEA |
|---|---|---|---|---|
| 1 | Balance | Berg balance scale (BBS) | (57, 62–65, 76, 78, 81) | (94, 95) |
| | | Time up and go (TUG) test | (61, 64, 66, 69, 79, 80) | (95–97) |
| | | Five times sit-to-stand test (FTSST) | (58, 59, 69, 79) | (98) |
| | | Mini/balance evaluation systems test (Mini/BESTest) | (58, 59, 79) | (99) |
| | | Fullerton advanced balance (FAB) scale | (67) | (100) |
| | | Thirty-Second sit to stand test (30-sSTS) | (61) | Not found |
| | | Probalance board (Static Balance) | (61) | (101) |
| | | Activities-Specific balance confidence (ABC) scale | (59, 79) | (102) |
| | | Balance master | (67) | Not found |
| | | Wii balance board (WBB) | (66) | (103, 104) |
| 2 | Walking/Gait | Ten-Meter walk test (10-mWT) | (60, 61, 63–65, 78, 80) | (98) |
| | | Six-Minute walk test (6-mWT) | (61, 63, 65, 66, 78) | (105, 106) |
| | | Functional ambulation categories (FAC) | (63, 65, 78) | Not found |
| | | 2-min Walk Test | (64) | (107, 108) |
| | | Dynamic gait index (DGI) | (79) | Not found |
| 3 | Motor (general) | Fugl-Meyer assessment | (60, 64, 76, 79) | (108) |
| | | Upright motor control test-extension (UMCT-E) | (58, 59) | Not found |
| | | Modified ashworth scale (MAS) | (64) | Not found |
| | | The short physical performance battery (SPPB) | (77) | (109) |
| 4 | Falls efficacy | Falls efficacy scale-international (FES-I)/Falls efficacy scale (FES-S) | (56, 64, 77) | (110, 111) |
| | | Falls behavioral scale | (77) | Not found |
| 5 | Functioning | Modified/Barthel index | (57, 61, 62, 64, 81) | (112) |
| | | Functional independence measure (FIM) | (76) | (113) |
| | | Stroke impact scale subscale (participation) | (64) | (114) |
| | | Scandinavian stroke scale | (62) | Not found |
| | | National institute of health stroke scale (NIHSS) | (64) | (115–117) |
| | | EuroQol-5D | (69) | (118–122) |
| | | SF-12 health survey (SF-12) | (77) | (123) |
| 6 | Self-efficacy | Stroke self-efficacy questionnaire (SSEQ) | (80) | Not found |
| 7 | Cognitive | Mini mental state examination | (62, 64, 79) | (124–127) |
| 8 | Psychology | Geriatric depression scale (GDS) | (62) | (128–132) |
| | | Hospital anxiety and depression scale (HADS) | (80) | (133) |
| 9 | Vision | Snellen's chart | (62) | (134) |
| 10 | Visuospatial | Line bisection test | (62) | Not found |
| | | Copy of drawing test | (62) | Not found |
| | | Clock drawing test | (62) | (135) |
| | | Cancellation test | (62) | Not found |
| 11 | Pain | Visual Analog Scale | (78) | (136) |
| | | EuroQol VAS | (69) | (137) |
| 12 | Caregiver's strain | Modified caregiver strain index (mCSI) | (77) | Not found |
| 13 | Others | Life-Space assessment | (77) | Not found |
| | | Modified reintegration to normal living index (mRNLI) | (77) | Not found |
| | | Goal attainment scale (GAS) | (77) | Not found |

and intervention specifically. Furthermore, a limited number of health professionals are involved in fall prevention studies, which results in the limited exploration of potential interventions and fewer research initiatives (140, 141). Conducting low-quality research isolated from the real-world limits the application of the findings (142, 143). Therefore, awareness about falls needs to be elevated, and interdisciplinary research should be encouraged.

## Features of Stroke and Falls Research in Southeast Asia

This study only found studies from 5 countries in Southeast Asia that are actively investigating stroke and falls. This trend was similar to the other reviews in Southeast Asia on general stroke research (144) and falls in older people (46). Publications in high-impact journals from Singapore, Thailand,

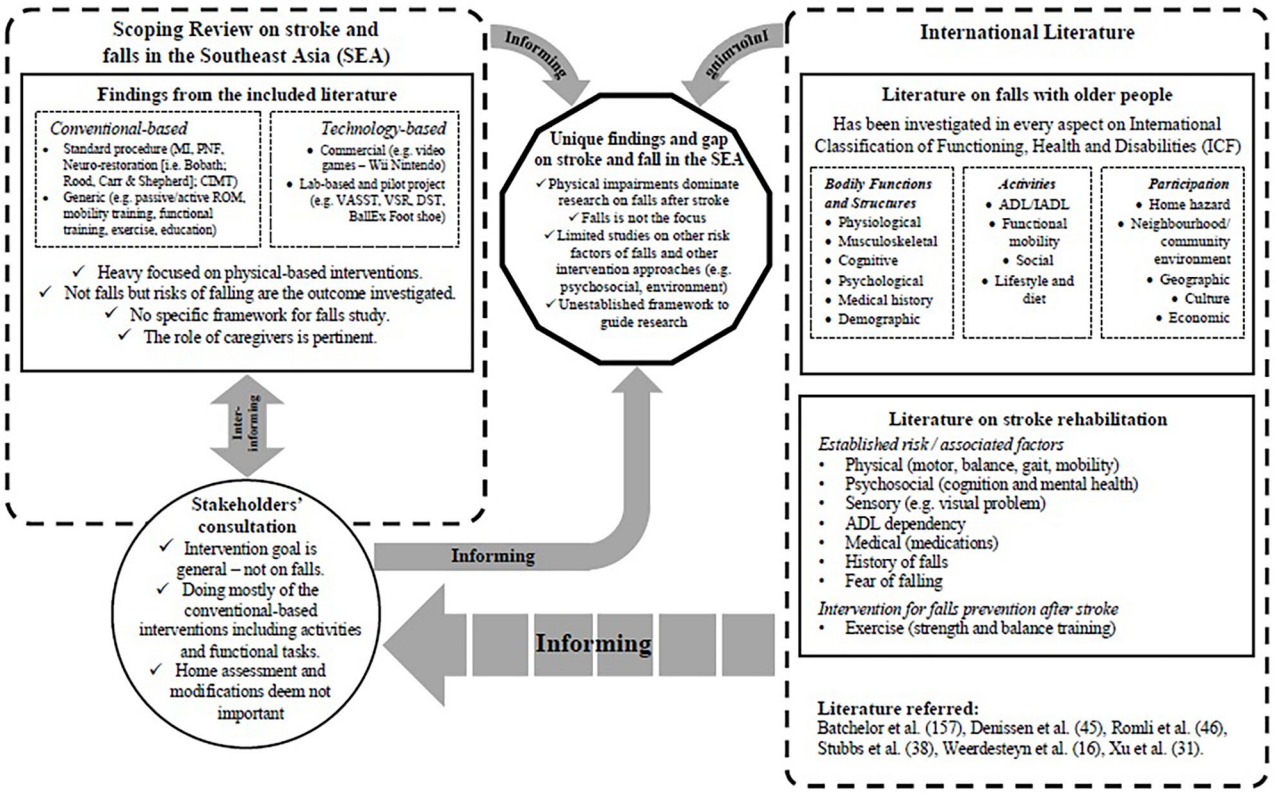


**FIGURE 3 |** Mapping of information of the scoping review.

and Malaysia may result from these countries having higher incomes and a higher percentage of Gross Domestic Product (GDP) being allocated to research and development (144). Limited funding hinders the initiative for distinctive efforts of stroke rehabilitation for falls prevention to be explored truly. This could cause literature bias as references on stroke rehabilitation only come from higher-income countries and might not be transferable, relevant, or appropriate for other Southeast Asia countries.

More than half of the studies were conducted in a clinical setting. This could be due to the limited rehabilitation services in the community, thus making it difficult to conduct programs and research (70). However, over the past decade, the number of community centers dedicated to stroke has increased to meet the need for a growing number of stroke survivors (69). Despite its growing significance, minimal empirical evidence on the benefits of these initiatives is available to date. Most community services are currently administered by non-governmental organizations and only used later or in chronic stage post-stroke. As Community-Based Rehabilitation (CBR) is a continuity of care after discharge from the hospital, it is essential to have healthcare professionals working in a CBR. Advanced training is warranted for healthcare professionals including falls prevention and intervention, community reintegration and participation. These aspects are most important for stroke survivors transitioning from the clinical setting to the community.

Falls rates and incidences reported in this study were lower when compared with international literature in which they reported that 25–37% of stroke survivors fell during the first 6 months after stroke and 40–50% fell between 6 and 12 months, respectively (27, 28, 145, 146). This is consistent with other Asian findings where fall prevalence is often lower than those reported in other international studies (46, 147). The low number of falls could be due to the dependency associated with Asian culture, whereby ill patients are cared for by their family members, particularly their spouse or children. Besides this, the fear of falling among stroke survivors and caregivers could also explain the low numbers of falls reported. Stroke survivors tend to limit themselves from walking and carrying out daily activities as these activities are perceived to be dangerous and may compromise their balance and lead to falls. While these routines are perceived to be appropriate to prevent falls, however, the restriction of activities caused by the fear of falling could eventually lead to increased dependency and anxiety, and decreased functional mobility, ADL, and community participation (148). In the long run, stroke survivors will be trapped into disability-worsened conditions and consequently increase caregivers' burden.

## Falls Prevention Is a Secondary Outcome in Stroke Rehabilitation

The seriousness of falls is neglected when considered alongside the numerous stroke impairments such as physical impairments and functions, problems in cognition, and daily activities. This could be related to the observability and tangibility of impairments due to a stroke, which provides constant attention compared to falls. Falls are usually denied and considered an inevitable event and only a by-product of impairments due to aging (30, 149–151). However, falls are an underlying sign of a greater problem and warrant prompt attention (30).

Stroke survivors and caregivers stated that the rehabilitation they undergo most often is to improve physical impairments and increase independence. Furthermore, activities and interventions are conducted to increase strength, balance, and gait speed, all of which are risk factors for falls. However, stroke rehabilitation, in general, has not been successful in precise target falls prevention. Indeed, although most stroke rehabilitation programs may indirectly target fall prevention, the goal is commonly implemented as a subcomponent rather than as an intervention of its own. This leads to falls prevention becoming a secondary outcome for stroke rehabilitation. Hence, it is crucial to make falls prevention a primary goal in stroke rehabilitation.

## An Over-emphasis on Physical Rehabilitation for Falls Prevention

Stroke survivors and caregivers expressed their views regarding undergoing rehabilitation to prevent falls. Healthcare professionals also agreed that rehabilitation for stroke survivors is often implemented according to the client's needs. The effectiveness of rehabilitation methods on physical, psychosocial, and cognitive outcomes varies according to the numerous rehabilitation methods used (152). However, this perspective is not comprehensive for falls prevention and intervention.

Most interventions implemented in this review focused on improving the physical impairments of stroke survivors. This is unsurprising as research on falls and stroke is still heavily focused on intervening for physical impairments (30). Exercise was found to be effective in improving balance and reducing spasticity, while other techniques such as functional training, task-specific gait training, and education assisted in the overall physical performance of the stroke survivors. Technology-based interventions also focused on physical rehabilitation, especially for lower body functions. While technology is considered supplementary modalities for therapy, technology should be explored beyond physical training (153). There were relatively fewer studies on psychosocial, environmental, and cognitive factors in this review. Even literature on stroke rehabilitation, in general, emphasized the physical motor aspects of intervention, with only some focusing on cognitive factors (154).

The majority of the studies were authored by physiotherapists. This could explain why physical impairment aspects still dominate stroke and falls research in this region. The risk and associated factors of falls in this review also illustrated similar findings as with many previous studies (21, 155), where physical impairments were the main risk factors for falls after stroke. This over-emphasis on physical rehabilitation is not only exclusive to stroke rehabilitation but also appears in other areas such as in cancer rehabilitation (152). This is consistent with Loh and Musa (152) who examined rehabilitation for cancer patients and reported that studies investigating physical outcomes dominate the literature. A narrow view of the role of rehabilitation and the heavy influence of the medical model may contribute to this standpoint. The medical model views clients as a specific problem of disease and disability and aims more toward curing the disease. This leads to the segregation of the expertise of health professionals (156). However, several cohort and case-control studies have established other risk factors for falls, which include fear of falling (157, 158), depressive symptoms (159), a fall history during hospitalization (20, 160), motor and sensory impairment (157), and environmental hazards (161). This necessitates research on stroke rehabilitation and falls to be open to other disciplines, and interdisciplinary research should be encouraged.

Compared to research on stroke, studies on falls with older people have received greater interest from researchers of various disciplines such as social sciences, human ecology, economics, built environment, engineering, and health sciences other than medical (162). As a result, this has extended the range of factors contributing to falls and should be modeled for stroke and falls research. Currently, the study of falls and stroke remains predominantly investigated only among the medical disciplines. Overall, the lack of evidence for non-physical rehabilitation methods highlights the lack of research work that extends beyond the rehabilitation methods for physical after-effects (152). Contemporary views of health have now shifted toward the biopsychosocial model of illness which views clients as holistic beings encompassing the need to treat their disability and empower them to function in society (163).

## Under-recognizing the Importance of Environmental Factors as a Risk Factor for Falls

Current evidence shows other established risk factors for falls and stroke such as fear of falling, depressive symptoms, history of falls during hospitalization, and having cognitive, motor, and sensory impairment (20, 31, 158, 159). However, home hazards are significantly absent as presently there are no studies available that investigate this factor in stroke and falls research. Conversely, there is evidence about the role of home hazards in fall management, and standardized instruments are also available to measure and establish the relationship between home hazards and falls (164–166). No studies from this review were found to have assessed environmental factors as one of the risk factors for falls. In addition, reducing home hazards has received skeptical reviews of its effectiveness in preventing falls, although the impact is apparent. Participants also reported many issues regarding home assessment and modifications after stroke. These issues include a lack of understanding of the concept and implementation of home assessments and

modifications and limited health personnel to conduct the assessment and intervention.

Another reason for the under-recognition of the importance of environmental factors is that there are not many home assessments available for use in Southeast Asia. Most assessment tools derived from Western countries and need to be adapted and validated before use. However, limited resources can hinder the process of adapting and validating these assessment tools (46, 166, 167). Although there is an increasing number of stroke survivors, limited staff and resources (70) signify the current impracticality to conduct home visits for all stroke survivors living in the community. Thus, there is a need to select and validate a high-quality self-reporting screening tool to assess home hazards that can be utilized for the stroke population and their caregivers. The use of home hazards instruments sensitive to cultural settings may capture more valuable and meaningful hazards (168, 169). With home hazards, healthcare professionals should focus on clutter, assistive devices (i.e., mobility aids, shoe), and the functional aspects of the person-environment fit, and in particular, attention should be given to the bathroom and stairs area as these were also found to be related to falls (170, 171). The use of technology such as photographs and videos were found to be the most credible and cost-saving method to conduct a home assessment while substituting a physical home visit (166). Therefore, this may improve the constraints of home hazards evaluation practices.

## Establishing a Comprehensive Framework to Guide Stroke and Falls Research

A strong underlying framework should become a foundation for Southeast Asian researchers. From the rehabilitation perspective, patients' functioning and health are associated with, but not merely a consequence of, a condition or disease. Furthermore, functioning and health are seen in association with a condition, personal and environmental factors and the rehabilitation context (172). The International Classification of Functioning, Health and Disabilities (ICF) document is a good guideline for steering fall research (173). The ICF is a comprehensive document that views health and disabilities on three main aspects: (i) body function and structure, (ii) activities, and (iii) participation, where these three aspects are influenced by personal and environmental factors (174). As falls risk is multidimensional, the ICF is suitable to investigate falls in the clinical practice thoroughly (175).

A study by Cieza et al. (175) demonstrated that falls among older women were associated with a wide range of health, functional and environmental factors consistent with the ICF classification. The study also established that while the ICF was developed as a classification system, it remains a useful framework to use as a guide for future studies related to falls risk in a community population. However, the lack of detail within the ICF about personal factors was an issue (175) because critical personal factors that determine increased falls risk may extend beyond the ICF classification factors and may include unique, individual features associated with a person-centered practice (176).

This scoping review revealed that all of the articles included were authored by a variety of professions; however, each article was dominated by only one single discipline. Involvement of other disciplines within and outside of healthcare (e.g., built environment, psychology, architecture, engineering, and social care) is warranted to study falls and stroke. Multidisciplinary and interdisciplinary research should be encouraged. Certainly, interdisciplinary research opens new paradigms and develops more creative and innovative solutions for a particular problem, including falls prevention and intervention (37, 38, 177).

Studies on falls with older people show the benefits of the involvement of various disciplines in falls prevention and intervention. It has also been found that observing the local and cultural context to identify novel factors will strengthen the knowledge and benefits the clients and stakeholders (46, 162, 178). Healthcare practices that are culturally sensitive were found to improve awareness of falls, clients' satisfaction, and other patient outcomes (178–181). Therefore, it is hoped that this scoping review provides an insight for future research to consider both elements when conducting studies on falls and stroke.

## Outcome Measures

This review identified that many of the outcome measures used in the studies were validated. The validation process included translation into the respective languages and cultural adaptations. However, only a few countries in the Southeast Asian region have conducted validation studies on these instruments. Moreover, many validated measures were conducted with the general population rather than with specific groups and settings.

These findings are similar to a review by Romli et al. (46) in which assessments used in their review were published standardized tools, but many were invalidated for Southeast Asia. This could be due to cost, practicality, clinical relevance, and a lack of knowledge over which outcome measures to choose (182). Furthermore, the use of non-standardized or generic tools may not provide accurate assessment information and may lead to under or overestimation of falls risk (165, 166, 176). Future research in Southeast Asia should cover every domain in the ICF as this has been proven to facilitate fall research (172, 174). Thus, this requires an assessment tool, especially for functional performance and participation, to be utilized. A comprehensive list of functional performance assessments has been made available (183). Researchers should use standardized assessments where possible and thoroughly investigate such tools' validity and reliability in the local context (164).

## Limitation and Recommendation

The scoping review is also characterized by certain limitations. The main limitation of this review is that many of the studies did not report on falls but focused more on the risk and associated factors of falls. Thus, the results are inconclusive in examining the effectiveness of stroke rehabilitation for reducing falls. Furthermore, only publications in English were included in the database. Although the majority of studies in this field

are currently published in English, this could mean that some studies from individual Southeast Asia countries have not been included in the database. Apart from that, since the nature of the review appears to include a summary of the evidence from a limited range of publications, a comprehensive evaluation of the studies' validity and possible bias evaluation should be carried out.

## CONCLUSION

This review describes stroke rehabilitation's current scenario for falls and the risk of falls in Southeast Asia. Despite falls in Southeast Asia being a significant issue, the management of falls in stroke has not been comprehensively investigated. Research that specifically targets falls prevention among the stroke population in Southeast Asia is warranted to increase the awareness of the importance of fall prevention in stroke. The stakeholders, including the stroke survivors, caregivers, and health practitioners, perceived falls as a serious event, however, their actions are not aligned with that perception. Furthermore, falls prevention strategies are only considered secondary outcomes and indirect goals achieved from rehabilitation such as improved balance from functional activities training. The over-emphasis on physical rehabilitation for falls after stroke necessitate the exploration and investigation of a broader spectrum of risk factors that extends holistically in the aspects of psychosocial, cognitive, and the environment. Attention to established risk factors and characteristics of falls derived from studies among the older population could also aid in implementing effective fall management programs for stroke survivors as it is evident that falls are multidimensional in nature. A more comprehensive review on stroke rehabilitation in general in Southeast Asia should be conducted to map out the similarities and differences of practices in place, providing novel insights for fall prevention strategies.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## AUTHOR CONTRIBUTIONS

MR directed the development of the inclusion/exclusion criteria and search strategy. HA implemented the search in the databases and lead the writing of the methods section of the manuscript. HA and MR collaborated on data analysis and drafting of the manuscript. TH, MS, and LM provided input on the direction of the data analysis and revised continuous amendments of the manuscript draft. All authors read and approved the final manuscript.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.611793/full#supplementary-material

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# Comparison of Retrospective and Prospective Falls Reporting Among Community-Dwelling Older People: Findings From Two Cohort Studies

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**Background:** While prospective recording is considered as the gold standard, retrospective recall is widely utilized for falls outcomes due to its convenience. This brings about the concern on the validity of falls reporting in Southeast Asian countries, as the reliability of falls recall has not previously been studied. This study aimed to evaluate the reliability of retrospective falls recall compared to prospective falls recording.

**Methods:** A secondary analysis of data from two prospective recording methods, falls diary and falls calendar, from two different research projects were obtained and analyzed. Retrospective falls recall was collected either through phone interview or follow-up clinic by asking the participants if they had fallen in the past 12 months.

**Results:** Two-hundred-sixty-eight and 280 elderly participated in the diary and calendar groups, respectively. Moderate (46%) and poor (11%) return rates were found on completed diary and calendar recording. Under-(32%) and overreporting (24%) of falls were found in diary compared to only 4% of overreporting for the calendar. Retrospective recall method achieved 57% response rate for the diary group (followed up at clinic) and 89% for the calendar group (followed up via telephone interview). Agreement between retrospective and prospective reporting was moderate for the diary (kappa =0.44; $p < 0.001$) and strong for the calendar (kappa = 0.89; $p < 0.001$).

**Conclusion:** Retrospective recall is reliable and acceptable in an observation study within healthy community older adults, while the combination of retrospective and prospective falls recording is the best for an intervention study with frailer older population. Telephone interview is convenient, low cost, and yielded a high response rate.

**Keywords: third world, falls, developing countries, culture, aged**

## INTRODUCTION

Falls among older people may lead to negative consequences to psychological and physical health, functional status, and increased mortality (1). While numerous studies have recorded a large number of risk factors for falls in older people, the presence of the history of at least one fall in the preceding year is the strongest predictor for the occurrence of subsequent falls (2). Therefore, it is important for healthcare practitioners to be able to correctly identify whether a previous fall had occurred.

It has been advocated that the prospective recording of falls represents the most accurate method of capturing actual incidences of falls, in terms of time and location of falls and the circumstances leading to a fall occurring. Recommended methods for prospective recording falls include telephone calls, diaries, calendars, and post-cards (3), with a minimum frequency of monthly recording (4). However, the use of prospective falls recording may have several drawbacks; the process is time consuming, requires a high level of commitment from health practitioners and clients, costly, and is susceptible to logistic issues such as inadvertently misplacing the records. Furthermore, missing data may occur due to non-returns.

The major challenges involved in the collection of prospective falls outcomes have led to researchers using retrospective recall of fall occurrences and number of falls as their selected method of measuring falls. Retrospective recall is achieved by asking the person about any previous falls occurrences on the common time frames of 6 or 12 months (3–5). While retrospective falls recording is a convenient, time-efficient, and low-cost method of identifying falls, the accuracy of the information obtained has often been criticized. Recall bias is prevalent among older adults. Cognitive impairment is common among older adults, with dementia being a major risk factor for falls, which lead to difficulty remembering the fall. Retrospective falls recall is therefore considered a less accurate method compared to prospective recall (4, 6). Moreover, cultural issues may also affect falls recall among Asian communities, who may view falls as part of normal aging, a natural event and unavoidable (7, 8).

Published guidelines have suggested that retrospective self-report may have resulted in over- and underreporting of falls (9). A scoping review on published studies on falls conducted in the Southeast Asian region suggested that all studies published thus far have only utilized retrospective falls recall to record fall events (5). In addition, an update review on falls studies in this region found that no prospective studies have been conducted. Accurate recording of falls is vital to form evidence-based policies for fall prevention in the region.

The recommendations favoring prospective recording of falls are based on published studies conducted exclusively in developed nations and pre-dominantly Caucasian communities. There is currently, no published evidence on the feasibility and accuracy of the various methods of recording falls in developing countries, and non-Caucasian populations. However, there is a need to identify appropriate methods to capture fall incidents among older people in this geographical region. This paper aims to evaluate the reliability of prospective and retrospective methods of recording falls among community-dwelling older people in Malaysia.

## METHOD

This paper involves analyses of secondary data from two different cohort studies. The studies had implemented differing methods of prospective data collection. The detail procedures of the studies have been reported elsewhere—the Malaysian Falls Assessment and Intervention Trial (MyFAIT) (10) and Malaysian Elders Longitudinal Research (MELoR) (11) prospective studies. In this paper, emphasis is given to the method of reporting falls outcomes for both cohorts. Data were retrieved on the characteristics of participant in both cohorts are on basic demographic information such as age, gender, ethnicity, education level, and living status. While other information that is valuable on falls such as body mass index (BMI), timed up and go (TuG), fear of falling status, and quality of life measured by CASP-19 instrument were also retrieved.

### Malaysian Falls Assessment and Intervention Trial

#### Design and Sampling

The MyFAIT involved community-dwelling older people at high risk of falls participating in an experimental two-armed randomized controlled trial (10). The MyFAIT study recruited a total of 268 older participants, aged 65 years and over, with two or more falls or one injurious fall in the preceding 12 months, into both arms of the study. Individuals with dementia, severe physical disabilities and psychiatric illnesses, or brain damage were excluded. All participants were recruited from primary care, the geriatric clinic, and the accident and emergency department.

#### Procedure

Participants were given monthly fall diaries with daily entries upon completion of their baseline assessment. New diaries were mailed to their homes before the end of every month with pre-paid envelopes to facilitate return of the previous month's completed diaries. Telephone reminders to return the diaries were made when no diaries were received after three consecutive months.

The MyFAIT fall diary (**Figure 1**) was designed and tailored to suit the heterogenous older Malaysian population in terms of language and educational attainment. The diary included written instructions in the three main languages used in Malaysia with daily entries prompting the individual to record the presence of any fall occurrence daily and to include descriptions of their fall. Free text space was used to record description of falls instead of tick boxes to reduce decision points and incorrect completion of data (12). The addition of pictures in the diaries ensured the inclusion of vulnerable groups of older adults who were illiterate or had lower levels of education. Visually impaired older adults received customized diaries with larger font sizes, and participants who preferred electronic diaries were emailed the softcopy versions. Two geriatricians evaluated the diaries for ease of use and accuracy of falls reporting. Support for diary

Week/Minggu 1: _____

*Mark ✔ in 'Fall' or 'No Fall' columns. Sila tandakan ✔ pada ruang Jatuh atau Tidak Jatuh.*

| | **Fall** *Jatuh* 跌倒  | **No Fall** *Tak Jatuh* 沒跌倒  | **Notes (How, Where, What time, Injuries)** *Nota (Mana, Bagaimana anda jatuh, Masa, Kecederaan)* 記錄 (其它事項, 請提供您在哪裡跌倒，跌倒時您在做什麼以及如何跌倒的資料) |
|---|---|---|---|
| **MON** | | | |
| **TUES** | | | |
| **WED** | | | |

**FIGURE 1 |** A sample of the monthly diary with daily entries used in Malaysian Falls Assessment and Intervention Trial (MyFAIT). The top row contains the date completed by the researcher before posting the diaries out to the participants. The participant is required to complete the diary at the end of the day, by marking the column "fall" or "no fall," next to the correct day of the week. The wider column is completed with free text if the older person is able to write or with the assistance of a friend or relative and is used to describe the mechanism, time, location, and injury associated with a "fall".

completion were printed instructions on how to use the diary (12), along with contact details of the research assistant. These instructions were also repeated by the geriatrician during baseline assessment visits.

At the end of the study period of 12 months, participants were invited to visit the hospital for clinic follow-up. They were asked during their follow-up visit whether they had experienced at least one fall during their follow-up.

## Malaysian Elders Longitudinal Research Study

### Design and Sampling

In brief, the MELoR project is a cohort study involving community-dwelling older people selected through simple random sampling stratified by the three major ethnicities of Malay, Chinese, and Indian from electoral rolls of three parliamentary constituencies in Greater Kuala Lumpur (12). In brief, the MELoR study had minimal exclusion criteria to maximize representativeness of valuable data on multidimensional aspects of health, economics, home design, ergonomics, media usage, technological engagement, physical activity, and legal issues among older adults. Only older people who refused to participate or unable to communicate or answer questions due to advanced dementia or severe speech impediments were excluded. For the purpose of this study, a total of 280 older participants of the MELoR project were randomly selected with simple random sampling from the overall cohort (i.e., $n = 1489$).

### Procedure

An attractive 1-month-to-a-page, 1-year calendar with daily entry was posted to all selected individuals as a desktop calendar for personal use, decorated with institutional and study logos and an attractive photograph of the study location as its front page. This was accompanied by a letter written in the four common languages used by older persons in Malaysia (English, Bahasa Melayu, Traditional Mandarin Chinese, and Tamil) to explain the

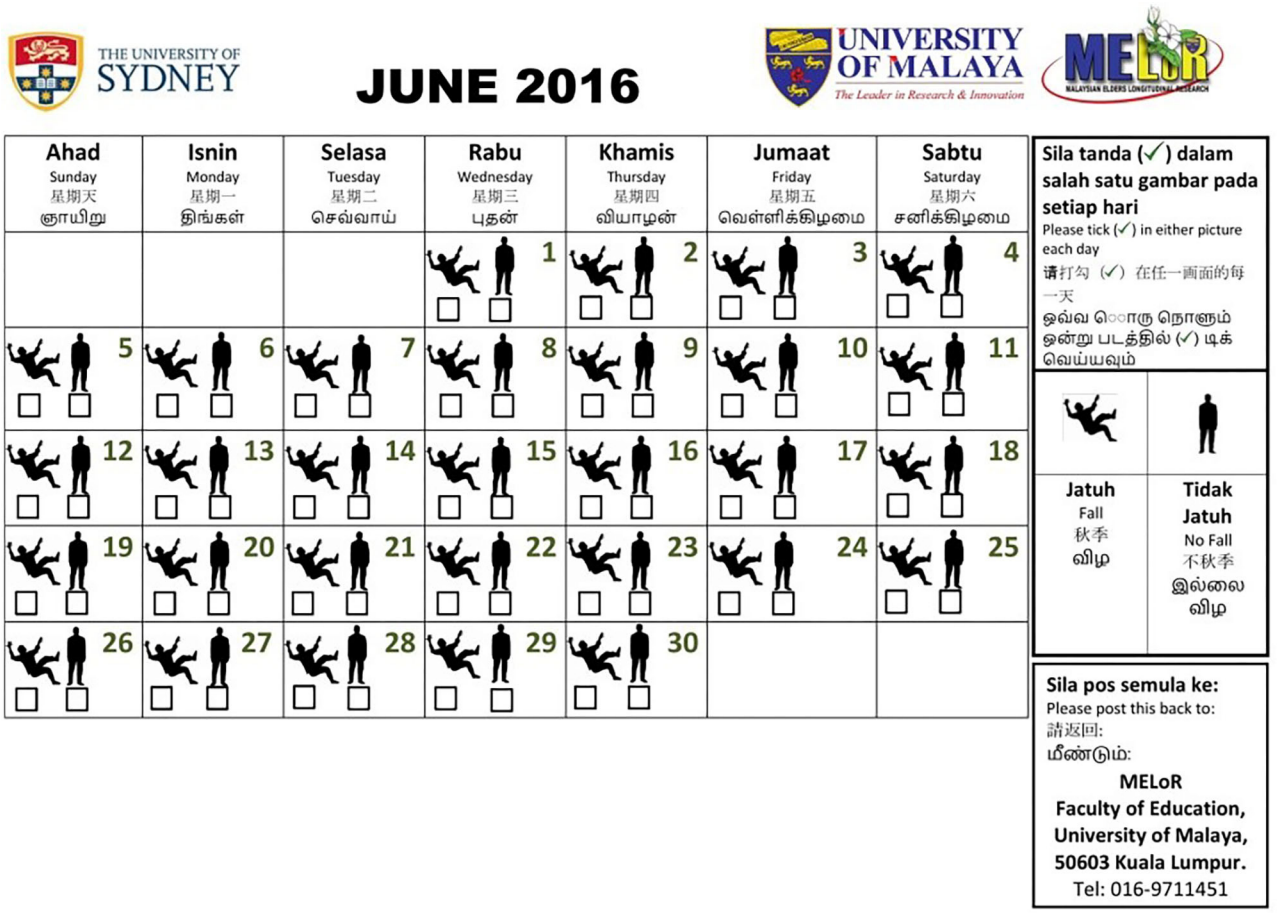


**FIGURE 2 |** A sample of the falls calendar used in the Malaysian Elders Longitudinal Research (MELoR) study. A 1-month-to-a-page desktop calendar was posted to selected participants. The calendar prompted daily tick-box entries below a falling or standing silhouette indicating the presence and absence of a fall. The instructions were available in four common languages within the page, alongside contact details and the return address.

purpose of the study and to provide a contact point for further clarification, as well as a self-addressed envelope to return the diary at the end of the study. The instructions to complete the calendar, in all four languages, were included within each page of the calendar. Each calendar page contained the dates of the month with one box dedicated to each day. Each box contained silhouettes of persons falling and standing with a tick box under each silhouette (**Figure 2**). The older person is required to tick on the relevant box each day, indicating whether they had fallen or not that day.

All participants were contacted at the end of the study to remind them to return their falls calendars and to ask them whether they had fallen in the previous year. A further history on the total number of falls were then obtained if the participant reported that they had fallen.

## Analysis

All statistical analyses were conducted using the Statistical Package for Social Sciences (SPSS) version 22. Basic demographic data were analyzed using descriptive statistics of frequencies and percentages for categorical data and means with standard deviations for continuous data. Comparison on the participants' characteristics between returners and non-returners of prospective recoding were also performed using inferential statistics such as independent *t*-test and chi-square depending on the nature of the variable. Response rates on retrospective recall and completion rates on prospective recordings were also analyzed using descriptive analysis. Interclass agreement between retrospective and prospective outcome was analyzed using Cohen's kappa agreement (13).

# RESULT

## Participant Characteristics and Response Rate

The characteristics of participants of the MyFAIT and the MELoR studies are summarized as follows. The MyFAIT participants were older (mean = 75.3; SD = 7.2) compared to the MELoR participants (mean = 71.9; SD = 8.98). The MyFAIT has marginally more women (67%) compared to the MELoR

**TABLE 1 |** Characteristics of the returners and non-returners of prospective recordings.

| Characteristics | MyFAIT ($N = 268$) | | *p*-value | MELoR ($N = 280$) | | *p*-value |
|---|---|---|---|---|---|---|
| | Returners ($n = 193$; 72.1%) | Non-returners ($n = 75$; 27.9%) | | Returners ($n = 31$; 11.1%) | Non-returners ($n = 249$; 88.9%) | |
| **Prospective recording** | 193 (100%) | 75 (100%) | | 31 (100%) | 249 (100%) | |
| Having falls | 82 (42.5%) | – | | 5 (16.1%) | – | |
| No fall | 111 (57.5%) | – | | 26 (83.9%) | – | |
| **Retrospective recall** | 127 (65.8%) | 25 (33.3%) | | 31 (100%) | 204 (81.9%) | |
| Having falls | 55 (43.3%)[a] | 9 (36.0%)[a] | 0.499◇ | 6 (19.4%)[a] | 30 (14.7%)[a] | 0.556◇ |
| No fall | 72 (56.7%)[a] | 16 (64.0%)[a] | | 25 (80.6%)[a] | 174 (85.3%)[a] | |
| **Age [mean (SD)]** | 74.9 (7.03) | 76.3 (7.72) | 0.166† | 67.5 (8.83) | 69.1 (8.98) | 0.381† |
| **Gender** | | | | | | |
| Male | 63 (32.6%) | 24 (32.0%) | 0.920◇ | 15 (48.4%) | 109 (43.8%) | 0.626◇ |
| Female | 130 (67.4%) | 51 (68.0%) | | 16 (51.6%) | 140 (56.2%) | |
| **Ethnicity** | | | | | | |
| Malay | 30 (15.3%) | 15 (20.8%) | 0.008*◇ | 7 (22.6%) | 74 (29.7%) | 0.363◇ |
| Chinese | 130 (67.4%) | 36 (48.0%) | | 16 (51.6%) | 89 (35.7%) | |
| Indian | 28 (14.3%) | 23 (31.9%) | | 8 (25.8%) | 83 (33.3%) | |
| Others | 5 (2.6%) | 1 (1.4%) | | 0 | 3 (1.3%) | |
| **Education level** | | | | | | |
| None | NA | NA | NA | 0 | 6 (2.5%) | 0.602◇ |
| Primary | NA | NA | | 4 (12.9%) | 52 (20.9%) | |
| Secondary | NA | NA | | 13 (41.9%) | 95 (38.3%) | |
| Vocational/tertiary | NA | NA | | 14 (45.2) | 95 (38.3%) | |
| **Living alone** | | | | | | |
| Yes | 138 (71.5%) | 54 (72.0%) | 0.910◇ | 2 (6.5%) | 22 (8.8%) | 0.655◇ |
| No | 55 (28.5%) | 21 (28.0%) | | 29 (93.5%) | 227 (91.2%) | |
| **Fear of falling** | | | | | | |
| Yes | 123 (63.7%)[b] | 54 (72.0%)[b] | 0.130◇ | 17 (58.6%)[c] | 183 (74.4%)[c] | 0.071◇ |
| No | 70 (36.3%)[b] | 21 (28.0%)[b] | | 12 (41.4%)[c] | 63 (25.6%)[c] | |
| **BMI [mean (SD)]** | 23.9 (3.98) | 25.3 (4.38) | 0.014† | 24.3 (4.06) | 25.6 (4.49) | 0.139† |
| **TUG [mean (SD)]** | 17.2 (12.99) | 19.3 (9.69) | 0.228† | 11.5 (3.54) | 12.6 (3.94) | 0.122† |
| **CASP-19 total [mean (SD)]** | 43.5 (9.59) | 40.1 (11.36) | 0.015*† | 43.5 (7.47) | 43.9 (7.55) | 0.805† |
| CASP-19 Control [mean (SD)] | 8.1 (2.86) | 7.5 (3.31) | 0.209† | 7.7 (2.85) | 7.8 (2.73) | 0.868† |
| CASP-19 Autonomy [mean (SD)] | 11.9 (2.82) | 10.7 (3.09) | 0.003*† | 10.9 (2.61) | 10.9 (2.89) | 0.985† |
| CASP-19 Pleasure [mean (SD)] | 13.3 (2.73) | 12.6 (3.69) | 0.139† | 13.7 (1.73) | 13.7 (2.02) | 0.905† |
| CASP-19 Self-realization [mean (SD)] | 10.3 (3.64) | 9.3 (4.16) | 0.062† | 11.2 (2.66) | 11.5 (2.55) | 0.507† |

◇*Independent t-test.*
†*Chi-square.*
**p ≤ 0.05.*
[a]*Compared with the total valid retrospective sample.*
[b]*Based on the FES-I questionnaire.*
[c]*Based on a single-item question of "Are you afraid of falling?".*
*NA, data are not available.*

study (55%). As the MELoR study involved stratified sampling according to ethnicity, the ethnic composition of the MELoR study involved equal distributions for the three main ethnicities where Chinese contributed for 37.8% followed by Indian (32.1%), Malay (29.0%), and others (1.1%). While MyFAIT participants were mostly ethnic Chinese (61.9%), followed by Indian (19.0%), Malay (16.8%), and others (2.2%). The characteristics between the returners and non-returners on the two cohorts are relatively similar ($p_s > 0.05$) except in the MyFAIT cohort where more Chinese ethnicity ($p = 0.003$) and better CASP-19 score ($p = 0.015$) were identified among returners compared to non-returners. **Table 1** describes in detail the characteristics of the returners and non-returners of the prospective recordings in the two cohorts.

In the 12-month study period of MyFAIT, 193 (72%) of the 268 participants had returned at least one diary. In further

**TABLE 2 |** Agreement between prospective and retrospective falls recording.

| | MyFAIT ($n = 127$) | MELoR ($n = 31$) |
|---|---|---|
| **Fall occurrences** | | |
| Prospective reported | 56 (44%) | 5 (16%) |
| Retrospective | 55 (43%) | 6 (19%) |
| Agreement | 91 (72%) | 30 (97%) |
| Underreporting | 18/56 (32%) | 0/5 (0%) |
| Overreporting | 17/71 (24%) | 1/26 (4%) |
| Kappa agreement | 0.44 | 0.89 |
| *p*-value | <0.001 | <0.001 |

detail, 1,488 individual diaries (46%) were collected out of a possible 3,216. One hundred fifty-two (57%) attended follow-up at 12 months. Of the 280 participants included in the MELoR study, 31 (11%) completed the calendar. Fifteen (47%) of the 31 participants who returned their annual calendar did so spontaneously, and another 16 (53%) did so after receiving the reminder phone calls. Response rate for phone calls was 83.9% ($n = 235$).

## Fall Incidents

### MyFAIT

At least one prospective fall was recorded in 82 (42.5%) of the 193 participants who have returned at least one monthly diary. One hundred fifty-two (56.7%) of the 268 participants attended follow-up assessments, with retrospective, self-reported falls in 64 (42.1%) of the 152 participants.

### MELoR

Of the 31 falls calendar returned, 5 (16.1%) participants recorded at least one fall in the past 12 months. Of the 235 participants contacted by phone, fall incidents were recalled by 36 (15.3%) of the older participants for the past 12 months.

## Agreement Between Prospective and Retrospective Methods

**Table 2** summarizes the level of agreement between these two methods.

### MyFAIT

Agreement between the presence and absence of falls in both prospective records and retrospectively recall was 72% ($n =$ 91/127). Fifty-six (44%) reported falls in their diaries, while 55 (43%) reported falls during their follow-up visits. Eighteen (32%) of the 56 fallers who had recorded falls in their diaries failed to report falls during their follow-up visit (underreporting). Conversely, 17 (24%) of the 71 who had not recorded falls in their diaries reported falls during their follow-up visit (overreporting). An interclass agreement using kappa analysis on retrospective self-reported falls and prospective falls diaries was moderate ($k = 0.44$; $p = 0.001$). Comparing the mean (standard deviation) number of falls, MyFAIT's prospective fall diaries recorded 0.97 (1.89) falls, and retrospective recall at 12 months reported 0.74 (1.14) falls.

### MELoR

Of the 31 participants for whom retrospective and prospective records were available, agreement between the presence and absence of fall occurrence in prospective calendar records and retrospective recall was 97% ($n = 30$). Six participants (19%) reported falls during telephone follow-up, five (16%) of whom had actually recorded fall occurrences in their calendar. There was therefore no underreporting, as all fallers identified using falls calendar reported falls during their telephone follow-up. One of the 26 non-fallers who returned their calendars reported falls during their telephone follow-up, yielding an overreporting rate of 4% for telephone follow-up. An interclass agreement using kappa analysis yielded strong agreement between both calendar recording and telephone recall ($k = 0.89$; $p < 0.001$).

# DISCUSSION

Accurate falls reporting is important to ensure reliable findings in falls research and help clinicians to identify older people at risk for recurrent falling and plan for future intervention and prevention efficiently. This current study indicates that there is an acceptable and satisfactory agreement between retrospective self-reported falls with prospective falls recording methods in both a hospital-based intervention study involving high risk falls and a community-based cohort study involving the general older population. Both prospective recording and retrospective recall yielded similar fall rates with a discrepancy of only one participant in both studies. If prospective falls recording was considered the gold standard, both over- and underestimations occurred with retrospective recall in MyFAIT, while minimal differences occurred in MELoR. This phenomenon is also reported in previous studies (4, 14–16). Nevertheless, the level of agreement between prospective and retrospective recording were within acceptable limits, with better agreement observed in a healthier, community-based cohort compared to individuals with recurrent or injurious falls in the intervention study.

Prospective recording of falls is markedly more demanding on human and financial resources and is prone to attrition (12). In resource poor settings, this may therefore not be a reasonable solution. Monthly fall diaries that requires monthly postal correspondence and phone calls to participants was not replicable in a large community-based cohort study. The alternative of a fall calendar yielded a low return rate, despite phone call reminders. The lack of engagement with prospective fall recording in the community cohort compared to the falls cohort may also have occurred as the falls cohort were incentivized by their involvement in a fall prevention intervention that may benefit them directly (17). Health-seeking behavior is likely to be higher for people with illness or injuries (18). The community cohort, on the other hand, did not receive incentives for returning their diaries and lacked the motivation of identifying falls since they had not experienced or identified falls as an issue. While incentives are important to reduce attrition in longitudinal studies, it was not always possible to ensure adequate reward with competing priorities of a cohort study. Healthier, older adults may also perceive falls as a natural occurrence and a trivial issue

related to aging (7), reducing the likelihood of calendar returns. The frequency of the researchers contacting the participants for reminder purpose might have an impact on the adherence of the participants to return the diary. The MyFAIT study has higher frequency of contact compared to the MELoR study. Thus, the researchers had the opportunity to increase their effort to retrieve the diary as many as possible to explain on why the response rate is higher for the MyFAIT study. With increasing use of electronic means of communication, the role of postal services has decreased. Therefore, older persons may not have developed a habit of posting letters, with post-boxes not being accessible to them. Alternative strategies such as the use of Smartphone Apps are not practical solutions, as the smartphone use among the Malaysian older population remains limited (19) and the App requires resources for development and maintenance.

Response rates for retrospective evaluation were higher in the community cohort than in the falls intervention study. Hospital visits were meaningful to the intervention participants and appreciated, as they received medical attention required; however, some of the frailer participants in the falls cohort had died, were no longer contactable, or were too frail to visit the hospital and may have an impact on the low response rate. In the community cohort, limited resources and no requirement removed the possibility of hospital visits and, if conducted, would have unnecessarily inconvenienced participants. Hence, participants could only be followed up via telephone, but the response rate is much higher. The methods were, however, not comparable between studies due to the differences in participant characteristics. In addition, falls intervention study cohort consists more Chinese ethnicity who are older and have higher falls rate (11, 20). The ethnicity representation of more Chinese and Indian of this study compared to the national population is somewhat different (20). However, the reason is that the two cohort studies were conducted in an urban setting where a larger proportion of the older population were ethnic Chinese and Indian (20).

Despite issues with low calendar returns in the MELoR cohort and high follow-up attrition in the MyFAIT study, falls rates returned for both retrospective and prospective data collection were similar for both studies regardless of the method of detecting falls. The overall agreement between fall diaries and retrospective recall was moderate for MyFAIT, while calendar-recorded events and retrospective telephone recall for MELoR showed nearly perfect agreement. This implies that retrospective telephone recall should be the preferred method of detecting falls in our community cohort. However, this finding should be interpreted with caution due to the low calendar return rate for our community cohort leading to non-return bias, with individuals who remember to return diaries significantly more likely to remember their falls accurately. While the similar falls rates for both calendar records and telephone recall are reassuring, it does not remove the possibility that calendar returners were less likely to fall while the overall cohort underreported falls (21). Conversely, while falls rates are nearly identical between prospective diaries and retrospective recall in MyFAIT, the high attrition rates for retrospective recall should detract from the temptation to only use retrospective recall as the sole method of detecting falls. Diary exercises alone would yield a response rate ranging from 46 to 72% depending on definition. We found that combining both prospective reporting and retrospective recall during clinic visits yielded an acceptable overall response rate of 82%. Hence, a combination of monthly diary with self-addressed envelopes and end-of-study visit is our recommended approach to falls detection in intervention studies for secondary falls prevention.

Our findings somewhat contradicted to that with previous studies, where prospective recording is a better option (14–16), but similar to that of a recent study (21). Developing countries face challenges in terms of financial constraints, lack of infrastructure, and lack of understanding about research among study participants (22). The differences observed in our two studies could just as well be attributed to cultural diversities in perception of falls, language use, and level of education (7, 11, 23). Despite emphasis on falls detection, as a strong indicator for recurrent falls, clinicians should also be aware of the prevailing opinion that primary prevention, that is, identification of increased risk of falling before any incident fall, would be preferable. This latter approach could be aided by the use of standardized instruments and new technology (23–25). Our findings has established suitable methods for recording falls, which will help alleviate mistrust on falls data recording retrospectively in community cohorts and encourage much needed falls-related research in developing countries.

The difference in the number of Chinese is higher among returners than non-returners in the MyFAIT group. There is complex explanation for this situation, as a previous study indicates that Malay ethnicity has the initiative for first action for consulting physician about their health concern (18), and falls are highest among Indian but lowest among Malay (26). However, the Chinese are the most in initiating self-treatment (18). Perhaps, this may explain why the Chinese are mostly returning their calendar, as they will seek for any possible approach to resolve their sustained health issue. This study also finds that the older people are with higher quality of life score, especially on autonomy aspect. People with better quality of life are more prone to have better health behavior (27), and who has higher autonomy is more responsible about oneself and has control over one's own health (18). This is translated into higher return rate of the diary among older people with better quality of life and autonomy.

One critical limitation of this study is the low return rate for prospective recording especially on the MELoR study, which may affect the reliability of falls outcomes collected in this way. The high reliability in the MELoR study may also be due to volunteer bias; however, the impact of this is presumed not significant (28). However, with the low response rate, and the study population comprising relatively healthy community-dwelling older people in an urban area, the generalizability of the study to rural older folks and disease-specific populations, such as those with cognitive impairment, may be limited. Future studies

should therefore target the latter populations to further establish the most suitable methods of detecting falls in these special populations.

Current clinical practice recommends the confirmation of the accuracy of falls history among older persons through collateral histories from the family or carers (29) or to extrapolate falls risk based on balance and mobility functions, sensory (i.e., vision), and medication intake (30). This study, however, suggests that practitioners should have confidence in self-reported or retrospective recall of falls among older patients, which should then go on to inform timely administration and early intervention of secondary prevention measures. The previous assumption that older people may conceal their falls (29, 31) may not necessarily be of concern based on our study findings. The Asian culture has strong respect and trust to professionals and expert with little inquiry on practice (32). Client–practitioner relationship is built on trust, and the information exchange is believed to enhance the quality of interventions (29, 31, 33).

## CONCLUSION

Retrospective falls recall using telephone interviewing in cohort studies involving community-dwelling older adults is preferred for measuring falls in our developing country setting, with low response rates likely for prospective recording methods. In addition, retrospective recall is the preferred method in developing countries due to its convenience and low cost. However, in intervention studies involving older fallers, a combination of prospective recording and retrospective recall should be considered. Our findings have established suitable methods for recording falls, which will help alleviate mistrust on falls data recording retrospectively in community cohorts and encourage much needed falls-related research internationally, especially in developing countries.

## DATA AVAILABILITY STATEMENT

The data analyzed in this study is subject to the following licenses/restrictions: The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation. Requests to access these datasets should be directed to mptan@ummc.edu.my.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Both, the MyFAIT trial (MEC Ref No: 943.21) and the MELoR project (MEC Ref No: 943.6) received ethical clearance from the University of Malaya. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

MR, LM, PT, RC, ST, and MT are equally contributed on designing and conducting the study and writing the manuscript. MR, LM, PT, and MT provides the critical feedback on the manuscript. All authors approved the final version of the manuscript.

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# Effectiveness of a Community-Based Muscle Strengthening Exercise Program to Increase Muscle Strength Among Pre-frail Older Persons in Malaysia: A Pilot Study

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Deterioration in muscle mass and muscle strength is common among the frail older persons, cause functional dependence and decrease in the quality of life. Therefore, the identification of cost-effective interventions to prevent or ameliorate frailty is crucially needed. The aim of this study is to determine the effectiveness of a Community-based Muscle Strengthening Exercise (COME) program to increase muscle strength among pre-frail older persons. This study was a quasi-experimental study. A total of 32 older persons aged 60 years and older with pre-frail symptoms were recruited from the community center. The COME was developed based on the Growing Stronger program and the Otago Home Exercise Program. COME was designed to strengthen all of the major muscle groups in the upper and lower extremities. The exercise program was conducted for 12 weeks and divided into 3 parts; (1) to strengthen the body slowly and gently, using only body weight, (2) to introduce dumbbells and ankle weights to increase strength and (3) to add various new ways to boost strength even more. Functional tests were measured before and after the intervention. The results revealed non-significant *p*-value for pre- and post-intervention comparison for all study outcomes. Observing the values of mean difference, the study intervention was shown to have slightly improved the time up and go (Mean difference = −0.25), and sit-to-stand duration (Mean difference = −0.41) as well as the handgrip strength (Mean difference = 0.68) among the participants. On the assessment of Cohen ES, all three improvements exhibited small effect sizes. Sit-to-stand duration was shown to have most benefited from the intervention with highest ES among the outcome variables (ES = 0.20). COME intervention program among pre-frail older persons showed favorable trend toward improvement of upper and lower extremities muscle strength. This study should be further tested in randomized control trial to confirm its effectiveness.

**Keywords: exercise, muscle strength, older persons, community-dwelling, pre-frail**

## INTRODUCTION

Frailty is a condition where deficits accumulated and causing vulnerability, which increases the risk of adverse outcomes including falls, delirium, and disability (1). Geriatric frailty is a major health condition associated with aging and has drawn growing attention in recent years due to its associations with multiple adverse outcomes. Deterioration in muscle mass and muscle strength are common among frail older persons and have effects on functional dependence and decrease in quality of life. Therefore, the identification of cost-effective interventions to prevent frailty is critically needed and has become one of the most important public health concerns.

Evidence based studies indicate that progressive strengthening exercise programs have been consistently effective in improving muscle strength and functional ability in older adults, as well as a reduction in the symptoms of various chronic diseases such as arthritis, depression, type II diabetes, osteoporosis, sleep disorders, and cardiovascular disease (2–4). As reported by Cochrane review, multi-component group exercise, including resistance and balance training, reduced the rate of falls by 22% and fall risks by 17% in adults aged 60 years and over (5). Other study found that dynamic standing balance exercise performed at least three times a week over a 3- month period significantly improved balance and mobility among older adults (6). Additionally, regular physical exercise training have been proposed as preventive measures for frailty and its adverse outcomes, targeted most of the frailty criteria such as weakness, low physical activity, slowed motor performance, and exercise intolerance (7). Cadore at al. reviewed several studies of the effects of exercise intervention on muscle strength and most of them showed an increase in muscle strength (8). Although various interventions have been developed to improve the outcomes of frail older people, a major obstacle that impede success in such interventions was due to the differences in the diagnosis of frailty by researchers.

The increasing trend of older population in Malaysia has been linked with increasing proportion of older persons with frailty. A study conducted in an urban area among 473 older persons aged 60 years and above in Klang Valley reported that 61.7% of the respondents were pre-frail and 8.9% were frail elders, which were detected using Fried's criteria (9). Another study on prevalence of frailty among older population aged 60 years and above in East Coast Malaysia revealed that prevalence of frailty syndrome was 18.3% (10). Several exercise intervention studies including multicomponent exercise with lifestyle intervention, and chair-based exercise have been conducted among the older population in Malaysia (11–13). These studies were carried out either among older adults with low resources settings, institutionalized, or at risk fallers to improve physical performance and reduce risk of falls. However, there is lack of intervention studies targeting pre-frail older persons in the community. It is important to strengthen the muscle at pre-frail stage to prevent further loss of muscle strength and minimize the adverse effects of frailty syndrome. Thus, this study aimed to determine the effectiveness of the Community-based Muscle Strengthening Exercise (COME) Program to increase the muscle strength among pre-frail older persons in order to prevent frailty.

## METHODS

### Study Design

This study was quasi experimental study with the same group involve as the control and intervention groups.

### Setting and Participants

The recruits included 36 pre-frail older persons aged 60 years and above who are attending the primary health clinic in Seri Petaling District with a Frailty Index Score of 1–2. The Frailty Index score was measured based on the following criteria as proposed by Fried et al. (14); unintended weight loss (5 kgs and more in the past year), self-reported exhaustion (identified by two questions from the CES-D scale), weakness (hand grip is less than the cut-off points mentioned on the original reference, adjusted for gender and body mass index), slow walking speed (walking speed more than the cut-off points mentioned on the original reference, adjusted for gender and height), and low physical activity (<383 kcals per week for men and <270 kcals per week for women). Score 0 indicated non-frail, 1 to 2 indicated pre-frail while 3 and more indicated frail. Other inclusion criteria are older persons with normal blood pressure, absence of abnormal heart sounds and murmurs, clear lungs bilaterally with no added sounds during inspiration and expiration, under control comorbidities, and no history of previous cardiac or respiratory problems in the past 2 weeks to 1 month prior to enrolment into the study. Screening of eligible participants was done by a physician.

### COME Program

The COME program was developed based on the Growing Stronger program proposed by Centers for Disease Control and Prevention, U.S. Department of Health and Human Services (15) and the Otago Home Exercise Program (16). The Growing Stronger program/ book was developed for the older adult who wants to grow stronger, healthier, more active, and more independent. It gives a safe, simple, and highly effective exercise program based on the principles of strength training. Meanwhile, the Otago exercise program was designed specifically to prevent falls which consists of a set of leg muscle strengthening, balance retraining exercises and a walking plan. The program was developed and tested in four randomized controlled trials and one controlled trial. However, the effectiveness of combination of these programs to improve muscle strength specifically among pre-frail older persons is yet to be tested.

COME was designed to strengthen all of the major muscle groups in the upper extremities (shoulders, upper arms, back, chest, and abdomen) and in the lower extremities (hips, thighs, knees, lower legs, and ankles). It also mainly targeted the shoulders, hands, hips, and knees, the muscles usually affected by osteoarthritis. The intervention was in the form of a group exercise program that was conducted by trained instructor for a duration of 12 weeks and consisted of three parts. Part 1 focused on strengthening the body slowly and gently, using only their own body weight while Part 2 introduced weights to increase

**TABLE 1 |** Detailed exercise for part 1, part 2 and part 3 of COME program.

| Part 1 (2 weeks) | Part 2 (4 weeks) | Part 3 (6 weeks) |
|---|---|---|
| **Warm up: 5-min walk outdoor/ indoor.** | | |
| i Squats – 10 reps<br>ii Push-ups: Conducted using terra band, 10 reps<br>iii Toe stands – 10 s, 10 reps.<br>iv Marching – standing or sitting for 30 reps with 1 min rest in between. | i Biceps curl – 3 sets of 10 reps, using 1-pound weight dumbbells with rest in between each set for 1 min.<br>ii Step-ups – number of steps counted for a duration of 1 min.<br>iii Overhead pressure –3 sets of 10 reps using 1-pound weight dumbbells with rest in between each set for 1 min.<br>iv Side hip raise – 10 reps for each leg. | i Knee extension – extend and hold for 10 s, 10 reps for each leg.<br>ii Knee curl – curl and hold for 10 s x 10 reps for each leg.<br>iii Pelvic tilt – hold for 10 s, 10 reps.<br>iv Bridging – hold for 10 s, 10 reps. |
| **Cool-down: Conducted at the end of every session.** | | |
| i Chest & arm stretch<br>ii Hamstring/ calf stretch<br>iii Quadriceps stretch<br>iv Neck, upper back and shoulder stretch | | |

strength. A variety with new way of exercise was added in Part 3 to further boost strength (**Table 1**). The instructors experienced training prior to the implementation of the intervention, which was given by a certified physiotherapist. The participants were divided into three groups with 10–14 participants each group according to their location. An instructor was assigned to each group to guide and monitor the participants. The intervention was conducted twice a week at the community hall and their attendance were recorded. Participants who attended at least 20 out of 24 sessions were included in the analysis. At the end of the intervention, the participants were given honorarium as token of appreciation.

## Measurements

Pre measurements were taken at the baseline whereby post-intervention measurements were taken after week 12 of the intervention. Socio-demographic characteristics and co-morbidity were assessed at the pre-intervention stage only using self-reported, structured questionnaire. The functional tests including timed up and go, Berg balance scale, sit-to-stand and hand grip strength were assessed before and after the intervention.

### Timed Up and Go

TUG is a commonly used as screening tool for mobility both in the community and in the inpatient setting. The subject was timed while they rise from an arm chair (approximate seat height 46 cm), walked three meters, turned and walked back to the chair and sat down again (17). The subject practiced the test once before being timed for familiarity. The subject wore his or her regular footwear and used their customary walking aid if necessary. A faster time (in seconds) indicated a better functional mobility performance.

### Berg Balance Scale

The scale is a performance-oriented measure of balance in older persons. Berg balance scale is a reliable, valid and widely used tool to measure balance. It consisted of 14 items that are scored based on a scale of 0–4 (18). The subject was given 0 score if he/she was unable to do the task, and a score of 4 was given if the subject was able to complete the task based on the assigned criterion. The maximum total score of the test is 56. The items included simple mobility tasks (e.g., transfers, standing unsupported, sit-to-stand) and more difficult tasks (e.g., tandem standing, turning 360°, single-leg stance).

### Sit-to-Stand

This test has often been seen as an indicator or proxy measure for lower extremity strength in older people. The subject was timed (in seconds) as they stood up and sat down as quickly as possible on a firm, padded, armless chair for five cycles (19). Subject performed the trial twice. The beginning of the timed test was prefaced with, "Ready, Set, Go" by the assessor. The time was recorded after the word "Go," and the assessor counted aloud each of the five completed cycles. The time recorded was ended when the subject returned to the seated position for the fifth time.

### Hand Grip Strength

Hand grip strength is a measure of maximum force generated by forearm muscle. A Jamar dynamometer was used to assess hand grip strength. Subject was seated comfortably on a chair without armrests. The shoulder was adducted and neutrally rotated, with the elbow at 90° flexion, and the forearm and wrist in a neutral position (20). Measurements started with the dominant hand. Three measurements (in kilograms) were obtained at 15 s intervals and the mean value was analyzed.

## Ethical Approval

The study was approved by the Medical Research Ethics Committee Ministry of Health Malaysia [NMRR-17-3489-38159 (IIR)].

## Statistical Analysis

Data analysis, for descriptive and multivariate analysis were performed using SPSS software (Version 21; SPSS Inc., Chicago, Illinois). Baseline descriptive statistics were presented in the form of mean (standard deviation) and frequency (percentage) for continuous and categorical variables, respectively. To determine the potential confounder in the study, baseline comparisons were done for the outcome variables namely timed up and go, Berg balance, sit-to-stand and hand grip strength, with sociodemographic and morbidity variables. Pearson correlation test was used to test potential association when both test variables were continuous. Independent *t*-test was used to compare study variables between two groups while one-way Analysis of Variance (ANOVA) was applied for more than two groups. For the pre- and post-intervention evaluations, paired *t*-test was

**TABLE 2 |** Characteristics of subjects and baseline comparison for timed up and go, Berg balance, sit-to-stand, and hand grip strength measurement.

| Study variable | Number (%) | Mean ± SD | | | |
|---|---|---|---|---|---|
| | | TUG | BB | STS | HG |
| Age | 66.81 ± 4.76[a] | 0.10[b] | −0.18[b] | 0.13[b] | 0.14[b] |
| **Gender** | | | | | |
| Male | 14 (43.7) | 12.03 ± 3.82 | 52.14 ± 6.31 | 13.91 ± 2.88 | 26.21 ± 3.77* |
| Female | 18 (56.3) | 10.62 ± 2.28 | 53.17 ± 2.41 | 14.57 ± 3.13 | 15.33 ± 4.84* |
| **Education level** | | | | | |
| Primary | 12 (37.5) | 10.61 ± 3.33 | 52.08 ± 3.00 | 13.72 ± 3.95 | 20.54 ± 7.73 |
| Secondary | 15 (46.9) | 11.73 ± 3.20 | 52.53 ± 5.89 | 14.92 ± 2.25 | 19.67 ± 5.93 |
| Tertiary | 5 (15.6) | 11.31 ± 2.28 | 54.80 ± 1.79 | 13.76 ± 2.40 | 20.30 ± 9.50 |
| **Marital status** | | | | | |
| Single | 2 (6.2) | 8.89 ± 0.70 | 53.50 ± 2.12 | 12.83 ± 0.09 | 11.25 ± 3.89 |
| Married | 30 (93.8) | 11.40 ± 3.12 | 52.67 ± 4.62 | 14.38 ± 2.99 | 20.68 ± 6.78 |
| **Smoking status** | | | | | |
| Never smoked | 26 (77.0) | 11.12 ± 2.66 | 53.35 ± 2.50 | 14.41 ± 2.88 | 18.62 ± 6.92 |
| Ever smoked | 6 (23.0) | 11.79 ± 4.81 | 50.00 ± 9.10 | 13.74 ± 3.68 | 26.50 ± 1.64 |
| **Comorbidity** | | | | | |
| 0 | 7 (21.9) | 0.07[b] | −0.37[b*] | 0.03[b] | 0.11[b] |
| 1 | 12 (37.5) | | | | |
| 2 | 5 (15.6) | | | | |
| 3 | 8 (25.0) | | | | |

*%, Percentage; TUG, Timed up and go; BB, Berg balance; STS, Sit-to-stand; HG, Hand grip strength.*
*Mean comparison between groups was done using independent t-test for gender, marital status and smoking status while ANOVA was used for education level. Pearson correlation test was used for numerical variables; age and comorbidity.*
*[a]Mean ± Standard deviation.*
*[b]Pearson correlation coefficient.*
**$p \leq 0.05$.*

**TABLE 3 |** Pre- and post-intervention comparisons using paired t-test for timed up and go, Berg balance, sit-to-stand, and hand grip strength measurement.

| Study variable | Mean ± SD | | Mean Diff. (95% CI) | Percentage of improvement, *n* (%) | *t* (df) | *p*-value | ES |
|---|---|---|---|---|---|---|---|
| | Pre | Post | | | | | |
| TUG | 11.24 (3.08) | 10.99 (3.06) | −0.25 (−0.89, 0.39) | 13 (40.6) | −0.78 (31) | 0.438 | 0.14 |
| BB | 52.71 (4.49) | 52.68 (4.78) | −0.03 (−1.21, 1.15) | 12 (37.5) | −0.05 (31) | 0.957 | – |
| STS | 14.29 (2.99) | 13.87 (13.87) | −0.41 (−1.17, 0.34) | 16 (50.0) | −1.11 (31) | 0.274 | 0.20 |
| HG | 20.09 (6.99) | 20.78 (6.40) | 0.68 (−0.92, 2.30) | 17 (53.1) | 0.87 (31) | 0.391 | 0.15 |

*SD, Standard deviation; Mean Diff., Mean difference; t, t-value; df, degree of freedom; ES, Cohen's effect size; TUG, Timed up and go; BB, Berg balance; STS, Sit-to-stand; HG, Hand grip strength.*
*Paired t-test was conducted separately for each study variable as outcome of the study.*

used to examine the significant difference between post- and pre-intervention. All significance was set at 0.05. In addition, Cohen's effect size (ES) was used to evaluate the impact of the intervention on the outcome variables (21). Cohen's ES either measured the sizes of associations between variables or the sizes of differences between means. Cohen's effect size in this study was calculated by subtracting the mean of post-intervention to pre-intervention and the result was divided by pooled standard deviation. Cohen suggested that effect size <0.10 would be considered a "trivial" effect size, 0.1–0.3 represented a "small" effect size, 0.3–0.5 as "moderate" and more than 0.5 a "large" effect size.

## RESULTS

A total of 32 older persons aged 60 years or older with pre-frail symptoms were recruited from the community center. From a total of 36 participants who began the study at the baseline, 32 participants remained until the end of the study corresponding to 88.9% of adherence rate. The dropout cases were removed from the analysis. The mean age of the respondents was 66.8 ± 4.76SD. More than half (56.3%) of the participants were male. Approximately 47% of respondents had received secondary education followed by primary (37.5%) and tertiary (15.6%). A majority of them were married

(93.8%) and never smoked (77.0%). As for comorbidity status, 21.9% had no disease, 37.5% had at least one disease, 15.6% presented with two diseases and 25.0% were burdened with up to three diseases. Participant characteristics is presented in **Table 2**.

**Table 2** shows baseline comparison of study outcome variables with sociodemographic and comorbidity variables. The results of the univariate analysis of Pearson's correlation, independent *t*-test and one-way ANOVA for the related variables, respectively, showed that the mean of the hand grip strength was significantly different among male and female participants. Comorbidity number was also significantly associated with Berg balance.

The results of the paired *t*-test (**Table 3**) revealed non-significant *p*-value for pre- and post-intervention comparison for all study outcomes; timed up and go ($t = -0.78$, $p$-value $= 0.438$), Berg balance ($t = -0.03$, $p$-value $= 0.957$), sit-to-stand ($t = -1.11$, $p$-value $= 0.274$) and handgrip strength ($t = 0.87$, $p$-value $= 0.391$). However, observing the values of mean difference, the study intervention was shown to have slightly improved the time up and go (Mean difference $= -0.25$), and sit-to-stand duration (Mean difference $= -0.41$) as well as the handgrip strength (Mean difference $= 0.68$) among the participants. On the assessment of Cohen ES, all three improvements exhibited small effect size. Sit-to-stand duration was shown to have most benefited from the intervention with highest ES among the outcome variables (ES $= 0.20$).

## DISCUSSIONS

Baseline data showed there is significant difference of mean hand grip strength between men ($26.21 \pm 3.77$ kg) and women ($15.33 \pm 4.84$ kg). An agreement was found with another study where the determinants of hand grip strength were reported to include gender and age effect (16). However, the mean hand grip strength in the present study was lower as compared to other populations such as Europeans (41.26 kg for men, 24.87 kg for women), Japanese-American men (36.65 kg) and South African (37.9 kg for men, 31.5 kg for women) (22–24). The present study also indicates that the number of co-morbidity was correlated with the Berg balance score. About 41% of the participants reported to have more than one morbidity, which could increase risk of falls among the pre-frail older persons.

This study aimed to evaluate the effects of COME intervention program on upper and lower extremity muscle strength. Loss of muscle mass and decreased muscle strength among the frail older persons resulted in functional impairment and increased risk of falling. The data show a tendency toward improvements with no significant improvement. Sit-to-stand was shown to have most benefited from the intervention indicated improvement on lower extremities muscle strength. Other studies exhibited similar effects of a variety of approaches of strength training such as resistance and vibration to the upper and lower extremity strength (25–27). The improvements of muscle strength may be explained by the capacity of skeletal muscles to increase its satellite cells proportion (28) and capillarization (29) through physical activity. Even though the ability of skeletal muscle to regenerate is compromised with aging, it retains the ability to positively respond to stimuli, such as exercise (30). Therefore, exercise targeted upper and lower extremities muscles could delay or prevent pre-frail older persons to become frail.

On the other hand, this exercise intervention is not effective in improving balance among pre-frail elderly. As the current study was targeted to strengthen upper and lower extremity muscles, the exercise movements targeted major muscles in upper (shoulders, upper arms, back, chest and abdomen) and lower extremities (hips, thighs, knees, lower legs and ankle), and was conducted in standing or sitting position. Researchers stressed out that the importance of training balance should consider complex motor behavior with more challenging movements than linear walking, such as walking-and-turning, where the turn-related changes in feet, trunk, and head movements are integral part of the kinematics of steering a body (31, 32). Thus, post-intervention Berg balance score of the current study showed no improvement in balance among the participants.

Despite, Distefano and Goodpaster concluded from their study that age-related loss of muscle strength and regenerative capacity could not be completely prevented by just a single intervention or training (33). However, constant exercise can significantly reduce, or prevent the declines in muscle metabolism and function due to the ability of skeletal muscle to retain its plasticity to some extant in response to exercise, thus providing convincing evidence that many of the negative age-related changes in muscle function and metabolism are caused by sedentary lifestyle secondary to aging.

## CONCLUSION

COME intervention program showed favorable trend toward improvement of upper and lower extremities muscle strength. This study should be further tested in randomized control trial to confirm its effectiveness. Moreover, this pilot study demonstrated the feasibility of community-based exercise program and its potential to increase muscle strength among pre-frail older persons.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Medical Research Ethics Committee Ministry of

Health Malaysia. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

RR and HMi conceived the study and participated in the experimental design, protocol development, and drafted the manuscript. HMa participated in formal analysis of data and drafted the manuscript. AA participated in experimental design and drafted the manuscript. All authors contributed to the article and approved the submitted version.

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# Effects of a Multi-Component Training Program on Healthy Older Adults' Prospective Memory Performance: Assessing Change Over Time

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Prospective Memory (PM) is a cognitive function affected by aging. PM is the memory of future intentions and is significantly involved in everyday life, especially among older adults. Nevertheless, there are a few studies focused on PM training among healthy older adults and these studies did not report the optimal duration of training regarding improving PM performance among older adults. The present study aimed to determine the effective duration for training PM performance among healthy older adults. The current study was a randomized, controlled, single-blind, within-participants crossover trial including a training program with a duration of 12 h. The sample of 25 older adults aged 55 to 74 years recruited from the active members of the University of the Third Age (U3A), Kuala Lumpur/Selangor, their family members, and friends. The study design ensured some participants would receive the training after baseline while others would wait for 6 weeks after the baseline before receiving the training. All participants were evaluated five times: at baseline, 6, 12, 16, and at 24 weeks post-baseline. Moreover, the training program ensured all participants were assessed after each training session. The minimum number of hours to achieve training effects for this multi-component training program was eight. Results supported the efficacy of the training program in improving PM performance among healthy older adults. Also, the optimal duration for the multicomponent training program on PM performance among healthy older adults was obtained. This trial is registered at isrctn.com (#ISRCTN57600070).

**Keywords: prospective memory, multi-component, training program, older adults, training duration**

## INTRODUCTION

Improving life expectancy and the age-related cognitive changes encourage researchers to develop new training approaches to promote healthy aging, independent living and prevent cognitive declines in older adults (1, 2). There is a global interest in cognitive training for older adults and most cognitive training studies demonstrated promising results (3). Strategy-based cognitive trainings improved specific cognitive functions in a compensatory manner, whereas process-based cognitive trainings used an intensive restorative manner to promote a specific cognitive function by exercising the underlying cognitive mechanisms of it repeatedly (4). Previous cognitive trainings primarily focused on specific populations (i.e., clinical), cognitive functions (i.e., working memory) or used a single training approach (i.e., strategy-based). Despite great benefits of strategy- or process-based trainings as independent approaches, to accomplish optimal results, there is an urgent need to use a combination of these two approaches (i.e., multi-component) across a greater range of cognitive functions among healthy older adults' population (5–8).

One of the most suitable targets for a multi-component training program is prospective memory (PM) which is a relatively neglected cognitive function in memory field of research. PM seems to be trivial, but has an important role in regard to having a successful and independent everyday life, especially among older adults (6, 9). PM is involved in remembering to perform an intended action in future (9). It is the memory for daily living tasks, including self-care (e.g., medication adherence), grocery shopping, cooking, and keeping appointments. PM is a critical cognitive function for older adults as it can promote self-care, independence, and well-being among them (9, 10). Wherefore, it is significant to maintain and promote PM performance among older adults.

Based on the nature of the "cue," there are three types of PM, including time-based, event-based, and activity-based PM (11). PM is a multi-phase cognitive process with four phases: (i) intention formation, (ii) delay maintenance interval, (iii) self-initiated cue recognition and intention retrieval, and (iv) intention execution (12). Being a multi-phase and multi-process cognitive function and closely associated with executive functions, attention, planning and several other cognitive functions, made PM a suitable target for a multi-component cognitive training (i.e., strategy- and process-based training) which would simultaneously target several cognitive functions including attention, cognitive control, memory, reasoning, and executive functions in one training program (12). Such holistic training program can show significant effects on all aspects of older adults' real life and well-being (6).

In addition, to boost the memory training effects, the training should be cost-effective, acceptable and tailored. Such program can incorporate older adults' personal differences and resources efficaciously (13, 14). Moreover, stronger experimental designs should be developed for such studies to show accurate results (15). However, there are a few studies aimed to evaluate or improve PM performance among older adults (16, 17), and there are fewer studies aimed to promote PM performance among healthy older adults (18–20).

Consequently, the primary study was designed to be a crossover trial and evaluated the effectiveness of a tailor-made preventative multi-component training program among healthy older adults (21). In that study, the multi-component training program including strategy- (e.g., implementation intentions) and process-based (i.e., Virtual Week (VW) computer-based board game) components was conducted on a group of healthy older adults to train their PM performance. The results showed that besides improving older adults' PM performance, training PM performance can cause older adults' levels of anxiety and negative mood (i.e., psychological well-being primary factors) to decrease and their level of independence was increased. Moreover, the effects of the training were persistent after 3 months from the last intervention session (21).

The VW board game simulates a number of real-life PM tasks to train time- and event-based PM performance. The VW paradigm has a general storyline for seven virtual days and each day includes an individual story with a number of PM tasks to perform (22, 23). The paradigm allows the examiner to record the performance of the participants for each training session. Hence, as the training program provided room to evaluate the participants' PM performance at the end of each session, for the current study, the optimal training duration was aimed to be found to aid future studies in regard to planning more cost-effective training programs for older adults (21).

## METHODOLOGY

The current study was a randomized, controlled, single-blind, within-participants crossover trial with 4- and 12-week follow-ups. The CONSORT statement was followed as the main framework to develop the methodology of the current study (24). After the baseline assessments were conducted, participants were randomly assigned into the treatment or control conditions. A 6-week tailored multi-component PM training program was conducted for the treatment group. The training program was consisted of two different components: process-based, and strategy-based components. The participants in control condition were not contacted during the training phase. After 6 weeks, participants crossed over and underwent the condition they had not experienced before.

### Participants

Participants were recruited from a pool of active members of the University of the Third Age (U3A) association Kuala Lumpur/Selangor, and the invitation to participate in the study was extended to their family members, and friends. A total number of 31 participants were screened before the group allocation. However, not all of them were able to participate in the study, and only 25 out of 31 joined the program. There were 6 men and 19 women Age ranged from 55 to 74 years.

There is a need to define the concept of "older adult" which could be defined in various ways. Based on the (25) definition, while in numerous (westernized) countries, older adults are defined as individuals who are 60 years of age and above,

various issues must be considered to define the concept of "older adults" in different countries. Explicitly, older adults should not be solely described according to the chronological age (25). Correspondingly, (18) proposed that several factors including abilities, resources, and the training target (e.g., PM performance) should be considered to describe "older adults" (18). Due to the fact that the nature of the primary and the current study and based on the World Health Organization strategies, older adults were described in accordance with the age of retirement from a paid job (i.e., receiving a retirement pension) (25). The retirement age for Malaysians had been changed from 55 to 60 years in 2013, and the study cohort for this study was at least 56 years old in that year, hence they retired at the age of 55. Therefore, the lower age range for the current study was age of 55.

Furthermore, because there are several factors involving in older adults' training, it is not unconventional to view people who are 55 years old and above as older adults (18). The target for the primary study was PM performance and the previous studies illustrated the changes associated with age in PM performance can be noticed in early stages of old age (9, 20, 26, 27). Accordingly, the ideal age to have preventative PM performance training programs for older adults was proposed to be 55 years and above (18, 20).

Additionally, based on the literature, older adults' age range is not a fixed factor and numerous studies considered various age ranges as older adults in line with their aim and study target (18, 28–31). Reviewing the literature, in most studies about older adults, young and old elders were both viewed as "older adults" which could be a concern about the equal benefits of cognitive training for these age groups. However, both age groups may gain equally from cognitive training programs (3, 32) due to the fact that the ability to learn remains mostly intact even in very old adults (33).

Eventually, the upper age limit for the primary study was considered based on the study location, the inclusion criteria of the study (21) and the participants' characteristics and some of the most important ones were: (i) one of the most significant inclusion criteria for the primary study was good command of English (because the program was conducted in English) and due to the fact that partaking in this training program required a minimum level of education, at least the secondary level of education was needed for the potential participants to be enrolled in the training program. Nonetheless, not many Malaysian elders have higher levels of education and a good command of English (34), and (ii) the risk of having (at least) mild cognitive impairments among Malaysian elders who are 75 years old and above is high (34).

Participants were screened on a single occasion prior to the baseline assessments to ensure they met the inclusion criteria of the study which included the absence of: (i) any neurological impairments, assessed with Mini-Mental State Examination (MMSE), (ii) any chief psychiatric disorders and learning disabilities, (iii) having experienced head traumas, general anesthesia, or cerebrovascular disease, and (iv) drug/alcohol abuse. Moreover, the lower educational level among participants was at least secondary educational level and they were required to have a good command of English. All participants were informed about the nature of the study and provided informed consent forms prior to entering the study.

## Baseline Measurements

All measurements used in this study showed high reliability and validity in clinical or older adults' populations and they are as follows: (i) Geriatric Depression Scale (GDS): a 30-item self-reported questionnaire used to measure the depression level among participants (35), (ii) Geriatric Anxiety Scale (GAS): a 30-item self-reported scale used to assess anxiety symptoms among older adults (36), (iii) Instrumental Activities of Daily living Scale (IADL): a measurement used to evaluate daily living activities (37), (iv) Prospective and Retrospective Memory Questionnaire (PRMQ): a 16-item questionnaire to assess the subjective retrospective (RM) and PM performance (38), and (v) Prospective Memory Tasks; a computerized program which was adapted from a similar program used in other similar studies to assess the objective PM performance (39).

## The Intervention Phase

The intervention included a 12-h (1 session per week, 2 h per-session) PM training program. It consisted of two main parts including process-, and strategy-based components. For the strategy-based component, "implementation intentions" (40) and instructions were used regarding participants' everyday PM tasks (e.g., self-care, social appointments). Participants wrote down a list of their daily living activities and how they usually performed them (e.g., monitoring their health, keeping appointments, grocery shopping). Next, the participants were instructed to transform the information to PM tasks through implementation intentions strategy (e.g., If I am home next Friday at 6.30 pm, I will call my friend and ask for her measuring cup). Furthermore, they were asked to visualize all necessary steps to fulfill a task. The process-based component included VW Board Game (22, 23). This game is a computerized board game in which participants move their tokens around the board with the roll of a dice. Each circuit of the board represents one virtual day, and the game includes 7 virtual days (and 1 trial day). Participants should make choices about different daily activities (ongoing tasks) and remember to do some other activities (PM tasks). A "perform task" button is placed on the game screen and participants ought to open it to select the task to perform. Each day of the VW game includes four regular, four irregular, and two stop clock tasks. The regular PM tasks represent usual daily PM tasks, such as taking blood pressure medication (two time-based, and two event-based tasks). The four irregular PM tasks are similar to occasional PM tasks which may occur in everyday life. These tasks also include 2 Time-based, and two event-based tasks (e.g., inviting a friend for dinner). There are two stop clock tasks, as well. Answers on VW are scored as follows: (i) correct: if the token is moved to or past the target square (on the board) immediately after the roll of dice for that task and before the next roll of the dice (for stop clock tasks, correct is to complete the task at the target time on time or within next 10 sec), (ii) little late: completing the task after the correct time passed but before next event card (for event-based), 1 h, and 30 sec passed for time-based, and stop clock tasks, (iii)

late: conducting the task after little late condition and before the end of that virtual day, (iv) little early: completing the task before the correct answer criterion and after the little late answer criterion for the previous event card, 1 h, and 30 sec for event-based, time-based, and stop clock tasks, respectively, (v) early: performing the task before the little early answer criterion and after the start of that virtual day, (vi) missed: the task was not performed at any time, (vii) cancel: when one opens the perform task list and closes it without selecting a task, and (viii) wrong: when a distractor task (there are some distractor tasks listed with PM tasks in the task list of each day) is selected. The game has a high reliability and consistency (22, 23, 39). For the current study, task difficulty was increased successively by increasing the number of tasks and hiding the clock from the screen so, time monitoring would be more complex. The game is designed to calculate and reveal participants results for each virtual day which provided a possibility to evaluate the change in participants' performance over the time. The results from VW were recorded for all participants after each session to be analyzed (measuring the change in their performance during the study period).

## Outcome Measures

Primary outcome measures of the current article were PM functions (time-, and event-based PM) measured with VW. The secondary outcome measures included the levels of independence, and psychological well-being (i.e., anxiety, depression).

## Statistical Analysis

All sessions results reported as means (M), and standard deviations (SD). The General Linear Model (GLM) was utilized to show change over time. The level of significance was set as $p < 0.05$. Moreover, analyzing the data on an intention-to-treat basis was considered.

# RESULTS

Although 31 participants were assessed initially for eligibility to participate in the current study, 25 participants entered the study eventually and they were randomly assigned into either the training or control groups. The groups did not show any significant differences in regard to their demographics and

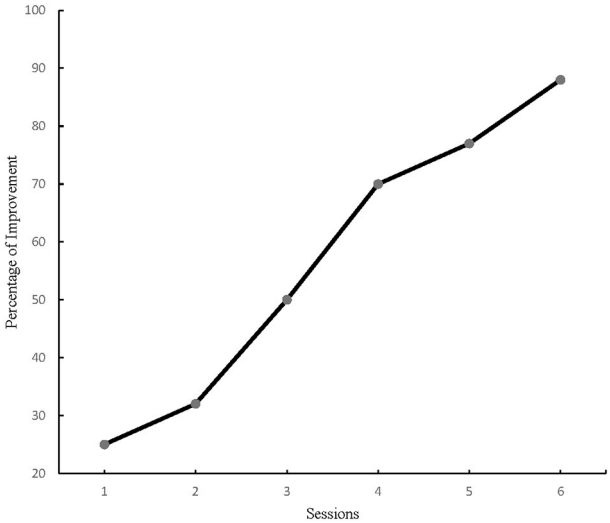


**FIGURE 1 |** Time-based PM performance change over time.

**TABLE 1 |** Study cohort demographics and baseline measures.

| | Study cohort ($n = 25$) | Treatment group ($n = 13$) | Control group ($n = 12$) | *P*-Value |
|---|---|---|---|---|
| Number | 25 | 13 | 12 | |
| Age (Range) | 55–74 | 55–74 | 55–71 | |
| Mean age (years) | 63.32 ± 4.44 | 63.69 ± 4.83 | 62.92 ± 4.14 | t = 0.79 |
| Women/Men | 19/6 | 10/3 | 9/3 | $\chi$ 2 = 0.81 |
| Years of Education (Range) | 10–20 | 10–20 | 11–20 | |
| Mean years of education | 14.04 ± 3.07 | 14.69 ± 3.37 | 13.33 ± 2.67 | t = 0.61 |
| Cognitive State (Range) | 27–29 | 27–29 | 27–29 | |
| Mean Cognitive State | 27.68 ± 0.74 | 27.62 ± 0.76 | 27.75 ± 0.75 | t = 0.66 |
| **PM Tasks** | | | | |
| Time-based PM | | 0.77 ± 1.36 | 0.92 ± 1.08 | $P > 0.05$ |
| Event-based PM | | 3.23 ± 1.64 | 2.33 ± 1.37 | $P > 0.05$ |
| Activity-based PM | | 1.31 ± 0.94 | 1.17 ± 0.71 | $P > 0.05$ |
| **PRMQ** | | | | |
| PM | | 28.85 ± 3.41 | 27.33 ± 2.93 | $P > 0.05$ |
| Total | | 54.62 ± 6.00 | 50.92 ± 3.91 | $P > 0.05$ |
| IADL | | 6.38 ± 0.65 | 6.08 ± 0.99 | $P > 0.05$ |
| GDS | | 7.46 ± 1.33 | 5.75 ± 1.13 | $P > 0.05$ |
| GAS | | 19.08 ± 2.66 | 19.8 ± 2.19 | $P > 0.05$ |

**TABLE 2 |** The VW game results for within-subject effects on time-based PM performance.

| Session | M ± SD | *F* (*p*) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1st Sess. | 2nd Sess. | 3rd Sess. | 4th Sess. | 5th Sess. | 6th Sess. |
| 1st Sess. | 46.00 ± 21.26 | | 00.54 ($p > 0.05$) | | | | |
| 2nd Sess. | 75.00 ± 50.50 | | | 1.89 ($p > 0.05$) | | | |
| 3rd Sess. | 60.99 ± 31.24 | | | | 4.66 ($p < 0.05$) | | |
| 4th Sess. | 77.50 ± 21.94 | | | | | 1.12 ($p > 0.05$) | |
| 5th Sess. | 84.20 ± 22.62 | | | | | | 2.26 ($p > 0.05$) |
| 6th Sess. | 91.85 ± 11.59 | | | | | | |

*Sess, Session; M, mean; SD, standard deviation.*

baseline characteristics (**Table 1**). All participants attended all training, and follow-up sessions.

The number of PM tasks increased continuously during the intervention phase therefore, at the end of each session, the percentage of correct answers were recorded for each participant. The primary outcome for the current study was PM performance measured with VW. The results for time-based PM performance analysis demonstrated a significant difference for within-subjects effect from the first to the last training session in the study cohort, $F$ (5, 144) = 39.38, $p = 0.00$, $\eta^2 = 0.57$. And the repeated GLM analysis of time-based PM performance showed a significant change between the third and the fourth sessions (**Figure 1**), $F$ (1, 48) = 8.70, $p < 0.005$, $\eta 2 = 0.15$. Consequently, all participants' time-based PM performance improved considerably by the fourth training session (**Table 2**). Similarly, event-based PM performance results showed a significant difference from the first to the last training session among all participants $F$ (5, 144) = 17.41, $p = 0.00$, $\eta^2 = 0.37$. Moreover, the repeated GLM analysis of event-based PM performance illustrated a significant change between the third and the fourth sessions (**Figure 2**), $F$ (1, 48) = 4.66, $p < 0.005$, $\eta 2 = 0.08$. Accordingly, all participants' event-based PM performance improved significantly by the fourth training session (**Table 3**). In sum, the results from this study suggested the minimum training duration to improve PM performance among healthy older adults was 8 h.

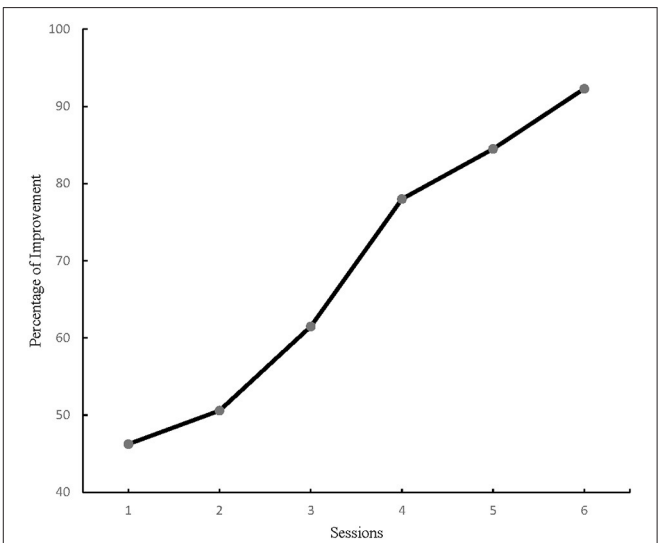


**FIGURE 2 |** Event-based PM performance change over time.

## DISCUSSION

As it was mentioned, PM is a significant cognitive function in regard to older adults' everyday life. Nevertheless, the body of literature regarding PM training programs among older adults is a very limited one (6) and there is a limited number of studies focused on the effectiveness of the training programs in terms of time and energy needed for such programs (13, 14). Likewise, there are a few studies aimed to improve PM using either strategy- or process-based approaches (5, 8, 19) and they showed some limitations; the primary focus of the process-based approaches were on the working memory (6, 19) and most strategy-based training programs either aimed to maintain or improve PM performance in a clinical population or they focused on just one everyday task (e.g., health tasks) (5, 7, 8). Either of these training approaches were shown to be effective; however, they did not show any significant and/or persistent effects. Incorporating strategy-based techniques in the current training program boosted the efficiency of the process-based techniques and showed to have significant training effects which was in line with the previous studies results (7, 18). Moreover, by combining strategy-, and process-based techniques, this study exceeded some limitations of the previous studies (6, 18–20). In addition, being "cost-effective" is one of the most significant characteristics of a training program, especially for older adults because there are several factors which may have large negative impacts on the results of the program (e.g., the increased number of drop-outs) (41). For instance, while this study had an excellent retention rate, one of the important drawbacks of this study was the number of participants. A number of individuals did not partake in the current training program due to reasons including transport costs, length, and time schedule of the program. Therefore, following the results of some previous studies (13), this study investigated the optimal training duration for a multi-component PM training program.

Being able to deliver a program which would address older adults' needs in an effective manner should be considered as a key factor to design a training program for these individuals. Cost-effectiveness as a concept could be defined as a characteristic

**TABLE 3 |** The VW game results for within-subject effects on event-based PM performance.

| | M ± SD | F (*p*) | | | | | |
|---|---|---|---|---|---|---|---|
| **Session** | | **1st Sess.** | **2nd Sess.** | **3rd Sess.** | **4th Sess.** | **5th Sess.** | **6th Sess.** |
| 1st Sess. | 23.32 ± 8.33 | | 3.15 ($p < 0.05$) | | | | |
| 2nd Sess. | 30.99 ± 19.91 | | | 6.90 ($p > 0.05$) | | | |
| 3rd Sess. | 48.88 ± 27.59 | | | | 8.70 ($p < 0.05$) | | |
| 4th Sess. | 68.99 ± 20.02 | | | | | 1.35 ($p > 0.05$) | |
| 5th Sess. | 76.26 ± 24.04 | | | | | | 2.70 ($p > 0.05$) |
| 6th Sess. | 85.61 ± 15.18 | | | | | | |

of a training program which allows the program to have the optimal effects utilizing the least number of resources (e.g., time, energy, money). Hence, computing the least number of resources and taking them into consideration before designing and conducting a program seems to be crucial (13, 14).

Results from VW revealed all participants made significant gains from the training program. They demonstrated to have improvement in their PM performance from the first intervention session to the last one. However, the significant change in their performance was achieved by the end of the fourth training session. Although participants kept improving after 8 h of training, their improvements were not significant. Therefore, this study found 8 h of a tailor-made multi-component training program is sufficient to improve PM performance among healthy older adults. These results could aid future similar studies to save time, energy and effort regarding developing and conducting similar programs (13, 21).

Although these results are encouraging, there were some limitations faced during this study. As it was mentioned before, the sample size in this study was rather small which led to some small yet potentially significant results. Nevertheless, the current study findings suggest further examination in a larger sample to extend the benefits of PM training among older adults. Another important limitation of the current study was not having long-term follow-ups (e.g., 12 months) to be able to show any possible long-term training effects. Furthermore, as the current study combined strategy-, and process-based approaches, the training gains of each approach remained unclear. The efficacy (i.e., training and cost effects) and generalizability of these two approaches are significant issues to investigate in future studies.

## CONCLUSION

Partaking in a customized multi-component PM training program resulted in significant training effects in PM performance. Training gains led to near and far transfer effects in the form of improved levels of independency and well-being. Additionally, this study was able to assess and achieve the optimized effective training duration to encourage future studies to design and conduct more cost-efficient training programs.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by The Ethics Committee for research involving human subjects of University Putra Malaysia (JKEUPM). The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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BRIEF RESEARCH REPORT
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# An Exploratory Qualitative Study With Older Malaysian Stroke Survivors, Caregivers, and Healthcare Practitioners About Falls and Rehabilitation for Falls After Stroke

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**Background:** Studies on rehabilitation for falls after a stroke remain limited despite its impact being profound. This scenario justifies a deeper understanding of why falls in stroke rehabilitation received less attention. Current investigations on the perception of falls and stroke also proved inadequate. Therefore, this study aims to explore the perceptions and experiences of older Malaysian stroke survivors, spousal caregivers, and healthcare practitioners on falls in stroke rehabilitation.

**Method:** A qualitative study of three focus groups with 18 individuals from one community-based stroke rehabilitation center was conducted. The discussions were audio-recorded, video-recorded, transcribed, summarized, and analyzed using thematic analysis.

**Results:** Three themes emerged from the analysis: (i) perceived factors and consequences of falls after stroke, (ii) physical-based interventions predominate in rehabilitation for falls after stroke, and (iii) the role of home hazards in fall prevention is taken for granted. Although, awareness of falls is high, they are regarded as a peripheral issue in stroke. Rehabilitation interventions such as improved functionality are believed to be adequate and can indirectly prevent falls. Other interventions for fall prevention such as home hazards management are relatively less known.

**Conclusion:** There is a need for more attention regarding home environment risk assessment and intervention among healthcare professionals, and more education for clients and caregivers is required. Although, other stroke interventions may also benefit stroke survivors, falls prevention should be a central component in stroke rehabilitation. As this study focused on a specific population, the findings should be validated with larger populations, and in diverse settings.

**Keywords: aged, stroke, falls prevention, falls interventions, qualitative study**

## INTRODUCTION

Stroke survivors are at high risk of falls (1, 2) and the risk is higher when compared with the older population (3–5). Studies reported that stroke survivors had a similar fall occurrence as the non-stroke but likely to report recurrent falls (6–8). In particular, the risk of falls increases after the transition from an inpatient setting to the community (9). Although, the risk factors and interventions of falls among older people are considered applicable for the stroke population, research on this topic is limited, less extensive, and has received less attention (10, 11). Qualitative studies among the elderly population have established the views and perceptions of falls and falls prevention (12–14) whereas qualitative studies that explore the experience of falls among the stroke population are still limited (15).

Most studies were conducted in the international context. Malaysia for example has distinct features in comparison with international settings. Regional variations in culture, sociodemographic composition, and geographical status can influence the perception of falls and stroke and practice regarding falls (11). Moreover, the availability of facilities in stroke rehabilitation shapes the practice and limited availability and accessibility of specialized stroke care in Malaysia may pose a challenge (16). One of the challenges in Malaysia is that treatments need to be self-directed or using local health services, given the lack of rehabilitation facilities in the country, and particularly in rural areas (17). For example, advanced countries have comprehensive programs such as the CAPABLE (18) and Stepping on (19) to help older people even with disabilities to age-in-place appropriately. However, such effort is absent in Malaysia.

In Malaysia, only two studies explored perceptions on falls and these studies were conducted among the elderly population (20), and with healthcare professionals (21). Older people viewed falls as insignificant or an inevitability of old age, with no importance to report it (20) but were worried about the lack of predictability and potentially serious effects of falls (20). As for the study among the healthcare professionals, four categories of barriers emerged which included perceived barriers for older people, healthcare professionals' barriers, lack of caregiver support, and healthcare system barriers (21). Furthermore, one study which delved into the perception of Malaysian occupational therapists on home hazards management on falls with older people showed that such effort is beneficial but undervalued (22). Most of the findings in the Malaysian studies are consistent with international literature either from older persons' (23–31) or practitioners' perspectives (32–37). However, some unique and distinctive perspectives were also identified from Malaysian studies. After a fall, older persons were found to prefer self-medicating with traditional remedies or treatments instead of seeing a doctor as they had previously found traditional medications to be effective (20). Also, older persons did not agree with suggestions to modify their homes, resented any interference with their furniture arrangements and some could not relate falls to environmental hazards as they felt that they fell because of their own carelessness (20). This shows the importance to explore local perceptions to get a better understanding on what may enhance the efficacy of local fall prevention programs.

Significant issues of impairment such as cognitive, social, functional, and emotional in stroke (38) makes the knowledge in falls prevention with older people difficult to be tranferred and generalized. Majority of attention in stroke rehabilitation focus on physical, motor, and functional improvement, as well as cognitive and physiological treatments (39), but fails to address falls prevention effectively. With the limited study available on falls and stroke, there is a critical need to understand the perceptions about falls among the stroke population and from the perspective of clients and practitioners. Hence, this study aims to explore the views and experiences of older stroke survivors, spousal caregivers, and healthcare practitioners on falls and rehabilitation for falls after stroke.

## METHODS

### Study Design

This qualitative study utilized focus group discussions (FGD) guided by the Ivanoff and Hultberg (40) framework. FGD is useful in generating a rich understanding of participants' experiences and beliefs or to explore a topic (41). A purposeful sampling approach was implemented and the participants were grouped based on their background and language spoken by them to ensure homogeneity. Purposeful sampling is a powerful method to provide richness and in-depth information as the selected participants are believed to be more likely to actively participate, contribute and have a wide experience on the topic (42). The study was conducted between October and November 2019.

### Participants

Older stroke survivors, spousal caregivers, and healthcare practitioners from one community stroke rehabilitation center were recruited. The inclusion criteria for stroke survivors comprises of patients being at least 6 months post-stroke, either they did or did not fall during the post-stroke period, aged 55 years old and above, and were able to comprehend and communicate in English or Malay. Stroke survivors who had aphasia, a diagnosis of a mental illness, or severe cognitive impairment were excluded from the study. Spousal caregivers who cared for the stroke survivors for a minimum duration of 6 months were selected to participate in the study. For healthcare practitioners, they were required to have at least 6 months of experience in managing stroke cases.

### Procedure

The participants were selected by the center's rehabilitation therapist-in-charge according to the pre-established criteria and among those deemed able to provide rich information for the discussion. These participants were approached and were asked for their willingness to participate in the study. Participants were provided with an information sheet and consent was obtained before the beginning of the session. Stroke clients and spousal caregivers were grouped in the same group while practitioners were separated into another group to ensure homogeneity in which it allowed autonomy and individual group members to be confident in voicing their views (43). The discussion was

conducted in a meeting room at the center isolated from other staff to ensure the participants' anonymity, and the discussions remained confidential.

Two researchers who were both occupational therapists acted as moderators to facilitate the discussions, while a research assistant took notes during the discussions. Prior to the beginning of the discussion session, one researcher presented a summary on falls and stroke rehabilitation in the Southeast Asia context from a scoping review–orally and in written form–to orientate the participants onto the topic. Next, each participants was provided with a list of questions (**Table 1**) to guide the discussion but was instructed not to stick prescriptively to the line of questioning. The questions were prepared by the junior researcher based on a literature review and verified by two senior researchers who have experience in conducting qualitative studies. In the discussion session, the participants could discuss in any language convenient to them as long as they were understood by all participants. All the groups discussed in pidgin language containing both English and Malay. As the participating researchers are native Malaysians, the messages are fully understood in either verbal or non-verbal forms. Each sessions had lasted for approximately 1 hour (ranged from 51 to 66 minutes) and was recorded using a voice recorder (ICD-UX543F), camcorder (HP V5061u 1080p), and manual note-taking.

## Data Analysis

Each participants was assigned a unique identifier corresponding to their sitting position in the focus group and these identifiers were used for data entry as well as to maintain the anonymity and confidentiality of participants (44). The data management and thematic analysis were guided by the Sutton and Austin framework (45).

The audio-recording was listened to several times and was transcribed verbatim. Listening to the audio-recording, reading the transcript, and referring to the research notes were done simultaneously to obtain an overall impression for interpretation. The technique called "reading between the lines" (45) was implemented by hearing the participants' voice tone, emotional expression, connotation, and non-verbal cues to get a feel for the participants' experience and to grasp the underlying message. As the session included pidgin language, the text was then translated into English by the first author to allow other researchers to be involved in the study (45, 46). Coding *via* the open, axial, and selective coding strategy enables the researcher to interact, compare, and apply data reduction and consolidation techniques. As the coding process progressed, its dynamic function and non-linear directionality enabled essential themes to be identified, coded, and interpreted (47). Coding was conducted by making notes in the margin of the hard copy of the transcript by two researchers independently. The researchers then meet up and compared, combined and performed cognitive discussions to harmonize the codes findings, and themes which were then generated. Data triangulation was done by comparing the audio-recording with notes taken by the research assistant. Most of the data were confirmed by the second FGD, while the third FGD with healthcare practitioners (disconfirming stage) also reported mostly similar views.

Credibility was ensured through the "member-checking" process by emailing the participants the document on the findings (i.e., codes and themes) for feedback. Most of the responses received were from healthcare participants mentioned that they agreed with the findings and it reflects most of the discussions. The trustworthiness of the findings was strengthened by providing the audio-recording, transcripts and the coding, and themes to a healthcare professional independent from this project for review. The reviewer found that the findings reflected the essence of the recorded discussions and purported the meaningful explorations.

# RESULTS

## Socio-Demographics and Fall Profile of Participants

All participants had voluntarily agreed to take part in the study. The stroke participants ($n = 6$) were relatively younger (age: 59–74) than the spousal caregivers (age: 64–74). The post-stroke duration of the stroke participants were over 12-months ($n = 3$) and 6–12 months ($n = 3$) post-stroke, with the majority among them did not have a history of falls ($n = 4$). A total of five spousal caregivers with caregiving experiences of between 1–9 years participated in the study and the majority were female ($n = 3$). Only two of the caregivers had their stroke spouses as participants in the study. Three of the caregivers reported that their spouse-who were not study participants, had falls after a stroke. Seven healthcare practitioners participated and the majority were physiotherapists ($n = 5$, 71.4%), followed by an occupational therapist ($n = 1$, 14.3%), and a speech therapist ($n = 1$, 14.3%). All therapists had between 1 and 5 years of work experience in stroke rehabilitation. A total of three focus group discussions were conducted. Two groups consisting of both stroke survivors and caregivers, while another group involved only healthcare practitioners. **Table 2** describes the characteristics of the participants in each focus group.

Three themes emerged from the analysis across all groups of participants. These themes included perceived factors and consequences of falls after stroke, physical-based interventions predominating in rehabilitation for falls after stroke and the role of home hazards in falls prevention being taken for granted. The conceptual themes of the study are illustrated in **Figure 1**.

## Theme One: Perceived Factors and Consequences of Falls After Stroke

The participants perceived falls as a common consequence of a stroke due to the sustained impairments experienced following stroke. However, a healthcare participant voiced that some falls can be prevented with proper interventions.

### Falls Incidence and Factors

Most participants including the spousal caregivers admitted that multiple recurrent falls occurred to them and their spouse after stroke. However, there were also stroke participants who did not have any falls after being discharged from the hospital.

**TABLE 1 |** Semi-structured questions.

| **Stroke clients and spousal caregivers** |
|---|
| Perception on falls |
| 1. Could you tell me about any falls or near misses that you had since your stroke. |
| 2. Do you think falls are something inevitable? If yes, why? If no, why? |
| 3. What do you do to prevent falls? |
| 4. What is your view of the interventions for fall prevention? |
| Home assessment and modification |
| 5. Have you done any home modifications? |
| 6. What is your opinion on home modification as a fall prevention strategy? |
| 7. Would you allow a home visit to identify potential hazards that might lead to falls? |
| Caregiver support |
| 8. How much help do you give to your stroke family member? |
| 9. What type of assistance did you give? |
| 10. How do you feel when your stroke family member is left alone to do their daily activities? |
| 11. How do you prevent falls for your stroke family member? |
| **Healthcare practitioners** |
| Perception on falls |
| 12. What is your opinion on falls after a stroke? |
| 13. Would you say that preventing and intervening to prevent falls among stroke survivors is a top priority in your service? |
| 14. Do you think your client (stroke survivors/caregivers) considers falls as an important issue? Why? Why not? |
| 15. Have your clients ever asked you about falls? |
| Current practice in stroke rehabilitation for falls |
| 16. Can you share with me how you offer advice and manage your stroke patients about preventing falls? |
| 17. What assessments do you conduct to assess the risk of falls? |
| 18. Do you think the current falls assessment and intervention services in Malaysia are based on evidence? |
| 19. What is your opinion on home visits for stroke patients before discharge or once home? |
| 20. What is your opinion on home modification as an intervention for fall prevention after stroke? |
| Service delivery |
| 21. Are there any constraints for healthcare practitioners to conduct effective fall rehabilitation services? |
| 22. Are there any administrative issues limiting the possibilities of falls rehabilitation services? |
| 23. Do your patients' families or caregivers take part when you offer advice on fall prevention? How do you find their support and care for fall problems for your patients? |
| 24. Do you think your patients face cost issues in addressing their falls? |

*"I fell four times after my stroke." (Stroke Survivor S)*
*"He (my husband) had many falls after his stroke, I think it was more than 50 falls." (Caregiver LY)*
*So far, I have not experienced any falls. I try to walk carefully so that if the floors are slippery, I could still prevent a fall. (Stroke Survivor L)*

In terms of the variety of location of falls, there was an even chance of falls happening indoors and outdoors. A client-participant mentioned that he had fallen in the toilet and while going up and down the stairs in the home. Outdoor falls in a restaurant and hospital were also reported.

**TABLE 2 |** Demographic data of participants.

| **Characteristics** | **[FGD 1] (*n* = 6)** | **[FGD 2] (*n* = 5)** | **[FGD 3] (*n* = 7)** |
|---|---|---|---|
| **Participant category** | | | |
| Stroke survivor | 3 (50%) | 3 (60%) | - |
| Spousal caregiver | 3 (50%) | 2 (40%) | - |
| Healthcare practitioner | - | - | 7 (100%) |
| **Age [median, (range)]** | 69 (59–74) | 71 (59–78) | 28 (24–32) |
| **Gender** | | | |
| Male | 3 (50%) | 3 (60%) | 1 (14.3%) |
| Female | 3 (50%) | 2 (40%) | 6 (85.7%) |
| **Race** | | | |
| Malay | - | 4 (80%) | 2 (28.6%) |
| Chinese | 5 (83.3%) | - | 1 (14.2%) |
| Indian | 1 (16.7%) | 1 (20%) | 2 (28.6%) |
| Others | - | - | 2 (28.6%) |
| **Marital status** | | | |
| Married | 6 (100%) | 5 (100%) | 1 (14.3%) |
| Single | - | - | 6 (85.7%) |
| **Education level** | | | |
| Secondary | 4 (66.7%) | 5 (100%) | - |
| Tertiary | 2 (33.3%) | - | 7 (100%) |
| **Monthly income** | | | |
| Below RM6275 | 6 (100%) | 3 (60%) | N/A |
| RM6275 and above | - | 2 (40%) | N/A |

*"I fell in the house, in the toilet [at home], and while in the hospital. I also fell when I was in a restaurant."* He also added *"When I was going down the stairs, I stepped down and I just lost control that in a particular moment and fell." (Stroke Survivor S)*

The participants recognized that physical, cognitive, and sensory processing impairments played a role in falls although some of these factors were not identified in the current literature.

*"My husband's coordination is not so good after his second stroke. I say to him to go right but he will go left, and this affects his steps." (Caregiver LY)*
*"He [the stroke survivor] cannot sit and turn on the weak side. If he does turn, he will fall. Moreover, he cannot remember which is the weak side of his body." (Caregiver LE)*

In addition, the familiarity of the environment was sometimes identified as a protective factor for falls. With the presence of stroke, the client-participants were more aware of their condition, and the people surrounding them (i.e., caregivers and healthcare practitioners), and were also aware of available hazards and had taken precautions. However, unfamiliar environments such as hazards in the neighborhood might not have been noticed and increased the risk of falling.

*"When he is walking and the road is uneven, suddenly he would fall." (Caregiver H)*
*"Some of them (stroke survivors falling) might not have been preventable because of the impairments but I believe with*

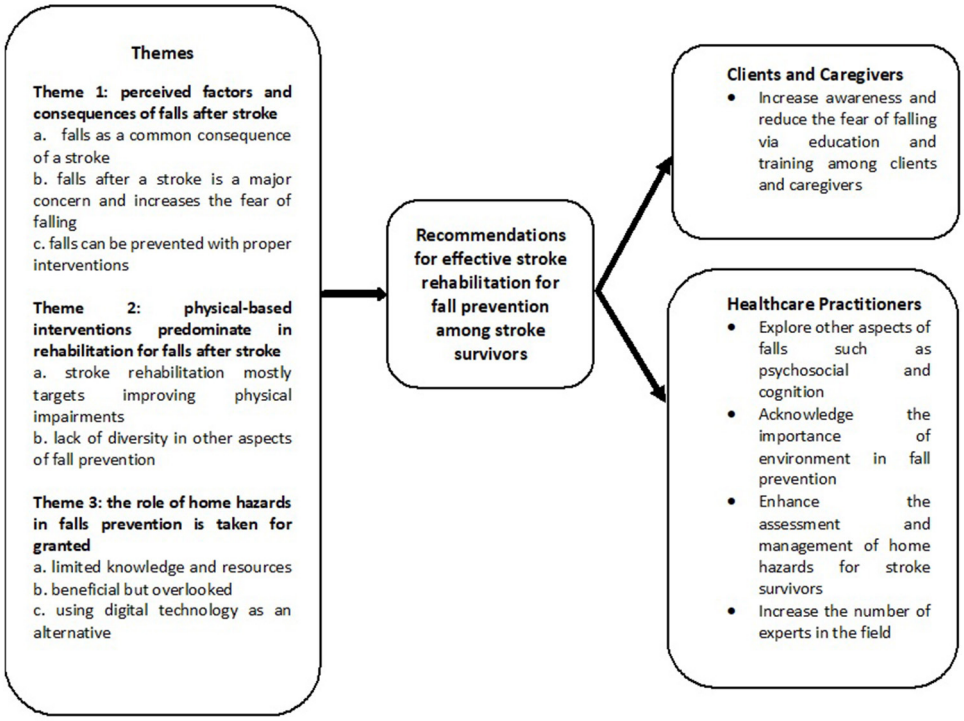


**FIGURE 1 |** Conceptual themes of the study.

*environmental modifications, some fall incidences could be prevented." (Healthcare Practitioner K)*
*"Yes, we will make sure that the environment is safe (for stroke survivors when they come for therapy). We put a chair behind them (so that they do not fall)." (Healthcare Practitioner K)*

### Concern About Falls Among Participants

Concern about falls after stroke was shared among participants, but not all of them agreed on the urgency of managing falls. Participants admitted that any fall incidence also increases the fear of falling. A stroke survivor also echoed that his number one concern after the stroke was the risk of falls after having near misses. The caregivers also became more conscious of falls and emphasized that they did not let their spouses do daily activities alone to avoid falls.

*"Even before the stroke he was walking unsteadily and after the stroke, he became more afraid to walk." (Caregiver LE)*
*"I am very scared of him walking alone as he could fall at any time." (Caregiver H)*
*"For me, the risk of falls is the number one important thing after stroke, although I have not had a fall." (Stroke Survivor J)*
*"When he wants to eat, I will prepare everything for him, he only sits down at the table." (Caregiver LY)*

However, the healthcare practitioners considered falls as a secondary outcome due to impairment in other areas, and that falls can be prevented when the impairments are treated.

*"I saw that patients who are more independent can prevent themselves from falling." (Healthcare Practitioner K)*
*"They can control their gait more when they are independent and are more aware of how to prevent themselves from falling." (Healthcare Practitioner M)*

## Theme Two: Physical-Based Interventions Predominate in Rehabilitation for Falls After Stroke

All participants agreed that stroke rehabilitation mostly targets towards improving physical impairments. Interventions for cognition, psychosocial, and the environment were not used as often, were often overlooked, and tended not to be regularly evaluated after stroke, with the main focus of management being on restoring physical function.

### Physical Impairments as the Central Attention in Stroke Rehabilitation

Most of the interventions mentioned by the participants were related to improving physical impairments. In addition, functional activities to improve physical impairments were also conducted as one of the main elements of the intervention.

*"(We also conduct) group exercises. For example, when we do balance training, we create a game for it such as throwing a ball to each other in a standing position so that they will have to maintain their balance." (Healthcare Practitioner M)*
*"We also do functional activities like gardening and domestic activities. For example, when you pour water inside of a cup or*

*when you do this activity while standing up, you can work on your balance." (Healthcare Practitioner G)*

### Lack of Diversity in Stroke Rehabilitation Research

All participants expressed that more research is needed to investigate the role of other aspects of stroke rehabilitation which included psychosocial, communication, and cognition issues, as falls are multidimensional.

*"I believe the psychological effects are more important than the physical but if you can have both, it would be excellent. A lot of people I see get defeated because they practically have no friends. (Stroke Survivor S)*
*"Well, of course, if they cannot communicate that they feel unstable, then how can the physiotherapists and occupational therapists assist in reducing the impairments?" (Healthcare Practitioner M)*

## Theme Three: The Role of Home Hazards in Fall Prevention Is Taken for Granted

The role of the environment was brought up in the focus groups as this was missing in the existing stroke literature. Participants mentioned that the environment was a factor in preventing falls. However, it was found that the role of the environment was not a central focus in falls prevention for stroke survivors.

### Limited in Knowledge and Resources

Healthcare practitioners expressed concern about the crucial need for home visits and modifications but due to limited manpower, lack of knowledge, cost and time constraints, and the inconvenience of conventional home visits, they were not able to conduct them efficiently.

*"It is a concern for us (conducting home visits) and we don't know the actual thing. We (physiotherapists) always ask the occupational therapist. We are limited by our profession here at the center, if it can be done, sure, we would like to do home visits too. The issue is manpower and timing." (Healthcare Practitioner M)*
*"Very helpful but very badly cost-effective and it takes an hour for a 20-min session vs. outpatient visits where patients can come into therapy. (Healthcare Practitioner K)*

### Beneficial but Overlooked

Healthcare practitioners perceived home assessment and modification as beneficial. However, a few client participants viewed that home visits and modifications were not necessary, expensive, and did not appreciate the undesired aesthetic value of their homes after the modifications.

*"Some patients felt that we should go to their homes, see their home environment and why they are tripping or why they are not functioning at their best level." (Healthcare Practitioner K)*
*"(Home assessment and modifications are) not necessary, you are just paying money to get a professional to come to your house and it would cost you a few hundred thousand of ringgit." (Stroke Survivor S)*
*"When they put in a grab rail around the house, it will become a hospital and I do not want my house to look like a hospital." (Stroke Survivor L)*

### Using Digital Technology as an Alternative

On some occasions, alternatives such as photos and videos of the home were taken by client participants and then sending it to the healthcare practitioner to ask for advice.

*"Usually, they will just take videos of their house and walk us through it, show us how they sit and stand, or they take pictures of their home environment because they know that we cannot go to their homes." (Healthcare Practitioner G)*

# DISCUSSION

This qualitative study showed similar yet distinctive perspectives on falls in stroke compared to older people in general. Older people tend to view falls as part of the "normal" aging process and contemplate falls as something unimportant to be discussed (20, 21), however, stroke participants considered falls as a frightful event and were more conscious toward preventing falls. This can be explained by the health-belief model whereby stroke survivors have the belief that they are susceptible to negative health outcome due to the apparent limitations features in physical and function; whilst older people may have no perception of an illness to affect them and they remain "healthy" as they do not believe themselves to be at risk of falling (48). Although healthcare practitioners considered falls as something that warrant attention, it was not their main aim for intervention (21). Lack of knowledge, lack of trained individuals, and other issues such as physical and functional aspects that require more attention has made falls to be a side-line of practice among healthcare practitioners. Perception on fall preventions is not an urgent matter as supported by previous studies (15, 20).

Falls prevention in stroke rehabilitation was indirectly targeted from interventions dominated by physical improvement either through exercise or functional activities. Other interventions targeting cognitive, communication, and psychosocial were available but not as extensive as physical and functional interventions and did not necessarily target falls prevention. The findings from this study reflects a finding from a systematic review whereby physical treatments dominate the fall prevention intervention (49). When compared to stroke rehabilitation in general (50–52) and studies on falls with older people (53, 54), interventions for falls prevention in stroke is unidimensional and has a narrow scope. This is not beneficial for stroke survivors as falls are known to be multifactorial (38). It is evident in this study that fear of falling exists among stroke survivors. Fear of falling and loss of confidence can lead to other effects, including self-restricted levels of activity (7). Following a stroke, cognitive function is often impaired. Cognitive impairment is likely to lead to impaired judgment, gait disorders and diminished dual-task capacity (55) which can contribute to falls among stroke survivors. Stroke survivors also expressed that after their stroke they become lonely and had a poor social life. Depression is a common stroke complication and a well-known risk factor for falls in the general older population (56). Therefore, more comprehensive and multifactorial interventions for fall prevention with stroke survivors is warranted.

Home hazards management in stroke rehabilitation does not receive the attention it deserves. Even a systematic review on falls prevention among stroke survivors only managed to find one study on pre-discharge home visits (49). Any compromise in managing a hazardous environment is a kin to allowing an appending fall to happen. In actual fact, home hazards management was found to be effective in fall prevention with older people (53, 57, 58) and instruments to evaluate home hazards are available (59). However, home hazards management either through an assessment or modifications is best performed by a home visit. This has made home hazards management unfavorable and challenging for therapists. Previous studies highlighted this issue where there are difficulties associated with healthcare practitioners conducting visits which includes clinical duties, the time needed for travel, scheduling a visit, and gaining access to observe the house (21, 22). These studies indicate that healthcare practitioners have the perception that home visits and hazards management has a small benefits-to-burden ratio where the effort and time can be substituted for more therapy sessions instead. Alternatives should be suggested such as the use of technology (e.g., telehealth, photo, and video recording) to facilitate home assessments and modification recommendations (51, 60). Nevertheless, using digital technology could occasionally lead to not capturing true situations and warrants further investigation.

This study had several limitations to be considered. One, the study recruited participants from the major ethnic groups and different rehabilitation professionals but had an over-representation of one profession. Physiotherapy is known to focus on physical function improvement (61) and this may contribute toward the emphasis on physical-based interventions. Secondly, a small sample size and recruitment of participants was only from one rehabilitation center in an urban community setting. Despite this, data richness was attained and adequate to provide meaningful findings (62). As this was the first study that delved into the perceptions of falls and rehabilitation for falls after stroke in Malaysia, it helped to identify theoretically proactive ideas that merit further exploration on a broader range of participants' experiences (63). Hence, this study had a optimal sample size for a qualitative study (64). In conclusion, this study provided insightful findings that served as a foundation of knowledge on the topic. However, future studies should be replicated in a larger population and diverse settings before it could be generalized.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Universiti Putra Malaysia Ethics Committee for Research Involving Humans (JKEUPM-2019-100). The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

MR and HA designed the protocol and conducted the focus group discussions. HA transcribed the interviews, analyzed the data with MR, and wrote the first manuscript. MR gave continual input as the manuscript progressed while TH, MS, and LM critically revised the final draft. All authors read and approved the final manuscript.

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# Do Living Arrangements and Social Network Influence the Mental Health Status of Older Adults in Malaysia?

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Living arrangement has been reported to have a significant influence on several mental health statuses of older adults, but their social network may confound this association. This study is aimed at examining the interactive effect of living arrangements and social network on the mental health status among older adults in Malaysia. A total of 2,188 Malaysian older adults living nationwide were included in this cross-sectional study. Participants were classified into four groups according to their living arrangements (living alone or not living alone) and social network size (assessed using Lubben's Social Network Scale-6). Poor social network was defined as the lowest quartile (fourth quartile) of the score. Mental health statuses, which include flourishing in life, life satisfaction, cognitive functions, loneliness, depression, and perceived stress, were measured. Multiple linear regression models, adjusted for age, gender, education, and comorbidities, revealed that a good social network was significantly associated with an increase on the flourishing scale scores, regardless of living arrangements. Not living alone and having good social network was significantly associated with increased Montreal Cognitive Assessment scores and decreased loneliness scores. This study found that living arrangements are not always a risk factor for the mental health status of older adults. However, it may be confounded by the level of their social networks. The results suggested that the effects of social network may exceed the impact of living arrangements. It is recommended that health professionals pay more attention to the social networks of older Malaysians to harness its benefits in improving their mental health status.

**Keywords: social network, living arrangement, mental health, older adults, interaction effect, Malaysia**

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## INTRODUCTION

The proportion of older adults in the overall population has been increasing substantially not only in the developed countries but also in many developing nations (1, 2). A recent report conducted by the United Nations (3) estimated that by 2050, one in six people in the world would be over the age of 65, up from 1 to11 in 2019. The increasing numbers of older people come with a challenge to promote and maintain the health system and quality of life (1, 2, 4, 5). A body of literature has documented the role of type of living arrangements and networks in shaping the mental health and life satisfaction of older adults (5–12). Older adults with stronger social support have an increased

likelihood of better health and higher increase in mental well-being than the socially disengaged (8, 10). In contrast, older adults who were living in a poor living arrangement (e.g., living alone) or who had a weak social network were suffering from conditions such as higher dementia (13), higher depressive symptom scores (14, 15), higher loneliness level (16, 17), lower general cognitive ability (18), lower levels of vitality (19), and higher mortality risk (20). The existing evidence revealed different aspects of an individual's social relationships that indicated that the structural deficits or abundance of one's network (10) has an effect on mental health outcomes. However, most of the existing studies investigate specific aspects of social relationships and its effect on individuals' mental health like the deficits of social network (15, 21, 22).

Social isolation and poor social networks are considered as a major public health threat (8) among older adults. A social network is the pattern of communication ties of a person, group, or community (23). Social support could also refer to the individuals' connection with others and the community, which include interpersonal interaction and communication, affection and companionship, caring and concern, financial assistance, and acceptance and respect (2, 24). The social network assessments include both the degree of connectedness (like weak and strong ties) and network composition (like family, friends, etc.) (25). Previous studies also stated that the effects of social relationships can be understood through understanding the components of supportive relations that indicate the degree of social integration, the actual support obtained from the network, and the satisfaction with the relationship (26). Prior literature had demonstrated the consequences of poor social network on individuals' quality of life (8, 27), mental health outcomes (9, 28, 29), cognitive decline (30, 31), mortality (20), and psychological well-being (32). Social network yielded various health outcomes including protection against depression and loneliness (16, 17, 20, 28), promotion of higher life satisfaction (8, 9, 33), safeguarding against Alzheimer's disease and dementia (34), improvement in cognitive function (30), and maintenance of general health (26, 29). Previous studies had also revealed various types of social network structures that were based on diverse or restricted social ties (8, 10).

Concomitantly, living arrangements could refer to the type of individual connections that bind the familial and non-familial relationships of a person to the other people they reside with (15). There are various types of living arrangements for older adults, which include living with a spouse, living alone, and living with others (35, 36). The types of living arrangements could also play an essential role in the levels of life satisfaction (2, 36), social support (4), various health outcomes (10, 11, 37), and psychological well-being (38). Living in households consisting of more than one individual is an essential feature for good mental health and recovery process, particularly for older adults (37, 39). Generally, urban communities' living arrangements have transitioned from a co-residence pattern to a more self-independent pattern, affecting the older adults' mental health status (3, 8, 40). However, other studies showed that family proximity was not related to older adults' mental health (41).

Generally, both social networks and living arrangements of older adults could play a critical role in their mental health status (14–17). Several studies have examined the correlation between mental health status and engagements in social activities (13, 15, 18, 20); however, there is a lack of evidence about the interaction effects of living arrangements and social networks on mental health among older adults (14, 20). In the Malaysian context, the number of individuals aged 65 years and above is estimated to be 6.7% of the population and is expected to increase to 15% over the next 10 years (42).

It is a cultural norm for older adults to co-reside with family members in Malaysia (2). Noted that 71% of older adults in Peninsular Malaysia were living with adult children, 16% were living with spouse only, and 9% were living alone. The recent 5th Malaysia Population and Family Life Survey documented over 70% of older Malaysians who were living with family members and others in their household, about 21% were living with spouse only, and 9% were living alone (43). Using the national household income and expenditure survey, (44) also recorded that over 60% of the elderly were living in co-residency with adult children, 18% were living in spouse-only arrangements, and 6% were living alone. Nevertheless, (44) noted that living arrangements were influenced by age, gender, ethnicity, location of residence, and marital status. Male elderly who lived in rural areas are more likely to live alone when becoming older, but the Chinese elderly are more likely to co-reside with an adult child. In addition, married elderly, were more likely to live in spouse-only living arrangements. Thus, far, only (2), had studied the relationship between living arrangements and life satisfaction among older Malaysians living in Peninsular Malaysia. They reported that older adults living in spouse-only arrangements and co-residency with adult children recorded higher life satisfaction levels compared with those living alone. Living arrangements showed direct and indirect effects on life satisfaction through the support function. This implied that supportive relationships and interactions between members in the living unit promote better evaluation of their life satisfaction.

Nonetheless, scientific evidence of social network and mental health among Malaysian older adults are few. Besides, the interaction effect of social network types and living arrangement types on the mental health of older adults have not been extensively investigated. Considering the lack of network studies in the Malaysian context, the purpose of the current study was to examine the interaction effect of living arrangements and social network on the mental health status among older adults in Malaysia.

The Social Convoy model was considered as the theoretical basis for this study because it discusses the nature of social relationships and their influence on health and well-being (45). This model was first developed by (45) to capture the social relations and social ties across the life span. They described the social relations as a convoy, where persons are surrounded by supportive people who move with them throughout their lives (45–47). These relationships may vary in terms of function (affect, aid, or affirmation exchanges), quality (positive or negative), and structure (composition, frequency, size or arrangements, and geographic proximity), and these have

significant impacts on their physical and mental health (45–47). The dimensions of convoys could be influenced by characteristics (e.g., age, gender, and occupation) and situational factors (e.g., demands and resource) (45, 47, 48). The convoy model also contributed to the study of interpersonal relationships and support in adulthood and aging (47). Consequently, the concept of Social Convoy has increasingly been included in the recent gerontological research to consider the current circumstances and possible predictions of the health, well-being, and lives of older adults (48). Furthermore, the definitions of social networks highlighted the role of social support and living arrangements on the psychological well-being of older adults (9, 10, 28). Based on the theoretical evidence, a conceptual framework of the current study was developed to determine the interaction effects of living arrangements and social network on the mental health status among older adults living in Malaysia (see **Figure 1**).

# METHODS

## Participants and Study Design

The data for the study consisting of 2,322 community-dwelling older adults were obtained from a nationally representative population-based survey entitled, Identifying Psychosocial and Identifying Economic Risk Factor of Cognitive Impairment among Elderly, conducted in Peninsular Malaysia. This study is a sub-project under a longitudinal study on a neuro protective model for healthy longevity (LRGS TUA). The details of the methodology have previously been published elsewhere (49). A multistage random sampling of Malaysian older adults from four states in Malaysia, i.e., Johor, Selangor, Kelantan, and Perak, were performed, and outcome measures were followed at 18 and 36 months. Data collection was conducted using a face-to-face interview by trained enumerators in a nearby community hall from May 2012 to February 2013, with a response rate of 90%. For this paper, only the first wave data were used.

## Ethical Consideration

This study was approved by the Medical Research and Ethics Committee of Universiti Kebangsaan Malaysia. Oral informed consent was obtained from all respondents who agreed to participate in the study.

## Measurement Tools

### Living Arrangements and Social Network

Living arrangements of respondents were determined by asking the question, "Are you living alone or with others?" with the answer options of, "Alone," "With a spouse," "With children," "With relatives," or "With others." Those who answered, "Alone," were assigned to the "Living alone group," while other responses were assigned to the "Not living alone group."

Social network was measured using the abbreviated version of the Lubben Social Network Scale (LSNS-6) (50), which consists of six questions assessing the size of three different aspects of social network such as active social network, perceived support network, and perceived confidant network. Those three aspects are attributed to family ties and a parallel set is attributable to friendship ties. Each question is scored from 0 to 5 with a maximum score of 30. A higher score indicates a larger social network.

### Flourishing Scale

The Flourishing Scale is an eight-item questionnaire Likert scale that measures self-perceived success in areas of relationship, self-esteem, purpose, and optimism (51). Respondents can choose an answer using a Likert scale ranging from 1 (Strongly disagree) to 7 (strongly agree). Total scores are calculated, and the sum of all item score ranges from 8 to 56; higher scores indicate greater flourishing in life. The scale is reported to have excellent reliability among the Malaysian population (52).

### Satisfaction With Life Scale

The Satisfaction with Life Scale (SWLS) (33) is a five-item questionnaire that measures global cognitive judgments of participants' life satisfaction, without measuring Neither positive or negative affect. Participants need to choose an answer from a scale that ranges from 1 (Disagree) to 3 (Agree). Total scores were calculated by summing up all items answered (ranges from 5 to 15), whereby a higher score indicates greater satisfaction. A previous study had reported SWLS as a valid and reliable measure of life satisfaction among Malaysian samples (53).

### Montreal Cognitive Assessment

Montreal Cognitive Assessment (MOCA) is a screening tool to measure cognitive impairments. The scores range from 0 to 30; a higher score indicates better cognitive function. MOCA was reported as a valid and reliable scale to measure cognitive impairments among Malaysian older adults (54).

### Loneliness Scale

The three-item Loneliness Scale is a questionnaire developed from the Revised UCLA Loneliness Scale. Each question is rated on a three-point scale (1 = Hardly Ever; 2 = Some of the Time; 3 = Often). The scale asks about how often the respondent feels that they lack companionship, feels left out, and feels isolated from others. All items are summed up to give a total score (ranges from 3 to 9). A higher score indicates greater loneliness. A previous study indicated that total reliability, concurrent and discriminant validity of the scales were satisfactory (55).

### Geriatric Depression Scale

The Geriatric Depression Scale (GDS) (49) is a 15-item questionnaire used to screen for depression, specifically developed for uses with older adults. The items are rated on a binary response (Yes/No). The GDS total score in this study was calculated based on the sum of all item response. A higher score indicates greater depression. The scale reliability and validity have been established among the Malaysian older adult population (56).

### Perceived Stress Scale

The Perceived Stress Scale (PSS) was developed to measure how controllable and unpredictable people viewed their lives, which is an essential component of the experience of stress (57). This study used the short form four-item PSS rated from 0 (Never) to 4 (Very often). Two items were negatively stated, and another

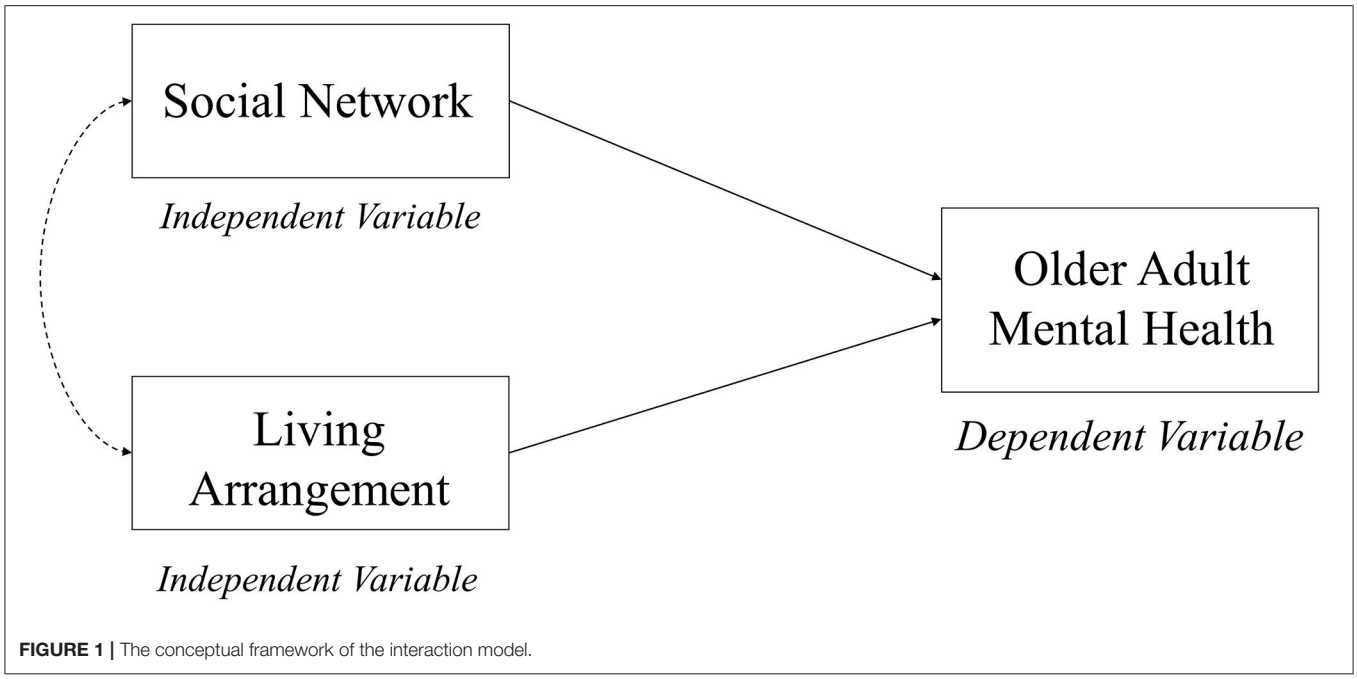


**FIGURE 1 |** The conceptual framework of the interaction model.

two were positively stated. The total scores ranged from 0 to 16. A higher score indicates greater stress. A validation study reported that PSS has a satisfactory reliability and validity among the sample of older adults (58).

## Data Analysis

To examine the interaction effects of living arrangements and social network, the LSNS-6 scores among all respondents were first divided into quartiles, where the lowest quartile (fourth quartile) was defined as the poor social network group, while the first to third quartiles are referred to as good social network groups. The respondents were then categorized into four groups as follows: Group 1, living alone and poor social network; Group 2, living alone and good social network; Group 3, not living alone and poor social network; Group 4, not living alone and good social network.

The descriptive statistics of the study variables among the four groups were examined using the Chi-square test for the categorical variables and *t*-tests for continuous variables. To assess the interaction effects of living arrangements and social network on the continuous mental health variables, multiple linear regression analyses were performed on Flourishing in Life Scale, SWLS, MOCA, Loneliness Scale, GDS, and PSS. Each regression models were adjusted for confounders: age, gender, education level, and comorbidities. All statistical analyses were performed using the IBM SPSS v22.0 (SPSS Inc. Chicago, IL).

# RESULTS

A total of 2,188 respondents were included in this study (mean age 68.95 ± 6.17, with 51.7% women and 48.3% men). **Table 1** presents the characteristics of respondents stratified by the combination of living arrangements and quality of their social network. Approximately, 67.2% of the respondents were not living alone and had good social network. Only 10.1% of the respondents were living alone, and 3.2% had poor social network, while 6.9% had good social network. Majority of women were living alone, regardless of having poor (70.4%) or good social network (72.2%). Respondents not living alone recorded higher educational achievements than respondents living alone, regardless of their social network quality. The mean score of the Flourishing in Life Scale score was almost equal in Group 2 (50.62%) and Group 4 (50.93%) respondents, respectively, and the differences were significant. Group 4 respondents recorded the highest SWLS (8.22). In addition, Group 4 also recorded the highest MOCA mean score (19.08). As expected, Group 1 respondents exhibited highest Loneliness (3.58) and GDS (7.25) scores. Highest mean score for PSS (3.19) was shown in Group 2, while Lubben score was highest in Group 4 (3.19).

The Chi-square tests and ANOVA tests showed that age, gender, and education level were among the significant socio demographic variables between the four groups. Assessing the mental health variables revealed that Flourishing Scales, MOCA, and Loneliness Scale scores were significantly different across the four groups. Mean scores for Flourishing Scale and MOCA were lowest among those living alone and having poor social network (Group 1). In addition, Group 1 also showed higher scores on the Loneliness scale.

**Table 2** presents the results of multiple linear regression analysis to examine the interaction effects of living arrangements and social network on the mental health variables. The regression models were adjusted for potential confounders: age, gender, education level, and comorbidities. The results showed that Group 4 (Not LA and good SN) was associated with Flourishing

**TABLE 1 |** Characteristics of respondents stratified by the combination of living arrangement and quality of social network.

| Characteristics | LA and poor SN (Group 1) | LA and good SN (Group 2) | Not LA and poor SN (Group 3) | Not LA and good SN (Group 4) | *P* |
|---|---|---|---|---|---|
| | ***n* = 71 (3.2%)** | ***n* = 151 (6.9%)** | ***n* = 495 (22.6%)** | ***n* = 1,471 (67.2%)** | |
| Age, mean (SD) | 70.52 (5.82) | 70.87 (6.17) | 68.91 (5.93) | 68.69 (6.23) | **<0.001** |
| Women, *n* (%) | 50 (70.4) | 109 (72.2) | 263 (53.1) | 710 (48.3) | **<0.001** |
| Men, *n* (%) | 21 (29.6) | 42 (27.8) | 232 (46.9) | 761 (51.7) | |
| Education, mean (SD) | 3.86 (3.91) | 4.08 (3.85) | 5.08 (3.93) | 5.45 (3.98) | **<0.001** |
| Hypertension, *n* (%) | 31 (43.7) | 69 (45.7) | 232 (46.9) | 670 (45.5) | 0.941 |
| Diabetes mellitus, *n* (%) | 21 (29.6) | 36 (23.8) | 106 (21.4) | 358 (24.3) | 0.377 |
| Arthritis, *n* (%) | 6 (8.5) | 19 (12.6) | 45 (9.1) | 163 (11.1) | 0.474 |
| Heart disease, *n* (%) | 5 (7.0) | 15 (9.9) | 38 (7.7) | 137 (9.3) | 0.632 |
| Flourishing, mean (SD) | 48.35(7.07) | 50.62 (6.46) | 48.38 (8.71) | 50.93 (5.80) | **<0.001** |
| SWLS, mean (SD) | 7.70 (2.71) | 8.10 (2.52) | 8.06 (2.52) | 8.22 (2.34) | 0.196 |
| MOCA, mean (SD) | 16.13 (5.46) | 17.27 (5.68) | 18.52 (5.60) | 19.08 (5.79) | **<0.001** |
| Loneliness, mean (SD) | 3.58 (1.38) | 3.36 (1.06) | 3.38 (1.09) | 3.20 (0.77) | **<0.001** |
| GDS, mean (SD) | 7.25 (2.03) | 6.99 (1.64) | 6.93 (1.62) | 6.99 (1.64) | 0.297 |
| PSS, mean (SD) | 3.10(3.10) | 3.19 (3.06) | 3.18 (3.22) | 3.14 (2.99) | 0.994 |
| Lubben score, mean (SD) | 4.03 (2.31) | 14.93 (5.06) | 4.13 (2.21) | 15.37 (5.23) | **<0.001** |

*LA, Living alone; SN, Social network; SWLS, Satisfaction with life scale; MOCA, Montreal cognitive assessment; GDS, geriatric depression scale; PSS, perceived stress scale.*

Scale scores and MOCA scores. Group 2 (LA and good SN) was significantly associated with high Flourishing Scale scores. Group 4 was also significantly associated with low Loneliness Scale scores. There was no significant association between the four groups and SWLS, GDS, and PSS scores.

## DISCUSSION

In this study, we have examined the interaction effects of living arrangements and social network on the mental health status of older adults in Malaysia. The study found that the interaction between living arrangements and social network has a significant impact on psychological well-being (Flourishing in Life Scale), cognitive function (MOCA), and loneliness. The current findings reinforce the results of previous studies in which the restricted social network of older adults was associated with more health and mental health risks than other types of social networks (10, 59, 60). More specifically, the results of the multiple regression analysis showed that older adults who have good social network, regardless of living arrangements, recorded higher psychological well-being than those who live alone and have a low social network. This is in line with the results of a quantitative study from China, which found that older adults who have a certain level of social interaction had lower odds of mental health problems (1).

Furthermore, the current study revealed that Malaysian older adults who did not live alone and had good social network reported higher cognitive functions and lower loneliness level than those who are living alone. Social network and social support seem to contribute to a better global cognitive function and episodic memory of older adults (30). Additionally, evidence found multiple associations of low social network, loneliness, and well-being of the Asian older adults (27). The finding of this study also observed that living arrangement is not always a risk factor for the mental health status among older Malaysians. Similarly, an empirical study from the Eastern United States found that living arrangement was not related to elderly mental well-being (41). However, another quantitative study from Malaysia conducted by (2) found that the living arrangements, directly and indirectly, play an essential role in predicting life satisfaction for older adults. The difference in results may be due to the different operationalization of living arrangements used in the current study, where the levels of the social network were also imputed.

On the other hand, the results of multiple regression analysis of the current study showed no significant associations among various types of interactions between social network and living arrangements with the scales of satisfaction with life, geriatric depression, and perceived stress. Our results contradicted previous quantitative studies regarding the role of diverse social ties of older adults in protecting against depression (9), achieving a higher life satisfaction (2), and reducing stress level (61). Previous studies did not include the interaction effects of social networking and living arrangements on the mental health well-being of older adults like we did in this paper. Furthermore, the current study showed that the demographic characteristics (such as age, gender, and education level) were significantly associated with diverse types of combinations for social network and living arrangements. This finding is consistent with studies conducted by (44, 62), where they corroborated that living arrangements were correlated with different socio demographic characteristics of older adults.

Our study showed that when there is good quality of social network, Malaysian older adults from different living arrangements tend to have higher mental health well-being. Our findings also supports the (45) Social Convoy assertion that strong social network will translate into support network,

**TABLE 2 |** Result of multiple linear regression for mental health variables.

| Status | Flourishing Scale | | SWLS | | MOCA | |
|---|---|---|---|---|---|---|
| | β (95% CI) | *P* | β (95% CI) | *P* | β (95% CI) | *P* |
| Group 1 | Reference | | Reference | | Reference | |
| Group 2 | **2.30 (0.43, 4.17)** | **0.016** | 0.38 (−0.27, 1.03) | 0.254 | 1.14 (−0.16, 2.44) | 0.084 |
| Group 3 | −0.30 (−1.95, 1.36) | 0.722 | 0.36 (−0.21, 0.94) | 0.215 | 1.07 (−0.09, 2.22) | 0.070 |
| Group 4 | **2.17 (0.59, 3.77)** | **0.008** | 0.54 (−0.01, 1.09) | 0.054 | **1.28 (0.18, 2.39)** | **0.023** |
| **Status** | **Loneliness Scale** | | **GDS** | | **PSS** | |
| | β (95% CI) | *P* | β (95% CI) | *P* | β (95% CI) | *P* |
| Group1 | Reference | | Reference | | Reference | |
| Group 2 | −0.20 (−0.45, 0.05) | 0.122 | −0.22 (−0.67, 0.24) | 0.351 | 0.10 (−0.76, 0.95) | 0.824 |
| Group 3 | −0.14 (−0.36, 0.09) | 0.225 | −0.18 (−0.58, 0.23) | 0.393 | 0.20 (−0.56, 0.95) | 0.609 |
| Group 4 | **−0.33 (−0.55, −0.12)** | **0.002** | −0.19 (−0.58, 0.20) | 0.333 | 0.19 (−0.54, 0.91) | 0.608 |

*Bold values are statistically significant at $P < 0.05$.*
*SWLS, Satisfaction with life scale; MOCA, montreal cognitive assessment; GDS, geriatric depression scale; PSS, perceived stress scale; β, regression coefficient; 95%, 95% confidence interval.*

which can be utilized when needed. The reassurance of support through the investment in long-term social relations buffers the impact of poor living arrangements such as living alone (32). Also suggested that social network is an important resource in the older adults' life as it improves their psychological well-being.

The findings of this study add new knowledge to the emerging literature on social network, living arrangements, and the mental health status of older adults. Our results indicated that the combined effects of living arrangements and strong social support network influence the mental health status of older Malaysians. Therefore, future intervention programs to improve the mental health status of the elderly, particularly in Malaysia and Southeast Asia, would need to consider the characteristics of the social network in the design of the intervention. It would be useful for the older adults and those intimately associated with them in understanding the relationship between socialization and living arrangements with the older adults' mental health status. Furthermore, the findings of this study indicate the need for attention to the mental health of the elderly who are living alone and having poor social support.

Nevertheless, the study has some limitations. First, even though the sample of the present study is large, the generalizability of the findings is limited as a case-centered approach was used to obtain the data, and optimal group is specific to the selected sample. Second, the analysis only involves first-wave respondents; therefore, only associational relationships were established, and causality cannot be ascertained. Third, the data were self-reported and may have inherent bias.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Medical Research and Ethics Committee of Universiti Kebangsaan Malaysia. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

The study concept was developed by TH. The manuscript was drafted by TH, HD, and MB. Data analysis was performed by HD. Data collection and management were completed by MB and TH. The manuscript was critically revised by TH, HD, MB, and RI. All authors contributed to the article and approved the submitted version.

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BRIEF RESEARCH REPORT
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# Muscles Affecting Minimum Toe Clearance

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The aim of this study was to investigate how the anterior and posterior muscles in the shank (*Tibialis Anterior, Gastrocnemius Lateralis and Medialis*), influence the level of minimum toe clearance (MTC). With aging, MTC deteriorates thus, greatly increasing the probability of falling or tripping. This could result in injury or even death. For this study, muscle activity retention taping (MART) was used on young adults, which is an accepted method of simulating a poor MTC—found in elderly gait. The subject's muscle activation was measured using surface electromyography (SEMG), and the kinematic parameters (MTC, knee and ankle joint angles) were measured using an optical motion capture system. Our results indicate that MART produces significant reductions in MTC ($P < \alpha$), knee flexion ($P < \alpha$) and ankle dorsiflexion ($P < \alpha$), as expected. However, the muscle activity increased significantly, contrary to the expected result (elderly individuals should have lower muscle activity). This was due to the subject's muscle conditions (healthy and strong), hence the muscles worked harder to counteract the external restriction. Yet, the significant change in muscle activity (due to MART) proves that the shank muscles do play an important role in determining the level of MTC. The *Tibialis Anterior* had the highest overall muscle activation, making it the primary muscle active during the swing phase. With aging, the shank muscles (specifically the *Tibialis Anterior*) would weaken and stiffen, coupled with a reduced joint range of motion. Thus, ankle-drop would increase—leading to a reduction in MTC.

**Keywords: minimum toe clearance, tibialis anterior, gastrocnemius, surface electromyography, aging, gait, joint angle**

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## INTRODUCTION

With an increasing elderly population worldwide, the number of fall and tripping related injuries have also increased (1). This poses a serious threat to the health and standard of living of the elderly. The occurrence of such accidents can also, negatively impact the economy—where society must bear the cost (1, 2). Due to this, it is vital that the underlying causes for these accidents are understood, so that precautionary measures or devices can be implemented.

There is sufficient evidence to show that one of the main causes for tripping and falling, is a low minimum toe clearance (MTC) (3, 4). This gait event is defined as being the smallest vertical distance between the ground and the lowest point of the foot (toes), during the swing phase. The swing phase, occurs between a toe-off (TO) and a heel-strike (HS) (5).

Multiple causes for a low MTC, both in adults and the elderly have been investigated through various studies. One such study, showed that dual task walking and low cognitive awareness were factors linked to a reduction in MTC (6). On the other hand, Mills et al. (4) showed that a lower step length and a slower walking velocity led to a decrease in MTC.

It is established that the primary ankle extensors and flexors were responsible for disorders such as drop foot, which led to a lower toe clearance (TC) (7). The anterior and posterior muscle groups associated with the ankle's movements are the *Tibialis Anterior* (responsible for dorsiflexion) and the *Gastrocnemius* (responsible for plantar flexion) in the shank. The *Gastrocnemius* is split into two subdivisions—the Lateralis and Medialis. With aging, a person's muscles would weaken and stiffen, along with a reduction in the range of motion (ROM) and flexion of their joints (8, 9). This results in a weaker ankle with greater foot drop, possibly leading to a reduction in MTC.

It was hypothesized, that the *Tibialis Anterior* would be the prominent muscle active (in the shank) during the swing phase, as compared to the *Gastrocnemius*. Thus, would play a significant role in influencing the level of MTC.

Furthermore, it was predicted that, with aging, the MTC would decrease, and this would be a result of weaker anterior and posterior shank muscles (lower muscle activity).

Young adults participated in this study using muscle activity retention taping (MART) techniques; to simulate aging gait on a muscular level (5). Hence, elderly subjects were not required as similar gait characteristics could be replicated. The validity and reliability of MART was discussed in reference (5). The hypothesis of this study differs from that in (5), as it aims to investigated the extent to which the shank muscles affect MTC, along with joint kinematics. The report herein, details the methodology, results, and conclusions from the conducted study.

# MATERIALS AND METHODS

## Subject Details

Data from five subjects were considered. Their average age, weight and height were 22.60 ± 1.52 years, 75.4 ± 11.30 kg and 1.70 ± 0.034 m, respectively. Ethical approval was obtained from the Monash University Human Research Ethics Committee (Project number: 23200). Each subject provided informed consent, prior to the trials, and were recruited *via* word of mouth (within the student community) from Monash University Malaysia. An example of a subject during a trial, is shown in **Figure 1**.

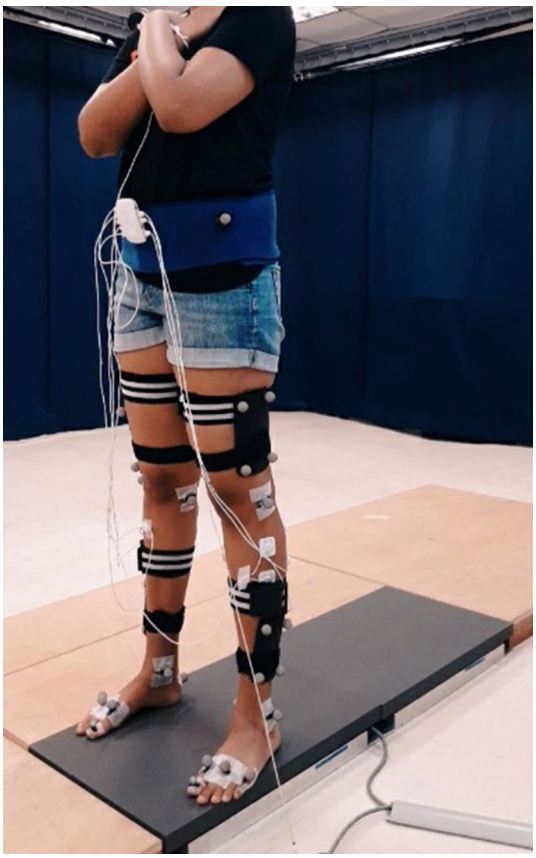

**FIGURE 1 |** Static trial for a subject with the placement of motion capture markers, Biosignalsplux SEMG electrodes and MART bands.

## Equipment and Apparatus

### Motion Capture System

The motion capture (mo-cap) system used, was Qualisys, Sweden with a sampling frequency of 200 Hz. With this, two BERTEC force plates were used to detect the swing phase gait events—a TO and HS. The lower body segments of a subject were tracked (in mm) based on a 3D cartesian coordinate system, where the origin was placed within the calibrated area (force plates). Qualisys Track Manager (QTM) was the management and control software. It was used to record the mo-cap data of participants, synchronize and record data from the force plates and trigger the Biosignalsplux SEMG data logger (synchronization). This ensured the timescales of all individual systems matched. In addition, QTM was used to label and identify the mo-cap markers placed on the subjects.

### Muscle Activity Retention Taping

MART was used to simulate elderly gait characteristics in young adults, focusing on the lower extremity muscles. MART was achieved by using two pairs of non-elastic blood flow restriction occlusion bands. The MART bands were placed on the shank and thigh segments of each foot. The bands on the shank were placed on the lower end of the *Gastrocnemius* and *Tibialis Anterior* to restrict the ankle's movements. While, the bands on the thigh were placed on the *Vastus Lateralis* and lower end of the *Rectus Femoris* to reinforce the reduction in joint motion and avoid compensation for the restriction on the ankle (5).

By restricting blood flow using MART, the increase in the transversal area of the muscle belly during contraction is reduced, leading to a decrease in the muscle length. This results in an increase in the stiffness of the muscle, a reduction in step length, walking velocity, ROM, and joint flexion. Thereby allowing the

**Abbreviations:** ADC, Analog to digital converter; HS, Heel Strike; ICC, Intra-class Correlation; IQR, Inter-quartile range; MART, Muscle Activity Retention Taping; MTC, Minimum Toe Clearance; MVC, Maximum Voluntary Contraction; PDM, Peak Dynamic Method; QTM, Qualisys Track Manager; RMS, Root Mean Square; ROM, Range of Motion; SD, Standard Deviation; SEMG, Surface Electromyography; TC, Toe Clearance; TO, Toe Off.

elderly gait characteristics (particularly a lower MTC) to be replicated in young adults (5).

The pressure range for safely restricting blood flow (due to MART), is between 180 and 200 mmHg. To ensure the pressure exerted, by each band is kept within this range—three force sensitive resistors (FSR-402) with an Arduino Uno, were used to maintain the restriction pressure at approximately 180 mmHg (10). This also ensures that each band exerts the same pressure, thus maintaining symmetry.

### Surface Electromyography

Surface electromyography (SEMG) was used to measure the action potential (hyperpolarization and depolarization) of the three subject muscles—*Tibialis Anterior, Gastrocnemius Lateralis* and *Medialis*. A Biosignalsplux SEMG data logging kit was used to collect the readings through Opensignals software, which connected to the datalogger *via* Bluetooth. There were six channels/electrode pairs (one for each subject muscle) and a ground electrode, which was placed on a bone segment (collar bone). Opensignals was also used when finding the maximum SEMG reading for each muscle.

## Procedure

In the pretest phase—first the SEMG electrodes were placed on the six muscles with respect to the guidelines as stated by the SENIAM Project (Surface Electromyography for the Non-Invasive Assessment of Muscles) (11–13). A maximum voluntary contraction (MVC) for the three muscles on each foot were obtained. Participants were asked to tense their ankle with as much force as possible, to set a baseline for the maximum possible muscle activation. Next, reflective mo-cap markers were placed on the lower body segments of participants, as recommended by Visual 3D, C-Motion Inc. USA (14). One extra marker was placed on the Hallux of each foot, to measure MTC. The subject was then asked to stand in a stationary position with their arms crossed, and a single static trial was recorded. Next, six dynamic trials were recorded. Subjects were asked to walk (at their own pace) along a walkway spanning approximately 5 m. This ensured that they would reach their normal walking velocity and step length before reaching the force plates.

In the post-test phase—the MART bands were placed on the shank and thigh segments of each foot. The mo-cap markers were realigned and a static trial was obtained. Next, six more dynamic trials were obtained with muscle restriction. This concluded the experimental trials.

## Data Collection and Processing

Visual 3D and MATLAB were used in data processing to extract the MTC, SEMG readings and joint angles. SPSS Statistics V26.0, IBM was used for statistical analysis of the collected data.

On Visual 3D, the static trial was used to create a hybrid static model, which was then superimposed onto the dynamic trials to create the lower body bone segments. To normalize the ankle joint angles to zero (when the subject stood upright)—kinematic only, left and right feet were created within the static model.

For the dynamic trials, the marker trajectories were first interpolated with a fame gap of 10, to fill in missing data points (15). The trajectories were then filtered using a Butterworth low pass filter, with a cutoff frequency of 8 Hz. Visual 3D created the gait events (using the force plate readings), and the swing phase was identified between a TO and HS. The MTC, knee and ankle joint angles were then computed and exported into MATLAB for further analysis.

The TC during the swing phase splits into three sections. First it reaches a maximum, just after a TO, followed by a "trough" in the cycle—which corresponds to the MTC. Finally, the TC reaches a second maximum before the HS. MATLAB was used to find the MTC by considering the trajectory of the Hallux marker (in mm) at the trough. It can be noted that MTC occurs around mid-swing (50 to 60 percent of the swing phase) (16).

By noting down the times at which MTC occurred, the relevant joint angles were found, for that instant. The sign of the angle denotes its state:

- Extension is positive and flexion is negative (for the knee)
- Dorsiflexion is positive and plantar flexion is negative (for the ankle)
- Inversion is positive and eversion is negative
- Adduction is positive and abduction is negative

Next, the collected SEMG signal was processed. The signal was cropped to the required timeframe—between when the subject enters and leaves the calibrated area (∼2 s), as taken from QTM. A Fast Fourier Transform of the signal was obtained and it was noted that the intensity of the peaks started to increase at around 30 Hz and reduced after 300 Hz. Hence, a 4th order Butterworth bandpass filter was applied with a highpass cut-off frequency of 30 Hz and a lowpass cut-off frequency of 300 Hz. This frequency range was identical to that, suggested for EMG signal processing in reference (17). The filter removed any high frequency noise to give a smoother envelope; and low frequency traces to remove movement artifacts and improve spectral resolution (17, 18). Next, the SEMG signal underwent full wave rectification. A root mean square (RMS) moving average envelope was computed (using the "movmean" function in MATLAB) to show the mean power of the signal. A sliding window size of 50 samples (corresponding to a 2.5 ms window) was used for a reasonable trade-off between roughness of the envelope and the area under it (19).

Finally, the SEMG signal was normalized using the peak dynamic method (PDM). The maximum muscle activation for each subject muscle was found by comparing the MVC and all other dynamic trials for that individual (20). The percentage of the RMS envelope to the PDM was then calculated and plotted. This is shown by the red curve in **Figure 2**. PDM gives a standardized signal to compare muscle activation across all subjects. For statistical analysis, the SEMG readings were obtained using two methods:

- The area under the normalized SEMG curve; during the swing phase (referred to as, "swing phase area" in this report).
- The individual muscle activations for each muscle at the time MTC occurs (referred to as, "at time MTC" in this report).

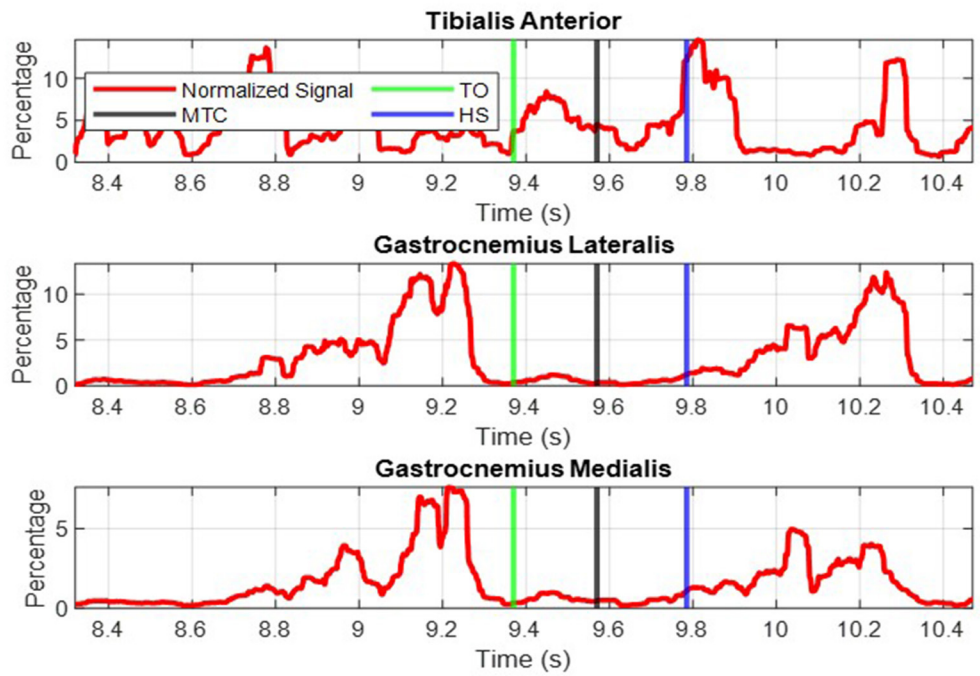


**FIGURE 2 |** Normalized muscle activation using the PDM.

## Statistical Analysis

SPSS was used for analysis of the within subject's collected data. Initially, a one sample Kolmogorov-Smirnov test along with a Shapiro-Wilk test was used to test for normality. From the 12 data sets tested (**Tables 1**, **2**), three were parametric. For these data sets the mean and standard deviations (SD) were considered while for the non-parametric data, the median and interquartile range (IQR) were used as measures of central tendency and variability, respectively (4).

Each subject performed six trials pre-MART and 6 trials with MART. The data values obtained from each trial, per subject, were considered as singular data points. Data (from all subjects) pre-MART were considered as pretest data and those with MART formed the post-test data. From the kinematic parameters, MTC was normalized with respect to the subject height (5); while the joint angles were normalized (to zero) when the subject stood in a static position. In addition, the SEMG data was normalized using the PDM, as discussed above.

Hypothesis testing was used to find if a significant difference existed in all variables; pre and post MART. For the parametric data sets, a paired samples *t*-test was used and for the non-parametric data, a Wilcoxon signed rank test. Each data set was compared within its pretest and post-test values to assess the simulated effects of aging (caused by MART). Following this, the intraclass correlation coefficient (ICC) was calculated for the post-test MTC (right and left feet), per subject. ICC can be used to measure the reliability (test re-test) and repeatability of the data collected and would indicate the level of similarity between collected MTC values per subject (21). The $\alpha$ value was 0.05 and the confidence interval was 95%.

# RESULTS

## Minimum Toe Clearance

MTC was found to be non-parametric. This was confirmed by previously conducted studies, which showed that MTC was positively skewed and leptokurtic (4, 5). The overall median MTC with the IQR is shown in **Table 1**. During normal walking (for adults) the median MTC was between 10 and 20 mm (5). On the other hand, for the elderly, the median MTC was below 12.9 mm approximately (22). This study obtained a pretest median MTC of 24.10 mm and a post-test MTC of 18.95 mm.

A Wilcoxon signed rank test was applied to give a significance of $P < \alpha$. Hence, a strong significant reduction in MTC after muscle restriction exists. This trend can also be seen by the decrease in the normalized median MTC from 0.014 before restriction to 0.011 after restriction.

## Joint Angles

As shown in **Table 1**, the joint angles for the knee and ankle were non-parametric, except ankle dorsiflexion/plantar flexion. Prior to muscle restriction, the overall trend at time MTC, placed the knee in flexion with a median angle of −47.56 degrees, and in adduction with a median angle of 4.79 degrees. After MART,

**TABLE 1 |** Results of kinematic parameters.

| Research variable | Normality test | Median/Mean | Pretest | Post test |
|---|---|---|---|---|
| | | **Toe clearance (mm)** | | |
| MTC (mm) | Non-parametric | Median (IQR) | 24.10 (7.70) | 18.95 (4.65) |
| MTC (normalized) | Non-parametric | Median (IQR) | 0.014 (0.005) | 0.011 (0.003) |
| | | **Joint angles at MTC (deg)** | | |
| Knee flexion/extension | Non-parametric | Median (IQR) | −47.56 (6.58) | −41.32 (8.44) |
| Knee abduction/adduction | Non-parametric | Median (IQR) | 4.79 (6.21) | −2.72 (10.41) |
| Ankle flexion/extension | Parametric | Mean (SD) | 8.42 ± 4.37 | 6.81 ± 3.33 |
| Ankle inversion/eversion | Non-parametric | Median (IQR) | 13.58 (8.47) | 17.04 (8.72) |
| Ankle abduction/adduction | Non-parametric | Median (IQR) | −3.61 (3.29) | −2.95 (3.41) |

**TABLE 2 |** Muscle activation (SEMG) results.

| Research variable | Normality test | Median/mean | Normalized muscle activation | |
|---|---|---|---|---|
| | | | Pretest | Post test |
| *Tibialis Anterior* (Swing Phase Area) | Parametric | Mean (SD) | 1617.54 ± 415.19 | 1726.55 ± 327.54 |
| *Tibialis Anterior* (At MTC) | Parametric | Mean (SD) | 3.64 ± 1.21 | 4.15 ± 1.55 |
| *Gastrocnemius Lateralis* (Swing Phase Area) | Non-parametric | Median (IQR) | 465.66 (302.25) | 490.95 (194.21) |
| *Gastrocnemius Lateralis* (At MTC) | Non-parametric | Median (IQR) | 0.93 (0.72) | 1.00 (0.63) |
| *Gastrocnemius Medialis* (Swing Phase Area) | Non-parametric | Median (IQR) | 403.87 (447.78) | 419.92 (530.36) |
| *Gastrocnemius Medialis* (At MTC) | Non-parametric | Median (IQR) | 0.72 (1.02) | 0.97 (0.96) |

there was a strong significant change in both knee flexion and adduction with $P < \alpha$. The overall post-test trend saw the knee flexion decrease (become less negative) while the knee went into abduction.

The ankle was initially in dorsiflexion at time MTC, with a mean of 8.42 degrees. It was also in inversion with a median of 13.58 degrees and in abduction with a median of −3.61 degrees; pretest. The change in the angles from pretest to post-test is expressed by the significance, as such:

- Ankle dorsiflexion: $P = 0.007$, which is $< \alpha$. Hence, a significant reduction in dorsiflexion was observed post-test.
- Ankle Inversion: $P = 0.004$, which is $< \alpha$. Hence, a significant increase in inversion was observed post-test.
- Ankle abduction: $P = 0.153$, which is $> \alpha$. Hence, no significant change in abduction was observed.

## Muscle Activation (Surface Electromyography)

**Table 2** shows the mean and median SEMG readings for each subject muscle. For the *Tibialis Anterior*, there was a significant increase in muscle activation, for the swing phase area ($P = 0.029$) and at time MTC ($P = 0.027$). This is also reflected by the overall increase in the mean values for the *Tibialis Anterior*.

The *Gastrocnemius Lateralis* followed a similar trend to the *Tibialis Anterior*. There was a significant increase in muscle activation due to MART. For the swing phase area, the significance was $P = 0.002$ and for the value at time MTC the significance was $P = 0.031$. Both these values are $< \alpha$ and show a reasonable significance strength.

For the *Gastrocnemius Medialis*, there was a significant increase in swing phase area muscle activation ($P = 0.005$). However, for the muscle activation at time MTC, there was no significant change between the pretest and post-test data ($P = 0.071$). It should be noted, that on overall, the *Tibialis Anterior* had the highest muscle activation, both for the swing phase area and at time MTC. While the posterior muscles had a lower overall activation. The two subdivisions of the *Gastrocnemius* had similar muscle activation readings, as shown by their medians in **Table 2**.

# DISCUSSION

The aim of this study was to investigate how the anterior and posterior muscles in the shank affect the level of MTC in elderly individuals. It was hypothesized, that the ankle is responsible for supporting the foot, during the swing phase. Therefore, the muscle responsible for ankle dorsiflexion—the *Tibialis Anterior*—should be the primary muscle that influences the level of MTC.

During SEMG signal analysis, the PDM gave a more accurate and reliable reading for the maximum activation of each muscle. When performing the MVC subjects may not contract their muscles with as much force as possible, hence there is no way to truly identify the maximum activation. Therefore, by comparing all muscle activation readings, across all trials, a better representation of maximum muscle activation can be found—justifying the use of PDM.

MART was used to simulate the gait characteristics of the elderly in young adults. From the results obtained, with MART, a significant decrease in MTC, knee flexion and ankle dorsiflexion

were observed. The median MTC decreased to 18.95 mm yet, the literature showed that for elderly individuals MTC should be below 12.9 mm (22). The difference in these values, were due to an offset present in the TC readings—between the tip of the toe and the Hallux mo-cap marker.

The results are in-line with the expected trends from the study on MART (5). The significant decrease in MTC, along with significant reductions in knee flexion and ankle dorsiflexion mirror the main elderly gait characteristics; reproduced in the young adult participants. In addition, a section of the hypothesis can be confirmed as the ankle's dorsiflexion has reduced. This means, the ankle tends to bend down more, showing that it contributes to the reduction in TC.

With regards to MART—the ICC for post-test MTC from subjects 1–5 were 0.70, 0.75, 0.83, 0.80, and 0.83, respectively. This shows a high similarity between MTC values per subject. The strong ICC (close to 1) shows high reliability and reproducibility of the data collected. Hence, the results obtained were not due to distortion caused by the placement of the MART bands. This also shows that the subjects walked in the same way each time, with MART, further justifying the repeatability of this study.

The mean and median SEMG readings showed that the *Tibialis Anterior* had a stronger muscle activation compared to the *Gastrocnemius*. From this, it can be deduced, that the *Tibialis Anterior* is the prominent muscle active, both, throughout the swing phase and at the time MTC occurs, which follows the hypothesis. The relevance of this, is shown by the fact, that the *Tibialis Anterior* works throughout the swing phase to support the ankle (in dorsiflexion) and prevent it from dropping down. This is what maintains the level of TC; hence, it can be concluded that the *Tibialis Anterior* is the primary shank muscle that influences MTC.

On overall, for the swing phase area, the *Tibialis Anterior* and *Gastrocnemius* saw a significant increase in muscle activation. A similar trend was found for the muscle activation at the time of MTC. This was contrary to the hypothesis—which predicted that the overall muscle activation would decrease, with MART. This was due to the simulated aging, where elderly individuals would have weaker and stiffer muscles (lower muscle activation) and thus be unable to maintain a high level of MTC. However, for all three subject muscles, the activation was significantly greater with MART (considering swing phase area), yet MTC and the other relevant kinematic parameters saw a significant decrease.

As the subjects were young adults, with healthy and strong muscles (compared to an elderly individual), the three subject muscles would have worked harder to maintain the achieved level of TC. In addition, the results show that the muscles may have operated to counteract and overcome the external restriction placed on them, hence the higher activation readings. Regardless, as the muscles were active, and showed a significant change with MART, it can be concluded that the shank muscles do indeed play a vital role in influencing the MTC. Thus, for an elderly individual, weaker shank muscles would result in a greater ankle drop, during the swing phase and thereby, a lower TC.

The inversion of the ankle increased, along with the knee moving into abduction (pointing away from the midline of the body). This shows a more restricted walking pattern, where the subjects are tensing their ankle muscles with each step. Such characteristics would be expected due to the muscles being restricted and would further support the increase in muscle activity after restriction.

Furthermore, the muscle activation at the time MTC, also shows a significant increase after restriction, for the *Tibialis Anterior* and *Gastrocnemius Lateralis*. The *Gastrocnemius Medialis*, however, shows no significant change after restriction. The significance of the *Gastrocnemius Lateralis* ($P = 0.031$) is a weak significance, however the *Tibialis Anterior* has a comparatively higher significance of $P = 0.027$. This supports the conclusion that the *Tibialis Anterior* is the more dominant muscle in influencing TC.

A limitation of this study was a small sample size—hence, future work would include using a larger sample size to more strongly generalize the results, to a larger population. In addition, power analysis statistical tests would also be conducted in the future, to determine the required sample size and further justify the results obtained. Furthermore, the FSR-402 sensors used may have produced minute variations in the data due to varying deflections of the thigh muscles. In the future, an improved taping method should be investigated for enhanced symmetrical restriction when performing MART.

## CONCLUSION

The effects of aging on the anterior and posterior muscles in the shank, along with their impact on the level of MTC was investigated. Aging gait was simulated in young adults using MART. The results showed a significant decrease in the MTC, knee flexion and ankle dorsiflexion, which is expected due to aging. In addition, the knee adduction became abduction after restriction, while the ankle's inversion increased. No significant change in the ankle's abduction was observed.

The *Tibialis Anterior* was found to be the dominant muscle in the shank compared to the *Gastrocnemius* as it had a higher overall muscle activation. After restriction, the muscle activity increased (contrary to the hypothesis). This may be due to the subject's counteracting the external restriction–the muscles working harder to be able to at-most achieve the given MTC.

In conclusion, the anterior shank muscles can greatly influence MTC by controlling how far the ankle can drop during the swing phase. Weaker shank muscles, as seen in the elderly, would lead to a lower MTC and thus, a greater fall risk. The findings of this study can be used when designing devices and methods to monitor and improve TC in the elderly. It can be recommended that health care professionals, emphasize on strengthening the shank muscles, focusing on the *Tibialis Anterior*—to improve MTC and reduce fall risk.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Monash University Human Research Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

AG conceived the study and the extent of its scope. CP performed the preliminary research and conducted the study. The methodology was finalized by CP, under the supervision of AG. The results for the study were obtained by CP, while the interpretation of the results and their respective conclusions were formulated by both CP and AG. The manuscript was written by CP under the supervision of AG. All authors read and approved the final manuscript.

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# A Qualitative Study on Formal and Informal Carers' Perceptions of Dementia Care Provision and Management in Malaysia

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**Background:** The number of people living with dementia worldwide is increasing, particularly in low- and middle-income countries (LMICs) where little is known about existing post-diagnostic care and support. This study aimed to better understand healthcare provision for people living with dementia in Malaysia, and to identify priorities for providing timely, quality, and accessible care and support to all.

**Methods:** This is a qualitative interview study on care providers and facilitators (health and community care professionals, paid carers, traditional medicine practitioners, faith healers, community leaders, non-governmental organisations). A topic guide, piloted in Malaysia and peer reviewed by all LMIC partners, elicited the understanding of dementia and dementia care and barriers and facilitators to care for people living with dementia and carers, and perceptions of key priorities for developing efficient, feasible, and sustainable dementia care pathways. Verbatim transcription of audio-recorded interviews was followed by iterative, thematic data analysis.

**Results:** Twenty interviews were conducted (11 healthcare professionals, 4 traditional medicine practitioners, and 5 social support providers). The findings indicate that dementia care and support services exist in Malaysia, but that they are not fully utilised because of variations in infrastructure and facilities across the country. Despite a locally recognised pathway of care being available in an urban area, people with dementia still present to the healthcare system with advanced disease. The interviewees linked this to a public perception that symptoms of dementia, in particular, are normal sequelae of ageing. Earlier detection of dementia is commonly opportunistic when patients present to GPs, government clinic staff, and general physicians with other ailments. Dementia may only be identified by practitioners who have some specialist interest or expertise in it. Workforce factors that hindered early identification and management of dementia included lack of specialists, overburdened clinics, and limited knowledge of dementia and training in guideline use. Post-diagnostic social care was reported to be largely the domain of families, but additional community-based support was reported to be available in some areas. Raising awareness for both the public and medical professionals,

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prevention, and more support from the government are seen as key priorities to improve dementia management.

**Conclusions:** This qualitative study provides novel insight into the availability, delivery, and use of post-diagnostic care and support in Malaysia from the perspective of care providers. The respondents in this study perceived that while there was a provision for dementia care in the hospital and community settings, the different care sectors are largely unaware of the services each provides. Future work should explore how care provision across different service sectors and providers can be supported to better facilitate patient access and referral between primary, secondary, and social care. The importance of supporting families to understand dementia and its progression, and strategies to help them care for relatives was emphasised. There is also a need for broad workforce training and development, at both the postgraduate and undergraduate levels, as well as improved general awareness in the community to encourage earlier help-seeking for symptoms of dementia. This will enable the use of preventive strategies and access to specialist services to optimise care and quality of life for people living with dementia in Malaysia.

**Keywords: dementia, Alzheimer's disease, memory loss, care provision, care management, professional awareness, low and middle income country**

## INTRODUCTION

Dementia can be defined as a progressive syndrome characterised in a conscious patient by deterioration in memory, thinking, calculation, orientation, comprehension, learning, language, behaviour, judgement, motor tasks, and emotions that has an impact on the ability of an individual to perform everyday activities (1). Around 50 million people worldwide suffer from dementia, with Alzheimer's disease being responsible for 60–70% of the cases and with the remainder comprising vascular dementia, dementia with Lewy bodies, and fronto-temporal dementia diseases (2). The impact of dementia affects not only people who directly suffer from it but also carers, families, and society in general (2). Global estimates suggest 82 million people will be living with dementia in 2030 and 152 million in 2050 with much of this increase in prevalence attributable to ageing populations in low- and middle-income countries (LMICs) (3, 4). Goals for dementia care include early diagnosis to promote optimal management, physical health, cognition, activity, and well-being; detection of accompanying illness; management of behaviour and psychological issues; and provision of long-term support and resource for carers (5).

Malaysia is a multicultural society and a federation of states located in Southeast Asia with a population of over 32.7 million, comprising 7% aged 65 and comprises a federation of states (6). Current estimates suggest that 8.5% of Malaysians aged over 60 years have dementia, yielding an estimated dementia population of 260,345 (7). Studies have shown, however, particularly in Asian countries, that dementia presentation is late because of stigma and acceptance of early symptoms by family members and patients alike as natural sequelae of normal ageing (8).

The Malaysian health care system consists of the public sector, tax-funded and government-run universal services, and a private sector that is funded through private health insurance and out-of-pocket payments from consumers (9). Comprehensive healthcare services range from preventive and primary healthcare to tertiary hospital care (10). In addition, traditional medicines from Chinese and Malay practitioners and products are utilised by large sections of the population. There are around 1,061 Ministry of Health (MOH) and 7,146 private primary care health clinics operating in Malaysia (11). Larger MOH facilities are run by family medicine specialists supported by medical officers, whereas community clinics are staffed by nurses or medical assistants who may have no specialist dementia training. In more remote areas, MOH mobile clinics deliver care (9). Private primary care clinics are largely operated by single-handed or small partnership generalist or specialist doctors, and without the complement of allied health care personnel. Estimates suggest that the public sector provides most (82%) of inpatient care in Malaysia, while the private sector provides most (62%) of the ambulatory care (12–14). While primary care may act as a gate keeper for patients in the MOH system to specialist services, there is no requirement to take this route for private referrals, and patients can self-refer to specialist services or hospitals.

Policies in health and social care for older people in Malaysia currently comprise the National Policy for Older Persons 2011, the National Health Policy for Older Persons 2008, and The Eleventh Malaysia Plan 2016–2020 (15), all of which emphasise active ageing, enablement, and empowerment. These policies do not address any specific age-related conditions, and no individual action plan for dementia currently exists. While healthcare is

**Abbreviations:** PWD, people living with dementia; WHO, World Health Organization; MOH, Ministry of Health; NIHR, National Institute for Health Research; DePEC, Dementia Prevention and Enhanced Care; NGO, Non Governmental Organisation.

largely taxation-funded and free for older adults within public systems, social care funding remains highly limited. Institutional care is primarily private- or charitable-sector funded, with limited government-funded places in existence (16). A recent study reports there to be approximately 12 public, 454 non-government organizations (NGO) and 1,019 private nursing homes in Malaysia (17). NGOs also provide some day care services for particular groups, but day to day care for older people /people living with dementia (pwd) is primarily provided by female family members at home, with or without assistance from maids or paid caregivers (18, 19).

Little is known about where services specific to dementia sit within the wider Malaysian health and social care systems or how these services are delivered and accessed. The aim of this study was to illuminate this gap in understanding by exploring current dementia care provisions in Malaysia from the perspective of key stakeholders who either provide or facilitate access to public or private dementia care and support services.

# MATERIALS AND METHODS

## Study Design

This explorative qualitative study is part of a broader program of research aiming to improve diagnosis and post-diagnostic care for pwd in LMICs (UK National Institute for Health Research Global Health Dementia Prevention and Enhanced Care [DePEC]. A qualitative approach was used, as this enables a richer understanding of views and experiences of the participants on the topic of interest (20). We used the Standards for Reporting Qualitative Research (SRQR) guidelines in writing this manuscript (21) (**Supplementary Material**). To ensure relevance and cultural acceptability, a purposively sampled panel of eight people with personal or professional experience in dementia care in Malaysia was invited to scrutinise the study design, topic guide, and recruitment strategy (22). The proposed approach to data collection (one-to-one interviews and/or focus groups), such as the study topic guide, was also piloted on a convenience sample of 10 hospital specialists and primary care physicians based in Johor, Malaysia, each with experience in providing dementia services. Following a pilot study using focus groups vs. one-to-one interviews, the interview approach was found to yield richer individual responses with respondents giving more detailed explanations and answers to questions. In focus groups, interruptions from other members of the group made it sometimes difficult for respondents to speak freely and explain their answers to questions from personal experiences. Following minor amendments to language and question format, a final semi-structured topic guide explored three key areas: a) perspectives and practice of participants on dementia care within the wider healthcare system for older adults within Malaysia, b) factors believed to influence the care received by pwd, and c) key priorities for improving the care of pwd in Malaysia (**Table 1**; Interview topic guide).

## Study Population and Sampling Procedure

Eligible participants were (a) providers or facilitators of services offering care and support to pwd or older adults in general, and (b) policy makers and commissioners involved in decision-making regarding healthcare policies and services for older people. We sampled from private, public, and complementary care providers and facilitators based in Kuala Lumpur and Selangor, Malaysia, and included paid or un-paid health and community care professionals, traditional medicine practitioners, faith healers, community leaders, and NGO leads. A purposive sampling frame (22) was developed in collaboration with Malaysia research colleagues to capture a broad range of perspectives from key providers of care to older patients in the Selangor district, and in particular those who were most likely to be involved in diagnosing dementia and delivering dementia care. The sampling frame differentiated the participants by role (e.g., doctor, nurse, allied health professional, community leader), clinical specialty, or area of expertise (e.g., neurology, geriatrics, generalist), sector (e.g., private, public, not-for-profit), organisation type (e.g., social care, primary care, secondary care), and location (e.g., rural, urban). No financial incentive to participate was offered. Given the range of care providers sampled, not all the participants had the same level or kind of knowledge or experience on all issues explored by the topic guide. Therefore, the sampling in this study was purposive and iterative, using "snowballing" to identify additional participants where data was felt to be incomplete (23). Potential participants were approached by email or telephone, provided with a summary of the research, and given the opportunity to ask further questions. All selected participants who were contacted agreed to participate.

## Data Collection

All interviews were conducted by RR, an experienced researcher based in Malaysia, between April 23, 2019 and October 16, 2019. Specialist training and on-going mentorship in qualitative interviewing, qualitative data management, and research governance were provided to RR by EM and SM. Informed consent was taken before an interview began, which included an agreement for the interview to be audio-recorded. The participants were assured of confidentiality. The interviewer (RR) presented herself as a researcher, and the interviewees were informed that their responses would be fully anonymised and that they could withdraw from the interview at any time. The interviews lasted 90 min on average and took place in a private room in the workplace of the participant and during or outside normal working hours. Field notes to aid analysis were made by RR both during and at the end of each interview. The interviews were conducted in English or Bahasa Malaysia, then later transcribed verbatim and fully anonymised. Bahasa Malaysia transcripts were then translated into English, with back translations undertaken on 20% transcripts to ensure accuracy in translation (24). The interviews continued until data saturation was reached, that is, when no new themes were emerging (20, 25).

## Data Analysis

Fully anonymised interview transcripts were analysed iteratively by EM and SM using a thematic analysis approach (25), supported by the use of NVIVO (26). Emergent themes were discussed in depth with RR to ensure the accuracy of interpretation and to guide avenues of further exploration in subsequent interviews. Discussions led to the development

**TABLE 1 |** Interview topic guide.

| | |
|---|---|
| **Section 1: About you** | |
| 1.1 Before we start, can I just ask a few questions about yourself? | Participant background: professional role and role in providing or facilitating dementia care or services |
| 1.2 How would you describe "dementia"? | Participant understanding and description of dementia; where knowledge of dementia was gained |
| **Section 2: About thehelp seeking behaviours of families/older people who are experiencing symptoms of dementia or who have a diagnosis of dementia.** | |
| 2.1 What do patients/families do first? Why? | Health-related help seeking behaviours in general and to older persons' health and symptoms of dementia |
| 2.2 What advice or intervention are people given? | Understanding of explanations offered to older people and families of forgetfulness or behavioural changes. |
| *2.3When do patients/families seek medical advice or care and what prompts them to do this?* | Understanding of timescale to seeking medical help and what delays presentation (e.g. cultural factors) |
| 2.4 Are there any other factors or reasons why patients present late/ with advanced dementia? | Understanding of other factors (location (rural/urban), convenience, knowledge of services, family finances) |
| 2.5 How can we get people who are experiencing symptoms of dementia into the healthcare system sooner? | What would make a difference; who would be the key stakeholders who could influence change in patient and family behaviours |
| Section 3: About dementia care in [country]<br>3.1 Can you tell me what healthcare provision is available in [country] for older people who are experiencing symptoms of dementia or who have a diagnosis of dementia? | Knowledge of a dementia care pathway and availability of dementia facilities (e.g. memory clinics); experience and understanding of how services are accessed. |
| 3.2 Once diagnosed, what is available in terms of treatment? | Knowledge and understanding of pharmacological and non-pharmacological treatment and interventions. |
| 3.3 What is available in terms of social support for people living with dementia and their families? | Understanding of who looks after people with dementia in the community; awareness of social support, training, information resources for families |
| **Section 4: Factors which influence the care received by people diagnosed with dementia** | |
| 4.1 What things do you think affect the care received by people living with dementia? | Perceived barriers and facilitators related to the pwd; carers; healthcare system; healthcare professionals |
| 4.2 How might care be improved—what needs to change/be put in place | Perceived gaps in current dementia care; aspired 'ideal' scenarios |
| 4.3 What are the 3 top priority areas to improve the quality of dementia care in your country? | What resources are needed to make change happen; How might these changes being implemented |
| **Section 5: Workforce capacity, support, training and development** | |
| 5.1 What, if any, dementia specific guidelines are available in your country? | Perceptions/experience of guideline use in practice; relevant to practice; accessibility of guidance |
| 5.2 What training is available to health and social care professionals about older people/ dementia? | Where formal training happens (e.g., core curricula for medical students, nurses, other professionals) |
| 5.3 What about training and information about dementia for families/informal carers? | Understanding of accessibility and uptake |
| **Section 6: Closing reflections, questions, and close of interview** | |
| ***6.1 Anything else that you'd like to tell or ask me?*** | Participant opportunity to add thoughts/ask questions |

of a coding frame, which was then applied independently to a common subset of transcripts by EM, SM, and RR to further check the accuracy of coding and data interpretation and capture of cultural nuances. Differences were reconciled through group discussion, and the coding frame was refined where necessary. EM then coded all the remaining transcripts, adding or revising codes where new themes emerged (20, 25). Emergent findings and the resonance of key themes were continuously checked during group analysis sessions with the wider study team (EM, SM, RR, MG, MP, and LR) to ensure the trustworthiness of interpretation. Final themes and subthemes were organised in relation to the three key areas of interest of the study.

## Ethical Considerations

Prior to data collection, the study was approved by the University of Malaya Medical Centre Medical Ethics Committee (MECID: 201922-7093) in May 2019.

# RESULTS

## Participants

Twenty interviews were undertaken with 11 healthcare professionals (geriatricians, psychiatrists, generalists, general practitioners, nurses, and allied healthcare professionals, e.g., occupational therapists and physiotherapists); five providers of social support (NGO leads, senior citizen association

leads, community leaders); and four traditional practitioners (Ayurveda, acupuncture, faith healing) All the interviewees were from the same state, Selangor; and 10 of the clinicians were from the same urban-based, semi-government hospital, while one was from an urban private clinic. Most of the interviewees were based in urban areas, with only two classed as being suburban-based. Fourteen interviews were conducted in English and six in Bahasa Malay (**Table 2**; Purposive sampling frame and participant demographics).

## Interview Findings

Findings are presented under three descriptively summarised major themes, each followed by related sub-themes and supporting verbatim quotes. Major themes are knowledge and understanding of available services and management of dementia; factors believed to influence dementia care provision; and priorities for the future–towards improving dementia recognition and timely care.

### Knowledge and Understanding of Available Services and Management of Dementia

Accounts of the participants revealed a good general understanding of the existing national healthcare system and available healthcare infrastructure in Malaysia. In terms of dementia care, confident description of care provision and pathways into care was limited to the regional level, and detailed description of care processes to immediate personal or organisational context of the participants (e.g., their primary role, clinical discipline, working environment). Outside of this personal context, the participants, particularly those from health vs. social or community settings, tended to demonstrate less clarity of practices and services of each other in relation to dementia care.

#### *There Are Multiple Routes Into Specialist Care Services*

When exploring how people with symptoms of dementia access dementia care, we found that there are multiple possible routes into specialist medical services, some formal (e.g., in the public sector a referral is required from primary to specialist care), many informal (e.g., collaborative working arrangements between hospital specialists). It was generally accepted that the first point of contact with medical services for people with any kind of ailment, namely, symptoms of dementia, would be in the community-based primary care setting, particularly government health clinics (Klinik Kesihatan, KK) and private general practice.

> *I think a lot of times [the first point of contact] will be in the Klinik Kesihatan, family medicine. I think in general practice … because they don't like to wait … they would actually rather just pay a little bit more to see [their own local doctor] so I think … general practitioners, the private GP clinic and also Klinik Kesihatan people* (General Physician 1)
>
> *Probably the first people will be the doctors, the private practitioners … And then from that they go to the specialist, but in this country I think most of them will go to the public the general …, government hospital. The Klinik Kesihatan, now that is where … they seek treatment … that to me is the first line of contact* (NGO 1)

However, patients can present to any one of a number of services (**Figure 1**; Multiple patient routes into specialist care in Malaysia). For example, in addition to community-based primary care services, teaching hospitals also have their own primary care clinics where patients can "walk-in." These facilities are staffed by family medicine specialists, medical officers (MO), and trainees; and patients requiring further review are referred to a hospital-based specialist. Within teaching hospitals, referral to and between specialities can be more straightforward. Referral from primary care was reported to be more commonplace for KK and rare for private general practice. The participants further confirmed that while a formal primary care referral is typically required to see a specialist doctor in a Ministry of Health hospital, referrals to private specialists are not required. Patients can, therefore, bypass primary care and self-present to private hospital-based specialists.

> *Usually when they come to the walk-in they will see the MOs first. And … if the MO finds it difficult to manage they can refer to the specialist for continuation of care. Or they can co-manage the case* (Psychiatrist 1)
>
> *So, we can call any one of them [our geriatricians]… and explain the situation to them 'look I'm suspecting you know [this] patient … may be having some memory impairment … I would really like your further advice and assessment.' … they will be happy to say, "yes, do write us a referral letter and ask the patient to come to our clinic"* (General Physician 2)
>
> *So the pathway of referral in our clinic, either from another specialist or from a general practitioner... that's how it works, we need a doctor's referral letter. In the private sector, the family members can just bring the patient without referral letter* (Geriatrician 1)

#### *Detection of Dementia Is Opportunistic and Specialist Referral Options Inconsistent*

The general sense was that people with early signs of memory problems only occasionally present to a clinic for that reason. There is no specific screening for dementia in any out-patient setting, and dementia is more often picked up by chance during consultations with generalist doctors consulting with or assessing patients for something else. Clues to indicate possible dementia may present to a doctor during history taking, for example, or the patient or a relative may directly raise their own concerns.

> *It's not like specifically seeing me because of dementia. It's more like seeing me for something else* (General Physician 2)
>
> *Most of the time they don't present as dementia, they present as something else* (General Practitioner)

When symptoms of dementia are detected, the consensus view was that referral to specialists was the best option for assessment and care. However, inconsistency in the availability of services (e.g., memory clinics) and relevant clinical specialists (e.g., geriatrician, neurologist, psychiatrist) was reported. In Malaysia, specialists who have had specific dementia training will predominantly be geriatricians, but sometimes the dementia specialist may be a psychiatrist with geriatrics training. Though not exclusively, geriatricians tend to be attached to a memory

**TABLE 2 |** Purposive sampling frame and participant demographics.

| Participant Role | Sex | Ethnicity | Years qualified | Dementia training | Organisation type and status | Location | Interview language |
|---|---|---|---|---|---|---|---|
| Geriatrician 1 | F | Chinese | 11 | Y | Hospital Semi-government | Urban | English |
| Geriatrician 2 | F | Malay | 7 | Y | Hospital Semi-government | Urban | English |
| Psychiatrist | M | Indian | 6 | Y | Hospital Semi-government | Urban | English |
| General physician 1 | M | Chinese | 8 | N | Hospital Semi-government | Urban | English |
| General physician 2 | F | Chinese | 2 | N | Hospital Semi-government | Urban | English |
| Medical officer 1 | F | Chinese | 10 | N | Hospital Semi-government | Urban | English |
| General Practitioner 1 | M | Indian | 28 | N | Clinic Private | Urban | English |
| Nurse 1 | F | Malay | 10 | Y | Hospital Semi-government | Urban | Bahasa |
| Nurse 2 | F | Malay | 13 | Y | Hospital Semi-government | Urban | Bahasa |
| Occupational Therapist 1 | F | Malay | 13 | N | Hospital Semi-government | Urban | Bahasa |
| Physiotherapist | M | Malay | 12 | N | Hospital Semi-government | Urban | English |
| NGO 1 | M | Chinese | N/A | N | NGO Not-for-profit | Urban | English |
| Senior citizen association 1 | M | Chinese | N/A | N | Senior citizen association Not-for-profit | Urban | English |
| Senior citizen association 2 | M | Chinese | N/A | N | Senior citizen association Not-for-profit | Urban | English |
| Community leader 1 | F | Malay | N/A | N | Residential organisation Not-for-profit | Suburban | Bahasa |
| Community leader 2 | F | Chinese | N/A | N | Senior citizen association Not-for-profit | Urban | English |
| Traditional practitioner 1 | M | Indian | 31 | N | Clinic Private | Urban | English |
| Traditional practitioner 2 | M | Chinese | 48 | N | Clinic Private | Urban | English |
| Traditional practitioner 3 | M | Malay | 34 | N | Medical centre Private | Urban | Malay |
| Traditional practitioner 4 | F | Malay | N/A | N | Freelancer Private | Suburban | Malay |

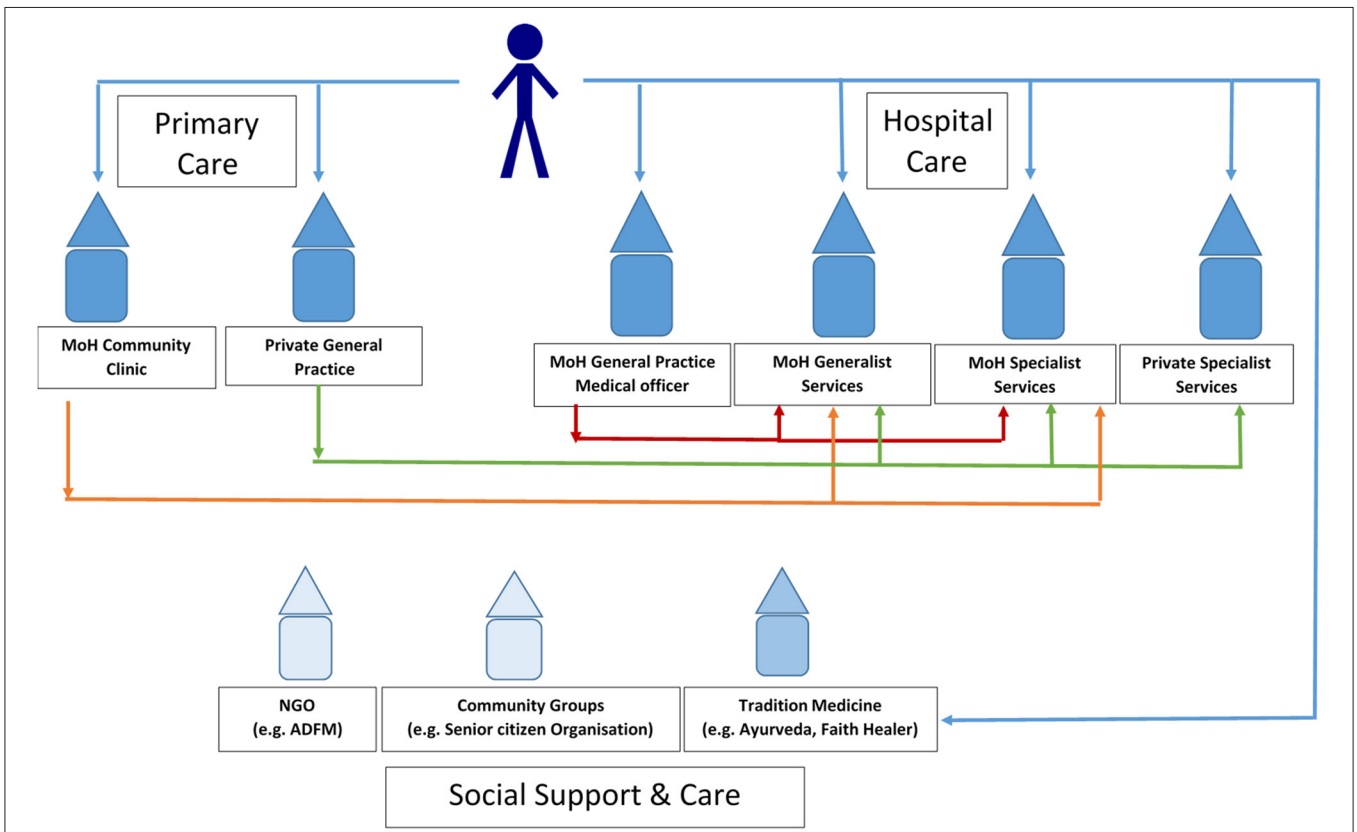


**FIGURE 1 |** Multiple patient routes to specialist care in Malaysia. The orange, green, and red arrows indicate several referral routes that can take a patient to specialist care. The blue arrows show the multiple routes that can take patients to specialist care and other support services.

clinic, but memory clinics are only available in some areas. In locations without a geriatrician, a referral may be to a psychiatrist or a neurologist where these hospital-based specialists are available. Together, these inconsistencies limit and confuse referral options, making it difficult for primary clinicians to know where or whom to refer a patient to.

> *But, in Malaysia there are only a few centers with specialists in dementia. They could be geriatricians, psychiatrists or neurologists. … the person would be very lucky to be able to see a specialist* (Geriatrician 1)
> *But they will meet the patient and then after that they don't know who to send the patient [to]. They may have picked up the problem but they don't know how, who or where to send the patient to* (General Physician 1)
> *And for a long time we … were referring them to a psychiatrist. But now that we are more aware of the existence of geriatric care within [Hospital 1] we refer to the geriatric department* (General Practitioner 1)

Following differential diagnosis in the hospital setting, assessment for dementia is made using mini-mental state exam (MMSE) (27) and Montreal Cognitive Assessment (MoCA) (28), and CT scan. Confirmation of a dementia diagnosis is given by a dementia specialist. Differentiation between dementia sub-types is not made, as the diagnosis is costly and treatment is usually the same. There is no universal process or register to record and/or share a diagnosis of dementia between specialities, locations, or sectors.

> *When [patients] do have symptoms of dementia usually we will investigate further. The usual stuff would be …their blood parameters - things like that or whether they warn in the CT scan. So after things have been worked up usually we will refer to a geriatrician because we have the service here* (MO 1).

### *Post-diagnostic Treatment Is Drug-Focussed With Few Non-pharmacological Options*

Like diagnosis, initiation and subsequent management of dementia using drug treatment is largely the domain of geriatricians and psychiatrists. Interviewees from other specialties and allied healthcare roles were aware of the use of drugs in post-diagnostic management of dementia but were less knowledgeable about the drugs used and how they worked. Two main groups of drugs are used, ACE inhibitors and NMDA receptor antagonists, to help with behaviour. However, the use of drugs is not universal amid considerations of potential benefits and harms to the patient. Drugs were not seen to be always effective in slowing disease progression, and their side effects gave cause for concern to those able to prescribe. Some interviewees expressed indifference about the value of drug therapy, given that they do not offer a cure. The high cost of drug therapies was also felt to (negatively) influence family preference for pharmacological treatment of dementia.

> *I do not have very much experience using those drugs, because usually we refer them to the geriatrician and it will be started by the geriatrician* (General Physician 1)
> *Because there is no medicine that can cure this … Okay you can delay [it] but even that also is not that very effective* (Community Leader 2)
> *And the medications that we offer they may not work for a certain percentage of patients and may cause … side effects. They're also very expensive* (Geriatrician 1)

Despite this, it was felt that treatment still tends to focus on medication, since hospitals often do not have the facilities to support non-pharmacological interventions. Furthermore, allied healthcare professionals (e.g., occupational therapists, physiotherapists) and nurses with dementia or elderly care training (e.g., geriatric nurses) tend to be attached to specific specialties. This further limits access to alternative, non-pharmacological therapies, such as those that focus on improving activities of daily living and safety assessment or cognitive training (e.g., reality reorientation therapy).

> *All of the geriatrics nurses in this ward have been trained to take care of patients with dementia. We would try to do some treatment like reality orientation, or therapy for instance* (Nurse 1)
> *Occupational therapy may give cognitive training exercises, and also cognitive compensatory strategies … also the occupational therapy can do a home safety assessment. … the physiotherapist can teach the family member some simple exercises, to keep the joint supple, reduce pain level, how to control the pain...* (Geriatrician 1)
> *That (non-pharmacological treatment) is difficult you see because this requires this requires a lot of teamwork. We don't have that team here. … [in] this hospital the focus is too much on, medication* (Psychiatrist)

### *Counselling and Education of Family Carers Are as Important as Medication*

Counselling and education of family carers on dementia and its progression were broadly considered to be of equal, if not greater, importance to medication management. Families shoulder the responsibility of providing care for pwd, and expectations of what this should or could entail to maintain quality of life for pwd were high. For example, as well as personal care, a supportive family was one that also actively maintained social interaction and tailored activities relative to the interests and personal characteristics of pwd. Nonetheless, it was acknowledged how difficult it can be for families to provide such a care environment without support. Educating caregivers, and in some instances the pwd themselves, about dementia and its progression and equipping them with behavioural strategies and coping skills to enable them to care for themselves as well as pwd, were considered by most interviewees as paramount.

> *Of course in dementia I think what is even more important than the pharmacological treatment is the non-pharmacological treatment* (Psychiatrist)
> *[Be]cause the role of medication in the dementia is … very minimal compared to the understanding of the disease and, preparing for the progression of the disease* (Geriatrician 2)

Providing counselling and education was also widely considered to be a key continuation of the role of dementia "experts"

(specialist doctors and geriatric nurses), and hospitals were considered responsible for providing training programs for caregivers. However, time and clinical workload constrain the provision of anything more than basic *ad hoc* counselling, if any at all, of pwd and family members during clinic appointments. Currently, the availability of structured training for family caregivers is understood to be very limited, and written information is more likely to be available in hospitals with established geriatric/psychiatric services. Resources specific to dementia can be available from private organisations, such as drug companies that sponsor educational material. It was suggested that families, particularly those living in urban settings, could access information on dementia from the Alzheimer's Disease Foundation Malaysia (ADFM) (29) or by doing a Google search.

> *We also, would also carry out training and carer education. That … is also very important. Let them know that this is a, progressive disease* (General Physician 1)
> *I can start … a small bit of counseling about how to look after the person with dementia, but it actually takes, quite a few sessions before the family members are familiar with how to do so* (Geriatrician 1)
> *We do offer education... Usually the geriatric clinic nurses or the geriatric nurses on the ward [have responsibility for this]... And also doctors, geriatricians.* (Medical Officer)
> *They [family carers] can learn the do's and don'ts when taking care of the patient. That is why the hospitals need to do a program like this* (Community Leader 1)
> *[It would] be much easier if the patient can get her diagnosis from the hospital first. The carers can [then] get advice directly on how to take care of their mother* (Traditional Healer 4)

### *Some Social and Community Support Is There, but It Is Not Visible*

Similar to education and counselling, the benefits to caregivers of community and social support were broadly recognised. Particular benefits included respite, but in particular the opportunity for caregiver interaction with other people in similar situations, which was felt to help carers to feel less isolated and more resilient through mutual support and shared learning. Alongside the understanding of dementia, such emotional support, rather than practical or monetary support, was felt by some to be all that is required by caregivers. Community-based interviewees suggested that social support is easily available from NGOs but conceded that there is a general lack of awareness of this support among both professionals and the public.

> *We really want the public to have this information, so that they can get the benefits out of it, especially to those who have a parent who is already senile, so that they would know what to do* (Traditional Healer 3)
> *NGO organizations are there and they all well equipped to [provide support]. The thing is that, [family carers] have to take them there. And family members are not taking [there] … it is because of the time … but the issue with all this system is that, people do not know that they exist* (Traditional Healer 1)
> *So there are organized activities but … not many people kind of understand their role in this health and well-being of senior people. Which, there is a great need* (Community Leader 2)

Many interviewees did indeed demonstrate a lack of clarity around what was actually available in terms of social support for pwd and their caregivers. There was awareness of government support for older people, but this was understood to have a more general elderly care focus rather than focus on dementia. Similarly, more general social support specifically for dementia was understood to be minimal, and it was felt that there would likely be geographical variation reliant on having a specialist interested in dementia care in the area. It was suggested that social workers may be able to offer some support services, and, although considered a rare option, some day care centre and residential care can be available from privately managed facilities at a cost. One specialist suggested that referrals can be made to social work for help around funds and carer support, and to ADFM for further information and social support, but whether or not this is common practice is unclear. Lack of awareness and clarity of healthcare professionals about what community-based support is available extended to them not knowing where to look for information about possible services and who provides them.

> *Specifically for dementia support I guess it is, still is very very very minimal. Even … support for older adults are, not much. I could not, I couldn't really pinpoint which one is specifically for dementia patient with dementia support* (Geriatrician 2)
> *And there are probably support groups but again we don't know where and who's doing it. Yeah. So it's every patient is left to his independent family* (General Practitioner)

## Factors Believed to Influence Dementia Care Provision

Generally, dementia is presented as having a low profile, with awareness lacking in both public and professional healthcare arenas. While some organised infrastructure and professional expertise exists, and was seen to be improving in some places, there remain significant gaps in workforce capacity and, in particular, workforce capability. Formal training in dementia is confined to doctors and nurses choosing to specialise in geriatrics. National guidelines for dementia care are not routinely used in practice; rather, doctors rely on their own expertise. Families shoulder the responsibility to provide and maintain quality post-diagnostic care to relatives living with dementia, and in the context of limited social support. Despite the acknowledgment of significant personal and financial costs this presents, societal expectation of family-based care remains strong.

### *Public and Professional Understanding and Awareness of Dementia Are Limited*

A lack of public knowledge and awareness of dementia was felt by many interviewees to be a key factor that influences both timely help seeking behaviours and the subsequent care that pwd receive. Late presentation, in particular, was highlighted as an issue and was felt to be the result of people not recognising that

there is a problem until symptoms become severe. Amid a public perception that older people become senile or lose their memory as a normal part of ageing, families typically seek help only when behaviour becomes too difficult to manage, or their relative has become aggressive. Late presentation of dementia greatly reduces treatment options and the opportunity for early intervention to slow down disease progression. It was also suggested that treatment and follow-up for dementia may not be continued if the family does not understand dementia is a disease. Generally, the interviewees did not express a strong sense of social stigma or cultural taboo attached to the label of dementia itself, but one specialist felt that shame associated with symptoms of dementia could be a factor contributing to delayed help-seeking.

> *Lack of awareness. People are aware of the physical health. But they are not very aware of the … dementia or even mental health, you know?* (Community Leader 2)
> *You see, when we talk about dementia and Alzheimer's, how many are actually aware about these?* (Nurse 2)
> *Sometimes we can see that the carers are not well exposed about dementia* (Occupational Therapist)
> *When the person starts to get agitated, like I said when the BPSD is severe, that is when they [families] would seek help* (Nurse 1)
> *They [families] wrongly perceive it as a normal part of aging. However they do seek medical attention when the dementia becomes advanced, or moderate, during moderate dementia the person may start having behavioral problems such as aggression* (Geriatrician 1)

Awareness of dementia among non-specialist healthcare professionals, such as primary care doctors, was also reported to be lacking, reducing the potential for early detection of dementia. It was suggested that this also lengthens the time to diagnosis as preliminary investigations, currently undertaken once a patient reaches a geriatric clinic, could be carried out in advance. Lack of dementia awareness in nurses was felt to cause complications with hospital stays, a poor understanding of how dementia impacts the person, and the care needs of pwd.

> *I'm not so familiar with the err dementia patient* (Traditional Healer 2)
> *Sometimes we can't be very sure that the person is truly senile. We understand that limitation. We don't know if that [is]actually a different disease, because we didn't do any research about that. That is when we need to ask them to go to the hospital. The hospital staff will look after them. They maybe do some scans, investigate the patient's blood and they will check everything. The doctors will help them* (Traditional Healer 4)
> *I think again creating awareness. In public and also awareness among healthcare professionals. It's very important* (Medical Officer)
> *But I think on the whole there is, generally I'd say, moderate awareness concerning this illness* (Psychiatrist)
> *So awareness is very important even among healthcare professionals. Not just awareness of the condition, they need to know where to send the patient to or how to investigate. So they need some guidance as to what's available to them locally in terms of specialist care. And what preliminary investigations they need to do* (Geriatrician 1)

### *Infrastructure and Workforce Capacity for Dementia Care Remains Insufficient*

While the provision of dementia services in Malaysia was seen to be improving, it was felt that there still are not enough geriatricians or geriatric services. Most existing geriatricians work in major hospitals in urban areas, but not all hospitals in major cities will have a geriatrician or related specialists. In areas without a geriatrician, getting an appointment to see a visiting geriatrician can take months if the clinic covers a large geographical area. Given the broad scope of geriatrics, doctors in services without a dedicated memory clinic can struggle with excessive workload and overloaded clinics. As in other specialisations where dementia does not take precedence (e.g., neurology and psychiatry), busy clinics tend to be problem-focussed and time-efficient. A patient with dementia can take time to assess, which can be difficult to justify in a busy clinic. Dementia can, therefore, be missed or ignored.

> *If we don't have this memory clinic, doctors cannot make a referral to a proper channel. But geriatric clinic is good too … if the hospital … has geriatric clinic services, they will refer this kind of case to the geriatric clinic first. But you see, the geriatrics medicine already covers too many things – their scope is broad. So if lets say we don't have any specific clinic for memory problems, there will be an excessive load of patients and it will be very difficult for doctors to handle the workload* (OT 1)
> *To be honest in the very busy clinic. We tend to unfortunately focus only on the primary [condition]. Unless the patient comes in with that actual complaint of memory problems, those symptoms might actually be brushed away* (General Physician 2)

As well as workforce capacity, workforce capability was consistently highlighted as a key factor influencing dementia care. While geriatricians receive good, comprehensive training in the care of older people, such training for other doctors is limited and is often offered as an optional rotation. Subsequently, generalist clinicians (GPs and general physicians) often lack knowledge around diagnosing and treating dementia, despite being involved in caring for pwd. Many students will now get a geriatric rotation, but only basic level dementia training is included as part of the core curriculum for medical studies. Dementia training is also limited in the basic nursing curriculum where gerontology is combined with mental health. More in-depth dementia learning for nurses only occurs when advancing to post basic study.

> *[undergraduate training] is very basic. They probably would just learn what dementia is, what are the basic treatments available … so there are several lectures maybe four or five hours' worth of exposure to the topic of dementia in undergraduate days* (Geriatrician 1)
> *It [dementia] was just included briefly and slightly. We don't really get to learn about dementia, in term of its care and treatment. We don't really learn those things* (Nurse 2)

Most of the healthcare professionals interviewed had gained knowledge of dementia through their direct experience of working with pwd and from working alongside senior and

more experienced colleagues. Uncertainty around the existence of dementia guidelines was evident, and it was suggested that they are not used often. Clinicians, instead, relied on their own experience on dementia or they referred to colleagues with more expertise. Though existing guidelines were felt to be relevant to practice, they were felt to be outdated, aimed specifically at doctors without mention of other multidisciplinary professionals and focus on pharmacological interventions. A further major barrier for dementia capacity building and development is limited budgets, which restrict manpower and resources for delivering care and introducing services.

> *But it's more like looking after the elderly patients [where] I gain my knowledge from* (General Physician 2)
> *I think there's a guideline for dementia treatment but not very sure. I don't think its been updated yet … I think, guidelines may be useful as a reference but we don't read it like "oh, we got this guideline". We see the patients [and] we do by experience like "oh, my boss used to do this, do that for dementia. I also do this, do that"* (General Physician 1)

### *Changing Family Circumstances Challenge Traditional Home-Based Care*

There is a strong cross-cultural expectation in Malaysia that families take responsibility for the care and well-being of older relatives. The support provided by the family was considered by all the interviewees to be a major factor affecting the care of pwd. However, societal changes to the traditional family structure means that children often now move away to work and do not remain living in close proximity to their parents. Symptoms of dementia may go undetected until a very late stage because of reduced contact. However, living near to or with older relatives does not guarantee family capacity or willingness to provide care for a relative with dementia. Family finances play a key role, and family members may still have to, or wish to, work. Those with more financial resources were considered able to hire a maid to care for pwd; but for others, the need to upkeep the household income may mean leaving pwd alone in the family home. Taking time off work to take relatives to clinic appointments can be costly and inconvenient. For those living in rural areas, there may be a considerable distance to travel and reliance on public transport (i.e., buses and ferries), which can make journeys difficult. These challenges can be a deterrent to attending follow-up appointments.

> *Usually in Asian culture society when you retire, or you [are a] pensioner, your family look after you. Your children and grandchildren stay together. But that sometimes is not happening now* (Senior Citizen Association 2)
> *One more thing is that, some patients are staying separately from their families. When this happens, nobody will notice the problem when it first starts* (Occupational Therapist)
> *But the children are still obliged to take care of their parents with love* (Traditional Healer 3)

In contrast, affluent families tend to live in urban areas with easy access to transport and closer proximity to services. While services provided by government clinics and hospitals are free or greatly subsidised, it was further suggested that those with less money may be reluctant or unable to pay for medication, equipment, or private care. Despite significant difficulties faced by families looking after a relative with dementia being widely acknowledged, social support for dementia was seen to be limited and mostly provided by NGOs. ADFM, for example, was believed to offer free advice, some day care, and training in dementia care for families, healthcare professionals, and English-speaking maids. Access to such support was felt to be influenced by limited availability of services and poor understanding of the role of NGOs.

> *It also depends on the financial status of the person with dementia and financial status of the family. Because looking after dementia is an expensive business* (Geriatrician 1)
> *A lot of people are unable to afford health care because they don't have money. Not only [for] medications but also equipment* (General Physician 2)
> *As for social support, most of it is private NGOs, so we know of the ADFM. Okay, so ADFM has a lot of activities but of course in the end they are only one group and there's only so many people they can reach out to, and then, dementia is a major problem affecting a lot of old people* (General Physician 1)

## Priorities for the Future—Towards Improving Dementia Recognition and Timely Care

Four key, but interlinked, priorities were identified: raising awareness and knowledge of dementia among the whole population; workforce capacity and capability development; greater family access to culturally sensitive social support services; and raising the profile of dementia through national investment in care services. Together, these priorities were considered essential for encouraging the earlier presentation and efficient diagnosis of dementia, as well as necessary to supporting improvements in the post-diagnostic care of pwd.

### *Raising Public Awareness and Understanding of Dementia Are Paramount*

A major priority area for the future is to improve awareness and knowledge of dementia among the whole population. Currently, raising awareness is offered by NGOs and private enterprises. However, it was felt that the government should take the lead to provide a public service or campaign that delivers a broad programme of education tailored to all age groups and pockets of the community felt most likely to have little awareness of dementia (e.g., rural dwelling citizens). Clear guidance should be provided so that people would know what to do if they have a relative showing possible signs of dementia. To encourage earlier help-seeking, a key message to deliver was that dementia is not a normal part of ageing. Clarity should be provided that although there is no cure, there are treatments to slow it down, and that if help is not sought, problems could progress. Several strategies were suggested, such as comprehensive health promotional and educational events and campaigns delivered at a national, regional, and community level, co-delivered by experts in dementia and community and religious leaders. Media coverage of dementia was further suggested in the form of TV and radio shows, and social media platforms.

*So I think the lack of awareness is quite rampant in Malaysia* (General Practitioner 1)

*I think it is about awareness – we need to increase it tremendously … but we don't really reach the rural areas – that is where we actually have to pay more attention in my opinion* (Occupational Therapist)

*But the thing is, the awareness of dementia is still very new. I guess we need to … try to get a lot of general practitioners to be involved in this. So they are a bit aware on the diagnosis and the treatment available. Or the support, care that we can offer this patient and carers* (Geriatrician 2)

*Tell them [public] this is abnormal … so then it will trigger them to say, "why is this happening it's not normal, let's bring him to a doctor"* (General Physician 2)

### *A Trained Specialist Workforce Is Needed to Improve Dementia Care in Malaysia*

A second key priority identified was to have more dedicated people to specialise in the care for older people and pwd, namely, doctors, nurses, medical assistants, and all allied healthcare providers. This would require the government to focus on establishing more psychiatric services, and in particular, more neuropsychologists and clinical psychologists to reduce the pressure on psychiatrists. Dementia care in Malaysia would benefit from having more geriatricians, at least one in each state, but ideally one in every hospital. To expand geriatric services, longer-term measures should aim to encourage more specialists into the area. In the shorter term, existing medical professionals, frontline workers, and possibly community workers, could be trained to recognise and pick up dementia. This would help to encourage more visible pathways and efficient referral to geriatric specialists offering dementia services, as well as increasing expertise in diagnosing and caring for pwd in the community. In particular, training general practitioners and general physicians in dementia was seen to be an important step towards improving dementia care, since they are often the first point of contact for patients. Proposed training included informal sharing of expertise by dementia specialists, as well as the development of a training programme by the Ministry of Health and Ministry of Higher Education that would lead to a credible qualification. The need for training extended to providers of dementia care at a community level, including residential care staff or carers who support pwd in a home setting.

*We need, more people who are committed to treat the elderly and the demented patients* (General Physician 2)

*Train the front-liners. You need to train us because if you train us we can pick up patients* (General Practitioner)

*I think at the hospital level, healthcare professionals should be educated on, diagnosing and treating patients with dementia. And that's pretty crucial* (Medical Officer)

*All personnel who are involve in care of dementia patients must be well trained and knowledgeable* (Traditional Healer 3)

### *Families Require Accessible and Culturally Sensitive Social Support*

The ideal scenario for the post diagnostic care of pwd was considered to be a good supportive family, with a good understanding of dementia to be able to care for them. Nonetheless, the significant challenges to families were recognised. Subsequently, a key priority in this respect was the improved provision of community and social support for family caregivers. Valuable support is currently provided by NGOs, but the scale of service they can offer is significantly limited. Establishing more community services was, therefore, considered of utmost importance to help improve post-diagnostic care for pwd. Relevant support services proposed include those that: bring medical care into the home (e.g., home visits by specialists for pwd who have developed cognitive and physical impairment); provide respite for carers and stimulation for pwd (e.g., community day centres with activities for pwd); and enhance the quality of life and care for pwd who live at home (e.g., a government-supported domiciliary care system with trained staff).

*People like us we try we try to help out. But the, number of people we can help, is actually minimal* (NGO)

*The third priority is about the home-based care, for those who can't afford to go to the old folks home. What I mean is the community around that area. (…) the community involvement* (Traditional Healer 4)

*We need to establish community centres. We need to establish community service for the elderly …* (Psychiatrist)

*I don't know but if you ask me right, dementia care is a very community kind of, management based kind of disease. Okay, they might come to the hospital once or twice to [review their] general condition, change in medication, but I think the community support is very important. Like community nurse, community Social Worker, pharmacy outside …* (General Physician 2)

Additional support for families should include education and training in dementia and dementia care, and financial support, in the form of an allowance from the government, to help with costs of medications and other aspects of care. Support services need to be sensitive to cultural and religious differences, since these can influence the understanding of symptoms, and because many people continue to visit traditional and faith healers. It was suggested that acknowledgement of such practices could assist cooperative working between conventional medicine and traditional/faith healers. Though not without challenges, such arrangement was considered by some as a potentially positive step that would be beneficial to patients.

*From what I understand, the first thing is to ensure that these care centers or any specific care centers for dementia to provide an environment that can make them feel close to Allah* (Traditional Healer 3)

*We need to try both ways, modern and traditional medicine* (Nurse 2)

*Okay, I think a lot of times people with like oh, a western medicine doctor and they will [be] like oh, I don't work with them. But at the end of the day we have to admit that a lot of people [patients] still work with all these people [traditional/faith healers] and I think that if you make people the enemy "Oh, you are faith healer, you're my … enemy", then you cannot co-operate with them … I don't believe in the same things as you, but I think we can*

*always cooperate. At the end... this [is] better for patients (General Physician 1)*

*I think if we collectively work together . . . Okay, the traditional healer has his other ways of massage, this and that, acupuncture, things like that... I think if you can integrate them it's amazing* (General Practitioner)

### *National Investment in Dementia Care and Dementia Prevention Are Paramount*

It was felt that dementia care in Malaysia is in its infancy and that the prevalence of dementia is likely to be vastly underestimated. Like other countries across the world, it was felt that Malaysia, as a nation, should be prepared for an ageing population. The profile of dementia and the impact it can have on society, therefore, need to be raised. The interviewees acknowledged that the government has many things to support but with a limited amount of resources. Nonetheless, it was unanimously proposed that increased central investment in dementia care is paramount to improving the capacity and capability to care of the nation for the older population of the country. Further government intervention proposed included establishing a national policy and the development of a national dementia healthcare plan. Finally, prevention was seen to be key, and several strategies enabled by government funding incentives were proposed. These are largely aimed at keeping older people healthy, active, and socialised.

*To make these people realize how much dementia has impacted on our society. In order to, you know, put pressure on the government to give us more money in terms of dementia care* (General Physician 2)

*I think starting from the government they need to allocate more resources to care [for] old people . . . I think dementia care in Malaysia is still in its infancy. There's a lot more we can do and I would like to do a lot more especially in this unit of mine* (Psychiatrist)

*We suspect the amount, the number of cases as recorded is definitely, definitely not, not projective of what is happening. This is a tip of the iceberg only* (NGO)

*To also educate them that if you follow a lifestyle which is healthy, you can prevent this from developing, you can reduce it . . . So if we give proper education, we will, first and foremost, be able to reduce, or prevent dementia in the society* (Traditional Healer 1)

## DISCUSSION

This is the first qualitative study undertaken in Malaysia that has captured the views of a range of primary and secondary care providers on access to dementia services, standardised diagnostics, treatment options, and availability and dependence on community services and family support. It has also attempted to understand awareness of dementia among care providers, the perceived influence of traditional beliefs on the management of dementia patients, and knowledge of workforce infrastructure to support dementia care in Malaysia, such as the utilisation of national guidelines. The study was conducted in Selangor, which is an urban area with the highest dementia care service provision in the whole of Malaysia and may, therefore, not represent views of clinicians in Malaysia as a whole, especially where more fragmented and less specialist service provision exists in other states. Nevertheless, the findings show that while a wide variety of services does exist for dementia management in Selangor, there is much room to improve infrastructure and the coordination of services across and within private and public sectors, particularly between primary and secondary care services, so that more standardised and equally accessible care pathways are available to all.

Dementia is a progressive disease and, as such, care needs alteration over time, requiring continual assessment and individual approaches to clinical problems and solutions. In higher income countries (HICs), task shifting out of the primary and secondary care sector into the community has allowed care to be distributed through a larger number of providers (30). When supplemented by national guidelines and a duty of care to provide a standardised care experience, this approach aims to ensure greater equality in care provision (31). Evaluating the conceptualisation of dementia in LMICs where patients have variable opportunities to access care in formal and informal ways is an essential step in understanding how patients and caregivers engage with available dementia services. A recent systematic review of the understanding of dementia in LMICs has found that based on the results of 19 studies, a successful programme of dementia care will need to be developed using a systematic multidisciplinary approach to find acceptable health and community care responses to dementia (32). As demonstrated in the findings, the lack of formal and institutional care for dementia in LMICs places a huge burden on relatives and carers, as well as clinicians, who are managing dementia cases as non-specialists (sometimes with little dementia-specific training) in addition to comprehensive acute and chronic general medical practice (33). While HICs, such as the UK, may have established care pathways for patients with dementia, the application of a similar programme in Malaysia or any other LMIC may not be cost-effective for larger ageing populations with a higher burden of disease, or be manageable within the existing infrastructure. To promote engagement with programmes, cultural contexts, expectations, and shared decision-making are distinct issues that will need to be addressed in the development and design of country-specific care pathways, which, ideally, should also be designed with input from all stakeholders that include patients, carers, medical practitioners, and health/social care ministries to ensure sustainable utilisation of services (32, 34).

In this study, while the respondents had a good understanding of the general healthcare system in Malaysia and their specific roles in the dementia care pathway, they had little understanding of what services may be available in other sectors, how to coordinate care for dementia and other comorbidities, and how to locate or access services other than those they were already using for patients. Similarly, the multiple routes of referral, such as professional and self-referral, made it difficult to follow up on patients and evaluate longer-term outcomes of care. Consequently, the efficiency and improvements to the quality of life as a result of using the dementia services may be difficult to identify and evaluate. Continued involvement and poor knowledge of referral pathways and the additional general lack of awareness of dementia contribute to the issue

of late presentation to medical practitioners. Perceptions of the value and efficacy of both pharmacological and non-pharmacological treatments may be influenced by their limited impact on advanced dementia. Late presentation is typical when behavioural problems become unmanageable at home. This delay in help-seeking is compounded by the cultural expectation that younger family members should care for the older generation without external help. From a public health perspective, the presentation of dementia at an advanced stage also makes it difficult to know the exact burden of disease of dementia in Malaysia, particularly so for early cases and for understanding the impact this will have in the future when formal care requirements escalate with disease progression. Unlike Nikmat et al. (8), the respondents did not perceive a current stigma or taboo associated with dementia, suggesting a potential shift in attitudes towards the condition over the past 10 years. However, we have shown that dementia symptoms can still continue to be seen as natural sequelae of ageing in Malaysia. As well as delays in help-seeking, this gap in understanding may also influence timely access to social and community support and uptake of available training, leading to families or paid helpers undertaking care themselves.

Earlier identification of dementia currently relies on opportunistic screening, often when patients are presenting to practitioners with another comorbidity. Since those comorbidities will also require referral and follow-up, there is a risk that families and practitioners may prioritise perhaps more visible problems, such as cardiovascular or respiratory disease over symptoms of dementia, and that these will go unmanaged for longer particularly if there is no clearly identifiable care pathway (35–37). In addition, dementia subtypes are not commonly diagnosed in Malaysia, which may have implications for developing both a local evidence base for treatment outcomes as well as optimising pharmacological management for individual patients. Given that this management is largely under the remit of specialist referral centres, there are likely to be discrepancies across Malaysia where specialists are fewer in number or do not exist. Similarly, non-pharmacological management options may also be limited, such as cognitive stimulation therapy, cognitive rehabilitation, reminiscence, and life story work (38).

While national guidelines for dementia care exist in Malaysia (second edition published in 2009 by Academy of Medicine of Malaysia, 2009) (39), the respondents felt that they were not followed routinely as the evidence base supporting the guidelines in Malaysia was limited and it depended on local service availability, infrastructure, and funding that were not available everywhere. Since resources are not nationally available, the care pathways are very difficult to follow. The guidelines were also felt to be outdated and do not include sufficient non-pharmacological management options. Non-pharmacological interventions may be more economical with improved quality of life outcomes, but they have not been evaluated in Malaysia. Malaysia has not prioritised dementia care over other medical conditions historically and depends heavily on national census and burden of disease data. Unless screening of dementia at an early stage, or early diagnosis, becomes a priority, it is unlikely that a detailed local evidence base for dementia care outcomes will be achievable; and, as a consequence, care will continue to be fragmented across the country with the bulk of services located in Selangor and other larger cities, which, by no means, is solely a LMIC problem (40).

As a clinical specialty, dementia and geriatrics are not perhaps perceived as a glamourous or popular choice for specialty training in Malaysia, as many medical practitioners select specialties where they can gain some element of private practice as well as working in the government system. For general practitioners, it is often not a priority for continuing professional development, so the knowledge and skills for managing dementia patients may be outdated and elementary. The two-tier government/private healthcare approach to service provision means that patients who can afford to will be able to access private services and a wider range of management and care options, but those who can only access government services will be limited to what is accessible in their area. Consequently, national guidelines need to take account of this to ensure some level of standardisation and duty of care in both these sectors. With an ageing population, in order that a sustainable trained workforce is developed for the future, dementia training needs to be expanded in medical curricula at both undergraduate and postgraduate levels. In addition, training for community leaders, religious leaders, and school children to educate for the future would help to improve awareness and address any stigma that currently exists with this disease, as has happened in UK and some LMICs (41–44).

## Strengths and Limitations of the Study and Further Research

A key strength of this study is its use of qualitative methods to provide novel and detailed understanding of dementia care in Malaysia and, in particular, the identification of important areas to improve services. This study provides an overview of the perceptions of formal and informal care providers in Selangor on dementia care in Malaysia. While the experiences of these care providers may not be representative of care providers in Malaysia as a whole, other hospitals and other urban settings, valuable insight is provided from the perspective of those providing dementia care at the frontline of public, private, and not-for-profit services. Further research should build on the current study to collect data in different states to evaluate care provision more broadly, which could also be compared between urban and rural areas. The culturally diverse population of Malaysia includes indigenous populations who may differ in their understanding of dementia and expectations of treatment. A future study on multiple stakeholders, such as carers, early dementia patients, formal and informal carers, ministers, NGO representatives, alternative medicine specialists, and community leaders, would, therefore, be beneficial, examining dementia care challenges at all levels. An integrated study on the culturally diverse population of Malaysia may provide different perspectives on dementia management and indicate needs and priority areas for these groups in the event of improvements on existing dementia management from a national perspective.

## CONCLUSIONS

The respondents in this study perceived that while there was provision for dementia care in the hospital and community settings, more could be done to coordinate these services across and within sectors to better facilitate patient access and referral between primary, secondary, and social care. A need for greater emphasis in both postgraduate and undergraduate training in dementia care was reported, as well as improved general awareness in the community to encourage earlier access to care. This will enable the use of preventive strategies and facilities for maximum benefit to potentially optimise quality of life for pwd and to encourage longer-term independent living.

### Implications for Practice

Dementia is a progressive disease, and this study has shown that people with symptoms of dementia in Malaysia often present late to secondary or tertiary care, typically when behavioural issues are too severe to cope with at home. The findings also highlight the already significant pressure on limited specialist dementia services, and on families providing care at home with little to no social support. This is a familiar circumstance for many countries that prompted the 2016 World Alzheimer Report recommendation of a shift towards Western "task-shifted" models of post-diagnostic care (45). Task-shifting involves shifting tasks from specialist, secondary care services to generalist healthcare settings, such as primary care, and/or sharing task between medical and non-medical staff'(30, 45). Task-shifting care models in the United Kingdom have explored shifting aspects of secondary care into the community, but such setup requires considerable infrastructure and buy-in from health professionals and the general public alike. A recent systematic review on post diagnostic care models for dementia has highlighted four primary care-led models from western countries with and without specialist consulting support and case management (46). The review has found that while nurse-led case management partnership models showed the most potential in terms of clinical and cost effectiveness, they may be more costly and needed greater evaluation before they could be universally recommended (46). Other studies have focussed on task-shifting by including a dementia nurse specialist in GP practices (30) but again further research into the remit of the nurse specialist role, cost effectiveness, and benefits of such model is needed. A recent Alzheimer's society report has illustrated how even in a developed country like the UK dementia care is still fragmented and lacks coordination (47). Models of care, such as task-shifting, would need greater health service integration and independent evaluation in Malaysia where care is still largely provided at home and there is little clinical intervention until end-stage dementia.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Malaya Medical Centre Medical Ethics Committee (MECID: 201922-7093) in May 2019. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

LR is the principal investigator on the NIHR Global Health DePEC program. MG, LR, and SM contributed to the study design and development and piloting of the topic guide, and provided oversight and coordination of the study. RR conducted the interviews and arranged their transcription and translation. EM, SM, and RR conducted the data analysis. All the authors contributed to the interpretation of the findings. MT and SK provided support in the identification and access to interview the participants. All the authors have approved the final manuscript.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.637484/full#supplementary-material

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BRIEF RESEARCH REPORT
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# A Cross-Sectional Assessment of Urinary Tract Infections Among Geriatric Patients: Prevalence, Medication Regimen Complexity, and Factors Associated With Treatment Outcomes

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**Background:** Urinary tract infections (UTIs) are the second most prevalent infection among the elderly population. Hence, the current study aimed to evaluate the prevalence of UTIs among older adults, medication regimen complexity, and the factors associated with the treatment outcomes of elderly patients infected with UTIs.

**Methods:** A retrospective cross-sectional study was conducted at the Department of Urology, Hospital Pulau Pinang, Malaysia. The patients ≥65 years of age were included in the present study with a confirmed diagnosis of UTIs from 2014 to 2018 (5 years).

**Results:** A total of 460 patients met the inclusion criteria and were included in the present study. Cystitis (37.6%) was the most prevalent UTI among the study population followed by asymptomatic bacteriuria (ASB) (31.9%), pyelonephritis (13.9%), urosepsis (10.2%), and prostatitis (6.4%). Unasyn (ampicillin and sulbactam) was used to treat the UTIs followed by Bactrim (trimethoprim/sulfamethoxazole), and ciprofloxacin. The factors associated with the treatment outcomes of UTIs were gender (odd ratio [*OR*] = 1.628; $p = 0.018$), polypharmacy ($OR = 0.647$; $p = 0.033$), and presence of other comorbidities ($OR = 2.004$; $p = 0.002$) among the study population.

**Conclusion:** Cystitis is the most common UTI observed in older adults. Gender, the burden of polypharmacy, and the presence of comorbidities are the factors that directly affect the treatment outcomes of UTIs among the study population.

**Keywords: asymptomatic bacteriuria, cystitis, medication complexity, outcomes, urinary tract infections**

## INTRODUCTION

Urinary tract infections (UTIs) are the most common type of infection among the elderly population around the world and the most common cause of hospitalization due to bacterial infections (1). Generally, a UTI is defined as an infection in the urinary tract system which may include both upper urinary and lower urinary tracts (2). Approximately 7 million hospital visits, 1

million emergency visits, and 100,000 hospitalizations are due to UTIs which are around 25% of all infections among older people every year (3). Approximately, the overall incidence of UTIs among older men and women ranges in one infection per 14–20 persons-years (4). The treatment and diagnosis of UTIs are more difficult among the elderly population as compared with the younger individuals because of many underlying risk factors, such as older age, spinal cord injuries, diabetes mellitus, impaired immune conditions, and most importantly catheterization (4).

Older adults are more prone to UTIs as compared with young individuals due to the high rates of urinary retention, urinary incontinence, long-term hospitalizations, presence of comorbidities, accompanying urinary catheterizations, and declining immune responses (5, 6). Modifiable risk factors of UTIs among older people include urinary tract abnormalities particularly in those with urinary retention or incontinence (e.g., prostatic hyperplasia), diabetes mellitus, urinary catheterization, and sexual intercourse, which is the major risk factor for both men and women in older age (7).

The prevalence of UTI is higher in women as compared with men in all age groups. In sexually active young women, the incidence of UTI ranging from 0.5 to 0.7 per person-year (8), however, in young men it is 0.01 per person-year. In middle age, the incidence of UTI decreases but it increases with the increase in age (2). An estimate of 10% of women aged more than 65 years reported UTI in the last 12 months (9), whereas this number increase up to 30% in women aged more than 85 years (10). In a study on postmenopausal women, the incidence of UTI has been reported as 0.07 per person-year and 0.12 per person-year in women with uncontrolled diabetes mellitus (4). The incidence of UTI significantly increases in both men and women aged more than 85 years.

Polypharmacy is the major risk factor for overactive bladder syndrome in older adults (11). "Overactive bladder syndrome" is the complex of symptoms that include the sudden need to urinate with the fear of involuntary leakage, nocturia, leakage of urine prior to urine intention, and pollakiuria. Some drugs stimulate incontinence as their adverse effect and some of the drugs have interactions between them that increase the chances of overactive bladder syndrome (11).

The clinical presentation of UTIs among older adults leads to complexity in the diagnosis due to localized urinary symptoms and typical clinical history as compared with the young individuals. The increased prevalence of asymptomatic bacteriuria (ASB) among the elderly population may lead to more difficulty in the diagnosis of UTIs (1U). In primary and secondary care, empirical antibiotics are prescribed for a suspected UTI in which more than 50% of the prescribed antibiotics are considered unnecessary among elderly patients (12). To reduce the threat of antibiotic resistance to public health, antibiotic stewardship programs and national guidelines for the rational use of antibiotics have been adapted to control this situation (13).

In the current study, we evaluated the prevalence of different UTIs, medication regimen complexity, and identify different risk factors involved in the treatment outcomes of UTIs among geriatric patients.

# METHODS

## Design of Study, Setting, and Time

We conducted a retrospective cross-sectional study at the urology department of a tertiary care public hospital (Hospital Pulau Pinang) in the northern territory of Malaysia. Data were collected from the record room of the urology department from October 2019 to February 2020.

## Study Population

We evaluated all the medical records of older adults from January 2014 to December 2018 (5 years) by using a convenience sampling technique. The inclusion criteria of the participants were: patients aged $\geq$ 65 years, complete medical and clinical information in the record, should have a UTI episode confirmed by the physician. Patients <65 years of age, incomplete records, and no information on UTI episodes were excluded from the study.

## Ethical Approval and Data Collection

**This** study was approved by the National Institute of Health and the Medical Research and Ethics Committee, Malaysia (NMRR-19-1037-46721) prior to starting the data collection. The **s**ocio-demographic and therapeutic data of the included participants were collected with the help of a comprehensive data collection form from the record room of the urology department, Hospital Pulau Pinang, Malaysia. All the parameters of the data collection form are presented in **Table 1**. The records of prescribed medicines of the included participants were also collected to assess the medication complexity by using the medication regimen complexity index (MRCI) (14).

The MRCI scores were calculated based on the medications prescribed to the patients. It has three sections with 65 items, such as "types of dosage forms," "frequencies of prescribed medications," and "other additional instructions regarding medicines." This tool provides the limitless entry of medicines to a single individual. There is no maximum score of this index, it increases with the increase in the number of medicines, however, the minimum score is 1.5, which indicates that one tablet or capsule once daily.

## Statistical Analysis

**S**tatistical analysis was performed by using SPSS version 24 (SPSS Inc., Chicago, IL, USA). The treatment outcomes of UTIs were compared with the categorical variables using the chi-square test and the $p$-value was considered as significant at <0.05. The continuous variables were reported as frequencies (percentages). Binary and multiple logistic regression were used to evaluate the association between each independent variable and the treatment outcomes with 95% *CI*, adjusted odds ratio (*OR*), and $p$-values ($p < 0.05$). The MRCI scores were analyzed as continuous variables.

# RESULTS

## Characteristics of the Study Population

In the current 5 year retrospective cross-sectional study, 460 participants were included in which women 279 (60.7%) were in majority as compared with men 181 (39.3%) with a mean

**TABLE 1 |** Sociodemographic characteristics of the study population.

| Characteristics | *N* (%) | Treatment outcomes | | *p*-value |
|---|---|---|---|---|
| | | Improved | Not improved | |
| **Gender** | | | | **0.017*** |
| Male | 181 (39.3) | 114 (24.8) | 67 (14.6) | |
| Female | 279 (60.7) | 205 (44.6) | 74 (16.1) | |
| **Age (years)** | | | | |
| 65–75 | 342 (74.3) | 246 (53.5) | 96 (20.9) | **0.041*** |
| >75 | 118 (25.7) | 73 (15.9) | 45 (9.8) | |
| **Marital status** | | | | |
| Single | 22 (4.8) | 12 (2.6) | 10 (2.2) | |
| Married | 256 (55.7) | 186 (40.4) | 70 (15.2) | 0.081 |
| Divorced | 47 (10.2) | 27 (5.9) | 20 (4.3) | |
| Widow | 135 (29.3) | 94 (20.4) | 41 (8.9) | |
| **Race** | | | | |
| Malay | 127 (27.6) | 93 (20.2) | 34 (7.4) | |
| Chinese | 271 (58.9) | 185 (40.2) | 86 (18.7) | 0.509 |
| Indian | 62 (13.5) | 41 (8.9) | 21 (4.6) | |
| **Home** | | | | |
| Own Home | 428 (93.0) | 296 (64.3) | 132 (28.7) | 0.748 |
| Nursing home | 32 (7.0) | 23 (5.0) | 9 (2.0) | |
| **Smoking** | | | | |
| Smoker | 148 (32.2) | 107 (23.3) | 41 (8.9) | 0.345 |
| Non-smoker | 312 (67.8) | 212 (46.1) | 100 (21.7) | |
| **Alcohol** | | | | |
| Alcoholic | 142 (30.9) | 95 (20.7) | 47 (10.2) | 0.447 |
| Non-alcoholic | 318 (69.1) | 224 (48.7) | 94 (20.4) | |
| **Polypharmacy (number of medications)** | | | | |
| ≤5 | 188 (40.9) | 120 (26.1) | 68 (14.8) | **0.033*** |
| >5 | 272 (59.1) | 199 (43.3) | 73 (15.9) | |
| **Co-morbidities** | | | | |
| Yes | 336 (73.0) | 247 (53.7) | 89 (19.3) | **<0.001*** |
| No | 124 (27.0) | 72 (15.7) | 52 (11.3) | |

**Using chi-square. $p < 0.05$.*

age of 72 ± 4 years. Most of the study participants 342 (74.3%) were in the age range of 65–75 years of age and 118 (25.7%) were above 75 years. Majority of the included population was married 256 (55.7%), Chinese 271 (58.9%), non-smokers 312 (67.8%), and non-alcoholic 318 (69.1%). Detailed association between the sociodemographic variables with the treatment outcome parameters (improved or not improved) among the study population infected with UTIs is presented in **Table 1**.

## Prevalence of UTIs Among the Study Population

The most common UTIs reported in elderly population are cystitis 173 (37.6%) followed by ASB 147 (31.9%), pyelonephritis 64 (13.9%), urosepsis 47 (10.2%), and prostatitis 29 (6.4%). Other co-morbidities present with these UTIs among the study population are diabetes mellitus, hypertension, dyslipidemia, ischemic heart disease, and chronic kidney disease as described in **Table 2**.

**TABLE 2 |** List of urinary tract infections (UTIs) and other co-morbidities among the study population.

| Urinary tract infections | *N* (%) | Co-morbidities | *N* (%) |
|---|---|---|---|
| Cystitis | 173 (37.6) | Diabetes mellitus | 198 (43.1) |
| Asymptomatic bacteriuria | 147 (31.9) | Hypertension | 156 (33.9) |
| Pyelonephritis | 64 (13.9) | Dyslipidaemia | 113 (24.5) |
| Urosepsis | 47 (10.2) | Ischemic heart disease | 59 (12.8) |
| Prostatitis | 29 (6.4) | Chronic kidney disease | 48 (10.4) |

Unasyn (ampicillin and sulbactam), Bactrim (trimethoprim/sulfamethoxazole), ciprofloxacin are the most commonly used antibiotics used to treat UTIs in the study population (**Table 3**).

**TABLE 3 |** List of oral medications among the study population.

| Oral medications | *N* (%) |
|---|---|
| Unasyn (Ampicillin and Sulbactam) | 263 (57.1) |
| Bactrim (Trimethoprim/sulfamethoxazole) | 143 (31) |
| Ciprofloxacin | 25 (5.4) |
| Levofloxacin | 17 (3.7) |
| Cloxacillin | 12 (2.6) |
| Hytrin (Terazosin) | 390 (84.8) |

**TABLE 4 |** Medication regimen complexity index by sections.

| MRCI total score | Mean (SD) | Minimum | Maximum |
|---|---|---|---|
| MRCI section A score | 5.85 (2.937) | 1 | 20 |
| MRCI section B score | 7.47 (2.890) | 2 | 17 |
| MRCI section C score | 0.74 (0.802) | 0 | 4 |
| MRCI total score | 14.04 (4.146) | 5 | 27 |

*Section A: Number of medications prescribed; Section B: Frequency of prescribed medicines; Section C: Additional instructions of prescribed medicines.*

## Medication Regimen Complexity

The number of prescribed medications ranges from 1 to 20 with a mean value of 5 medicines per patient included in the current study. Over 59.1% of the included participants are taking more than five medicines simultaneously which leads to the high burden of polypharmacy. The total MRCI score for the study population ranging from 5 to 27 per patient with a median of 14. The MRCI scores in detail are presented in **Table 4**.

## Factors Associated With the Treatment Outcomes of UTIs Among the Elderly Population

**The** different associated factors involved in the treatment outcomes of UTIs among the elderly population have been predicted by using binary logistic regression analysis. Gender, marital status, age, race, smoking status, alcohol consumption, home, polypharmacy, and presence of co-morbidities are the factors that are analyzed to predict their association with the treatment outcomes of UTIs among the study population. Out of these nine independent variables, only four (gender [$OR = 1.628$; $p = 0.018$], age [$OR = 1.580$; $p = 0.042$], polypharmacy [$OR = 0.647$; $p = 0.033$], and the presence of co-morbidities [OR = 2.004; $p = 0.002$]) of them show statistically significant association with the treatment outcomes in binary logistic regression. These associated variables are then tested in multiple logistic regression, all of them show significant association except the age factor ($OR = 1.378$; $p = 0.168$). **Table 5** shows the detailed presentation of binary and multiple logistic regression analysis.

# DISCUSSION

Urinary tract infections are the most common type of infections in all age groups, particularly, in older adults due to their compromised immune response and sedentary lifestyle. A UTI can be defined as the presence of a significant number of bacteria (quantitative method) in the urinary tract system which may lead to symptomatic or asymptomatic infection (15).

The current study shows a high prevalence of cystitis (37.6%) among the study population followed by ASB (31.9%), pyelonephritis (13.9%), urosepsis (10.2%), and prostatitis (6.4%). Urine is stored in the bladder and uropathogens can enter and colonize in bladder much easier than other parts of the urinary tract system and cause cystitis (16). Previous literature also reported high prevalence of cystitis among the elderly population than any other type of UTI (17, 18).

Urinary tract infections are more common bacterial infections in women as compared to men of all ages and increases with the increase in age. During the reproductive years, all women have at least one episode of UTI in their life and it increases up to 60% in their postmenopausal years. Hormonal changes, anomalies in the urinary tract, compromised immune system, urinary incontinence, functional disability, nutrition deficiency, and presence of other illnesses are the main risk factors contributing to UTIs in the elderly population (19). Moreover, loss of estrogen in elderly women changes the flora of the vagina, a decrease in the number of lactobacilli in vaginal flora leads to periurethral colonization. Urine production is increased while the capacity of the bladder decreased, decreases in voided volume, and decreases in the urinary tract threshold which ultimately leads to a higher risk of UTIs among older women. The present study also shows the high prevalence of UTIs in women (60.7%) as compared with men (39.3%). A high prevalence of UTIs in women (62.5%) than in men (37.5%) was found by Chaudhary et al. (20). One more study reported a 51.3% prevalence of UTIs in women and 48.6% in men (21).

The choice of antibiotics to treat UTIs among older adults is more complex as compared with young individuals due to the presence of a large range of pathogens, possibility of antibiotic resistance is higher, particularly, in the hospitalized patients or who receive more courses of antibiotics in their life span (22). In the present study, Unasyn (ampicillin and sulbactam) (57.1%) is the most prescribed antibiotic for the treatment of UTIs among the elderly study population followed by Bactrim (trimethoprim/sulfamethoxazole) (31%) and ciprofloxacin (5.4%). Unnecessary antibiotics should not be prescribed to older adults to reduce the risk of mortality and morbidity, moreover, narrow-spectrum antibiotics should be used to treat UTIs among the elderly population. For suspected UTI in the elderly population, the best practice is to send the urine sample for culture and sensitivity and wait for the results rather than to start broad-spectrum empirical therapy to reduce the risk of unnecessary antibiotic use in clinically well patients. If empirically therapy is required, the patterns of previous isolates of sensitivity, resistance patterns, and previous medication records should be evaluated, and the choice of antibiotic should be reassessed after 48–72 h based on the results of urine culture and sensitivity tests (22).

In the polypharmacy of elderly patients, inappropriate or unnecessary prescribing and adverse drug reactions are very common (23). In the present study, polypharmacy ($OR = 0.642$; $p = 0.033$) is one of the most important risk factors involved in the treatment outcomes of UTIs among the elderly population. The majority of the included participants (59.1%) are taking more

**TABLE 5 |** Predictors affecting the treatment outcomes of UTIs among the study population.

| | | Binary logistic regression | | | | Multiple logistic regression | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 95% CI | | | | 95% CI | |
| **Variables** | ***N* (%)** | **Odd ratio** | ***p*-value** | **Lower** | **Upper** | **Odd ratio** | ***p*-value** | **Lower** | **Upper** |
| **Gender** | | | | | | | | | |
| Male | 181 (39.3) | | Reference | | | | Reference | | |
| Female | 279 (60.7) | 1.628 | **0.018*** | 1.089 | 2.434 | 1.529 | **0.044*** | 1.011 | 2.312 |
| **Age (years)** | | | | | | | | | |
| 65–75 | 342 (74.3) | | Reference | | | | Reference | | |
| >75 | 118 (25.7) | 1.580 | **0.042*** | 1.017 | 2.453 | 1.378 | 0.168 | 0.873 | 2.175 |
| **Marital status** | | | | | | | | | |
| Single | 22 (4.8) | | Reference | | | | | | |
| Married | 256 (55.7) | 0.452 | 0.078 | 0.187 | 1.092 | | | | |
| Divorced | 47 (10.2) | 0.889 | 0.821 | 0.321 | 2.463 | | | | |
| Widow | 135 (29.3) | 0.523 | 0.166 | 0.209 | 1.308 | | | | |
| **Race** | | | | | | | | | |
| Malay | 127 (27.6) | | Reference | | | | | | |
| Chinese | 271 (58.9) | 1.272 | 0.315 | 0.796 | 2.032 | | | | |
| Indian | 62 (13.5) | 1.401 | 0.314 | 0.727 | 2.701 | | | | |
| **Home** | | | | | | | | | |
| Own Home | 428 (93.0) | | Reference | | | | | | |
| Old Care Home | 32 (7.0) | 0.877 | 0.748 | 0.395 | 1.948 | | | | |
| **Smoking** | | | | | | | | | |
| Smoker | 148 (32.2) | | Reference | | | | | | |
| Non-smoker | 312 (67.8) | 1.231 | 0.345 | 0.800 | 1.895 | | | | |
| **Alcohol** | | | | | | | | | |
| Alcoholic | 142 (30.9) | | Reference | | | | | | |
| Non-alcoholic | 318 (69.1) | 0.848 | 0.447 | 0.555 | 1.297 | | | | |
| **Polypharmacy** | | | | | | | | | |
| ≤5 | 188 (40.9) | | Reference | | | | Reference | | |
| >5 | 272 (59.1) | 0.647 | **0.033*** | 0.434 | 0.966 | 0.642 | **0.033*** | 0.426 | 0.966 |
| **Co-morbidities** | | | | | | | | | |
| Yes | 336 (73.0) | | Reference | | | | Reference | | |
| No | 124 (27.0) | 2.004 | **0.002*** | 1.302 | 3.085 | 1.872 | **0.005*** | 1.205 | 2.907 |

*$p < 0.05$.

than five medicines simultaneously for the treatment of their diseases which leads to the high burden of polypharmacy and medication regimen complexity. Older adults taking 5–8 drugs simultaneously were at high risk of hospitalization due to adverse drug reactions as compared with those who were taking 0–4 drugs (23). The clinicians are required to make modifications in the regimen of elderly patients experiencing UTIs to reduce the risk of drug-drug interactions and adverse drug reactions. Women receiving alpha-blockers for their hypertension causes incontinence reported in a case-control study, however, when these antihypertensives were discontinued, almost complete resolution was observed in their urinary symptoms. The use of loop diuretics instead of thiazide among 172 elderly patients with hypertension and heart failure was associated with increased frequency of urine and relaxation of the bladder to reduce the risk of UTIs (24). Previous literature reported cough-induced incontinence after the initiation of ACE inhibitors among older adults and remits after discontinuation (25, 26).

The presence of comorbidities is a significant predictor among the elderly patients with UTIs effecting their treatment outcomes in the present study ($OR = 1.872$; $p = 0.005$). Diabetes mellitus (43.1%) and hypertension (33.9%) are the most common comorbidities present among the study population. Diabetes mellitus effects the immune system of older adults due to autonomic neuropathy that leads to incomplete emptying of the bladder and poor metabolic control, which all contribute to the increased risk of UTIs in elderly patients with diabetes mellitus (27). A similar prevalence of UTIs among diabetic individuals was reported by Pargavi et al. (37%) (28), Yadav et al. (38%) (29), and Sewify et al. (35%) (30).

Our current study has several limitations. First, given the retrospective study design, it is possible that there are confounding factors associated with the treatment decisions and clinical outcomes we did not include. Second, this is a single-center study and may not be generalizable to other settings. Additionally, given the retrospective nature of our study, we

were unable to collect physical exam data on infection severity among geriatric patients. Additionally, we excluded a significant number of patients with incomplete medical records, which may limit the impact of our findings. Finally, we did not collect information on antibiotic-associated adverse events, adherence to guidelines by the physicians due to limited data available in the medical records.

## CONCLUSION

In conclusion, a high prevalence of cystitis (37.6%), asymptomatic bacteriuria (31.9%), and pyelonephritis (13.9%) were observed in the study population of elderly patients. Gender ($OR = 1.529$; $p = 0.044$), polypharmacy ($OR = 0.642$; $p = 0.033$), and presence of other comorbidities ($OR = 1.872$; $p = 0.005$) were the potential risk factors for the treatment outcomes of UTIs in older adults. By reducing the burden of polypharmacy and medication regimen complexity, the treatment outcomes of UTIs among the elderly population could be improved.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by National Institute of Health and Medical Research and Ethics Committee, Malaysia (NMRR-19-1037-46721). Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

## AUTHOR CONTRIBUTIONS

AA conceptualized and designed the study, conducted the statistical analyses, interpreted the data, and drafted the manuscript. AK, HZ, and MA revised the manuscript for intellectual content, read, and approved the final version of the manuscript. IA helped in data collection and supervised the drafting of the manuscript, supported in interpreting the data, and revised the manuscript for intellectual content. All authors read and approved the final manuscript.

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# Implementation of a Healthcare of Elderly Course With Multi-Professional Teachers for Undergraduate Medical Students in a Public University in Malaysia—A Quasi-Experimental Pre and Post Study

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Clinical practise in the ageing population is changing from organ-specific specialty care to holistic care. This is done through comprehensive geriatric assessment and multi-disciplinary team management. Hence, we adopted an approach consisting of multi-professional teachers teaching a Healthcare of Elderly Course (HEC), in a public university in Malaysia. We aimed to analyze the students' attitude, self-perceived competency and interest in geriatric medicine as a career before and after the course. We also investigated variables that might influence this interest among these students. All 96 students in the course were invited to participate in the survey. Sixty-eight (70.8%) completed both pre and post-course questionnaires. Although most students (93%) have a positive attitude (University of California at Los Angeles Geriatric Attitude Scale >3) toward older adults at baseline, it did not significantly increase post-course. We found that the mean scores for self-perceived competency increased from 3.62 (±0.76) to 3.81 (±0.56) post-course ($p < 0.01$). However, the students remained neutral with no significant change in the mean interest in pursuing a geriatric medicine career after the course. Students with higher self-perceived competency post-course were found to be more interested in geriatric medicine ($\beta = 0.56$, $p < 0.001$). In conclusion, the HEC in our centre could sustain a positive attitude and increase self-perceived competency in students. It is important to increase the preparedness of our graduates in managing older adults with frailty and multimorbidity. Future studies may involve inter-professional education of students from multiple disciplines undergoing the same course to nurture real-life collaborations in managing the ageing population.

**Keywords: geriatric medicine, undergraduate, curriculum, Malaysia, competency**

## INTRODUCTION

In a rapidly ageing Asia, where it is projected to be the home of more than half of the aged population of the world by 2050, developing a competent workforce in managing ageing and age-related diseases becomes an utmost priority (1). The first national survey on the teaching of geriatric medicine in Malaysian medical schools showed that the most prominent barrier to curriculum delivery was the lack of expertise, followed by the subject not being included in the curriculum. It was shown that none of the core geriatric competencies achieved a 100% coverage, and only a third of the participating medical schools had access to geriatricians (2). The gaps in teaching the subject further led to inadequate graduates being competent in geriatric medicine. It is a vicious cycle that needs to be intervened with meticulously planned approaches.

To develop more exposure for the learners and increase doctors with expertise in the field, the Programme Standards for Undergraduate Medical Education (3) has incorporated Geriatric Medicine as one of the core competencies. Furthermore, as developing countries have limited resources, an innovative and effective curriculum must be designed. Nevertheless, in developing a curriculum, consideration must be made on understanding the attitude and interests of medical students toward ageing and a career in geriatric medicine (4). The Malaysian Society of Geriatric Medicine (MSGM) has developed a recommended undergraduate curriculum for ageing and geriatric medicine tailored for Malaysians (5). The curriculum has been validated with understanding of the unique nature and needs of our ageing population. Validation was done through a rigorous Delphi exercise with experts who teach in academic institutions and clinical geriatricians who have worked with medical officers. This combination of experts helped to address the gaps between undergraduate education and real-life practise, and fulfil the principles of outcome-based education.

A dedicated course on ageing and geriatric medicine at the undergraduate level has been shown to improve the attitude and self-perceived competency of medical undergraduates in managing older adults with frailty and multimorbidity (6). To achieve this, the teaching approach on ageing and geriatric medicine often involves multi-professional teachers and applies innovations to ensure that students graduate with adequate competency (7).

The attitude of an individual toward older adults plays an important role in this specialty learning, partly because ageism has a considerable impact on medical practises toward older adults (8). Earlier this year, the United Nations had identified ageism as a global challenge and called for urgent actions for anti-ageism strategies. Ageism is simply defined as discrimination, stereotyping and prejudice against a person based on their age. This leads to financial loss through psychological, behavioural, and physiological change (9). It is ubiquitous with every one in two people being ageist, whereby this is primarily seen in the younger population, the male gender, and those of lower education background (10). Hence, there is a need to also assess this perception among our students undergoing the course.

The medical program at Universiti Putra Malaysia (UPM) is a 5-year program and leads to the conferment of the Doctor of Medicine (MD). Our institution did not have a geriatrician in the faculty for the last two decades, but this did not hinder students from an in-depth learning about this growing population. A Healthcare of Elderly Course (HEC) has been offered as a 3-week course for undergraduate medical students since 2000. Since its inception, this course was primarily taught by visiting geriatricians from the Malaysian Ministry of Health. The clinical bedside teaching was initially carried out in the Geriatric Unit, General Hospital Seremban, under the guidance of the current Head of National Geriatric Service, Dr. Yau Weng Keong. Until the recent COVID-19 pandemic, the students continued to have bedside teaching and learning on geriatric medicine in Hospital Kuala Lumpur. This hospital is the largest public hospital under the Ministry of Health to offer such service. The COVID-19 pandemic has dramatically changed the course's content and delivery, where it involved online lectures and inconsistent contact with patients whenever the Movement Control Order was enforced in the nation. This might cause tremendous stress and anxiety to our students (11), especially when they need to learn a multi-faceted course like ageing and geriatric medicine.

This paper discusses the change in attitude, self-perceived competency, and interest in a career in geriatric medicine among undergraduate medical students of Universiti Putra Malaysia before and after an HEC. The association between attitude and previous experience of taking care of older adults was investigated. Additionally, the influence of gender, ethnicity, experience in caring for older adults, attitude toward senior citizens, and self-perceived competency on the interest to pursue a career in geriatric medicine is also discussed.

## MATERIALS AND METHODS

### Study Design

This was a Quasi-experimental without Control Groups, Pre, and Posttest study undertaken between August 2020 to November 2020 for a span of 14 weeks. All 96 medical students who underwent the 3-week HEC were invited to answer an online questionnaire before and within 2 weeks after completing the course. The curriculum allocated the students into four groups with 24 students in each group. Students rotated between Otorhinolaryngology (3 weeks), Ophthalmology (3 weeks), Family Medicine/Radiology (3 weeks), and Healthcare of Elderly (3 weeks) courses.

The 3-week HEC was embedded in the clinical year (third year) and comprised of three parts: lectures, practical sessions, and tutorials. The lectures were delivered by field experts over a week to cover various topics on ageing and geriatric medicine. These field experts were namely geriatricians, rehabilitation physicians, neurologists, occupational therapists, psycho-geriatricians, and lawyers. This was followed by a 2-week practical sessions of a geriatrician-led ward rounds, geriatric outpatient clinics, home visits, and occupational and physiotherapy clinics. The tutorial consisted of a series of seminars, where students presented and discussed healthy ageing

and geriatric syndromes. At the end of the course, students were required to submit a logbook and sit for a theory examination.

Participants were aware that personal identifiable information was not collected within the questionnaire. Thus, participants remained anonymous and this encouraged truthfulness. As this course was conducted entirely in English and the students were required to attain a certain level of English proficiency before enrolling into the medical programme, their English command was adequate to complete the questionnaire.

## Measures

A written informed consent was provided by every participant in this study. Information on age, gender, ethnicity, experience in taking care of older adults in the family, and the interest to pursue geriatric medicine as a career were collected from all participants through the questionnaire. Attitude was assessed using a 14-item survey by the University of California at Los Angeles Geriatric Attitude Scale (UCLA-GAS) (12) and self-perceived competencies questionnaire from (6). These questionnaires were used due to their reliability.

The online questionnaires were developed using Google Forms, and the link was shared through WhatsApp and e-mail. Likert scales from 1 (strongly agree) to 5 (strongly disagree) was used to assess attitude and self-perceived competency, and from 1 (strongly interested) to 5 (strongly disinterested) to evaluate interest to pursue a career in geriatric medicine (**Supplementary Material 1**). Cronbach alpha for the UCLA-GAS and Self-Perceived Competency questionnaires were 0.668 and 0.975, respectively. This study was reviewed and approved by the Universiti Putra Malaysia Ethics Committee (JKEUPM-2020-320).

## Data Analysis

All measured variables were summarised to mean (standard deviation) for continuous variable and frequency (percentage) for categorical variable. For comparisons of means between before and after course completion, repeated measure of ANOVA was used. Analysis of within-subject effects was checked using repeated measure of ANOVA, namely the assumption of compound symmetry, normality of residuals, and homogeneity of variance. Linear regression was used to analyze the association between the following:

1) previous experience of taking care of an older adult and attitude, and
2) gender, ethnicity, experience in taking care of an older adult, attitude toward older adults and self-perceived competency, and the interest to pursue a career in geriatric medicine.

Attitude and competency scores were calculated according to the responses of the students. For positive statements, the scoring systems used for the responses were as follows: a score of 5 for strongly agree, a score of 4 for agree, a score of 3 for neutral, a score of 2 for disagree, and a score of 1 for strongly disagree. Reverse scoring was done for the negative statements. The maximum score for each positive attitude, perceived competency and interest, was 5. The $p < 0.05$ was considered as significant. Data analysis was done using IBM SPSS version 23.

# RESULTS

## Sociodemographic Variables

Out of the 96 students, 68 completed both pre and post-course questionnaires, resulting in a response rate of 70.8%. Nearly 30% of students responded either to the pre or post-test questionnaire (incomplete response). This might be due to the changing situation during the pandemic, where a fraction of students could not attend clinical sessions during the Movement Control Order. Hence, the inability to complete the survey. The majority of students were female (65%, $n = 45$). The students were mostly of the Malay ethnic group (55.9%, $n = 38$), followed by Chinese (23.5%, $n = 16$), Indian (17.6%, $n = 12$), and other groups (2.9%, $n = 2$).

## Attitude Toward Older Adults

The mean pre-course UCLA attitude score was 3.41 (±.36), which indicated an overall positive attitude toward older adults, at commencement of the course. Only five students, or 7.4%, demonstrated scores (<3) consistent with a negative attitude toward older adults. The mean post-course UCLA attitude score reported a slight increment to 3.45 (±.35), which was not statistically significant ($p = 0.299$).

**Table 1** shows means, standard deviations, and *p*-value of the attitudes of students toward older adults for each question in the UCLA-GAS. The statement most disagreed upon was "*The federal government should reallocate money to research on AIDS or paediatric diseases.*" The highly agreed statements (score >4) were for "*It is interesting listening to old people's accounts of their past experiences*" and "*It is society's responsibility to provide care for its older adults.*" Upon completion of the course, three students (4.4%) reported maintaining a negative attitude. None of the mean scores of individual components showed a significant change post-course.

## Self-Perceived Competencies of Students

Self-perceived competency scores of students significantly improved upon completion of the course [mean score pre-course of 3.62 (±0.76) vs. post-course of 3.81 (±0.56); $p = 0.009$]. Fifty-nine students (86.8%) had a positive (>3) perception of their competency at the start of the course, and by the end of the course, sixty-six students (97.1%) had a positive perception of their competency. **Table 2** shows the means, standard deviations, and *p*-value of the self-perceived rating scores of students for each competency question.

The highest self-perceived post-course competency was noted for the statement "*I feel competent to recognise when my older patient needs to transition to a more supportive living situation (such as assisted living or a skilled nursing facility),*" with a post-course mean score of 3.96. Meanwhile the statement with the lowest self-perceived post-course competency was "*I feel competent to recognise, evaluate, and treat dementia in my older patients,*" with a post-course mean score of 3.66. The statement "*I feel competent to recognise, evaluate, and treat behavioural disturbances in my older patients with dementia*" and "*I feel competent to recognise, evaluate, and treat acute delirium in my older*

**TABLE 1 |** Students' means, standard deviations, and *P*-value of attitudes toward older people for each question.

| Attitude question | Mean(SD) | | Mean difference (post-course–pre-course)‡ | *p*-value |
|---|---|---|---|---|
| | Pre-Course† | Post-Course† | | |
| 1. Most old people are pleasant to be with | 3.90 (0.81) | 3.85 (0.78) | −0.04 | 0.625 |
| 2. The federal government should reallocate money to research on AIDS or paediatric diseases | 2.04 (0.82) | 2.10 (0.90) | 0.06 | 0.583 |
| 3. If I have the choice, I would rather see younger patients than elderly ones | 3.15 (0.82) | 3.00 (0.91) | −0.15 | 0.206 |
| 4. It is society's responsibility to provide care for its elderly persons | 4.41 (0.67) | 4.38 (0.65) | −0.03 | 0.718 |
| 5. Medical care for old people uses up too much human and material resources | 3.25 (0.90) | 3.44 (1.04) | 0.19 | 0.155 |
| 6. As people grow older, they become less organised and more confused | 2.25 (0.82) | 2.24 (0.87) | −0.02 | 0.888 |
| 7. Elderly patients tend to be more appreciative of the medical care I provide than are younger patients | 3.66 (0.77) | 3.69 (0.90) | 0.03 | 0.771 |
| 8. Taking a medical history from elderly patients is frequently an ordeal | 2.50 (0.78) | 2.62 (0.99) | 0.12 | 0.280 |
| 9. I tend to pay more attention and have more sympathy toward my elderly patients than my younger patients | 3.74 (1.03) | 3.72 (0.93) | −0.02 | 0.907 |
| 10. Old people in general do not contribute much to society | 3.74 (0.91) | 3.91 (0.82) | 0.18 | 0.083 |
| 11. Treatment of chronically ill old patients is hopeless | 3.85 (0.82) | 4.00 (0.79) | 0.15 | 0.214 |
| 12. Old persons don't contribute their fair share toward paying for their health care | 3.53 (0.86) | 3.68 (0.70) | 0.15 | 0.221 |
| 13. In general, old people act too slow for modern society | 3.35 (0.84) | 3.29 (0.96) | −0.06 | 0.636 |
| 14. It is interesting listening to old people's accounts of their past experiences | 4.43 (0.63) | 4.44 (0.61) | 0.02 | 0.843 |

†*Mean pre- and post-scores derived from the 5-point Likert scale evaluation instrument: 1 = strongly disagree; 5 = strongly agree.* ‡*Difference = mean post-course scores—mean pre-course scores. SD, standard deviation.*

*patients*" showed the most significant improvement post-course, with a change in mean score of 0.32 and 0.29, respectively ($p < 0.001$).

## Interest in Geriatric Medicine as a Career Choice

Most students remained neutral toward having geriatric medicine as a career of choice, both in the pre-course (52.9%) and the post-course (61.8%). At commencement, 35.4% of students were either interested or strongly interested in having geriatric medicine as a career choice, while 11.8% were either disinterested or strongly disinterested. Post-course, 29.4% of the students showed interest, while 8.8% were disinterested, and none were strongly disinterested. However, there was no significant difference in the interest of geriatric medicine as a career of choice in the pre and post-course ($p > 0.95$).

## Experience in Taking Care of Older Adults

Among the 68 students, 48 (70.6%) had experience in taking care of older adults in their family. There was no significant association between attitude and experience in taking care of an older adult family member ($p = 0.509$).

## Association Between "Interest in Geriatric Medicine as a Career of Choice" and Study Variables

Among gender, ethnicity, experience in taking care of an older adult, attitude toward older adults, and self-perceived competency, we found that only self-perceived competency of students showed a good and significant association ($\beta = 0.56$, $p < 0.001$) with the interest of the student in a future career in geriatric medicine (**Table 3**).

**TABLE 2 |** Students' means, standard deviations, and *P*-value of self-perceived rating scores for each competency question.

| Competency question | Mean(SD) | | Mean difference (post-course–pre-course)‡ | *P*-value |
|---|---|---|---|---|
| | Pre-Course† | Post-Course† | | |
| 1. I feel competent to recognise, evaluate, and treat dementia in my older patients | 3.50 (0.86) | 3.66 (0.75) | 0.16 | 0.078 |
| 2. I feel competent to recognise and minimise medication interactions for my older patients | 3.51 (0.87) | 3.68 (0.78) | 0.16 | 0.132 |
| 3. I feel competent to recognise, evaluate, and treat acute delirium in my older patients | 3.46 (0.89) | 3.75 (0.70) | 0.29 | **0.001** |
| 4. I feel competent to recognise, evaluate, and treat behavioural disturbances in my older patients with dementia | 3.46 (0.92) | 3.78 (0.69) | 0.32 | **0.001** |
| 5. I feel competent to recognise, evaluate, and treat depression in my older patients | 3.51 (0.92) | 3.76 (0.67) | 0.25 | **0.016** |
| 6. I feel competent to recognise, evaluate, and treat gait disturbances in my older patients | 3.60 (0.92) | 3.82 (0.71) | 0.22 | **0.035** |
| 7. I feel competent to recognise, evaluate, and treat falls in my older patients | 3.69 (0.85) | 3.91 (0.64) | 0.22 | **0.018** |
| 8. I feel competent to diagnose, evaluate, and treat various causes of urinary incontinence in my older patients | 3.76 (0.90) | 3.87 (0.71) | 0.10 | 0.240 |
| 9. I feel competent to evaluate the decision-making capacity of my older patients | 3.59 (0.89) | 3.71 (0.65) | 0.12 | 0.230 |
| 10. I feel competent to evaluate the cognitive function of my older patients | 3.71 (0.83) | 3.82 (0.65) | 0.12 | 0.220 |
| 11. I feel competent to evaluate the functional capacity of my older patients | 3.76 (0.83) | 3.90 (0.60) | 0.13 | 0.151 |
| 12. I feel competent to recognise when my older patient needs to transition to a more supportive living situation (such as assisted living or a skilled nursing facility) | 3.76 (0.92) | 3.96 (0.61) | 0.19 | 0.074 |
| 13. I feel competent to choose/recommend and arrange my older patient's transition to a more supportive living facility (such as assisted living or a skilled nursing facility) | 3.68 (0.91) | 3.81 (0.68) | 0.13 | 0.236 |
| 14. I feel competent to care for patients who reside in community care facilities | 3.66 (0.78) | 3.93 (0.63) | 0.27 | **0.008** |

†*Mean pre- and post-scores derived from the 5-point Likert scale evaluation instrument: 1 = strongly disagree, 5 = strongly agree.* ‡*Difference = mean post-course scores–mean pre-course scores. SD, standard deviation. P-value in bold indicates significant mean difference.*

## DISCUSSION

In this study, it was hoped to uplift the image of clinical practise toward the ageing population. Although attitude is one of the critical constructs of ageism, the specific course did not significantly improve attitude. The UCLA-GAS may screen for stereotyping and discrimination related to ageism with acceptable reliability on four dimensions of attitude: Social Value, Medical Care, Compassion, and Resource Distribution. Among the four dimensions, attitude toward medical care contributes the most to the overall attitude (13).

The attitude of a person is a complex, multidimensional, and challenging aspect to accurately quantify in medical education research. Nevertheless, to combat ageism among medical graduates, attitude toward older adults must be accurately quantified and understood, and this should be the future work in the field of geriatric education (14). A locally

**TABLE 3 |** Association between Interest in geriatric medicine as a career of choice and study variables (post-course).

| Variable | β(SE) | 95% CI | *P*-value |
|---|---|---|---|
| **Gender** | | | |
| Male (reference) | – | – | – |
| Female | 0.14 (0.20) | −0.26, 0.53 | 0.497 |
| **Ethnicity** | | | |
| Malay (reference) | – | – | – |
| Non-Malay | −0.06 (0.19) | −0.44,0.31 | 0.734 |
| **Experience in caring for older people** | | | |
| No (reference) | - | - | - |
| Yes | 0.20 (0.20) | −0.20,0.60 | 0.324 |
| **Attitudes toward older people** | 0.38 (0.26) | −0.14, 0.90 | 0.152 |
| **Self-Perceived competency** | 0.56 (0.17) | 0.23, 0.90 | **<0.001** |

*P-value in bold indicates significant association.*

developed, validated, or modified instrument will tremendously help medical educators to effectively develop geriatric medicine curricula that foster positive attitude toward older adults and combat ageism as a core graduate outcome (5, 8). Even though our study did not show any association between previous experience of caring for an older family member and attitude toward an older adult, another study among senior medical students in a public university in Malaysia ($n = 116$) showed that having grandparents, was a significant association ($p < 0.05$) (15).

Our study highlighted that the self-perceived competency of students heightened after the course. This was in line with another study in Australia (6). Students perceived themselves to be most competent in managing transitions of care and least capable in recognising, evaluating, and treating dementia. The most remarkable improvement of self-perceived competencies was in managing behavioural symptoms of dementia, followed by identifying, evaluating, and treating acute delirium. A self-assessment among graduates tends to differ with seniority, with an over estimation among the younger age group. Therefore, this assessment should be taken alongside a formal assessment by the faculty to ensure congruence (16). Student self-perceived competencies can be considered as a credit to the current curriculum. They should be conducted on a regular basis to implement necessary interventions and to enhance professional competencies and the quality of care (17). It was previously found that many medical institutions and medical educators have used the self-assessment of students as one of the measures to fulfil an outcome-based education (18).

Increasing the workforce in geriatric care has been a focus in many research on geriatric education. Our study showed that a higher self-perceived competency score had a significant association with a higher interest in pursuing a career in geriatric medicine. This might be explained by the impact of a positive influence of the module toward a career choice in geriatrics (19). Our study also showed no association between previous experience and interest. This differed from a finding in another study which found that frequent contact with an older adult and undertaking courses in ageing significantly increased the interest of students in working with older adults (19, 20). Studies have shown that medical students did not have enough exposure to older adult patients during their education and, therefore, did not see the drawbacks of ageing with multimorbidity (21, 22). Hence, having a dedicated course, such as HEC, will increase their exposure, skills, and experience at the undergraduate level. It was also suggested that a more positive attitude had been linked to a willingness to pursue geriatric medicine as a career (23, 24). However, despite generally having a positive attitude toward older adults, no significant association was found concerning the interest of our students in geriatric medicine. Only 1 in 3 students in our study considered a future career in geriatric medicine, mirroring the findings in studies done in Singapore and Ireland (19, 25).

The training of the healthcare workforce should not only focus on the attainment of knowledge and skills in managing diseases pertinent in the ageing population, but also the ability to work in an interdisciplinary team (26, 27). Therefore, a more refined older adult-friendly curriculum is recommended to nurture enthusiasm in caring for older adults (28). Although the complexity in handling older adults was found to be a significant barrier to working in the field, the exposure to a course in ageing and geriatric medicine would help spark interests (29).

## STRENGTH

This was the first study in Malaysia that assessed the attitude, self-perceived competencies, and interests of students in pursuing a geriatric medicine career before and after an HEC with multi-professional teachers at the undergraduate level. This study was carried out during the COVID-19 pandemic to assess if the change in the implemented teaching method can sustain a good attitude after the course and improve self-perceived competencies.

## LIMITATION

There a few limitations identified in this study. Firstly, the study was conducted during the COVID-19 pandemic, with limited bedside teaching in the ward and clinic. Only about half of the students could attend a clinic session with a geriatrician, while the other half received no clinical exposure. Secondly, this study had a small sample size and was conducted in a single public institution, thus limiting generalizability. Thirdly, only medical students in the early clinical years (i.e., third year) were involved in the study, thus, the findings may not apply to other different cohorts of health professionals. Finally, we did not have a

control group in this study. Hence, the results may call for judicious interpretations.

## CONCLUSION AND RECOMMENDATION

Our study has shown that implementing multi-professional teachers in an HEC could sustain a positive attitude and improve self-perceived competencies among the undergraduate medical students at our learning institute. However, increasing the enthusiasm in students for pursuing a geriatric medicine career alone was not sufficient as most students remained neutral after the course. Therefore, a more refined older adult-friendly curriculum that addresses the complexity of caring for older adults is recommended to encourage a future career in the field.

In an ageing society, the training of the healthcare workforce should not only focus on knowledge and skills in managing the diseases pertinent in the ageing group but also the ability to work in an interdisciplinary team. Although our course involves multi-professional teachers, it only partially exposes our students to the reality of managing an older adult as a team. We recommend that the course employ an inter-professional teaching method in the future, which may include nursing, pharmacy, law, dietetic, physiotherapy, speech therapy, occupational therapy, and social workers. Secondly, although the UCLA-GAS was internationally validated among medical students and health professionals, there is a need to consider the multicultural background of local students. Future studies should focus on a locally validated tool to measure the attitude toward older adults and perhaps construct against ageism related stereotyping and discrimination.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Universiti Putra Malaysia Ethics Committee JKEUPM-2020-320. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

HS, NZ, and UD: conceptualisation. HM and HS: methodology. HM and NZ: formal analysis. NZ, LI, and WW: investigation. HS: writing—original draught preparation of all sections. HS and AM: writing—original draught preparation of introduction. NZ and UD: writing—original draught preparation of introduction and discussion. HM and NZ: writing—original draught preparation of methods and results. HS, NZ, UD, AM, and WW: writing—final review and editing. All authors contributed to the article and approved the submitted version.

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## SUPPLEMENTARY MATERIAL

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# Ageing Population's Impact on Economic Growth in Malaysia From 1981 to 2019: Evidence From an Autoregressive Distributed Lag Approach

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This study investigates the impact of the ageing population on the economic growth for short- and long-run estimations in Malaysia, by using time series data from 1981 to 2019. This study adopts the autoregressive distributed lag (ARDL) method with the Bound test approach for the long-run estimation and the vector error correction model for the short-run estimation. Several econometric diagnostic tests were applied for validation and the appropriate model specification basis. The estimated result of this work indicates that the age dependency ratio proxy for the ageing population variable has a significant negative impact on economic growth in Malaysia. A 1% increase in old age dependency will decline gross domestic product's (GDP's) growth by an average of 6.6043% at the 5% level of significance. Hence, an increase in the ageing population will impede economic growth. Although controlled variables (e.g., physical capital, labour participation, and human capital) have a significant positive impact on economic growth in Malaysia, there is evidence of a long- and short-run relationship between economic growth and the ageing population variable, and also the control variable.

**Keywords: ageing population, economic growth, endogenous growth model, ARDL, Malaysia**

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## INTRODUCTION

In general, there is a constant fluctuation in gross domestic products (GDP) in Malaysia over time. **Figure 1** shows the GDP growth in Malaysia from 1961 to 2019. There was a sharp decline in 1985 due to low commodity prices. In 1998, the Asian Financial Crisis led to negative GDP growth. In 2009, the global financial crisis led to negative GDP growth. On the contrary, the increase in GDP for 1973 and 1976 was due to the increase in oil prices, as Malaysia is an oil exporter. In 2015, there was a reduction in GDP growth due to the goods and services tax (GST) implementation; therefore, the government provided Bantuan Rakyat 1 Malaysia to increase the consumption of citizens. In 2009, to reduce the impact of the global recession on Malaysians, the monetary policy of the overnight policy rate was reduced. Therefore, we can see that Malaysia used both fiscal and monetary approaches to reduce the impact of the recession. According to WHO (1)[1], the continued decline in fertility rates followed by an increase in life expectancy will likely result in an increase

[1]https://www.who.int/news-room/q-a-detail/population-ageing

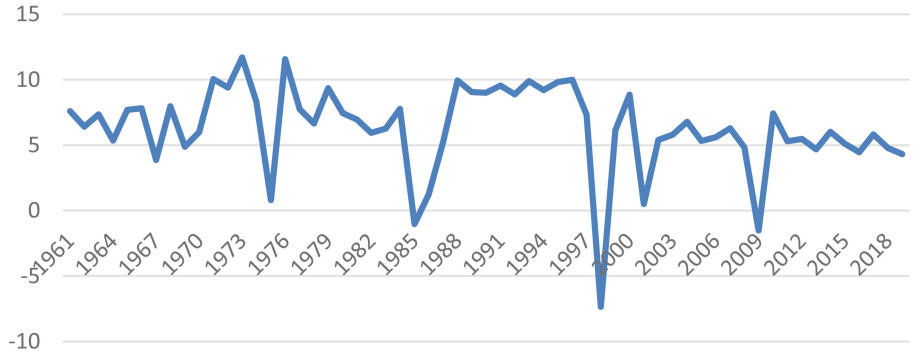


**FIGURE 1 |** GDP growth in Malaysia, 1961–2019. Source: DOSM (2).

**TABLE 1 |** The age dependency ratio, fertility rate, and government health expenditure (2000–2018).

| Year | Age dependency ratio | Fertility rate | Government health expenditure (% of GDP) |
|---|---|---|---|
| 2000 | 6.241 | 2.78 | 1.17 |
| 2002 | 6.527 | 2.54 | 1.37 |
| 2004 | 6.695 | 2.36 | 1.46 |
| 2006 | 6.967 | 2.25 | 1.67 |
| 2008 | 7.238 | 2.19 | 1.60 |
| 2010 | 7.359 | 2.15 | 1.68 |
| 2012 | 7.812 | 2.11 | 1.86 |
| 2014 | 8.373 | 2.07 | 2.03 |
| 2016 | 8.980 | 2.04 | 1.89 |
| 2018 | 9.623 | 2.00 | 1.92 |

*Source: World Bank (3–5).*

in the ageing of the world's populations, where there is an increase of people above the age of 65 years compared with younger people. A nation is considered to have an ageing population if 7% of the population is 65 years old and above. Currently, Malaysia is moving towards having an ageing population. It is estimated that 7% of the population (2.3 million people) will be 65 years old and above in 2020 (2).

In **Table 1**, the age dependency ratio for older people shows an increasing trend, whereas the fertility rate in Malaysia shows a decreasing trend. Research done by Tang and Tey (6) in Malaysia found that higher education, career development of women, and the cost of living led to a decline in the fertility rate for Malaysia. Low fertility rates and increases in longevity can result in an increase in the aged population (7).

Conversely, the general expenditure of the government on health is increasing slightly. According to Meijer et al. (8), the increase in health expenditure is due to the usage of advanced technology, which is likely to benefit Malaysians (including the elderly). Due to the increase of an ageing population in Malaysia, the fifth thrust in Tenth Malaysia Plan aims to focus on the elderly by encouraging the elderly to stay active, productive, and healthy as their age (9).

Both developed and developing countries (such as China, Thailand, Sri Lanka, etc.) experience an ageing population. However, it could create certain impacts for Malaysia. In **Table 1**, the population of people aged 65 years and above increased tremendously, whereas the growth of general expenditure for healthcare only increased slightly over the year. Meanwhile, Japan invested 10.9% of its GDP in 2018 for health expenditure, as it is one of the countries with a higher ageing population (10). Therefore, by moving towards an ageing population, the Malaysian government needs to increase budget allocation for public healthcare expenditure.

Furthermore, having an ageing population could impact the number of labour participants, as there is a decline in population growth. According to Otsu and Shibayama (7), population ageing will decrease the income of the country as it leads to a decline in the size of the workforce. An increase in the ageing population might also lead to a decline in the productivity of the workers. This can be supported by Börsch-Supan et al. (11), who found that older individuals will lead to less productive work outputs after a certain age. Therefore, an increase in the ageing population will likely slow down the productivity of a country.

Moreover, based on the research done by Maestas et al. (12)[2], it was found that ageing will lead to a decrease in economic growth for the United States. Between 1980 and 2010, a 16.8% increase in the population who were 60 years and older led to a 9.2% reduction in GDP. Therefore, having an aged population might slow down Malaysia in becoming one of the developed countries of 2030. Lastly, it is important to have more GDP growth in the country as the income can be used by the government to provide more public goods to Malaysians. In view of the possible problems that may occur due to an ageing population, it is wise for the government to implement policies that help to solve the ageing population so that it can facilitate an increase in GDP growth. The limitation of the study is that there is a limited number of data available in Malaysia.

[2]http://www.nber.org/papers/w22452.pdf

The study focuses on the GDP growth of Malaysia. The variables used are the age dependency ratio as a proxy to the ageing population, and control variables like physical capital, labour participation, human capital, and GDP growth for Malaysia. The data covers 39 years, 1981–2019. This study primarily investigates the impact of an ageing population on economic growth in Malaysia. The objectives of this study include an investigation into the relationships between the ageing population and control variables, such as capital and human capital with GDP growth, the size of the effect of each factor on the GDP growth during the short run, and identification of applicable policies to increase GDP growth in Malaysia.

This study attempts to answer the following research questions:

1. What are the determinants of GDP growth in Malaysia?
2. How can an ageing population, labour participation, physical capital, and human capital make an impact on GDP growth in the short- and long run?

## LITERATURE REVIEW

Several researchers have conducted research works aimed at studying the impact of the ageing population to recommend policy frameworks that will assist the relevant institutions (such as economic planning units and authorities) to provide essential policy instruments and social needs to the population. This will boost the economic growth and development process, especially in developing and underdeveloped countries. These theoretical and empirical studies are examined in this section.

### Theoretical Framework

From a theoretical framework, the economic theory argues that an ageing population can impede the growth of the economy. Modigliani and Brumberg (13), through their life cycle hypothesis, support the opinion that an ageing population can slow down economic growth. The life cycle hypothesis suggests that at an early stage, the ageing of the population will affect a rise in national savings. However, as the population continues to age and some relative proportion of the population reaches their retirement age, this hypothesis predicts a reduction in aggregate savings due to an increase in the ageing population.

Moreover, Solow's growth theory states that in an economy where the population is ageing, the stable economic growth of a country becomes difficult to attain. Stable growth conditions or steady state growth are only possible if the age structure of the population remains constant. However, an economy with an ageing population has an inconstant age structure. Hence, this is only possible during the transition of the economy towards its steady state. Based on this theory, the ageing of a population has a negative impact on economic growth (14, 15).

In addition, the Malthusian catastrophe by Thomas Malthus (16), in his book titled *An Essay on the Principle of Population*, describes a world in which uncontrolled population growth exceeds the resources needed to survive. He argued that human populations tend to grow at a much faster rate than human needs can grow, such as food, clothes, and other agriculture-based products. Therefore, Malthus (16) states that humanity is condemned to living in poverty forever because the growth of agricultural production will always be overtaken by population growth. Malthus's theory raises a question as to the recent argument about the consequences of an ageing population.

Romer (17), Grossman and Helpman (18), and Aghion and Howitt (19) state through endogenous growth models that the population size of a certain country is essential for the long-term development of the economy. The argument is that larger countries can grow more quickly because they have more scientists to employ and feature larger markets with more profit opportunities for competitive and innovative firms. Moreover, Romer (17) argues that a drop in both mortality and fertility lead to population ageing while leaving the population size constant. Therefore, our research will employ an endogenous growth model and focus on the implications of population ageing for GDP per capita growth. Since technological progress has been identified as the main driving force behind economic growth (17), we are particularly interested in seeing the effects of an ageing population on economic growth that will include labour, physical capital, and human capital as our control variables.

Prettner (20) combines endogenous growth models by Romer (17) with semiendogenous growth models and found that a rise in longevity has a positive impact on per economic growth. The reduction in fertility rates has a negative impact on economic growth. Furthermore, the positive longevity effect dominates the negative fertility effect. Population ageing fosters long-run growth in the endogenous growth framework. The main conclusion of Prettner (20) is that constant demographic change does not necessarily hinder technological progress and constitutes economic prosperity. He also argues that declining birth and death rates could lead to an increase in the rate of economic growth.

### Empirical Framework

Selvaratnam et al. (21) emphasise that the increase in life expectancy in Malaysia has led to an increase in government spending on reward and pension costs, as well as the employee's provident fund (EPF) and health expenditure for the elderly. An increase in the population life expectancy causes the older age group to significantly increase, which impacts the economic and social aspects. This presents a financial burden to individuals, families, and policymakers. It involves substantial expenses to provide housing and health facilities. Furthermore, Louria (22) emphasises that an increase in average life expectancy has the potential to increase longevity to about 100–120 years. This will create many social problems, such as a possible increase in health expenditure for the population aged 65+, quality of life issues, the potential for more financial resources, challenges to the possibility of social security and pensions, and other possible issues. By using the autoregressive distributed lag (ARDL) method and vector error correction model, Baharin and Saad (23) support these findings where rising numbers of the ageing population significantly affected health expenditure in Malaysia. Similar work by Ismail et al. (15) argues that the reduction of the old dependency ratio can reduce the tax and social security

contributions paid by employees to fund retirement income and healthcare for the elderly. Therefore, it can also increase the labour supply. This means that there are fewer people to feed and thus more accumulated savings for productive investments in the economy. Therefore, an increase in the old age dependency ratio means that there is an increase in ageing that will hinder economic growth.

On an empirical level, the relationship between the ageing population and growth has been analysed in detail with various results. Certain literature found negative relationships between an ageing population and economic growth, such as the study by Brendan and Sek (24). By adopting the ARDL bound testing approach, they found a significant negative long-run relationship between dependency on the old and economic growth in India. This applies to India, which is expected to experience the negative effect of old age and risk a drop in saving rates and unemployment. From this study on the dependency on the old ratio, most countries such as South Korea, the Philippines, Thailand, Malaysia, and Singapore revealed a negative effect but an insignificant result. This indicates that most Asian countries have a higher youthful population compared with the ageing population, since individuals under the age of 15 contribute highly to the economy, more so than those aged 65 and above. Other studies by Maestas et al. (12)[3] and Rahman (25) also found that the declining fertility rate and rising ageing proxies (such as the old age dependency ratio and population aged 65+) tend to slow down economic growth. However, Teixeira et al. (26) found that the ageing population negatively impacts the growth of developed countries, but not that of less developed countries or developing countries. They argue that the growth of the old age dependency ratio significantly reduces the growth prospects of developing countries, whereas growth of the ageing index and the old age dependency ratio significantly constrains the growth of less developing countries.

Some studies found positive relationships between ageing populations and economic growth, such as those highlighted by Brendan and Sek (24). They found that Japan has the highest old age dependency; thus it has long entered the phase of ageing. To overcome these problems, Japan has been using active ageing policies (such as the Silver Human Resource Centre) and various policies that employ the elderly into the workforce. This initiative will be reducing the negative effect of ageing and simultaneously creating a more positive effect on their economy. Other studies using ARDL by Ismail et al. (15) and Taasim (27) found that the age dependency ratio, population aged 65+, and a reduction of fertility have a positive impact on economic growth. Furthermore, Futagami and Nakajima (28) found positive effects of population ageing on economic growth, such as the development of labour-saving technology and increased investments into human capital. Scarth (29) argues that population ageing could lead to productivity growth by motivating increased investments into human capital, as labour becomes a relatively scarce production factor resource. For this reason, policymakers should focus on improvising policies on long-term care and on investments in technological advancements, education, and health.

[3]http://www.nber.org/papers/w22452.pdf

## METHODOLOGY

The study was conducted to estimate the impact of the ageing population on economic growth in Malaysia. The data for the relevant variables were obtained from the World Bank and Penn World Table 9. The variables used for this analysis include the GDP growth per capita and age dependency ratio, the old population (% of working-age population), the control variables [i.e., gross capital formation (% of GDP) as a proxy to physical capital], labour force participation rate, total (% of total population ages 15+), and human capital index, based on the years of schooling and returns into education (15, 24–26). All the data for these variables were collected from 1981 to 2019, which covers a period of 39 years.

The theoretical framework model used in our study is based on Romer (17). It applies endogenous growth theory to claim that human capital is a significant determinant of economic growth. The equation is as follows:

$$\mathrm{Y_t} = \mathrm{f}\,(\mathrm{K_t}, \mathrm{L_t}, \mathrm{H_t}),$$

where $Y_\mathrm{t}$ is output, $K_\mathrm{t}$ is capital, $L_\mathrm{t}$ is labour force participation rate, and $H_\mathrm{t}$ is the human capital. This study was carried out by modifying the model developed by some researchers, such as Romer (17), Pretnerr (20), Ismail et al. (15), and Brendan and Sek (24). The specification of the economic growth model for this study is as follows:

$$GDPG_t = B_0 + B_1 LAGEING_t + B_2 LK_t + B_3 LL_t + B_4 LHC_t + \varepsilon_t$$

where $GDPG_t$ represents the included *GDP* growth per capita, acting as the economic growth variable to be described in the model. $AGEING_t$ represents the age dependency ratio, old population (% of working-age population), and control variables $K_t$ is the gross capital formation (% of GDP) as a proxy to physical capital. $L_t$ is the labour force participation rate, total (% of total population ages 15+), and $HC_t$ is the human capital index, based on years of schooling and returns to education, respectively.

In this research, the analysis was conducted by using the ARDL model approach. Before proceeding with the ARDL method, we conducted a pretest to check whether our data was stationary. We examined whether the data integrated at I (0), I (1), or I (2). If the data is not stationary at the same level, we can use ARDLs. In this study, we conduct the Philip–Perron (PP) test and Augmented Dickey Fuller (ADF) test. The primary focus of the analysis was to examine the long-run relationships between ageing and economic growth. Hence, the Bound Test, developed by Pesaran et al. (30), has been applied to estimate the possible cointegration between variables. Model specification for the bound test is as follows:

$$GDPG_t = B_0 + \sum_{i=1}^{p} B_{1i} \Delta LAGEING_{t-i} + \sum_{i=0}^{q_1} B_{2i} LK_{t-i} + \sum_{i=0}^{q_2} B_{3i} LL_{t-i} + \sum_{i=0}^{q_3} B_{4i} LHC_{t-i} + \varepsilon_t$$

The selecting order of the ARDL ($p$,$q1$, $q2$, $q3$) uses the Akaike Information Criteria (AIC). The parameter containing the $\Sigma$ sign indicates a short-run relationship between the variable and the dependent variable. The parameters indicate the long-run relationship between the variables in the model. Based on Pesaran et al. (30), all these variables are said to be cointegrated or possess a long-run relationship when all the variables in the above mentioned equation are simultaneously at the same level of lag. *F*-statistics from the Bound Test can be used to find the existence of cointegration among variables in the model. Commonly, the Bound Test has two critical values, known as the upper limit of I (1) and the lower limit of I (0). All variables are said to be integrated at the non-stationary level under the upper bound, whereas all the variables are integrated at the stationary under the lower bound.

These variables are said to be cointegrated and long-run relationships when the *F*-statistic value is greater than the upper bound value. An error correction model was then generated from the above ARDL model. Its analysis aims to simultaneously obtain estimated values for long and short-run parameters for all variables in the model. Lastly, these models were checked by diagnostic tests, such as the normality test, Breusch–Godfrey serial correlation LM test, Heteroskedasticity test Breusch–Pagan–Godfrey, ARCH test, cumulative sum (CUSUM), and CUSUM square test, to ensure that the models were free from unnecessary problems, such as normality, stability, serial correlation, heteroskedasticity, and misspecification.

# RESULTS AND DISCUSSION

## Unit Root Test Result

The unit root test is used to test the stationary status of each variable, irrespective of whether the variable has unit roots. This study utilises the ADF test, which is proposed by Dickey and Fuller (31) and PP. Based on the results of the unit root test, all the variables (i.e., GDP growth, older age dependency, labour participation, physical capital, and human capital) are significant at the 1% level of significance in PP and ADF stationarity tests, at first difference. Thus, we can conclude that all the data are stationary at first difference (**Table 2**).

**TABLE 2 |** Unit root test result.

| Variable | Augmented Dickey Fuller (ADF) | | Philips Perron (PP) | |
|---|---|---|---|---|
| | Level | First difference | Level | First difference |
| GDPG | −5.0765 *** | −7.4727*** | −5.0765*** | −18.7528*** |
| | (0.0010) | (0.0000) | (0.0010) | (0.0000) |
| LAD | −3.4359 | −3.8176** | −2.8401 | −7.9575*** |
| | (0.0643) | (0.0290) | (0.1929) | (0.0000) |
| LK | −2.1443 | −5.5442*** | −2.2664 | −5.5442*** |
| | (0.5056) | (0.0003) | (0.4412) | (0.0003) |
| LL | −4.5395** | −5.1811*** | −4.5708** | −17.6792*** |
| | (0.0044) | (0.0009) | (0.0041) | (0.0000) |
| LHC | −2.1334 | −6.2945*** | −2.1796 | −6.2945*** |
| | (0.5110) | (0.000) | (0.4864) | (0.0000) |

**** and ** denotes significant at 1 and 5% significance level, respectively. The figure in parenthesis (…) represents P-value or probability value for the significance level.*

**TABLE 3 |** ARDL long run results.

| Variable | Estimation of long-run coefficient | |
|---|---|---|
| | Coefficient | *t*-Statistic |
| LAD | −6.6034 | −2.6792** |
| LK | 3.9430 | 2.7213** |
| LL | 33.0956 | 3.2736*** |
| LHC | 17.8709 | 3.4323*** |
| C | −154.4565 | −3.8140*** |
| **ARDL bound test estimate** | | |
| *F*-statistic | 11.24934 | |
| Narayan (32) | I(0) | I(1) |
| **Critical value** | | |
| 10% | 2.2 | 3.09 |
| 5% | 2.56 | 3.49 |
| 1% | 3.29 | 4.37 |

****, **, and * are denoted as significance levels at 1, 5, and 10%, respectively.*

## Estimation Output Result

In our study, the models selected for ARDL are 2, 0, 3, 4, and 4. *R*-squared results show the value of 0.9292 (which indicates the older age dependency, labour participation, physical capital, and human capital) explains nearly 92.92% of the variation in GDP growth. The remaining 7.08% is explained by other factors that are not included in this study (**Table 3**).

## Bound Testing Result

*F*-statistic in the bound test is 11.2493, which is greater than the lower bound I (0) =3.29 and upper bound I (1) = 4.37 at a 1% significant level, as obtained from the critical value table of Narayan (32). Hence, we reject the null hypothesis that no long-run relationship exists. We accept the alternative hypothesis that there is a long-run relationship between GDP growth and its determinants, which are old age dependency, labour participation, and physical and human capital. From the bound testing, there is a long-run relationship; therefore, we can further develop the ARDL model.

$$\mathrm{GDPG} = -154.4565 - 6.6034\mathrm{LAD} + 3.9430\mathrm{LK} + 33.0956\mathrm{LL} + 17.8709\mathrm{LHC}$$

$$(40.4974)^{***}\quad (2.4647)^{**}\quad (1.4489)^{**}\quad (10.1098)^{***}\quad (5.2066)^{***}$$

Based on the abovementioned equation, the result shows that there is a negative relationship between old age dependency and GDP growth. A 1% increase in old age dependency will decline GDP growth by an average of 6.6043% at the 5% level of significance. On the contrary, physical capital, labour participation, and human capital have positive relationships with

GDP growth. Increasing 1% of labour participation and human capital will increase GDP growth by an average of 33.0956 and 17.8709%, respectively, and is statistically significant at the 1% level of significance. A 1% increase in physical capital will increase GDP growth by an average of 3.9430% and is statistically significant at the 5% level of significance.

The estimated result indicates that the old age dependency ratio proxies for the ageing population variables have a significant negative relationship with the economic growth in Malaysia. This implies that an increase in the ageing population will impede economic growth in Malaysia. Based on theoretical studies, Romer (17) highlighted that population ageing is favourable for long-run economic growth. However, the relative change between fertility and mortality will determine whether it is associated with an increase or decrease in long-run economic growth. This study is not aligned with the endogenous growth model by Pretnerr (20) because he argues that increases in longevity have a positive impact on economic growth. However, this result aligns with the life cycle hypothesis by Modigliani and Brumberg (13). This confirms the argument of the economic theory, which is as follows: when the population continues to age and some proportion of the population reaches their retirement age, there is a reduction in aggregate savings due to an increasingly ageing population; this situation will lead to slow economic growth.

While for empirical studies, Selvaratnam (21) and Louria (22) point out that an increase in life expectancy/an ageing population has the potential to create many economic and social issues, such as the increase in health expenditure for the aged population (23), more long-term financial resources, challenges to social security and pensions, quality of life problems, and so forth. Ismail et al. (15) also argue that the reduction in the old population dependency ratio can reduce taxes and social security amounts. This proportion of accumulated savings could have been allocated to other productive aspects of the economy. In other words, the increase in ageing might hinder economic growth.

## Error Correction Test Result

Thereafter, we examine the short-run models. We had to compute the error correction term (ECT) to form the short-run model. When we differentiate the dependent variable, it is already removed from the long-run information. Therefore, the long-run information is captured by ECT. Thus, $\phi$ needs to be in a negative form, $-2 < \phi < 0$. The 1981–2019 result shows that the ECT was negative, which is −1.655. This indicates that the feedback mechanism is significantly effective in Malaysia. Thus, the speed of adjustment towards long-run equilibrium is 165.5% annually. Changes to the independent variables (i.e. old age dependency, labour participation, physical capital, and human capital) are corrected by GDP growth. The 165.5% deviation in the long-run was corrected by GDP growth. This reflects a significantly high-speed adjustment to long-run equilibrium after a shock. Therefore, any short-run deviation will take about 0.60 years to bring the shock back to equilibrium (**Table 4**).

**TABLE 4 |** ARDL short run and diagnostic test results.

| Variable | Estimation of short-run coefficient | |
|---|---|---|
| | **Coefficient** | ***t*-statistic** |
| D(GDPG(-1)) | 0.4582 | 3.7118*** |
| D(LK) | 20.5699 | 10.7524*** |
| D(LK(-1)) | 2.0003 | 0.6918 |
| D(LK(-2)) | 11.0066 | 3.8146*** |
| D(LL) | 18.0272 | 3.4112*** |
| D(LL(-1)) | −36.4204 | −5.3345*** |
| D(LL(-2)) | −21.3657 | −3.2828*** |
| D(LL(-3)) | −16.7536 | −3.0967*** |
| D(LHC) | 173.9205 | 1.2979 |
| D(LHC (-1)) | 403.8911 | 2.4712** |
| D(LHC(-2)) | 307.5912 | 1.6750 |
| D(LHC(-3)) | −481.2427 | −3.4383*** |
| $ECT_{t-1}$ | −1.6550 | −9.3460*** |
| **Diagnostic checking** | | |
| **Test** | | ***P*-value** |
| Normality | | 0.7136 |
| BG serial correlation LM | | 0.4166 |
| Heteroskedasticity | | 0.4364 |
| ARCH | | 0.1768 |

****, **, and * are denoted as significance levels at 1, 5, and 10%, respectively.*

# DIAGNOSTIC CHECK TEST RESULT

## Histogram-Normality Test

Based on the Histogram-normality test, it seems that the residuals are normally distributed as the Jarque-Bera value of 0.6750 with a *P*-value > 5% significance level. Therefore, it indicates that the data have residual or error terms which are normally distributed; the error term follows the normal distribution.

## Serial Correlation Test

For the serial correlation test, we used the Breusch–Godfrey serial correlation LM test. We found that there is a higher order correlation between error terms. The test shows that the *P*-value (0.4166) is > 5% significance level. Thus, we fail to reject the null hypothesis of no autocorrelation. A higher probability value > 0.05 strongly indicates the absence of a serial correlation in the residuals. Thus, we can conclude that the data do not have an autocorrelation problem.

## Heteroskedasticity Test

For the heteroscedasticity test, we used the Breusch–Pagan–Godfrey Heteroskedasticity test result. Under the null hypothesis, there is an absence of the heteroskedasticity problem and the presence of homoscedasticity. The variance of the error term is constant. For the alternative hypothesis, there is a presence of the heteroscedasticity problem and an absence of homoscedasticity. This test found that the *P*-value (0.4364) is >5% significance level.

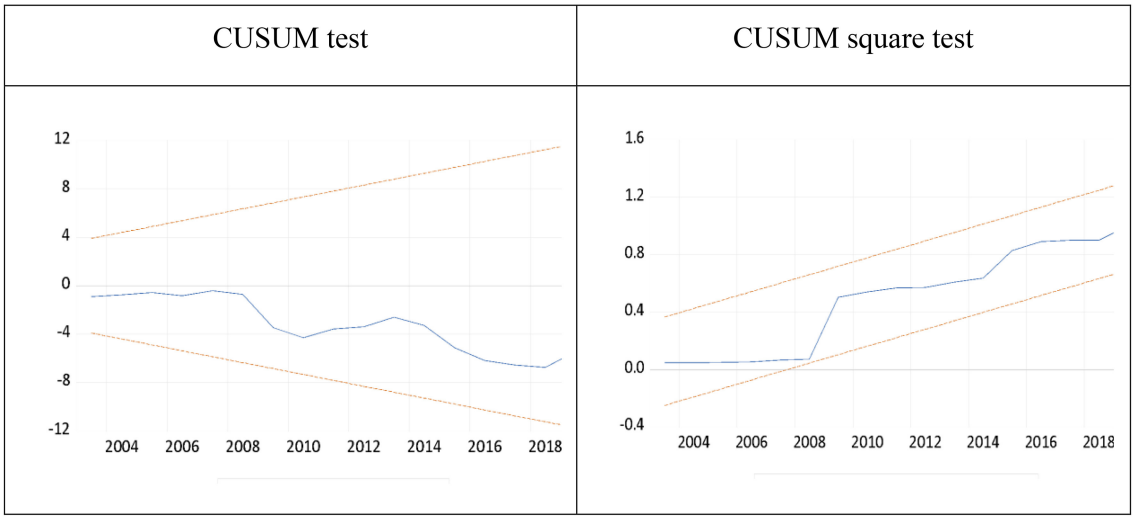


**FIGURE 2 |** CUSUM and CUSUM square test results.

Therefore, we fail to reject the null hypothesis of no pure heteroscedasticity. We can conclude that there is no heteroscedasticity problem and the error terms have constant variance.

## Autoregressive Conditional Heteroskedasticity

Based on the ARCH result, the *P*-value (0.1768) is more than the 5% significance level. Thus, we fail to reject the null hypothesis of no ARCH problem; therefore, our data do not have ARCH problems.

## Stability Test

Based on **Figure 2**, a visual inspection of the plot above indicates that the plots of CUSUM appear inside 5% critical bands or stay within the critical bounds. These simply imply that the estimated parameters in the CUSUM test are stable over the sample period. Similarly, the estimated parameters in the CUSUM square test are stable or stationary across our period of study.

# CONCLUSION AND POLICY RECOMMENDATIONS

This study attempts to investigate the impact of the ageing population on the economic growth for the short- and long-run estimations in Malaysia by using time series data. Its estimated result indicates that the old age dependency ratio proxies for the ageing population variables have a significant negative relationship to economic growth in Malaysia. This implies that an increase in the ageing population will impede economic growth in Malaysia. Although control variables (such as physical capital, labour participation, and human capital) have positive relationships with economic growth in Malaysia, there is evidence of a long- and short-run relationship between economic growth and ageing population variables, and also control variables.

Romer (17) highlighted that population ageing is favourable for long-run economic growth. However, the relative change between fertility and mortality will determine whether it is associated with an increase or decrease in long-run economic growth. This study is not aligned with the endogenous growth model by Pretnerr (20) because he argues that increases in longevity have a positive impact on economic growth. However, this result aligns with the life cycle hypothesis by Modigliani and Brumberg (13). This confirms the argument of the economic theory, which is as follows: when the population continues to age and some proportion of the population reaches their retirement age, there is a reduction in aggregate savings due to an increasingly ageing population; this situation will lead to slow economic growth. Moreover, Selvaratnam (21) and Louria (22) point out that an increase in life expectancy/an ageing population has the potential to create many economic and social issues, such as the increase in health expenditure for the aged population (23), more long-term financial resources, challenges to social security and pensions, quality of life problems, and so forth. Ismail et al. (15) also argue that the reduction in the old population dependency ratio can reduce taxes and social security amounts. This proportion of accumulated savings could have been allocated to other productive aspects of the economy. In other words, the increase in ageing might hinder economic growth. Furthermore, the findings in this study are in tandem with the findings of Brendan and Sek (24), Maestas et al. (12)[4], Teixeira et al. (26), and Rahman (25).

Based on our results, we found that labour participation and human capital are the most significant determinants

[4]http://www.nber.org/papers/w22452.pdf

of GDP growth in Malaysia. This finding confirms that the endogenous growth theory (which is labour productivity and human capital) is another growth engine, along with physical capital. Thus, we recommend that policymakers and economic planning authorities control these two variables to boost the growth of the economy so that Malaysia can become a developed country by 2030. These variables should be reviewed along with related mechanisms to achieve higher productivity, sustainable economic development, and growth.

Furthermore, Malaysian policymakers and authorities should consider active ageing policies that are widely implemented in Japan, such as the Silver Human Resource Centre, that employ the elderly into the workforce because this group has a lot of experience and can contribute to ideas and guidance for future generations. Recently, there is a rising trend of an ageing population in Malaysia. This raises concerns about whether Malaysia will suffer from the negative effect of old age, decreasing saving rates, and possible unemployment in the future. Indubitably, all these issues require further analyses and are on our future research agenda.

## DATA AVAILABILITY STATEMENT

Publicly available datasets were analysed in this study. This data can be found at: the world bank and penn world table.

## AUTHOR CONTRIBUTIONS

AI and SM contributed to the conception and design of the study, organised the database, performed the statistical analysis, and wrote the first draft of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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# Prevalence, Circumstances, and Risk Factors of Falls Among Community Dwelling Members of University of the Third Age

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**Objective:** Study aimed to identify the prevalence of falls and associated contributory factors among older Malaysians.

**Methods:** A cross sectional study among community dwelling older adults aged 50 years and above. Self-administered questionnaires on history of falls in the previous 12 months, physical assessment and computerized and clinical measures of balance were assessed on a single occasion.

**Results:** Forty nine (31.0%) participants fell, with 4.4% reported having multiple falls within the previous 12 months. Slips were the most prevalent cause of falls, accounting for 49% of falls. More than half (54.5%) of falls occurred in the afternoon while participants walked inside the home (32.7%), outside home (30.6%), and 36.7% were in community areas. More than half of respondents were identified as having turning instability. Step Test, turn sway, depression, physical activity level and edge contrast sensitivity were significantly worse for fallers ($p < 0.05$). Multiple logistic regression analysis showed that turning performance, visual acuity and back pain were significantly associated with falls risk, accounting for 72% of the variance of risk factors for falls among studied population.

**Conclusion:** Falls are common among community dwelling older Malaysians. The findings provide information of falls and falls risk factors among community dwelling older adults in Malaysia. Future intervention studies should target locally identified falls risk factors. This study has highlighted the importance of instability during turning as an important fall risk factor.

**Keywords: accidental falls, risk factors, community dwelling, older adult, balance**

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## INTRODUCTION

Falls are common events among older people and have become known as one of the "geriatric giants" (1–3). Due to their increasing falls prevalence with increasing age (4) and the unprecedented rate of aging populations worldwide (5–7), falls have become one of the most common and serious health problems in older adults (8–11). A recent review of epidemiological studies of fall across countries, indicated that the range of fall in the community setting older person

is between 20 and 33%. These falls resulted in serious injuries in 10–20% of cases, and 2–6% resulted in a fracture or other serious injuries requiring hospitalization.

Although there are many studies of falls risk factors and falls prevention interventions, the majority of these have been undertaken in Western countries (1, 12). There have been a small number of studies that have reported falls incidence in Asian nations such as Taiwan (8, 13), Japan (14, 15), Korea (16–18), Hong Kong (13), Singapore (19, 20), and Thailand (21). These small number of studies have reported varying rates of falls, between 10 and 33%, for the proportion of older people falling in Asian countries in a 12 month period (7). Differences in age, racial background, socio-demography, environment and population settings, life-style (diet, activity, sunlight exposure), body dimensions, and culture between countries might all contribute to the differences of fall prevalence, circumstances and consequences of falls across different regions of the world (22–24). Additionally, differences in sampling, recruitment and methods of data ascertainment (retrospective vs. prospective falls data), and possibly cultural differences in willingness to report specific health problems such as falls, may account for some of these differences. In addition, research is needed to identify prevention strategies that will be effective in different cultural contexts (3, 25).

The older population in Malaysia is growing rapidly. In 2007, they were 1,195,480 people aged 65 years and above which represented 4.41% of the total population (Department of Statistic, 2018). It was projected that by the year 2019, older persons population aged 65 and above would reach 7% and would double to 14% in 2043 and Malaysia will become and aged nation by year 2030 whereby the older population comprises 15% of the total population. This demographic change seen older people forming a more significant part in the Malaysian society. This situation creates the need for preventive action to minimize the impact of the problems associated with aging, such as falls. Therefore, the magnitude of the problem of falls and associated contributory factors needs to be defined in the Malaysian context, and management strategies should be designed within the context of local needs and the Malaysian primary and public health care systems. The aims of this study were to identify the prevalence of falls in community dwelling older Malaysians, and associated risk factors and circumstances.

# METHODS

## Study Design

A cross-sectional study using convenience sampling was undertaken to quantify the prevalence of falls in previous 12 months and to identify the risk factors for falls and circumstances of falls among studied population. In the present study, a fall was defined as "unintentionally coming to the ground or some lower level and other than as a consequence of sustaining a violent blow, loss of consciousness, sudden onset of paralysis as in a stroke or epileptic seizure"[1].

[1]The prevention of falls in later life. A report of the Kellogg International Work Group on the Prevention of Falls by the Elderly. (1987). Danish Medical Bulletin, 34 Suppl 4, 1–24.

## Setting, Participants and Sampling

Participants were recruited through the distribution of flyers to all members of University of the Third Age (U3A) Selangor and Kuala Lumpur, Malaysia, based at the Institute of Gerontology, Universiti Putra Malaysia. University of the Third Age (U3A) Malaysia, is program that provide lifelong learning courses to older adult aged 50 years and above. Inclusion criteria for the study were (i) living in the community and (ii) being aged 50 years and above. The cut-off age of 50 years and above was used in this study rather than 65 years of age because of a lower life expectancy in Malaysia compared to in Western countries. The life expectancy for Malaysia was 72.2 and 77.3 years for males and female, respectively (26), and (iii) able to tolerate standing at least 6 min independently or with a single point stick support. Older adults who expressed interest in participation were contacted through an initial phone call to discuss details of what the project involved. Screening was carried out during this phone conversation to ensure all eligibility criteria for the study were met. Written consent was obtained from each participant.

Data were obtained by trained researchers based on a structured questionnaire, and a series of tests of physical performance. The structured questionnaire comprised of five main sections: (i) socio-demography information, (ii) physical and medical conditions, (iii) history of falls and falls risk assessment, (iv) psychological aspect associated with falls, and (v) self-reported level of physical activity. The physical performance measures, reported below, included both clinical and laboratory assessments of balance and mobility. The questionnaires were interspersed between the physical performance tests. The interview and assessments were conducted at the assessment laboratory and lasted ∼90 to 120 min. Participants were allowed to have a rest between the tests if required.

## Measurements

Height (SECA Bodymeter), weight and body composition (BF-418, TANITA, Japan) were measured by trained assessor. Level of physical activity was assessed using Human Activity Profile, a questionnaire with 94 activity items listed in order of increasing energy expenditure. Each item was rated as "still doing," "have stopped doing," or "never did." The Adjusted Activity Score (AAS) (highest numbered item listed as "still doing" less the number of items rated as "have stopped doing") was used in the analysis.

Visual edge contrast sensitivity was assessed using the Melbourne Edge Test. This test presents 20 circular patches containing edges with reducing contrast (27, 28), with the highest numbered circle where the direction of the edge of contrast is correctly identified recorded and were reported in the study.

### History of Falls and Fall Risk Assessment

Participants were asked to recall any falls in the preceding 12 months. For each fall, data was reported on location, activity at the time of fall, obstacles involved in the fall, any warning signs, type of injuries and medical attention sought (falls circumstances were collected for up to a maximum

of four falls). Falls risk was assessed using the Falls Risk Assessment of Older Person-Community version (FROP-COM), a validated tool with moderate accuracy in predicting future falls (29).

### Clinical Measures of Balance and Mobility

The clinical test battery used in this study included simple and quick tests of balance performance that are routinely used in clinical practice and research and been shown to be reliable and valid in older populations as followed; Timed Up and Go (TUG) Test (30, 31), The Functional Reach (FR) test (32), The Step Test (ST) was used to evaluate the speed of performing a dynamic single limb stance task (33).

### Computerized Balance Assessment

Computerized Postural Balance Performance tests were undertaken using Neurocom® Balance Master force balance platform (Neurocom International, Inc., Clackamas, OR, USA), which computes forces from force transducers under the plate on which the participant stands or moves (34, 35). Participants wore a safety harness attached to an overhead rail for the first two tests. There are five measures of balance performance were assessed on the Balance Master long force plate as follows; (i) Modified Clinical Test of Sensory Integration of Balance (mCTSIB); (ii) Limits of stability (LOS) test were used to quantify the ability of the participant to intentionally displacing their Center of Gravity (COG). The LOS measure has been shown to be sensitive to identify fallers and predict future falls and to have good internal consistency, ICC $>$ 0.84; (iii) Sit to Stand (STS) test was performed on the long force plate to quantify several movements characteristics related to the ability to stand up from a seated to a standing position without overbalancing; (iv) Walk Across (WA) test was used to quantify several characteristics of gait including stride length (cm) and step width (cm); and (v) The step quick turn (SQT) test was used to quantify two movement characteristic as the participant quickly turned 180 degrees. All test was repeated three times and the average was used for data analysis.

### Psychological Measures

Psychological aspects associated with falls (fear of falling and depression) were measured using the Short Falls Efficacy Scale-International (FES-I) (36) and the Geriatric Depression Scale (GDS-15) (37), respectively. The FES-I measured the participants' self-reported level of concern about falling when performing seven selected activities. The score was ranged from 1 (not concern at all) up to 4 (very concern) for each item, with a maximum score of 28.

## Statistical Analysis

Descriptive analysis was applied to participant demographic data and all outcome measures. Performance on all outcome measures were compared between participants who reported one or more falls in the preceding 12 months and those reporting no falls, using *t*-test for continuous/normally distributed variables, and chi squared for categorical variables. Univariate logistic regression was performed to determine variables associated with falls and variables with a $p < 0.1$ were then included in a multivariate logistic regression (38). All analyses were conducted using SPSS vs. 22.0, and the critical value for all analyses was $p < 0.05$.

**TABLE 1 |** Socio demographic profile of respondents ($N = 156$).

| Variables | | Means (SD) Median [IQR] | Percentages (%) |
|---|---|---|---|
| Sex | Male | | 43.1 |
| | Female | | 56.9 |
| Age (years) | | 63.2 (6.2) | |
| Ethnicity | Malay | | 80.6 |
| | Non-Malay | | 19.4 |
| Marital status | Married | | 76.3 |
| | Divorced/widowed/ Never Married | | 23.7 |
| Education level | Primary | | 13.5 |
| | Secondary | | 54.5 |
| | Tertiary | | 32.0 |
| Living arrangement | Lived alone | | 6.4 |
| | Lived with spouse only | | 26.3 |
| | Lived spouse/children/ others | | 67.3 |
| No. of children | | 3.6 (2.1) | |
| Monthly Income (MYR) | | MYR1900 [MYR2000] | |
| Employment status | Not working/ retirees | | 89.4 |
| | Still working | | 10.6 |
| Cognitive score (AMTS) | | 9.44 (0.8) | |

*M, mean; SD, standard deviation; Mdn, median; IQR, interquartile range; MYR, Malaysian Ringgit; AMTS, Abbreviated mental Test Score.*

# RESULTS

## Participants Profile

A total of 156 participants were assessed (**Table 1**). The age of study participants ranged from 50 to 78 years old, with mean (SD) age was 63.2 (6.2), and more than half of the participants (57%) were females. The majority of participants were Malay (83.4%) and most were still married (76.3%). In terms of education level, all participants were literate (able to write and read) with more than half of participants (56.5%) having received secondary education. Most participants (73.1%) were retired and the median income for study participants was MYR1900 per month. There was no significant difference of socio-demographic between faller and non-faller.

**TABLE 2 |** Physical and health profile of participants ($N = 156$).

| Variables | *M* (SD)/*Mdn* [IQR] | Percentages (%) |
|---|---|---|
| Height (cm) | 155 (8.1) | |
| Weight (kg) | 66.2 (13.3) | |
| **BMI (kgms$^{-1}$)** | | |
| Underweight (<18.5) | | 0.8 |
| Normal (18.5–24.9) | | 23.1 |
| Overweight ≥ 25 | | 48.1 |
| Obese | | 28.0 |
| **Number of health conditions** | | |
| None | | 36.1 |
| 1–3 conditions | | 56.4 |
| 4 or more conditions | | 7.5 |
| **Medical problems** | | |
| Diabetes mellitus | | 30 (19.2) |
| Arthritis | | 26 (16.7) |
| Cardiac problems | | 23 (14.7) |
| Back pain | | 23 (14.7) |
| Dizziness | | 19 (12.2) |
| Neurological condition | | 19 (12.2) |
| Respiratory problem | | 13 (8.3) |
| Osteoporosis | | 7 (4.5) |
| **Number of prescribed medications** | | |
| No medication | | 36.1 |
| 1–2 medications | | 33.8 |
| 3 or more medications | | 30.1 |
| Fall Efficacy Score (FES-I) | 17.6 (6.1) | |
| Geriatric Depression Scale (GDS-15) | 2.1 (1.9) | |

*M, mean; SD, standard deviation; Mdn, median; IQR, interquartile range; BMI, Body Mass Index.*

**TABLE 3 |** Falls related information ($n = 49$).

| Information of fall | | Frequency (Percentage %) |
|---|---|---|
| Number of falls within last 12-month period | One | 42 (85.7) |
| | Two | 7 (14.3) |
| Cause of falls | Trip | 15 (30.5) |
| | Slip | 23 (46.9) |
| | Loss of balance | 11 (22.4) |
| Location of falls | Inside home | 17 (34.7) |
| | Outside home | 14 (28.6) |
| | Community area | 18 (36.7) |
| Time of falls | Day time | 23 (46.9) |
| | Night time | 26 (53.1) |
| Activity during falls | Walking | 23 (40.8) |
| | Turning | 20 (46.0) |
| | Bending/reaching/avoiding obstacle | 6 (12.2) |
| Experience falls related injuries | No injury | 9 (18.3) |
| | Minor Injury (did not require medical attention) | 22 (44.9) |
| | Minor Injury (did require medical attention) | 13 (26.5) |
| | Severe injury (fracture, dislocation, hospitalization) | 5 (10.2) |

## Health Condition and Psychological Factors

In terms of health and medical conditions, 56% of participants reported of having at least one to three health problems and 7.5% had four and more health problems that might affect their balance performance (**Table 2**). The most common health conditions reported were diabetes mellitus (19.2%), arthritis (16.7%), cardiac problems (14.7%), and back pain (14.7%). Thirty percent of participants reported taking three or more types of medication daily and antidepressant (29.5%) was the most common taken medication. Only two participants in present study, used a single point of stick during outdoor activity. The majority of participants were considered not to have depressive symptoms based on a GDS score of between 0 and 4 (39, 40), with an overall mean score for GDS-15 of 2.22 ± 2.3 SD. Study also found that the mean score of FES-I was 17.6 (6.1 SD) and 16.8 (6.4SD) among non-fallers and fallers respectively.

## Prevalence, Circumstances, and Consequences of Falls

Study found 49 (31.4%) participants had at least one fall in the previous 12 months, and seven of these participants (14.3%) reporting experiencing two falls within the 12 months prior to the date of interview (**Table 3**). Out of the 49 participants who fell, 31 (63.3%) were female and 18 (36.7%) were males. The mean age of fallers and non-fallers were 63.3 years (6.5 SD) and 62.5 years (6.8 SD), respectively. There was no difference in the proportion of fallers who were male (36.7%) or female (63%), $\chi^2$ $(1, n = 156) = 1.36$, $p = 0.243$ nor between the three age groups (36.7%) of fallers were aged 50–59, 32.7% aged 60–69 and 30.6% aged 70 years and above, $\chi^2$ $(2, n = 156) = 1.36$, $p < 0.05$.

The self-perceived causes and consequences of fall were obtained from the participant's explanation regarding their falls. Most fallers fell at home (63.3%). The bathroom, kitchen and dining area, and bedroom were the most common areas where falls occurred inside the home, and the backyard area was the most prevalent area reported for falls occurring outside the home. Thirty seven percent of fallers reported falling in community areas, with the most frequent location for these falls being in front of shops, streets (including curb, uncovered drain or uneven walking paths), and park areas. Trips and slips were the most prevalent causes, accounting for 77% of falls, with a further 20.4% being described as due to loss of balance. Almost a third of fallers fell in the forwards direction and 18.4% fell backward. Based on self-report regarding the severity of injuries incurred during falls, nine fallers (18.4%) reported no injury, while 40 fallers (81.6%) suffered injuries from their fall. More than half of fallers (71.4%) sustained minor injuries such as

**TABLE 4 |** Univariate analysis of physical and psychological condition of participants according to fall status.

| Parameter | Non-faller ($n = 107$) Mean (SD) | Faller ($n = 49$) Mean (SD) | *P*-value |
|---|---|---|---|
| Body mass index ($kg/ms^{-2}$) | 27.2 ± 4.7 | 28.6 ± 4.5 | 0.071* |
| Contrast sensitivity (MET score) | 21.2 ± 1.7 | 20.5 ± 1.9 | 0.028** |
| **Physical activity and psychological aspect** | | | |
| Fall efficacy score (FES-I) | 17.6 ± 6.1 | 16.8 ± 6.4 | 0.437 |
| Depression (GDS-15) | 1.9 | 2.9 | 0.008** |
| Physical activity level (HAPAAS) | 65.4 | 62.7 | 0.328 |

**statistically significant at $p < 0.05$, **statistically significant at $p < 0.01$.*

**TABLE 5 |** Univariate analysis of balance and mobility performance of participants by fall status.

| Parameter | Non-faller ($n = 107$) Mean (SD) | Faller ($n = 49$) Mean (SD) | *P*-value |
|---|---|---|---|
| **Clinical measures of balance** | | | |
| Functional reach test | 27.4 ±6.5 | 28.0 ±5.7 | 0.577 |
| Step test (worst side) | 16.5 ±3.5 | 14.9 ±3.7 | 0.012** |
| Timed up and go | 10.1 ±1.9 | 10.6 ±2.3 | 0.177 |
| Timed up and go with dual task | 11.3 ±2.5 | 12.2 ±3.6 | 0.066 |
| Timed chair stands | 17.4 ±5.9 | 17.6 ±5.4 | 0.873 |
| **Laboratory measures** | | | |
| mCTSIB—mean COG sway (deg/sec) | 0.6 ±0.4 | 0.7 ±0.4 | 0.331 |
| LOS—composite movement velocity (deg/sec) | 3.1 ±1.3 | 2.9 ±1.0 | 0.223 |
| LOS—composite reaction time (sec) | 1.9 ±1.2 | 1.3 ±1.3 | 0.552 |
| Walk across—step width (cm) | 17.7 ±6.2 | 17.8 ±3.0 | 0.853 |
| Walk across—speed (cm/sec) | 62.8 ±15.0 | 57.4 ±16.8 | 0.044** |
| Sit to stand test- mean rising index (%of body weight) | 16.2 ±8.5 | 13.8 ±5.8 | 0.073 |
| Sit to stand test- mean COG sway (deg/sec) | 2.8 ±0.9 | 2.8 ±0.9 | 0.801 |
| Step quick turn—worst side time turning (sec) | 2.2 ±0.8 | 2.5 ±0.8 | 0.039** |
| Step quick turn worst sway turning (deg/sec) | 49.0 ±8.0 | 52.2 ±9.3 | 0.028** |

***statistically significant at $p < 0.01$.*

**TABLE 6 |** Multiple logistic regression association with fall status.

| Parameter | Exp (B) | 95% CI | | *P*-value |
|---|---|---|---|---|
| | | Lower | Upper | |
| BMI ($Kgms^{-2}$) | 1.065 | 0.977 | 1.166 | 0.156 |
| Visual contrast sensitivity (MET score) | 0.874 | 0.701 | 0.809 | 0.028* |
| Depression (GDS score) | 1.149 | 0.938 | 1.408 | 0.179 |
| Back pain (no) | 0.214 | 0.077 | 0.596 | 0.003** |
| Timed up and go (dual task) | 0.941 | 0.759 | 1.167 | 0.579 |
| Walk across—speed (cm/sec) | 1.010 | 0.974 | 1.047 | 0.072 |
| Step test (worst leg) | 0.888 | 0.845 | 1.070 | 0.607 |
| Turning impairment (yes)[#] | 4.824 | 1.707 | 12.839 | 0.003** |

**Statistically significant at $p < 0.05$, **Statistically significant at $p < .01$.*
*OR, odd ratio; CI, confidence interval; BMI, Body mass Index; MET, Melbourne Edge Test;*
*[#]Turning impairment categorized—yes = turn sway or turn time or both outside of normal limits on the Neurocom™ Balance Master.*

grazes, bruises, sprains, and cuts, while 10.2% reported suffering a severe injury such as fracture or dislocation as a consequence of their fall. Among those five participants who experienced severe injuries, one participant had a fractured patella, one experienced an ankle fracture, one had a wrist fracture and two had ankle dislocations. Meanwhile, those fallers who had minor injuries, 22 (62.8%) did not require medical treatment and 37.2% did seek medical attention. Consequently, most of the fallers perceived these injuries has restricted their mobility for at least 3 days up to a month.

## Risk Factors for Falls

Independent group *t*-test indicates a number of significant differences were identified between fallers and non-fallers with fallers having higher BMI, lower MET score, and higher depression score (**Table 4**), as well as poor balance (Step Test), and more sway and took longer time to perform the step quick turn test, and slower walking speed (**Table 5**). In addition, presence of back pain was significantly associated with falls status, $\chi^2(1) = 3.56$ ($p \leq 0.05$). Participants with those reporting back pain are three time odd to fall than those without back pain (O.R: 2.87).

A multiple logistic regression was performed to ascertain the effect of BMI, step test, turning performance, degree of sway and turn taken during step quick turn test, level of depression, having back pain problem and edge contrast sensitivity on the odd that participants have fall as listed in **Table 6**. The logistic regression model was statistically significant, $\chi^2(3,7) = 7.885$, $p = 0.048$. The model explained 20.7% of the variance in having a fall, and correctly classified 71.8% of fallers. Those who were identified as having imbalance during turning were 4.8 times more likely to have a fall compared to those who did not have turning impairment.

# DISCUSSION

Results from this study indicated the frequency of falls among older people in Malaysia was common and comparable to previous a range of 13.8 to 62.1% as reported by other studies (41). Of note, the majority of Asian studies reporting falls rates were substantially lower than those reported in the present study. Our study, similar to the majority of studies reported in the Kwan et al. (13) review used retrospective recall of falls in the past 12 months, which has been shown to under-estimate actual falls numbers by ∼20% due to the possibility that participants has been forgotten to recall their fall experiences (42). There are other factors that might contribute to the lower falls rates reported

in some of these previous studies, including not having a clear definition of fall and different interpretation between participants and researcher. Zecevic et al. (43) concluded that older people prone to consider falls resulted from loss of balance, due to the unintentionally trip or slip whereas healthcare professional tend to refer falls as incident that leads to injuries and illness. In cultural perspective, among Asian population, fall was seen to be disgraceful experience that might be reported to other people (44). Interestingly, the current study found that those in the group 50's experienced more falls compared to older group. This finding is similar to previous study which reported that 62% of those were aged 50 years and above experienced more fall compared to others older age groups (41) and consistent with the other Asian studies that reported the younger age groups experienced more falls (16). Possible explanations for this unexpected finding may be due to the recruitment which constituted participants among U3A membership that relatively healthy and active. Furthermore, the younger group may be involved in more vigorous activity levels that could increase exposure to the risk of falls as compare to older aged group that less active.

In contrast to the previous studies, there is no significant effect of age, gender and socio demographic aspect contribute the prevalence of fall in the present study. Variables that significantly correlated with falls were: step test, edge contrast sensitivity score, BMI, having back pain, depression level and abnormal turning performance during SQT test. The most significant variable for fall was instability during turning with odds ratio 4.82.02 increasing risk of falling. As noted, majority of the participants have been classified of having turning instability based on the measures of Neurocom$^{TM}$ Step quick turn Test. Step quick turn is one of the computerized protocol that provides objective measure of turn sway and turn time (aged and gender matched) normal limit were found to be significantly correlated to falls among studied population. This finding informed that turning was a major problem in the studied population. Concurrently, previous finding reported that fall during turning may resulted eight times of hip fractures (4). Therefore, possible intervention that address on improving turning performance could be benefit to the studied population.

Nonetheless, there is a potential bias in using a volunteer sample, as it may not accurately represent the overall community dwelling population especially comparing the current findings with other study that used representative sample. In addition, the aged of 50 years and above was used in this study which differed compared to others from the previous report which applied cuts off age of 60 years and above.

## CONCLUSION

The findings of this study provide insight into the circumstances, consequences and correlates risk of falls in the Malaysian context, and highlight that fall is a common problem among active older adult community dwelling Malaysians. Results also highlighted that one of the main factors differentiating fallers from non-fallers that has rarely been investigated in the past is unsteadiness during turning activities, and this risk factor warrants further investigation in terms of contributory factors and potential interventions.

## DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Research Ethics Committee of University Putra Malaysia (UPM/FPSK/PADS/T7-JK Etika-PerF01-Nov/10/Q1). The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

AA, TH, and KH conceived the study and participated in the study design, measurement and assessment protocol, and drafted the manuscript. MH and TH participated in formal analysis of data and drafted the manuscript. RI participated in drafting the manuscript. All authors reviewed and approved the final version of the manuscript.

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# The Application of Technological Intervention for Stroke Rehabilitation in Southeast Asia: A Scoping Review With Stakeholders' Consultation

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**Background:** The technological intervention is considered as an adjunct to the conventional therapies applied in the rehabilitation session. In most high-income countries, technology has been widely used in assisting stroke survivors to undergo their treatments. However, technology use is still lacking in Southeast Asia, especially in middle- and low-income countries. This scoping review identifies and summarizes the technologies and related gaps available in Southeast Asia pertaining to stroke rehabilitation.

**Methods:** The JBI manual for evidence synthesis was used to conduct a scoping study. Until September 2021, an electronic search was performed using four databases (Medline, CINAHL, Scopus, ASEAN Citation Index). Only the studies that were carried out in Southeast Asia were chosen.

**Results:** Forty-one articles were chosen in the final review from 6,873 articles found during the initial search. Most of the studies reported the implementation of technological intervention combined with conventional therapies in stroke rehabilitation. Advanced and simple technologies were found such as robotics, virtual reality, telerehabilitation, motion capture, assistive devices, and mobility training from Singapore, Thailand, Malaysia, and Indonesia. The majority of the studies show that technological interventions can enhance the recovery period of stroke survivors. The consultation session suggested that the technological interventions should facilitate the needs of the survivors, caregivers, and practitioners during the rehabilitation.

**Conclusions:** The integration of technology into conventional therapies has shown a positive outcome and show significant improvement during stroke recovery. Future studies are recommended to investigate the potential of home-based technological intervention and lower extremities.

**Keywords: technological intervention, rehabilitation, developing countries, low-middle income countries, developed countries, Southeast Asia, cerebrovascular accident**

## INTRODUCTION

Strokes or a cerebrovascular accident (CVA) is caused by the blockage or bursting of the cerebral blood vessels—the leading cause of neurological disorder globally (1). Stroke is one of the most common non-communicable diseases worldwide, especially in Asia (2, 3). In high-income regions of Asia Pacific, North America, East, and Southeast Asia, those aged 50–64 years have the highest prevalence rates of both ischemic and hemorrhagic stroke (2). According to the World Health Organization (WHO), stroke or cerebrovascular accidents are the second leading cause of death and the third leading cause of the disabilities (3–5). Aldehaim et al. (6) also stated that 40% of those who survived a stroke experience a physical disability that needs special treatment, and another 10% of them end up in a nursing home or other long-term rehab centres. Caring for stroke survivors can be depressing and burdensome, and it may affect the well-being of both survivors and caregivers.

The Southeast Asia region with the size of over 4.5 million $km^2$ constitute of low-income (Myanmar, East Timor, Cambodia, Laos), middle-income (Vietnam, Philippines, Indonesia, Thailand, Malaysia), and high-income (Brunei, Singapore) countries (2–7). The region is heavily populated with a population of nearly 700 million people and the area is diverse in terms of ethnicity and culture, but it also shares similarities in dietary, climate, and lifestyle (2, 3, 8). In terms of stroke prevalence, Indonesia is at 8.0, the Philippines is at 9.0, Singapore is 36.5 (>45 years old), Thailand (18.8 for >45 years old), Vietnam (6.1), and Malaysia (7.0) for every 1,000 population (2). Stroke is a major public health problem because it is the predominant cause of physical impairment and disability among adults (9).

Stroke recovery treatment or rehabilitation typically requires conventional therapy, where it is labor intensive involving therapist-clients education and training (10). Rehabilitation is a goal-oriented process that helps people with disabilities reach their full potential in emotional, physical, cognitive, social, and functional skills (11, 12). Rehabilitation physicians, occupational therapists, physiotherapists, speech therapists, rehabilitation nurses, and medical social workers are among the healthcare professionals involved (13, 14). Generally, the rehabilitation process may take place in various settings, including inpatient, outpatient, group, and home-based (15–18). The survivor's period of recovery from stroke depends on the stroke's severity stage, and usually, the treatment starts once the main cause of stroke has been diagnosed (13).

The rehabilitation treatment is essential for stroke survivors to achieve the highest level of functional independence, reducing or preventing the impairments (11). However, this process could be time-consuming and will lead to extra costs. The cost is described as medical procedure on ancillary or referral and an idea of loss of productivity and the costs generated from the recovery processes (8). This fact has become a critical issue to both health practitioners and clients. Thus, due to these scenarios, technological solutions could be the beneficial adjunct and alternative toward the existing conventional method or therapy, making it more accessible to everyone. In addition, the technological intervention provides access to rehabilitation services for those facing physical, financial, and attitudinal barriers.

Most developed countries implement the technology in rehabilitation therapy as an initiative to help stroke survivors during their recovery period other than focusing only on conventional therapy (19, 20). It is known that the recovery process can be varied depending on several factors such as the client's impairment level, the therapy intensity and access, or the individual activity and participation. Technological interventions such as robotics, video-based therapy, teleconferencing, virtual reality, and assistive devices are more commonly explored and utilized in developed countries, mainly due to their readiness and availability (21, 22).

However, the extent of technology use in low-and middle-income countries is uncertain as it is not explored comprehensively. Therefore, this scoping review aims to systematically identify and review the evidence of using technological intervention combined with conventional therapy or traditional methods in helping the recovery period of stroke survivors. The efficacy of rehabilitative interventions is investigated and discussed according to technological clusters or categorizations.

## METHODOLOGY

The framework consists of seven consecutive stages following the Joanna Briggs Institute (JBI) framework (23): (i) developing the review question, (ii) defining inclusion and exclusion criteria, (iii) conducting a search strategy, (iv) evidence screening and study selection, (v) data extraction, (vi) data analysis, and (vii) presentation of results. Each stage is discussed further in the following subtopics, and the Preferred Reporting Items for Systematic Reviews and Meta-analysis extension for scoping reviews (PRISMA-ScR) (24) (**Supplementary Table 1**) was adopted as a guideline for the report of the scoping review.

### Developing a Review Question

The study adopted the Population-Concept-Context (PCC) framework (25) to determine the research question's extent. The population is stroke survivors, and the concepts are the implementations of the technological intervention in stroke rehabilitation. The context of this study is focused on the Southeast Asia region. This scoping review was developed based on the question, "What are the technologies and gaps available in Southeast Asia pertaining to stroke rehabilitation?"

#### Defining Inclusion and Exclusion Criteria

Studies considered to be included in this scoping review when they fulfill the following criteria:

(i) Stroke rehabilitation as defined by Young and Forster (26) as using a mixture of a therapeutic and problem-solving approach to limit the impact of stroke-related brain damage on daily life,
(ii) Utilizing technology as a medium of therapy or rehabilitation delivery. Technology is a broad term that refers to how

one uses and understands the instruments and craft and how it affects the ability to control and adapt to the social and physical environment. It can also refer to physical objects that people use, such as computers, hardware, or utensils, but may also lead to broader themes such as structure, organizational methods, and techniques. Meanwhile, rehabilitation technology uses technology to meet the needs of people with disabilities. It helps cut the barriers and gives more opportunity to people with disabilities in education, rehabilitation, employment, living at home, and recreation.

(iii) The technology investigated is either for the stroke survivors or people surrounding them (i.e., family members, caregivers) or anybody that deals with the stroke cases,
(iv) The study is conducted in Southeast Asia, and
(v) Any study design (i.e., case study, qualitative study, quantitative survey, experiment) and setting (i.e., clinical, community, institution) are eligible to be included.

Meanwhile, exclusion criteria are as follows: (i) Non-English, (ii) gray literature (i.e., thesis, dissertation, book), (iii) non-original or review study (i.e., letter to editor, literature review, protocol), and (iv) no full text available (i.e., conference abstracts). The exclusion of non-English and gray literature is expected to have minimal impact on the findings (27, 28).

## Conducting a Search Strategy

The electronics search was conducted using the following databases: MEDLINE, CINAHL, Scopus, MyCite, and ASEAN Citation Index on 30th November 2019 and last updated on 22nd September 2021. The keywords used are related to strokes and its associated terminologies (e.g., cerebrovascular accidents, CVA), rehabilitation (including physiotherapy, occupational therapy, speech therapy, etc.), and Southeast Asia (including each name of the countries members). Boolean operators, parenthesis, exact, and wildcards were used when necessary. Search string used was ("cerebrovascular accident" OR "CVA" OR "stroke") AND ("rehabilitation" OR "therapy" OR "therap*" OR "occupational therapy" OR "physiotherapy" OR "physical therap*" OR "speech therap*") AND ("Southeast Asia" OR "Malaysia" OR "Singapore" OR "Thailand" OR "Indonesia" OR "Brunei" OR "East Timor" OR "Cambodia" OR "Myanmar" OR "Vietnam" OR "Laos" OR "Philippines") on those four databases.

## Evidence Screening and Study Selection

The titles and abstracts were independently reviewed by two authors (SNSS and HAA), and the eligibility of the studies for inclusion was based on the previously mentioned criteria. Any conflicts between the two authors were resolved through discussions for each article. Studies were included in the first screening stage (titles plus abstract) if any of the two authors agreed that they were eligible for inclusion or if there was a dispute about whether to exclude them. Studies were included in the second screening stage (full text) when both authors agreed to match all the inclusion criteria. When contradictory studies were detected during the full-text screening, an independent arbitrator (MHR) an author with a healthcare background, was consulted. The two authors' pre-consensus agreement on the included full-text articles was calculated using percentages. Because a critical appraisal of each study is not required for scoping reviews, no quality evaluation was carried out.

## Data Extraction

The summary of all the study details, including the citation, nation, study objective, design, setting, interventions, and findings, was presented in a matrix table. The technological intervention was then classified either as advanced or simple.

## Data Analysis

The findings obtained from the review were summarized into observational studies, intervention studies, and qualitative studies. The review syntheses were integrated with the stakeholders' consultation session described extensively in the next section. All the data on the efficacious and validity of using the technological intervention in stroke rehabilitation in Southeast Asia was documented.

## Consultation

As part of the data analysis, stakeholders were invited to engage in a roundtable discussion or known as consultation. The discussion-like exercise aims to identify stakeholders' priorities and questions to guide the literature review (2). The session with the stakeholders mimics a qualitative research design on FGD session (29) but could be not rigorous as it is a complementary step in a scoping review (30). Six stakeholders were recruited from various fields to provide richness and expertise contribution. Prior to the discussion, all the participants gave their informed consent. The six stakeholders chosen were an industrial designer ($n = 1$), an ergonomist ($n = 1$), an engineer ($n = 1$), a physiotherapist ($n = 1$), an occupational therapist ($n = 1$) and a physiatrist ($n = 1$). The consultation session was done virtually via the Zoom teleconference platform. Each participant was given a summary of the preliminary findings of this scoping review and a set of open-ended questions to guide the discussions; (i) What is the current practice of technology-use intervention compared to the gathered literature? (ii) What is the perception of the efficacy of technologies used in stroke rehabilitation? (iii) What is the perception of implementing technologies as a medium of intervention for stroke rehabilitation? and (iv) What improvements and suggestions can be provided for technology-based application for stroke rehabilitation intervention? The discussion was conducted in pidgin languages which were convenient to the participants. The whole session was recorded using a voice recorder and through note-taking. The qualitative data were analyzed by developing a coding excerpt from the session. The themes were generated and selected by comparing with review findings and discussions among the authors. One session was conducted and required two and a half hours to complete.

## Presentation of the Results

The findings were reported narratively, and the literature and stakeholders' consultation information were synthesized. The narrative review is sequenced in themes generated among the

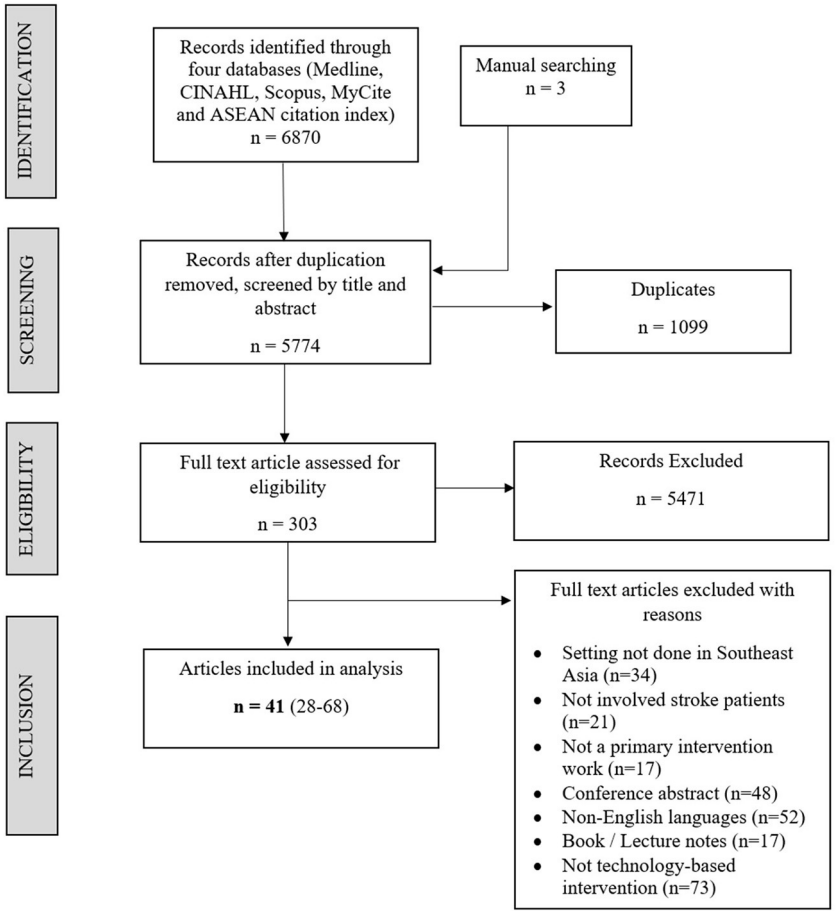


**FIGURE 1 |** Screening process flowchart.

authors. The result is combined with external literature—not only from the systematic searching inclusion, to enhance the understanding and synthesis.

## RESULTS

The initial search yielded a total of 6,873 citations from five electronic databases, and three additional manually founded citations based on **Figure 1**. The reasons for excluding the articles during the full-text screening are provided in **Figure 1**. From the screening process, a total of 41 studies (31–71) met the eligibility requirements and were included in this scoping analysis, as summarized in **Supplementary Table 1**.

A total of 1,470 participants participated from the selected 41 studies with different impairments, types, and stages of stroke severity. The data was narratively summarized according to a pre-defined theme on survivors' diagnosis, rehabilitation intervention available in recovery sessions, and stroke survivors' intervention. The theme was established through discussions among researchers, who compared the findings of various studies. The review's findings were combined with the stakeholders' consultation support.

### Characteristics of Included Studies

The studies found were in the following countries: Singapore ($n = 25$) (31, 34, 35, 38, 39, 42, 44–46, 48–54, 56–58, 64–69), Thailand ($n = 10$) (32, 33, 36, 41, 43, 47, 51, 59, 61, 63), Malaysia ($n = 5$) (37, 40, 55, 68, 71), Indonesia ($n = 1$) (62) and no study were found from Myanmar, Vietnam, Philippines, Laos, Brunei, East Timor and Cambodia. All the included studies were written in the English language. The studies were published between 2009 until 2021. From the 41 articles, there are randomized-controlled studies ($n = 18$), clinical studies ($n = 7$), case report ($n = 2$), an experimental study ($n = 2$), a crossover study ($n = 1$), a pilot study ($n = 7$), an open-labeled study ($n = 2$) and a qualitative study ($n = 2$). Thirty-two studies ($n = 32$) were conducted in the hospitals and the remaining nine ($n = 9$) were conducted in the community.

### Types of Technological Intervention in Southeast Asia

The most complex or newest technology accessible in post-stroke rehabilitation can also be referred to as advanced technological intervention (72, 73). Simple technology is referred to as

traditional or non-mechanical, such as crafts and tools that predate the Industrial Revolution 4.0 concept (74–77). The simple technology can be practiced or fabricated with a minimal capital investment by an individual, and a single individual's knowledge of the practice can be comprehended (77).

## Advanced Technological Intervention

The study has classified six ($n = 6$) types of advanced technological intervention for post-stroke rehabilitation, which are robotics, transcranial magnetic stimulation (TMS), transcranial direct current stimulation (tDCS), motion analysis, motion capture, and virtual reality.

### Robotics

Modern robotics have made tremendous progress and contribution to healthcare as they can help physicians perform various tasks (74–80). Robotic adoption is increasing tremendously in hospitals—robotics help regain and improves the function in both upper and lower extremities. In this scoping review, seven ($n = 7$) studies (31, 35, 42, 45, 47, 62, 67) were identified that implemented the robot-assisted therapy intervention in helping the survivors regain their abilities to the highest level of independence. Robotics technology found in the literature include: MIT-Manus robot coupled with EEG-based MI-BCI, a combination of EEG-based MI-BCI Haptic Knob robotic rehabilitation, a robotic exoskeleton with EMG signal, a Haptic Knob rehabilitation robot, and a soft robotic glove both focuses on grasping assistance. All the robotics mentioned before focus on upper extremities rehabilitation. From the studies mentioned, six ($n = 6$) studies (31, 35, 42, 45, 47, 67) showed that the use of robotics was effective in helping stroke survivors, while only Utomo et al. (62) reported that the use of the robotic is not effective for short-term rehabilitation. Medical robots are extremely useful in assisting physicians. However, being professionally trained to work with the medical robots and for the robot to fully respond to the clinician's instructions are somewhat time-consuming and require continuous training (81).

### Transcranial Magnetic Stimulation

In the TMS method, magnetic impulses were sent through the skull to stimulate the brain. The treatments have shown promising results in improving the upper extremities in stroke survivors (82, 83). Three ($n = 3$) studies (41, 51, 60) included in this scoping review reported the use of TMS as a treatment to help stroke survivors. Most of the survivors who completed the entire course of this treatment experienced an improvement in their impairments after 6 months of treatment (51). The treatment used was able to help the stroke survivors to recover their movement and brain function. All the studies included here implemented this technology to treat upper-limb impairment (shoulder to hand). The results show that TMS may enhance the paretic arm reach-to-grasp performance on the non-lesioned hemisphere. From the studies mentioned, it is found that two ($n = 2$) studies (41, 51) had shown that using the TMS method is helpful for stroke survivors. Although most of the studies had shown the effectiveness of using the TMS method, a study from Tretriluxana et al. (60) shows that this intervention is only applicable toward the smaller objects when using the reach-to-grasp (RTG) action.

## Transcranial Direct Current Stimulation

From the past three decades, tDCS has become an increasingly popular technique in rehabilitation treatment (84). The use of tDCS in stroke research has gained particular interest, because both online and offline effects of tDCS can improve functional outcomes (85, 86). In the tDCS technique, a mild electrical current travel through the skulls and stimulates the brain. This treatment can help the survivors recover their movement from stroke and other conditions. Seven ($n = 7$) studies (38, 46, 56, 59, 63, 69, 71) in this scoping review found that this technique did improve the recovery process. Majority (38, 46, 56, 63, 71) showed positive results in both upper and lower limb functions, except two ($n = 2$) studies (59, 69). These two studies reported that tDCS does not increase the motor activity on lower limb muscles and gait performance and does not improve any motor function in stroke survivors.

### Motion Analysis [Motor Imagery Brain-Computer Interface (MI-BCI), Electroencephalogram (EEG), and Electrocardiograms (ECG)]

Motion analysis captures the video of the human motion with specialized computer software that analyses the motion in detail. This technique provides the healthcare practitioner with a detailed picture of a person's specific movement challenges to guide proper therapy. In this scoping review, nine ($n = 9$) studies (38, 39, 45, 46, 48, 56, 62, 64, 69) implemented this treatment with stroke survivors. Most studies (39, 45, 46, 56, 64) have shown a tremendous enhancement on the upper limb rehabilitation treatment with this technique, except for two studies (62, 69). The intervention is less effective for short-term improvement on lower-limb function (62), similar to the single conventional intervention (69).

### Motion Capture

Motion capture is a technique that involves using technology capable of recording and determining the location of points on an actor's body in a particular amount of time (87). A motion capture device is required to precisely monitor participants' movement, to allow physicians to deliver therapeutic advice based on observable data (88). It typically occurs by using a costume or other similar device, which the actor should dress him or herself (87). Only three ($n = 3$) studies (34, 50, 70) included in this scoping review used motion capture as a strategy for stroke recovery, such as Nintendo Wii. All the studies mentioned above show that motion capture in the rehabilitation setting could enhance the conventional therapy in upper limb subacute and chronic stroke survivors. The studies showed much potential as an adjunct therapy in upper limb stroke recovery and can be employed effectively in an acute inpatient environment.

### Virtual Reality

Virtual reality has emerged as a therapeutic tool facilitating motor learning for balance and gait rehabilitation (89–91). The survivors can retrain themselves to perform the motions within a virtual environment (92). The use of VR-based therapy could provide a positive learning experience while at the same time could be engaging and motivating. Besides, VR applications have a huge potential for education and training purposes since the simulation can be conducted repeatedly which could not be replicated in a real-world application (93). This offers a significant advantage over conventional training. From the included studies in this scoping review, seven ($n = 7$) studies (39, 40, 44, 50, 53, 55, 57) implemented VR intervention combined with the conventional method for the rehabilitation treatment. Five ($n = 5$) studies demonstrate that the combined intervention has improved both upper limb function and lower limb postural standing balance, while only two ($n = 2$) studies (40, 53) show the opposite result. Both studies stated that this technology does not necessarily enhance physical function or improve the upper extremity recovery in stroke survivors.

## Simple Technological Intervention

Simple technological intervention can also refer to a system or equipment that is non-battery powered and relatively easier to fabricate (61). This technology is affordable, adaptable, easily managed, and only uses little energy and resources to stay entirely environmentally friendly. The study has identified three ($n = 3$) types of simple technological interventions for post-stroke rehabilitation, which are telerehabilitation, simple tech assistive technologies (AT), and gait training (GT).

### Telerehabilitation

Telerehabilitation, commonly referred to as tele-therapy or tele-stroke, is information and telecommunications technology that allows clients to get medical care from doctors located remotely (76). It is one of the distance-supporting therapies to help both survivors and caregivers. Five ($n = 5$) studies (37, 52, 65, 66, 68) were identified in this scoping review explored telerehabilitation as the technological aid to help the clients in rehabilitation. These studies (37, 52, 68) show that the application of telerehabilitation is effective as an adjunct to the rehabilitation process because it is comfortable and easy to be used, which contributes to the stroke recovery process. In addition, telerehabilitation could be a promising solution in stroke rehabilitation since this technology may simulate autonomous repetitive practice to improve the health outcome (65, 66). The telerehabilitation technologies used in the studies were video-based therapy, a smartphone with ECG-recording, and videoconferencing with tele-therapists.

### Low-Tech Assistive Technology

Equipment used to increase, maintain or improve the functional capabilities of individuals with disabilities in all aspects of life, including at work, home, or in the community-dwelling is referred to as assistive technology (AT) (32, 61). Whereas low-tech assistive technology or low-tech AT is defined as devices or equipment that do not require much training, inexpensive, and do not have complex or mechanical features (32). Low-tech AT differs from high-tech AT because it does not require the use of a power source (36). There are three studies ($n = 3$) (32, 36, 61) identified to use low-tech AT, such as light touch and force contact cane, insole shoe wedges, and a new multidirectional reach tool. The use of this simple technological intervention has shown a progressive effect to improve the stability and balance of stroke survivors. Integration of low-tech AT toward conventional training is suggested to enhance gait speed, standing and walking symmetry, and balance. In addition, low-tech AT is considered an alternative and inexpensive tool for balance training in stroke rehabilitation treatment (61).

### Gait Training (Treadmill Training)

Gait analysis measures movement in various situations, making it significant and helpful in numerous applications such as rehabilitation activities, sports training, and identifying problems, among others (80). Walking speed, body-weight-bearing abilities, and balance have all improved because of the training. The training allows therapists to track oxygen uptake, which helps the cardiovascular health assessments (94). It aids in treating neurophysiological problems and the stimulation of paretic muscles. Treadmill training was used in two ($n = 2$) studies (49, 54) to assist stroke survivors in their rehabilitation sessions. A variable automated speed and sensing treadmill (VASST) was adopted for chronic stroke by Chua et al. (49) and this technique was proven to be beneficial, safe, and practicable to use. In contrast to another study (54), the combination of electromechanical gait trainers (GT) and conventional therapy has the same effect on stroke survivors' ambulation and health status than conventional therapy alone. As a result, there is no significant difference compared to merely using conventional treatments.

## Stakeholder's Consultation

The stakeholders involved were from two major disciplines i.e., technical sciences (industrial designer, engineer) and health sciences (physiatrist, occupational therapists, and physiotherapist). Findings from the stakeholders' discussion are summarized below.

The current method implemented in stroke rehabilitation or stroke recovery process is mostly conventional methods. The technological intervention is said to be an adjunct to the current conventional therapies where it can be implemented to help stroke survivors to recover faster. In Southeast Asia countries, however, especially in the less developed nations, there is still a lack of technological interventions applied for rehabilitation purposes even in the tertiary hospitals.

In addition, the intervention implemented should be able to motivate the stroke survivors during the rehabilitation session and give meaningful outcome to them. The technological intervention also needs to reduce the labor costs of stroke rehabilitation, while simultaneously allow the survivors to undergo their treatments with minimum supervision. In some cases, however, survivors tend to rely entirely on the interventions and become too dependent on the therapy, which eventually causes other impairments to occur. If this happens,

the technological intervention is not much different from the conventional method and could be neglected. The appropriate technological intervention to be implemented should be flexible and not limited to only specific functional impairment and easy to be learned by the practitioners and caregivers.

On the other hand, technological intervention in rehabilitation might bring challenges to both practitioners and survivors. For example, the survivors need to be fully assisted during the rehabilitation session when using the advanced technological intervention at the hospitals. It is preferred for the technological intervention with long and continuous practice to be carried out as a home-based therapy to improve the recover process. The technology-based therapy is recommended to be applicable toward most stroke survivors with various stages or severities, and diverse functional impairments. Moreover, the technology should be intuitive, interesting and attractive in terms of functionality and physical appearance to encourage the continuous use (95).

From the consultation session, it can be concluded that the technological interventions are expected to facilitate the needs of survivors, practitioners, and caregivers during the rehabilitation. The intervention should also be user-friendly, safe to use, and easily operated by the clients and healthcare practitioners. In addition, most of the existing interventions found in Southeast Asia were classified as high-tech interventions, and the clients are required to attend the therapy session in the hospital or rehab center. This adds to the financial burden of the survivors and their families. Therefore, it is highly recommended to make full use of the current advanced technology to help reduce the recovery period and provide a more affordable home-based technological intervention for post-stroke rehabilitation.

## DISCUSSIONS

This scoping review addresses a new research area related to the technological therapy implemented in stroke rehabilitation for stroke survivors in Southeast Asia. It provides a comprehensive understanding of this topic and has identified the critical gaps. The consultation session conducted with the stakeholders provides additional value to the review. According to a framework designed by Arksey and O'Malley (96), a review can be improved, and the findings generated are more valuable when practitioners and consumers contribute to the work in the consultation session (97).

The main goal of rehabilitation is to help stroke survivors be as independent as possible and attain the best quality of life (98). The treatment receives by the stroke survivors is to help them relearn the lost skills when part of the brain is damaged. These skills may include coordinating the leg movements to regain walking ability or teaching survivors new ways of performing tasks by complementing the remining disabilities (99). There is a strong consensus among the rehabilitation experts that the most important element in any rehabilitation programme is for the stroke survivors to be carefully directed, well-focused, and perform a continuous practice (100).

From the past decade, new technology is constantly changing the rehabilitation arena. Technological treatment is helping in neuroplasticity and learning progress i.e., the key in the recovery process of stroke (94). Moreover, the technological treatment gives clients more repetitions, practice time, and intensity than the conventional method.

### The Lack of Technology Utilization

It is pertinent that many countries in Southeast Asia build rehabilitation centres to benefit in stroke rehabilitation treatment. However, most centres rely on conventional therapy rather than utilizing technology for rehabilitation. The critical factor to the lack of technology utilization in rehabilitation facilities is the dearth of urgency and emphasis for clinical rehabilitation by the policy-making authorities (101). The clients at the rehabilitative phase are often not in dire need than those in emergency trauma or requiring a lifesaving procedure (102). Besides, the lack of awareness among healthcare professionals toward advanced rehabilitation technology may influence the utilization of technology in rehabilitation facilities (103). The absence of active interest groups or society in promoting rehabilitation technology also hinders the awareness of the advantage of advanced rehabilitation equipment. Furthermore, conventional practices and manual therapy have long been accepted by therapists to be providing substantial benefits to clients (104). One of the purposes of using the technological intervention is to reduce the burden of stroke survivors' caregivers and families. However, if the cost of the technology is not proportional to the benefits obtained from its application, it will lead to financial burden for the stroke survivors and their family members. Thus, there is a need to ensure the cost-effectiveness of the interventions implemented for this purpose.

### Country's Economic Status Influences the Implementation of Technological Interventions

Based on this scoping review, Singapore has reported the highest number of studies ($n = 25$) involving the advanced technological intervention implemented in stroke rehabilitation and followed by Thailand ($n = 10$), Malaysia ($n = 5$), and Indonesia ($n = 1$). In Southeast Asia, Singapore has rapidly developed from a low-income country to a high-income country (105) and has become another developed country after Brunei (106). Likewise, Thailand has made extraordinary social and economic development progress during the last four decades, shifting from a low-income to an upper-middle-income country in less than a generation (107). As a result, Thailand has become a reference for a nation's development success story, with robust growth and significant poverty reduction and significant social progress (107).

This paper reveals that the acceptance of technological advancement has a relevant correlation with the country's economic growth. This correlation is apparent when comparing the number of studies using technological interventions in stroke rehabilitation in Southeast Asia countries based on their

economic status. It justifies why Singapore has reported the most studies followed by other countries. Unfortunately, in low and middle-income countries, the technology for rehabilitation is not widely used, though there are attempts on its applications for therapeutic purposes (108, 109).

In this scoping review, most of the interventions used were advanced technologies and found mostly in the tertiary hospitals or the rehabilitation units. Besides, the stroke rehabilitation facilities available are platform-based. This could be somewhat inconvenient in terms of traveling and logistics, especially if the client stays far away from the health institutions. Due to this, the home-based therapies should at least offer compatible benefits and affordable in price. An overpriced technological aid causes a burden on survivors' caregivers and their family members, eventually demotivating them to continue the therapy sessions.

## Further Promoting the Use of Technological Interventions in Stroke Rehabilitation

The mentioned technological interventions in the selected studies were mostly practical to be implemented as an adjunct to conventional therapy. However, in this scoping review, it is found that most of the technological interventions applied were focused on physical training, especially on the upper extremities, and only a few studies were meant for the lower extremities. When a person is diagnosed with a stroke, he/she usually experience difficulties in performing the activities of daily living (ADL) due to weakened mobility (110). A review by Hobbs & Artemiadis (111) suggested the exploration of other technologies for lower limb stroke rehabilitation—which were not found in this scoping review, such as on physical implementation (i.e., exoskeleton and powered orthoses) and targeted sensorimotor pathways (i.e., vision and auditory feedback, equilibrioception, cutaneous and haptic perception, inter-limb coordination mechanisms). Hence, it is necessary for the stroke survivors to perform repetitive lower limb exercises to help them regain the gait, balance, and overall mobility. This is, therefore, highlights the need to encourage more studies on technological intervention for lower extremity rehabilitation.

Equally important, more attention on other components such as cognitive, social, and emotional support using technology is required, as agreed by the previous review finding (2). There are several other technological advancements for rehabilitation that can be researched by referring to the international reviews, which include the use of information technology and apps for home-based, cognitive and caregivers' intervention (112–115), wearable devices for upper-limb, participation intervention (116, 117), and other emergence availability of the Industrial Revolution 4.0 and Internet of Things.

Another essential point, technological interventions reported in the reviewed studies mostly took place in hospitals and rehabilitation centres, with very few in the community-dwelling population. Traveling from home to the hospitals regularly for continuous therapy sessions could be burdensome, especially for rural areas (118). More importantly, the current coronavirus (COVID-19) pandemic outbreak causes an urgent need to reduce hospital stays and visits (119). At this crucial time, stroke clients have been forced to be catered to as a lower priority to avoid overburdening the healthcare system (119, 120). Because of this, the clients' therapy sessions have been reduced as a result of physical distancing and this has indirectly affected the quality of care in stroke survivors. For the same reason, the technological intervention should be fundamentally safe, user-friendly, cost-effective, engaging and motivating. The home-based technological aids or devices can also be designed to be portable or even wearable to fit into a limited space. Furthermore, these devices or tools should be durable so that little maintenance is required over potentially long periods of use (119).

It is relevant to use technological intervention as an alternative method to provide clients with high-quality therapy to optimize long-term functional outcomes and promote stroke survivors' independence and quality of life. This is particularly for those who have difficulties traveling to the hospitals or rehabilitation facilities. Therefore, it is undoubtedly that there is an obvious need to further promote the integration of technological aids toward the conventional techniques in stroke rehabilitation, due to positive effect shown on the client's recovery period, a decrease of human labor intensive, reducing the traveling cost, and lessening the hospital visits.

## Limitation

This scoping review has several limitations. Firstly, although the exclusion of gray literature gives a small impact, it may still be beneficial in controlling for the overestimation of conclusion (121), providing better coverage and wider evidence mapping (122). Hence, limited resources in terms of facility and access to gray literature, lack of expertise in searching such evidence, and lack of manpower and financial support have prevented our efforts from including the gray literature. Many publications are made available in English due to the lingua franca status and most of the findings from gray literature were also translated into journal publications for knowledge-sharing purposes (28). Nevertheless, this scoping review is still valuable and comprehensive in conveying the practice.

Secondly, during the stakeholders' consultation, some panels briefly raised the limitation on utilization and acceptance of technology in practice and limited client preferences. Nevertheless, although it is interesting to explore users' perspectives in understanding the use of technology and how it benefits them, it is beyond the scope of this scoping review.

# CONCLUSION

Strokes cause survivors to live with severe disabilities that affect their daily activities due to paralysis and impaired balance and mobility. From the standpoint of rehabilitation, the clients must engage in an extensive and continuous therapeutic exercise for the recovery process. The conventional stroke rehabilitation techniques usually take longer for stroke survivors to fully recover since they rely on the therapy sessions and exercises conducted by the therapists. New rehabilitation techniques, such as constraint-induced, biofeedback, and robot-assisted therapy,

have evolved in recent years and have been embraced as an adjunct to conventional techniques.

The integration of technological intervention toward conventional therapies has shown a positive outcome to the survivor's post-stroke recovery process. This is indeed a better form of therapy especially during the pandemic, where face-to-face consultation is restricted, which at the same time encourages the survivors to undergo treatments. As a result, they could regain independence on mobility and perform the activities of daily living (ADLs). However, there are several gaps identified in this scoping review, which include the lack of studies on technological intervention toward lower extremities. Besides, most of the interventions were found in the hospitals and rehabilitation units, and only a few studies were done in the community-dwelling or home-based therapy. In addition, many technologies are still yet to be explored since this scoping review only covers Southeast Asia countries and the technologies available are predominated by prosperous countries. International references and collaborations should be further encouraged to promote the use latest technological advancements. Nevertheless, this scoping review reveals that the utilization of technologies in stroke rehabilitation has begun to be acknowledged and established in Southeast Asia.

## DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

## AUTHOR CONTRIBUTIONS

The inclusion/exclusion criteria and search strategy were developed under the supervision of MR and RC. The search in the databases was carried out by SS, HA, and MR who also led the writing of the methodology section in the manuscript. SS, RC, HA, and MR worked together on data analysis and manuscript writing. SS, MS, and HR contributed information on the direction of the data analysis and revised continuous amendments of the manuscript draft. The final manuscript was read and approved by all the authors.

## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.783565/full#supplementary-material

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