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Late-life psychopathology

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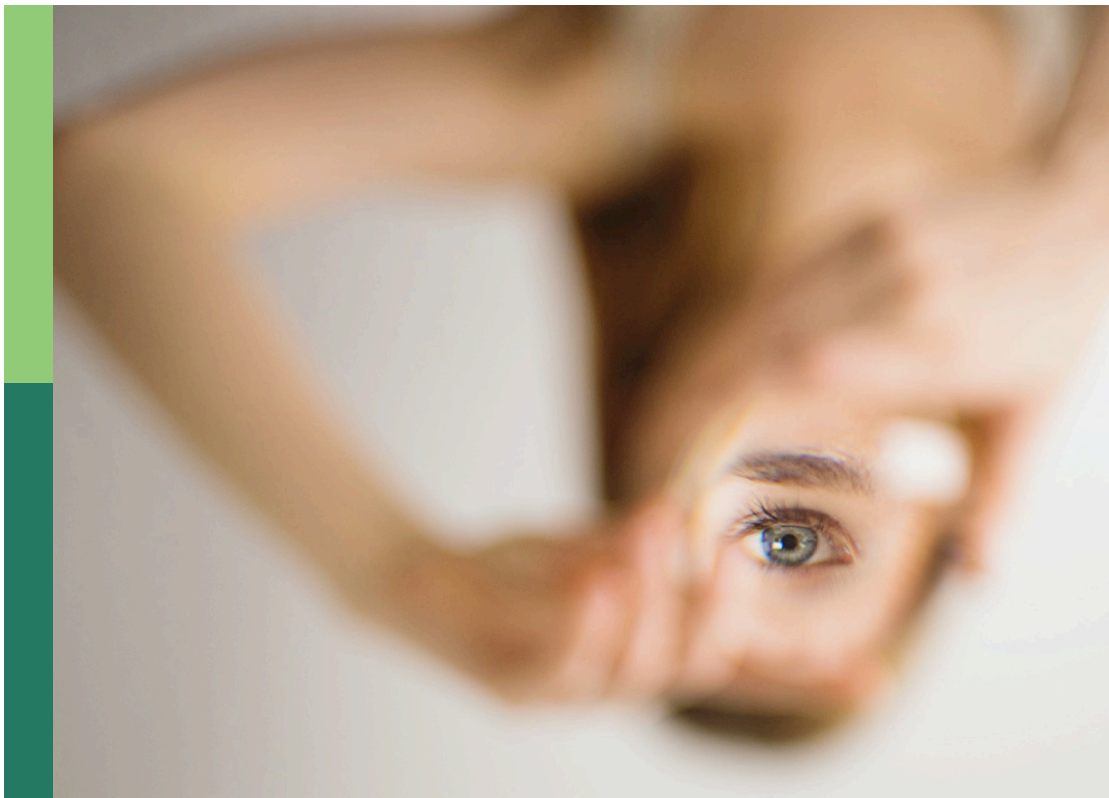

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Late-life psychopathology

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Editorial: Late-life psychopathology

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Editorial on the Research Topic
Late-life psychopathology

The Research Topic, "*Late-life psychopathology*," concerns how psychopathology might present itself in old age. The collection includes a broad spectrum of older individuals' behavioral, cognitive, and emotional issues, including mood disorders, anxiety disorders, psychotic disorders, sexual disorders, insomnia, and personality disorders. Along with the psychopathological disorders in older adults, this Research Topic focused on the psychopathological similarities and differences across the various age groups.

Psychological health issues are particularly challenging for the older. Alzheimer's disease and dementia, depression, anxiety, and intense loneliness are just a few of the psychological health problems burdened with negative consequences in old age. However, many older persons encounter difficulties seeking proper psychological resources and support. Healthcare professionals need to comprehend the different mental health issues that older individuals confront to provide them with the finest available treatment.

Depression is one of the most prevalent mental health issues among older adults, and it is associated with poor physical health and a lower quality of life. Anxiety is another prevalent issue among older adults and can be attributed to changes in lifestyle, such as retirement or deteriorating physical health. Age-related or other biological factors, such as Alzheimer's disease, can cause cognitive impairment, including memory problems, problem-solving difficulty, and other thought processes challenges. These psychological disorders may have a substantial impact on the persons afflicted as well as their close family members.

It is essential to comprehend how these psychological disorders manifest to develop treatment strategies that meet the needs of older individuals. In addition to delineating psychopathological issues in older adults, the articles in this Research Topic collection offer future recommendations for mental health professionals and scientists.

Psychological problems in older adults are often overlooked and untreatable because clinicians believe psychological disorders are either a sign of a physical ailment or a natural consequence of aging (Durak, 2018). While the Diagnostic and Statistical Manual of Mental Disorders 5th Edition (DSM 5; American Psychiatric Association, 2013) acknowledges that a major depressive episode may be the first sign of irreversible dementia in many older adults, it also emphasizes that memory problems often resolve when the major depressive episode is treated effectively. Thus, it is crucial to comprehend how various health issues present and interact with one another to create effective treatment strategies that cater to the requirements of older people.

Besides, chronic physical diseases and psychological disorders interact negatively and exacerbate each other's severity, making treatment more difficult in older adults. Furthermore, exposure to high-stress levels renders older adults more vulnerable to psychopathology than the different age groups. For example, older adults have been disproportionately affected by the COVID-19 Pandemic (Durak and Senol-Durak, 2020), resulting in many individual and negative social consequences around the world as a result of the days-long quarantine, social isolation, limited ability to leave the house, vulnerability to the virus due to physiological health problems, and high virus-related mortality ratio.

Psychopathology can appear differently in older adults than in younger adults. Specialists attempting to conduct a psychological assessment or diagnose such disorders in older adults should be more cautious and thorough than in other age groups. These include changes in sleep patterns or difficulty falling or staying asleep; withdrawal from one enjoyable activity; significant apathy or lack of energy; confusion, disorientation, and difficulty making decisions; difficulty expressing themselves, difficulty following a conversation, or impaired speech; anxiety, paranoia, or delusional thinking; irritability or mood swings; and memory loss or confusion between recent and distant events. According to the DSM-5, in contrast to other age groups, older adults' agoraphobia is associated with fear of falling and incontinence, and little is known about "body dysmorphic disorder" despite its prevalence among older adults. In this context, the Research Topic "*Late-life psychopathology*" encourages cross-sectional and longitudinal comparative studies on the types, assessment, and treatment of psychopathology in older adults, as well as on the contributory variables associated with the presence of psychopathology in older adults.

Psychopathology at a later age is often characterized by a complex interaction of several co-occurring disorders, such as dementia, social isolation and loneliness, anxiety and mood disorders, depression, psychological traumas, schizophrenia, and even substance abuse (Bernacchio et al., 2009). For instance, insomnia symptoms are associated with depressive symptoms and suicide risk in older adults; suicidal older adults tend to misuse substances (Webb et al., 2018); and physical dependency with bereavement increases the risk of suicide (De Leo, 2022). Justice-involved older adults are more likely to have or develop mental illness and substance use disorders (Han et al., 2021). Recent discussions have focused on the importance of previous events in one's life. For instance, older adults with substance use disorders are more likely to be abused than those without the disorders (Mercier et al., 2020). Besides, sexual assault and emotional abuse may play a role in the development or experience of aging-related genitourinary dysfunction in older women (Gibson et al., 2019).

This collection of articles focuses on the types, assessment, and treatment of psychopathology in older adults, contributory variables associated with the presence of psychopathology in older adults, and psychopathological similarities and differences across the various age groups. For example, social isolation and loneliness in older adults tend to be common descriptions of older adults' quality of life and generally negatively affect older adults' wellbeing and health (Gardiner et al., 2018; Smith and Lim, 2020; Smith et al., 2020). Social isolation is especially so in light of our global pandemic (Berg-Weger and Morley, 2020; Smith et al., 2020; Wong et al., 2020; Kasar and Karaman, 2021; Kotwal et al., 2021; van Tilburg et al., 2021).

It is reported that 50% of adults over sixty are at risk of social isolation, and nearly one-third of the older adult population experiences loneliness and social isolation (Berg-Weger and Morley, 2020; Fakoya et al., 2020). Feelings of loneliness also tend to be linked to depression and other mental health problems (Calati et al., 2019; Lee et al., 2019). It is frequently emphasized by several researchers that older adults are more likely to feel lonely and socially isolated (Fakoya et al., 2020; Smith et al., 2020; Rentscher et al., 2021). Those feelings have arisen during the pandemic outbreak (Rodrigues et al., 2022), particularly during the acute phase of the epidemic (Luchetti et al., 2021). Recently, several researchers have discussed the applicability of technology to reduce social isolation (Sen et al., 2022), while others have highlighted the value of face-to-face communication (Su et al., 2023).

Still, many cultural and social factors could help older adults deal with these problems and improve their quality of life. In one of the articles in this issue, the authors looked at whether or not intergenerational relationships could help older people feel less alone and have a more positive view of getting older by testing the mediational role of intergenerational relationships between a sense of loneliness and a positive attitude toward later life (Liu et al.). They found that the overall quality of intergenerational relationships was positively related to older parents' attitudes toward later life but partially mediated by a sense of loneliness. A systematic review and meta-analysis of remotely delivered interventions on loneliness in older adults by the authors of another paper suggest that such timely interventions could help reduce loneliness in older adults through a systematic review and meta-analysis of remotely delivered interventions. Nonetheless, it may be altered by media type, treatment strategy, participant characteristics, measurement time points, and other variables.

Under the "*Late-life psychopathology*" topic, researchers were invited to submit manuscripts about the diverse types of psychopathological disorders and the psychological assessment of psychopathology in older adults. The Research Topics are articles about the onset, development, prevalence, and assessment of psychopathological disorders and related problems in old age. The following are some of the main themes recommended but not limited to mood disorders, anxiety disorders, death anxiety, psychotic disorders, suicide, complex traumas, mourning, sexual dysfunctions, insomnia, substance use, suicide, social isolation-loneliness, and neglect-abuse-violence against older adults.

The Research Topic, late-life psychopathology, has thirteen published articles. Ten of the thirteen papers are "original research," with the other three falling into one of three categories: "perspective," "opinion," or "systematic review."

The first article by Xiang Y. et al., entitled *"Delays in Seeking Medical Services in **Elderly** Patients with Senile Cataract,"* is an original research article that determines how often people with senile cataracts delay visiting the doctor and receiving treatment, as well as uncovers any relevant consequences or risk factors. According to the authors, the findings of this research may assist physicians in better understanding and treating psychopathology in older people. Longevity benefits humanity but introduces new challenges to healthcare and society. However,

postponing medical appointments and treatment is a widespread and critical issue among seniors, resulting in disease progression and a worse prognosis. This research evaluated the prevalence of delaying medical visits and treatment, visual impairment, life inconvenience, perceptions of disease treatment, and associated factors in individuals with senile cataracts. A total of four hundred patients, ages 60 to 94, are enrolled. A considerable proportion of older individuals with senile cataracts delay medical visits (73.5%) and surgical treatment (74.5%), impairing their ability to lead a normal life. Almost half have erroneous beliefs about cataract therapy. The authors recommend that the public pay more attention to the health of older and younger individuals, as well as their senior relatives.

The second article by Fu et al., entitled *"The Effectiveness of Remote Delivered Intervention for Loneliness Reduction in Older Adults: A Systematic Review and Meta-Analysis,"* is an original research article that conducts an updated meta-analysis and systematic review to assess the efficacy of a remotely delivered intervention for loneliness in older people using randomized controlled trials (RCTs). A wide variety of mental health issues, including depression, schizophrenia, and psychotic disorders, are examined by remote-delivered intervention. Following a comprehensive search of major databases, thirteen articles are reviewed. The findings support the idea that a remotely delivered intervention may help older people feel less lonely; however, the effectiveness is impacted by factors such as media type, treatment strategy, and group format. This study indicates the value of remote-delivered intervention in reducing loneliness and warrants further investigation into its use. With little modifications, these interventions may be compatible with COVID-19 shielding/social distancing strategies and help older people overcome loneliness.

The third article by Liu et al., entitled *"Intergenerational Relationship Quality and Attitude toward Later Life among Aging Chinese Adults in Hong Kong: The Mediating Role of the Sense of Loneliness,"* is an original research article that assessed the quality of intergenerational relationships using a four-dimensional framework: Affectual intimacy, structural-associational solidarity, consensual-normative solidarity, and intergenerational conflict. They examined the influence of intergenerational connection quality on older adults' perspectives about later life as evaluated by feelings of isolation. The effects of structural-associational solidarity and intergenerational conflict on attitudes toward later life were almost totally mediated by a feeling of loneliness. In contrast, the effects of consensual-normative solidarity and affectual closeness were only somewhat mediated. The research reveals that isolation among older individuals is a modifiable risk factor that needs greater consideration in social policies and services and might be mitigated within the family context.

The fourth article by Xiang X. et al., entitled "*Childhood adversity and cognitive impairment in later life,*" is an original research article that intends to investigate the association between childhood adversity and cognitive impairment in older adults using longitudinal data from the Health and Retirement Study (HRS; 1998–2016 surveys), as well as the potential moderating influences of gender, race, and education in a population-based sample of older Americans. The authors noted that they were motivated to conduct the study because empirical evidence is equivocal on whether the detrimental impact of childhood adversity on cognition in early life survives into later adulthood, with contradictory results in the existing literature. The researchers concluded that there is variance across gender and ethnicity, with some aspects of childhood adversity continuing to impair cognitive function in later life (e.g., grade retention). In contrast, other events may have the reverse effect.

The fifth article by Patel, entitled "*Vulnerability as determinant of suicide among older people in the Northern Indian States,*" is an original research article that discusses the nature of suicide among older people. This study's data was gathered from news articles published in Indian newspapers, magazines, and online news portals between March and June 2022, focusing on sixty cases of senior citizens who committed suicide in the northern Indian states of Bihar, Delhi, Haryana, Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, and Uttarakhand. According to the study, the number of older people who commit suicide increases significantly as they age and become more vulnerable. According to the study, older people are more likely to commit suicide because of personal, family, and societal problems. This vulnerability has been shown to negatively affect not just suicidal behavior but also family abuse, chronic disease, depression, poverty, and social rejection, all of which are associated with suicidal behavior.

The sixth article by Castro-de-Araujo et al., entitled *"Patterns of multimorbidity and some psychiatric disorders: A systematic review of the literature,"* is a systematic review article that investigates the association between five prevalent psychological disorders (such as depression, anxiety, PTSD, substance use disorder, and psychosis) and non-psychiatric diseases (such as tuberculosis and HIV), as well as the pattern of association between them. Because the influence of psychological problems on people with non-psychiatric chronic illnesses is not well known, this is a comprehensive review of research published in multimorbidity since 2015, including both psychological disorders and chronic diseases. After reviewing fifty-six articles, only twenty-six were selected for inclusion in the study, and it was determined that there are strong associations between depression, psychosis, and multimorbidity. This study presents an overview of the multiple morbidity paradigm, emphasizing mental illness and probable prospects, which is important for managing the processes associated with multiple morbidity patterns.

The seventh article by Aisenberg-Shafran, entitled *"Psychotherapy for late-life psychopathology–updates to promote aging in place,"* is a perspective article. The goal of the study discussed in this article is to look at the diverse ways to improve older people's psychological wellbeing. A key point of this article is that even if psychopathology in older adults does not fulfill the diagnostic criteria for mental disorders, it will nonetheless have repercussions for the affected person, as well as for their loved ones, the workplace, and the larger community. It is insufficient to rely on psychologists, social workers, or gerontologists to improve older people's mental health. This global commitment requires psychoeducation at all levels of society, from children and teens to older people, medical experts, government officials, and lawmakers. Furthermore, the study suggests that community-based psychotherapy clinics be established inside academic institutions to serve local populations better. As indicated by higher suicide

rates among older adults, a sizable portion of the population could benefit from psychotherapy in their later years but does not get help. Difficulty in finding help in easily accessible hospitals is a daunting task due to the stigma surrounding those who deal with mental illness and the negative preconceptions associated with psychotherapy and other forms of psychological treatment based on outdated ideas. Some of the recommendations in the paper include offering low-cost, high-quality psychotherapy to older adults, with the goals of improving their wellbeing as they age and helping them adjust to major life changes (like retirement, widowhood, declining health, and loss), helping family members through the challenges of caregiving or aging alongside a loved one, and building professional and therapeutic training with an emphasis on working with the older adult population.

The eighth article by Zhou et al., entitled *"The effects of aging and perceived loneliness on lexical ambiguity resolution,"* is an original research article focusing on the social factors associated with the language process in older adults. Besides investigating the effects of aging with a performing control group, this study also examined the perception of loneliness on lexical ambiguity resolution. Findings revealed that older adults performed greater lexical effects than younger adults but had similar sub-lexical ambiguity. The results of this study also demonstrated that higher perceived loneliness was associated with displaying a greater sub-lexical ambiguity disadvantage effect. This study highlighted the important link between social connections and language processing in older adults.

The ninth article by Choi and Marti, entitled "*Intent disclosure in late-life suicide: age group differences in correlates and associations with suicide means,*" is an original research article that examines associated factors with the disclosure of intent to die by suicide across three age groups (65–74, 75–84, and 85+) of older suicide decedents using 2017–2019 data from the United States National Violent Death Reporting System (NVDRS). Aside from having important preventive implications, the study's attention has been relatively under-examined in prior publications. The authors note that the suicide incidence among older adults continues to climb, especially among males aged seventy-five and over, and that there is a dearth of research into effective interventions for preventing suicide in older adults. Additionally, they recommend interacting with older people who express suicidal ideation as a means of suicide prevention. The findings provide insights into the demographic and clinical characteristics of older-adult suicide decedents who disclosed their suicide intent and have important clinical implications for reducing premature mortality from suicides.

The tenth article by Hafford-Letchfield et al., entitled "*Talking really does matter: Lay perspectives from older people on talking about suicide in later life,*" is an original research article investigating potential barriers and enablers in discussing suicidal tendencies from the perspectives of lay older people. Fifteen in-depth interviews with participants aged 70–89 are performed and examined thematically. The data collection method (in-depth interviews) is advantageous since it allows research participants to express themselves freely and yields abundant data to better comprehend the phenomena under investigation. The findings illustrate the potential for involving older people themselves and people working with older people who may not be in touch with professionals to encourage and develop conversations with them about suicidal thoughts that can help with support and signposting to further assessment. The results have significant implications for providing proper assistance for older adults and, as a result, minimizing suicide ideation. The research highlights the need to increase awareness of the variety of suicide manifestations at later ages and promote more sensitivity to how it may emerge. This understanding will increase the likelihood of identifying and reacting to expressions and behaviors associated with suicide.

The eleventh article by Zhao et al., entitled *"The relationship between gender, marital status, and depression among Chinese middle-aged and older people: Mediation by subjective well-being and moderation by degree of digitization,"* is an original research article that examined the association between depression, subjective wellbeing, degree of digitization, and socio-demographic variables, namely gender and marital status, among 15.586 middle-aged and older people from the 2018 national baseline survey data of the China Health and Retirement Longitudinal Survey (CHARLS). Findings of the mediating effect of subjective wellbeing between gender and depression, the mediating effect of subjective wellbeing between marital status and depression, and the moderating effect of degree of digitization between subjective wellbeing and depression highlighted the practical keys for policymakers and mental health therapists. The authors suggested improving middle-aged and older adults and promoting their integration.

The last article by Aisenberg and Harmatz, entitled *"Improving depressive symptoms and maintaining cognitive abilities of seniors within the nursing homes: A pilot study of brief mindfulness-based interventions for seniors in a semi-randomized trial,"* is an original research article that presents an intervention using a brief intervention on mindfulness for older adults in nursing homes. The study involves eight half-hour sessions, either with an 8-week course of weekly meetings or a 4-week course of two sessions per week, compared to a control care-as-usual group. Such brief interventions are important as current interventions are usually too long and costly, heavily dependent on counselors for delivery, and physically and cognitively demanding for older adults in nursing homes. The authors demonstrate that the brief interventions were promising in improving mindfulness, psychological distress, and, selectively, cognitive capacity. It potentially impacts providing a quick intervention treatment to older adults in enhancing their quality of life and wellbeing.

Regarding future study proposals, empirical investigations on older persons with various psychopathologies and other health problems associated with older adults, such as dementia, are recommended. Several studies on older adults have explored anxiety (Mowla et al., 2022) and depression (Richardson et al., 2020; Tyler et al., 2021; Mowla et al., 2022). However, those studies have examined socio-demographic aspects of psychopathologies in great detail. In future research, it is proposed to explore a variety of psychopathologies (other than depression and anxiety) with biopsychosocial variables. For instance, it can be observed that three of the papers contained in this collection concentrate on the problem of suicide among older people who reside on various continents. For the purpose of formulating preventative

initiatives, it is generally agreed that research concentrating on the factors that influence suicide rates among older adults will be required.

This collection of research includes studies that investigate psychopathology and four studies that investigate the wellbeing of older adults. It is generally agreed upon that the issues related to the health and happiness of older adults are extremely significant for preventative measures. A few studies have highlighted how important it is for the wellbeing of older adults to have meaningful relationships with their peers. The value of intergenerational interactions as well as therapies that can be offered remotely to combat loneliness, have been emphasized throughout the volume. Implementing new strategies for promoting the wellbeing of older adults will necessitate using evidence-based trials in the future.

Karakose (2022) highlighted the importance of the quality of late-life marriages, which may directly associate with both spouses' mental health. Understanding the interpersonal and intrapersonal factors related to mental health issues within marriages may provide more resources to enhance the quality of their lives in older couples. Also, a recent study on spousal caregiving couples by Monin et al. (2019) mentioned that the health issues of both partners might uniquely impact caregivers' relationship satisfaction. Thus, future studies should investigate the aspects of relationship satisfaction related to one's own and the partner's health among older caregiving couples.

This Research Topic is limited to the topics in the articles listed above. We should mention that several factors have been linked to mental health issues in older adults. For example, personality factors, particularly neuroticism and conscientiousness, have been found to be closely associated with late-life depression and Alzheimer's disease and related dementias (Kotov et al., 2010; Hayward et al., 2013; Koorevaar et al., 2013; Terracciano et al., 2014, 2021; Sutin et al., 2018; Singh-Manoux et al., 2020; Aschwanden et al., 2021; Luchetti et al., 2021). From a broader perspective, psychological health strategies for older adults should also focus on identifying and addressing risk factors that are more prevalent in older adults, such as chronic physical conditions, inadequate social support networks, neglect and abuse, lack of transportation, financial barriers, or specific issues brought on by cultural differences, as well as how these risk factors contribute to the onset, maintenance, and long-term effects of mental health problems.

In conclusion, the prevalence of psychological disorders such as depression, anxiety, stress, psychosis, and substance abuse increases as the world's population ages. Thus, healthcare providers, researchers, and policymakers must recognize the importance of addressing mental health issues in older populations and work to develop effective, evidence-based strategies for preventing, assessing, and treating mental health conditions in this population that are specific to the needs of older adults.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Delays in Seeking Medical Services in Elderly Patients With Senile Cataract

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Delay in seeking medical services is common in elderly populations, which leads to disease progression and life difficulty. This study aims to assess the prevalence of delay in medical visits and treatment and define associated effects and factors in patients with senile cataract, which may help obtain a better understanding of late-life psychopathology and provide the basis for interventions. Patients aged more than 60 years were prospectively recruited in Zhongshan Ophthalmic Center (ZOC). All participants were diagnosed with binocular senile cataract and decided to have primary surgery in ZOC. The distributions of the popularity of delaying outpatient visits and treatment, the degrees of visual impairment, the influences on quality of life, and the reasons for delaying treatment among participants were accessed by the descriptive statistics. Factors associated with the perceptions of cataract treatment were accessed using a binary logistic regression model. A total of 400 senile patients aged from 60 to 94 years were enrolled. At diagnosis, 82 (20.5%) participants had a low vision with monocular acuity of both eyes below 0.05. All participants have felt that their normal lives were affected, and 64 (16%) participants felt that their lives were affected severely. Only 17 (4.25%) participants have sought for medical services immediately after feeling vision loss, and 294 (73.50%) participants have felt vision loss since a year ago before seeking medical help. A total of 298 (74.50%) participants have delayed the surgery time, and 229 (57.25%) patients delayed it for more than 12 months. There were 147 (36.75%) participants delaying surgery on account of no knowledge about it and 114 (28.50%) participants delaying surgery because of fear. There are a high proportion of elderly patients with senile cataract delaying their outpatient visits and surgery treatment, whose normal lives were severely affected. Increasing medical service propaganda about cataract and other common diseases in elderly populations would probably be helpful for improving perceptions of diseases and decreasing medical delays. Public needs to draw more attention to the healthy and medical status of the elderly ocular patients.

Keywords: senile cataract, medical delays, self-neglect, senile psychology, older patient

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INTRODUCTION

An increasingly remarkable population of senior citizens are benefiting from longevity with the advances in medical technology and health policy (Rousson and Paccaud, 2010; Zeng et al., 2017). Epidemiological studies show that 11% of the world's population is over 60 years of age, and this proportion is expected to increase to 22% by 2050. However, this longevity presents new challenges for healthcare and society, as elderly people have higher morbidities of cancer and chronic diseases due to senescence (Fries, 1980; Gil and Withers, 2016). Therefore, early diagnosis and treatment are necessary and significant to allow for earlier recovery, better prognosis, and reduced medical expenditure (Bousquet et al., 2013; Davis et al., 2013).

Nonetheless, delayed medical visits and treatment are a common and serious problem in elderly patients (Mosqueda and Dong, 2011). Physicians have a high frequency of encounters with elderly patients who neglect symptoms of diseases until their lives are severely affected, which likely leads to longer treatment, more complications, and worse prognosis (Schoepfer et al., 2013; de Haan et al., 2018). As a consequence, delaying treatment provokes disease progression and life deterioration (Yurdakul et al., 2015). In addition to critically impacting patients' lives, delaying treatment may cause enormous economic and mental pressure on family members, as well as a tremendous waste of healthcare resources, which negatively affects the aging population (Pita Fernández et al., 2010; Li et al., 2018).

Senile cataract is the most common eye disease in elderly adults; it has a prevalence of 13–50% among people older than 60 years worldwide and causes vision loss, sometimes even blindness (Liu et al., 2017; Song et al., 2018). Senile cataract progresses slowly and regularly leads to the deterioration of visual function and life quality, similar to many perennial older diseases. Surgery is the only effective treatment for cataract (Lam et al., 2015; Liu et al., 2017). However, the rate of surgery for cataract is low, and a large proportion of elderly patients with cataract miss early diagnosis and treatment and come to hospitals with low vision and a reduced quality of life (Hashemi et al., 2014; Wang et al., 2016; Pawiroredjo et al., 2017).

Currently, great efforts have been made in biomedical research regarding the pathways of anti-aging (Fontana et al., 2014). Nevertheless, less attention has been paid to the actuality of the delay in diagnosis and treatment in elderly patients. Our study investigated elderly patients with senile cataract to obtain more specific knowledge about the effects of delaying diagnosis and treatment. We analyzed the prevalence, effect, and risk factors of delays in seeking medical help and proposed some solutions to improve the current situation.

MATERIALS AND METHODS

A prospective study was carried out at the Zhongshan Ophthalmic Center (ZOC), Guangdong, China, from June 2017 to July 2018. A total of 400 patients who were diagnosed with senile cataract and planned to undergo cataract surgery were consecutively recruited. This study was approved by the Ethical Review Committee of ZOC. The tenets of the Declaration of Helsinki were followed throughout this study.

Sample Selection

The inclusion criteria in the study were as follows: (1) diagnosed with senile cataract at the ZOC; (2) aged more than 60 years; (3) planning to undergo cataract surgery for the first time; (4) from Guangzhou city; and (5) signed the informed consent document. The exclusion criteria were as follows: (1) diagnosed with other ocular diseases and (2) diagnosed with cognitive impairment. Patients meeting the included requirements were enrolled consecutively.

Data Collection and Interpretation

The collected data included Snellen acuity, demographic information, visual function, and quality of life. All the data for the same person were obtained on the same day. The acuity data were obtained from clinical test results. The demographic information was collected with a questionnaire and included sex, age, education, economic conditions, awareness of senile cataract, family support status, and so on. The degree of visual impairment and effects on quality of life were collected using a scale of vision function and quality of life (Fan et al., 2008). The demographic information questionnaire was designed and revised based on suggestions from eight professors in the cataract department and 20 patients with senile cataract seen at the ZOC (refer to **Supplementary Material**). The scales were finished under instructions, and the answers to each question were recorded.

To facilitate the analysis, the results of visual impairment and effects on quality of life were transformed into numerical values ranging from 0 to 100. In each question, there are four options representing four degrees of severity; in the analysis, we adopted values of 1, 2, 3, and 4 to represent the four options. For questions 7a, 7b and 11a, 11b on the visual function scale, only the answer with the greater value was used in the analysis. Each participant's final score was divided by the total scale score and then multiplied by 100 to obtain a result ranging from 0 to 100. The greater this value was, the more severe the patient's visual impairment and effects on quality of life were.

Statistical Analysis

Patients going to outpatient visits more than 1 week after vision loss and patients deciding to accept cataract surgery more than 1 week after the doctor's recommended time for surgery were defined as delays in medical visits and treatments in the analysis. We described the distributions of the acuity level, demographic characteristics, visual impairment, and effects on quality of life for different age groups and the duration of delays in medical visits. Then, we explored the factors associated with the perceptions of drug and surgical treatment for cataract. All analyses were performed using IBM SPSS 22.0.

We performed descriptive statistics to compare the distributions of sex, education level, income, acuity, and different durations of delay in medical visits and treatment among individuals of different ages. We then determined the descriptive statistics of individuals with different durations to identify significant differences using the chi-square tests or

using Fisher's exact test if there is an expected frequency of less than 5. A binary logistic regression model was applied to explore the factors associated with the perceptions of drug and surgical treatment. Exp (B) values signify the influence degrees of associated factors; values greater than 1 indicate a positive effect, and values less than 1 indicate a negative effect. Fisher's exact test was conducted to analyze the distributions regarding reasons for delaying surgery treatment and reasons for finally undergoing surgery. P-value < 0.05 was considered statistically significant.

RESULTS

A total of 400 patients were enrolled. Participants aged 60–94 years were categorized into different age groups according to sex, education level, income, visual acuity, and different durations of delays in medical visits and treatment (refer to **Table 1**). Four participants were older than 90 years. A total of 154 (38.5%) participants were male, and 92% had a high school education or less. The monocular Snellen acuity of participants ranged from no light perception to 0.3, and 82 (20.5%) participants had blindness, with monocular acuity of both eyes below 0.05. In addition, the education level exhibited distributional differences among different age groups. The younger group has a higher education level. The duration of delay in cataract surgery was associated with age, and the older patients tended to delay cataract surgery longer.

The distributions of sex, age, education level, cohabitation status, income, visual impairment, and effects on quality of life of participants with different durations of delay in treatment are presented in **Table 2**. There was no significant distributional difference among the three groups. A total of 294 (73.50%) participants had experienced vision loss for a year before seeking medical help at the hospital. Only 55 (13.75%) participants had come to the hospital within 6 months of noticing vision impairment. Notably, 232 (58.00%) participants felt that their normal lives were mildly affected, and 64 (16.00%) participants felt that their lives were severely affected. Also, 46 (11.5%) participants lived alone. None of the patients lived in a retirement home. The visual impairment evaluation scores ranged from 47 to 100. Individuals with scores ranging from 40 to 59 accounted for more than half the participants, and those with a high level of visual impairment (scores between 80 and 100) constituted 14.25% of all participants. The effects on quality of life scores ranged from 31 to 100. In total, 47% of participants had scores ranging from 50 to 69, and 34.25% indicated a high level of effects on quality of life (scores between 70 and 100).

The distributions of the durations of delays in surgery and the reasons for the final surgery choice are presented in **Figure 1**. A total of 102 patients chose to have surgery according to the doctors' orders. However, 298 (74.50%) participants delayed the surgery time, and 229 (57.25%) patients delayed it for more than 12 months beyond the doctor's recommended time. The reasons why patients delayed surgery exhibited distributional differences among four groups ($P < 0.001$). The reasons patients cited for finally undergoing surgery were multiple; the most common reason was that their lives were being affected by the cataract, which was selected by 351 (87.75%) patients (shown

TABLE 1 | Demographic characteristics of the participants according to age.

	Age (year)	60–69	70–79	≥80	*P*-Value
Sex	Male	44 (44.00%)	62 (35.63%)	48 (38.10%)	0.389
	Female	56 (56.00%)	112 (64.37%)	78 (61.90%)	
Education	Primary school and below	46 (46.00%)	97 (55.75%)	87 (69.05%)	0.001
	High school diploma	49 (49.99%)	60 (34.48%)	29 (23.02%)	
	Bachelor's degree and above	5 (5.00%)	17 (9.77%)	10 (7.94%)	
Annual personal income (yuan)	0–30,000	47 (47.77%)	59 (33.91%)	43 (34.13%)	0.163
	30,000–50,000	31 (31.00%)	77 (44.25%)	55 (43.65%)	
	>50,000	22 (22.00%)	38 (21.84%)	28 (22.22%)	
Best monocular acuity (Snellen acuity)	0–0.05	22 (22.00%)	38 (21.84%)	22 (17.46%)	0.180
	0.06–0.20	50 (50.00%)	83 (47.70%)	51 (40.48%)	
	0.21–0.3	28 (28.00%)	53 (30.46%)	53 (42.06%)	
Delay in outpatient visits	No[a]	4 (4.00%)	8 (4.60%)	5 (3.97%)	0.276
	0–6 months	5 (5.00%)	22 (12.64%)	11 (8.73%)	
	7–12 months	18 (18.00%)	17 (9.77%)	16 (12.70%)	
	>12 months	73 (73.00%)	127 (72.99%)	94 (74.60%)	
Delay in cataract surgery	No[b]	34 (34.00%)	43 (24.71%)	25 (19.84%)	0.031
	0–6 months	8 (8.00%)	21 (12.07%)	10 (7.93%)	
	7–12 months	11 (11.00%)	7 (4.02%)	12 (9.52%)	
	>12 months	47 (47.00%)	103 (59.20%)	79 (62.70%)	

Participants aged 60–94 years were categorized into different age groups according to sex, education level, income, visual acuity, and different durations of delay in medical visits and treatment.

[a] *Patients go to outpatient visits within 1 week after feeling the vision loss.*

[b] *Patients decide to accept cataract within 1 week after the doctor's recommended time for surgery.*

TABLE 2 | Demographic characteristics, visual function, and life quality of participants according to the duration of delay in medical visits after feeling vision loss.

		No	0–6 months	6–12 months	>12 months	*P*-Value
Total		17	38	51	294	
Sex	Male	5 (29.4%)	18 (47.4%)	16 (31.4%)	115 (39.1%)	0.392
	Female	12 (70.6%)	20 (52.6%)	35 (68.6%)	179 (60.9%)	
Age	60–69 years old	4 (23.5%)	5 (13.2%)	18 (35.3%)	73 (24.8%)	0.276
	79–79 years old	8 (47.1%)	22 (57.9%)	17 (33.3%)	127 (43.2%)	
	>80 years old	5 (29.4%)	11 (28.9%)	16 (31.4%)	94 (32.0%)	
Education	Primary school degree and below	14 (82.4%)	20 (52.6%)	26 (51.0%)	170 (57.8%)	0.403
	High school degree	3 (17.6%)	14 (36.8%)	21 (41.2%)	100 (34.0%)	
	Bachelor degree and above	0	4 (10.5%)	4 (7.8%)	24 (8.2%)	
Feel life influenced	Mildly	10 (58.8%)	26 (68.4%)	25 (49.0%)	171 (58.2%)	0.498
	Moderately	3 (17.6%)	9 (23.7%)	15 (29.4%)	77 (26.2%)	
	Severely	4 (23.5%)	3 (7.9%)	11 (21.6%)	46 (15.6%)	
Live with	None	2 (11.8%)	6 (15.8%)	2 (3.9%)	36 (12.2%)	0.144
	Spouse	6 (35.3%)	12 (31.6%)	13 (25.5%)	66 (22.4%)	
	Children	5 (29.4%)	10 (26.3%)	22 (43.1%)	77 (26.2%)	
	Spouse and children	4 (23.5%)	10 (26.3%)	14 (27.5%)	115 (39.1%)	
Annual personal income	0–30,000	6 (35.3%)	17 (44.7%)	20 (39.22%)	106 (36.1%)	0.670
	30,000–50,000	9 (52.9%)	16 (42.1%)	20 (39.2%)	118 (40.1%)	
	>50,000	2 (11.8%)	5 (13.2%)	11 (21.6%)	70 (23.8%)	
Best monocular acuity (Snellen acuity)	0.00–0.05	5 (29.4%)	3 (7.9%)	13 (25.5%)	51 (17.3%)	0.249
	0.06–0.20	9 (52.9%)	23 (60.5%)	22 (43.1%)	164 (56.1%)	
	0.21–0.30	3 (17.6%)	12 (31.6%)	16 (31.4%)	79 (26.5%)	
Evaluation of visual impairment	40–59	5 (29.4%)	20 (52.6%)	25 (49.0%)	163 (55.4%)	0.154
	60–79	9 (52.9%)	16 (42.1%)	19 (37.3%)	86 (29.3%)	
	80–100	3 (17.6%)	2 (5.3%)	7 (13.7%)	45 (15.3%)	
Evaluation of the effects on quality of life	30–49	3 (17.6%)	7 (18.4%)	12 (23.5%)	53 (18.0%)	0.664
	50–69	5 (29.4%)	19 (50.09%)	24 (47.1%)	140 (47.6%)	
	70–100	9 (52.9%)	12 (31.6%)	15 (29.4%)	101 (34.4%)	

The distribution of sex, age, education level, cohabitation status, income, visual impairment, and effects on the quality of life of participants with different durations of delay in treatment are presented.

in **Figure 2**). A total of 41 (10.25%) patients chose to undergo surgery as recommended by doctors. The reasons why patients finally accepted surgery indicated no distributional differences among the four groups ($P = 0.066$).

The participants held different opinions about the effectiveness of drug treatment for senile cataract. Notably, 56 participants thought that the drug treatment was valid for cataract, 188 held the opposite belief, and 156 had no opinion about the drug treatment. The factors associated with perceptions of drug treatment are shown in **Table 3**. Several factors were associated with the participants' perceptions of drug treatment, including effects on quality of life, attempts at drug therapy, and the frequencies of required physical tests. Attempted drug therapy had the strongest relationship with the participants' perceptions of drug therapy. The participants whose doctors had recommended were most likely to consider the drug treatment effective. Patients who had not undergone physical tests tended to hold the same opinion.

The elderly patients had different perceptions regarding cataract surgery. There were 147 participants who had no idea about the surgery treatment. Four factors were associated with awareness of cataract surgery (**Table 4**). Patients who delayed outpatient visits and were mildly affected tended not to know about surgical treatment. In addition, patients who held the opinion that senility causes vision loss were less likely to know about surgical treatment.

DISCUSSION

Some surveys have reported the status of and factors associated with delayed treatment in patients with different diseases, especially cancers and infectious diseases (Saver et al., 2016; Getnet et al., 2017; de Haan et al., 2018; Leung et al., 2018; Vizza et al., 2018). However, the status of delayed diagnosis and treatment in elderly patients has not received much attention and warrants greater concern. A large proportion of elderly patients with senile cataract who were recruited for our study delayed their outpatient visits and surgical treatment. We describe the prevalence of delayed outpatient visits and treatment among elderly patients with senile cataract and analyze the factors associated with disease perceptions.

A high proportion of the elderly patients (95.75%) in our study delayed their outpatient visits and diagnosis, and 74.5%

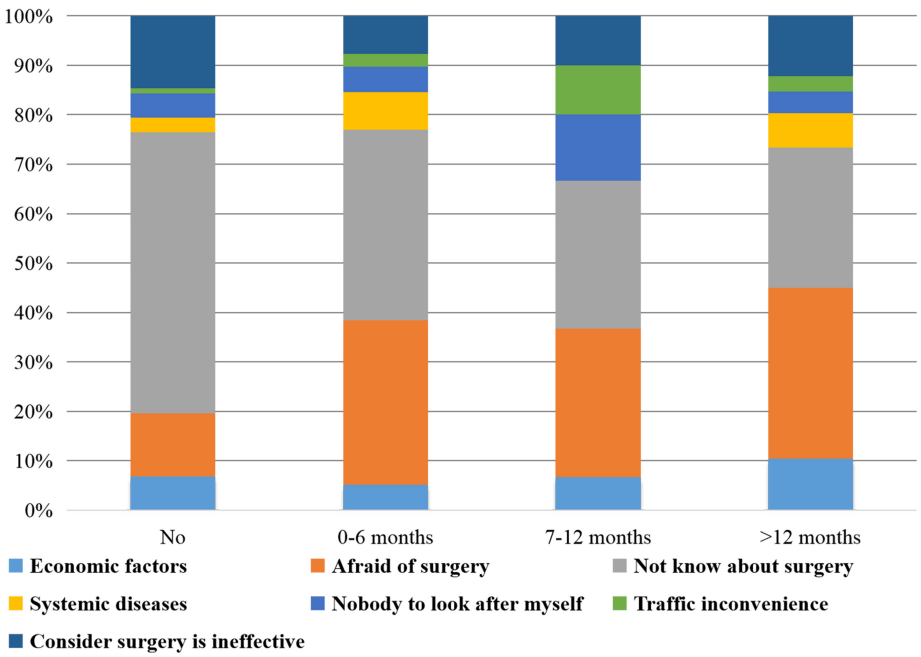

FIGURE 1 | Distribution of durations of delaying surgery treatment and reasons for it. A total of 298 (74.50%) participants delayed surgery, and 229 (57.25%) delayed it for more than 12 months. The reasons why patients delayed surgery exhibited distributional differences among four groups ($P < 0.001$). There were 114 (28.50%) participants delaying surgery on account of fear and 147 (36.75%) delaying it because of having no knowledge about it.

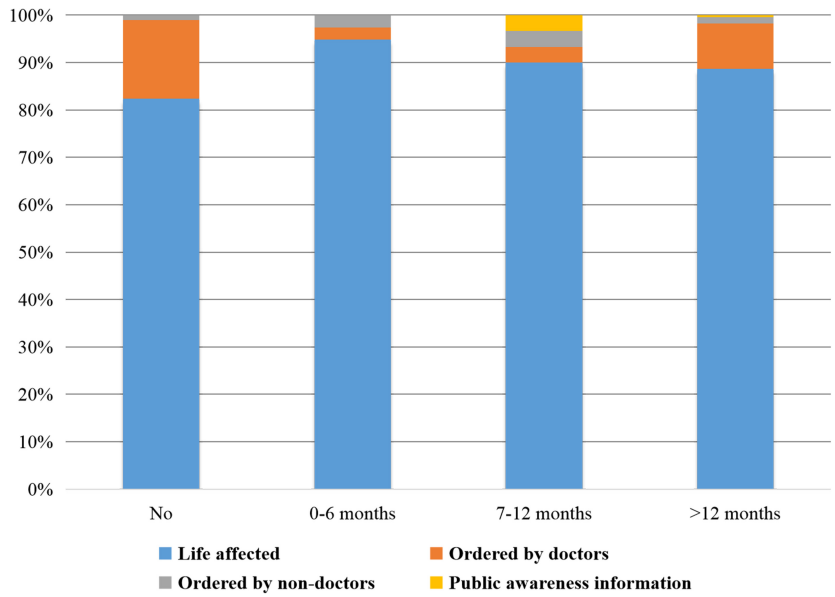

FIGURE 2 | Distribution of durations of delaying surgery and reasons for finally undergoing surgery. The reasons why patients finally accepted surgery indicated no distributional differences among the four groups ($P = 0.066$). Notably, 351 (87.75%) patients chose to undergo surgery because their lives were affected and 41 (10.25%) patients chose to undergo surgery as recommended by doctors.

delayed surgical treatment. It has been reported that self-neglect is the most common form of elder mistreatment; it usually manifests as neglecting self-health and is reportedly on the rise (Payne and Gainey, 2005). Self-neglect is a public health problem that crosses all demographic and socioeconomic strata of the aging population (Mosqueda and Dong, 2011). Similar to previous studies, our study revealed a relationship between age and delaying treatment, with older patients tending to have longer durations of treatment delays (Knoepfli et al., 2019). We suppose that older patients are more likely to confuse senility

TABLE 3 | Factors associated with perceptions of drug treatment.

	Exp (B)	Sig.	95% CI
Effects on quality of life			
No	1.000		
Yes	4.345	0.007	1.502–12.571
Drug treatment			
None	1.000		
Recommended by doctors	18.570	0.000	5.902–58.428
Recommended by self	1.155	0.730	0.508–2.625
Physical test in 3 years			
None	1.000		
When feeling unwell	0.690	0.545	0.208–2.294
Annually	0.169	0.002	0.055–0.520

Participants who thought drug treatment was invalid were considered the standard group, and those who believed that drug treatment was effective were the comparison group. Exp (B) signifies the degree of influence on perceptions of drug therapy, with a value greater than 1 indicating a positive effect.

TABLE 4 | Factors associated with perceptions of surgical treatment.

	Exp (B)	Sig.	95% CI
Delayed outpatient visits			
<6 month	1.000		
6–12 months	2.254	0.066	0.948–5.356
>12 months	2.184	0.016	1.156–4.124
Reason for vision loss			
Senility	1.000		
Cataract	3.721	0.000	2.308–5.999
Other	1.131	0.773	0.491–2.604
Effects on quality of life			
Severe	1.000		
Moderate	0.303	0.004	0.136–0.676
Mild	0.269	0.001	0.128–0.566
Physical test in 3 years			
None	1.000		
When feeling unwell	0.387	0.001	0.219–0.685
Annually	0.840	0.757	0.277–2.544

Participants who thought the surgical treatment was invalid were considered the standard group, and those who believed that surgical treatment was effective were the comparison group. Exp (B) signifies the degree of influence on awareness of cataract surgery, with a value greater than 1 indicating a positive effect.

and disease symptoms and have fewer perceptions regarding disease treatment.

The senile cataract progresses slowly, gradually affecting normal life (Lam et al., 2015). Similar to many older diseases, cataract develops chronically and is not easily perceived by elderly people (Steel, 2005). In our study, 37% of participants believed that senility causes vision loss. The degradation of body functions and symptoms of chronic diseases are frequently confused by elderly populations (Tchkonia and Kirkland, 2018). As a consequence, a great proportion of elderly patients neglect early symptoms and miss opportunities for early diagnosis and treatment. We propose that elderly patients with senile cataract are also likely to miss opportunities for early diagnosis and treatment. In addition, incorrect perceptions of disease treatment can lead to delayed treatment; indeed, 147 (36.75%) participants have no thoughts regarding surgical treatment, the only effective therapy for senile cataract. Increased information about common diseases in elderly populations would probably be helpful for improving perceptions of diseases. More promotional brochures and medical lectures can be delivered at senior citizens' activity centers.

The visual impairment and effects on quality of life experienced by elderly patients who do not receive early cataract treatment can seriously affect their normal life. The participants' visual impairment and effects on their quality of life scale scores indicated that their normal life was greatly affected. In addition, although some of them lived with spouses and children, their family members probably did not notice their declining life functions or advise them to go to hospitals, as more than 80% of the participants finally sought treatment because of the effects on quality of life rather than because of recommendations from family members. The attention paid to elderly populations by their family members is limited. It has been reported that perceived neglect and reduced care were associated with increased mortality risk in a general population of elderly adults (Barnes et al., 2008). The health status of elderly family members should receive greater attention from the younger family members who are advised to learn about common older diseases and their early symptoms. Younger individuals have the responsibility to care for the health status of the elderly and suggest them to go to the hospital when something is wrong (Hudson and Johnson, 1986).

It is important to identify modifiable factors for the improvement of perceptions of cataract treatment. The factors associated with the perceptions of cataract treatment are presented in **Tables 3**, **4**. The factor "effects on quality of life" is an important cause associated with perceptions of drug treatment. Patients who have difficulty in daily life may have more intrinsic motivation to find an effective way to solve the cataract problem. The doctors' recommendations have an obvious effect on the incorrect beliefs about treatment, which illustrates the dominant role of doctors in elderly patients' disease awareness. In addition, frequent physical tests have a negative effect on perceptions regarding cataract treatment. People who undergo regular physical tests usually take their personal health more seriously; however, their perceptions of diseases are mostly incorrect, which is beyond our expectations. We presume that conservative treatment approaches from doctors based on test results in the early stage of cataract likely lead to improper perceptions of disease treatment among patients. Patients who think that the reason for vision loss is cataract instead of senility and feel severely affected have better perceptions of surgical treatment, which is understandable. The dissemination of knowledge of cataract disease may contribute to early disease treatment. Similar to previous results, modifiable social and behavioral factors can enhance the perceptions of diseases and consequently improve the prognosis of older people, reinforcing the evidence for establishing intervention strategies (Fried et al., 2004; Glymour and Osypuk, 2012). More detailed treatment information after diagnosis, including the recommended treatment regimens for different stages of the disease, recommended follow-up intervals,

and the consequences of disease progression, need to be provided to elderly patients *via* doctor–patient communication, medical examination reports, and so on.

There were limitations to this study. First, the participants were from Guangzhou city, and only patients with senile cataract were enrolled. Caution should be used when generalizing the results to other populations. Second, this was a cross-sectional survey that did not allow cause–effect relationships to be determined. Longitudinal studies should be considered in the future. In addition, more studies are warranted to investigate the prevalence of and factors associated with delays in medical visits and treatment in elderly patients for other severe and acute diseases.

CONCLUSION

Our study is the first to illuminate the prevalence of and effect of delays in medical visits and treatment in elderly patients with senile cataract and to draw attention to the health and medical status of the elderly. Some interventions are necessary to improve disease knowledge and address self-neglect in elderly patients. We propose that younger individuals attach more importance to the health of elderly family members.

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 Ethical Review Committee of ZOC. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

YX and HL contributed to the conception and design of the study. HJ contributed to the acquisition of data. LZ and QL performed the statistical analyses. YX contributed to drafting the manuscript. HL contributed to revising the manuscript critically for important intellectual content. All authors contributed to the interpretation of data and approved the final version of this 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/fpsyg.2022.930726/full#supplementary-material

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The effectiveness of remote delivered intervention for loneliness reduction in older adults: A systematic review and meta-analysis

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Background: Remotely delivered intervention is widely applied to loneliness treatment in older adults, but the effect is controversial. This study aimed to evaluate the effects of remotely delivered intervention on loneliness using a systematic review and meta-analysis.

Methods: The PubMed, the Cochrane Central Register of Controlled Trials, EMBASE, CINAHL (EBSCO), PsycINFO (EBSCO) databases were searched for studies, the search ended on 7 July 2021. Thirteen randomized controlled trials of remotely delivered intervention compared with usual care, brief contact, or no intervention for loneliness were included. A random-effects model measured estimation of loneliness reduction. Furthermore, standardized mean differences (SMDs), 95% confidence intervals (CIs), publication bias, and heterogeneity were calculated. Subgroup analysis was used to explore the factors that might affect the treatment effects.

Results: The evidence of remotely delivered intervention on loneliness reduction was certain (SMD = −0.41 [95% CI, −0.70 to −0.13]). Media subgroup analysis supported the effectiveness of intervention delivered by video call (SMD = −0.54 [95% CI, −0.83 to −0.25]); treatment strategy subgroup analysis found evidence to support the effectiveness of increasing social support and maladaptive social cognition treatment strategy (SMD = −0.47 [95% CI, −0.77 to −0.18] and SMD = −1.04 [95% CI, −1.98 to −0.10], respectively); participants subgroup analysis shown the effectiveness of intervention for older adults living in LTC and social isolation (SMD = −1.40 [95% CI, −2.43 to −0.36] and SMD = −0.55 [95% CI, −0.74 to −0.36], respectively); group format subgroup analysis testified the effectiveness of intervention carried out in individual format (SMD = −0.39 [95% CI, −0.71 to −0.07]); measurement time points subgroup analysis found the positive effect of intervention at 3 months and 3 to 6 months stage (SMD = −0.33 [95% CI, −0.52 to −0.14] and SMD = −0.32 [95% CI, −0.57 to −0.07], respectively).

Significant publication bias was detected ($p < 0.05$), and the heterogeneity of the studies was substantial.

Conclusion: This systematic review and meta-analysis demonstrate that remotely delivered intervention can reduce loneliness in older adults, and it appears to be affected by media type, treatment strategy, participants characteristics, group format, and measurement time points.

KEYWORDS

remote delivered intervention, loneliness, older adults, meta-analysis, systematic review

Introduction

Loneliness is common among older adults, and it can have side effects such as social isolation (Mountain et al., 2014), depression (Heller et al., 1991), less social support (Choi et al., 2020), and lead to suicide (Conwell et al., 2021). The World Health Organization is estimated to have 20–40% of affected older adults (Perissinotto et al., 2012). The main therapeutic goal in the treatment is loneliness reduction.

Loneliness interventions are based on four strategies: (a) enhancing social skills; (b) providing social support; (c) increasing opportunities for social interaction; and (d) addressing maladaptive social cognition (Masi et al., 2011). These intervention elements could be adapted for remote delivery (Yousefi Nooraie et al., 2021). In mental health problem treatment, the satisfaction of remotely delivered intervention is equivalent to or significantly higher than face-to-face intervention (Guaiana et al., 2021).

Because many older adults with loneliness have trouble accessing support groups or specialists for physical conditions or traffic barriers (Chesney et al., 2003; Crystal et al., 2003), remotely delivered intervention may be a practical option in treating loneliness (Poscia et al., 2018). Information and communication technology may overcome the social and spatial barriers of social interaction by enabling accessible, affordable communication and activities of multiple forms (i.e., textual, audio, or visual) between the elderly (often with limited mobilization) and others anytime and anywhere (Chen and Schulz, 2016). With Corona Virus Disease 2019 (COVID-19) shielding/social distancing measures, remotely delivered interventions for older adults become more urgent (Williams et al., 2021).

Remotely delivered intervention could include psychology and sociology intervention (Gorenko et al., 2021). Although not fully understood, the theoretical psychological basis of intervention is considered to include the change in social behavior by changing persons' mental process. For example, cognitive behavioral therapy helps individuals to look for disconfirming evidence to reframe perceptions of loneliness and self-efficacy to change behaviors, increase social connections, and decrease loneliness (Hickin et al., 2021). The theoretical sociological basis of intervention includes the increase of social engagement by connecting to the outside world, improving social skills, engaging in activities of interest, and boosting self-confidence. Increased social engagement is linked to decreased risk of cognitive decline, depression, and loneliness (Gorenko et al., 2021). For each patient, information on participants' technology accessibility and needs are used to define the proper media type and treatment strategy to achieve optimal therapeutic effects (Gorenko et al., 2021).

Effects of entirely remotely delivered interventions have been evaluated on different mental illnesses, like depression (Guaiana et al., 2021), schizophrenia (Kasckow et al., 2014), mental disorders (Leach and Christensen, 2006), psychotic disorders (Baker et al., 2018), and other mental health problems (Hailey et al., 2008). Whether remotely delivered interventions have a definite therapeutic effect on loneliness in older adults is controversial (Ibarra et al., 2020). Because of the small number of published studies and their heterogeneity, many systematic reviews have reported inconsistent results (Masi et al., 2011; Choi et al., 2012; Cohen-Mansfield and Perach, 2015; Gardiner et al., 2018; Noone et al., 2020; Jin et al., 2021; Lee et al., 2021; Williams et al., 2021). Nevertheless, several high-quality randomized controlled trials (RCTs) have recently been published (Lai et al., 2020; Kahlon et al., 2021; Shapira et al., 2021). This study aimed to conduct an updated meta-analysis and systematic review on the loneliness reduction obtained by remotely delivered intervention for loneliness in older adults.

Materials and methods

Protocol and registration

We followed the reporting guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis 2020

(PRISMA 2020; Page et al., 2021). The completed PRISMA 2020 checklist was provided in online **Supplementary material**. The protocol was registered in PROSPERO (registration number is CRD42021285534).

Search strategy

We identified studies that evaluated the efficacy of telephone-delivered intervention for older adults with loneliness by searching the following electronic databases: PubMed, the Cochrane Central Register of Controlled Trials, EMBASE, CINAHL (EBSCO), PsycINFO (EBSCO). The search ended on 7 July 2021. A combination of free-text terms and medical subject heading terms was used for the subject search. Search terms included the following: (1) aged, aging, elderly, old*; (2) lone*; combined with (3) telephone and hotline. Using PubMed search strategy as an example, the detailed search strategy in online **Supplementary material**. After the electronic search, we supplementary screened relevant articles from the reference lists of included studies or previous systematic reviews. The language of included studies was English.

Inclusion criteria

Studies were included based on the following criteria: (1) older adults who are over the age of 65 years (Shenkin et al., 2017), whether or not they were experiencing symptoms of loneliness, social isolation, depression, anxiety, or other mental illness at baseline; (2) treatment by remotely delivered intervention; (3) treatment of a control group with brief contact, social activity, usual care or no intervention; and (4) outcomes of loneliness as measured with any instrument.

Definitions

For the meta-analysis, the remotely delivered intervention group comprised the patient who received any intervention delivered *via* the telephone, video call, internet, or computer, with a social connection or psychosocial (mental, emotional, social, or spiritual) focus, or a combination of these. And the control group included those who received brief contact, usual care, or no intervention, "brief contact" represented brief calls (Lai et al., 2020) or brief telephone visits (Choi et al., 2020), "social activity" represented sports activity (Jing et al., 2018) or daily social activity (Shapira et al., 2021), "usual care" represented standard, conservative therapy (Kahlon et al., 2021), "No intervention" represented either no routine treatments or alternatives (Tsai et al., 2020).

Data extraction

Two authors (FZ and YM) independently reviewed all titles and abstracts to determine eligibility and retrieve articles. Two authors resolved their disagreement by discussion. If they could not make an agreement, another author (MC) was consulted, and a decision was made by a majority vote. The following information was extracted based on a fixed protocol: authors, year of publication, country, age distribution, gender proportion, study design, numbers of remotely delivered intervention and control participants, the intervention and control groups (e.g., intervention media, strategy, group format, participants' background, duration of follow-up), measurement time points(s) and outcome measures.

Validity assessment

As described in the Cochrane Handbook for Systematic Reviews of Interventions, the Cochrane Collaboration's risk of bias tool was used to assess bias in each eligible study (Higgins and Green, 2008). The quality assessment covered the following domains: (1) sequence generation; (2) allocation concealment; (3) blinding; (4) incomplete outcome data; (5) selective outcome reporting; and (6) other possible sources of bias. The meta-analysis results were interpreted in terms of findings regarding the risk of bias. RevMan 5.4.1 (Review Manager 5.4.1; Cochrane Collaboration) software presented the results graphically.

Statistical analysis

RevMan 5.4.1 and Stata 12.0 (StataCorp) software were used to analyze the data in this meta-analysis. Measurement data were used for statistical efficacy analysis using Cohen's standardized mean difference (SMD) with 95% confidence intervals (CI). Cochran's Q test and I^2 statistics were used to examine overall heterogeneity between studies and within subgroups of studies. Benchmarks of I^2 can be categorized as having low (25%), moderate (50%), and high (75%) heterogeneity (Higgins et al., 2003). Because of the variation of the study characteristics (e.g., mode of telephone intervention, participants' characteristics), we assumed that the true effect size might vary from study to study. Thus, comparisons were based on a random-effects model (Borenstein et al., 2010). Media, strategy, group format, participant, and measurement time points subgroup analysis were used to examine the effect of different intervention types on loneliness outcomes in older adults. Three sensitivity analyses were performed to assess the stability of the pooled effects by omitting 1 of 3 individual studies to determine their influence on the pooled SMDs. Two studies (Shapira et al., 2007; Jarvis et al., 2019) were omitted because of the inadequate participant included in treatment, and the

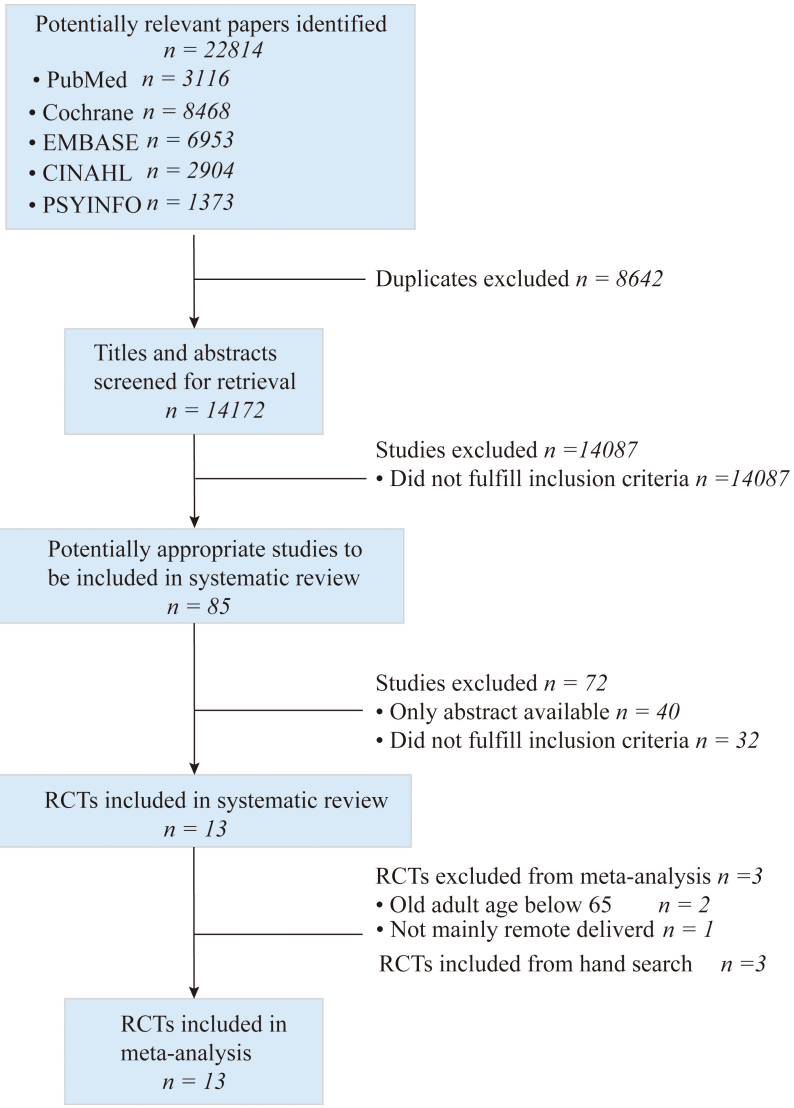

FIGURE 1
Flowchart of study selection.

other (Tsai et al., 2020) was omitted because of its large CI. The remaining studies (the group with adequate participants included in treatment or the group with relatively small CIs) were then used to recalculate the pooled SMDs. A funnel plot was applied to detect publication bias. The Egger test evaluated the significance of the intercept. All p values were two-sided, with $p < 0.05$ considered significant.

Results

Literature screening

As shown in **Figure 1**, 22,814 studies were identified with computerized search; after importing these articles into EndNote X9 software, 8,642 were duplicated articles, and 14,087 did not meet our inclusion of criteria following a review of the title and abstract. The full text of the remaining 85 articles was obtained. In addition, 75 studies were excluded for the following reason: conference abstract (n = 40), did not address loneliness and remotely delivered intervention (n = 32), age below 65 (n = 2; Heckman et al., 2006; Brodbeck et al., 2019), treatment not mainly through remotely delivered intervention (n = 1; Conwell et al., 2021). Finally, three studies were included in a hand search. Thirteen articles that met our inclusion criteria were included in the qualitative synthesis (Heller et al., 1991; Hartke and King, 2003; Shapira et al., 2007, 2021; Slegers et al., 2008; Mountain et al., 2014; Jing et al., 2018; Jarvis et al., 2019; Nelson et al., 2019; Choi et al., 2020; Lai et al., 2020; Tsai et al., 2020; Kahlon et al., 2021).

TABLE 1 Characteristics of the Included RCTs*.

Study	Location	Remotely delivered intervention group								Control group			
		Age (yr)	Men (%)	Media	Strategy	Group	Participant	Interval (h)/ duration (wk) /session	Sample size	Intervention	Sample size	Measurement timepoint (wk)	Outcome measure (loneliness)
Hartke and King, 2003	United States	70	26	Telephone	Support	Group	Caregiver	1/8/1	43	Usual care	45	24	UCLA
Lai et al., 2020	Canada	80	33	Telephone	Support	Group	Isolation	?/8/?	30	Brief contact	30	24	DJLS
Kahlon et al., 2021	United States	70	21	Telephone	Support	Indvdl	Isolation	0.2/4/5	120	Usual care	120	4	UCLA, DJLS
Heller et al., 1991	United States	74	0	Telephone	Contact	Group	Community	?/30/?	241	No treatment	53	10,20,30	UCLA
Shapira et al., 2021	Israel	72	19	Video call	Skills	Mixed	Isolation	2–3/4/?	64	No treatment	18	4	UCLA
Tsai et al., 2020	Taiwan	81	25	Video call	Contact	Group	LTC	0.1/24/1	32	No treatment	30	4,12,24	UCLA
Jarvis et al., 2019	South Africa	75	13	Internet	Cognition	Group	LTC	1.5/4/2	15	Usual care	17	2,4	DJGLS
Nelson et al., 2019	United States	76	47	Telephone	Cognition	Indvdl	LTC	0.8/7/1	31	Usual care	28	8,16	UCLA
Mountain et al., 2014	United Kingdom	82	34	Telephone	Contact	Mixed	Community	0.3/6/1	35	Usual care	35	24	DJGLS
Choi et al., 2020	United States	74	33	Video call	Cognition	Indvdl	Isolation	?/5/1	43	Brief contact	46	6,18	PROMIS-L
Jing et al., 2018	China	75	30	Internet	Cognition	Indvdl	Community	?/6/6	40	Soc activity	39	24	3-point Likert scale
Slegers et al., 2008	United States	70	?	Internet	Contact	Indvdl	Community	4/2/3	57	No treatment	38	16	DJGLS
Shapira et al., 2007	Israel	80	41	Internet	Contact	Indvdl	LTC	?/15/1	22	Soc activity	26	14	UCLA

UCLA, UCLA loneliness scale, University of California at Los Angeles; DJLS, De Jong Loneliness scale; DJGLS, The De Jong Gierveld Short Scales for Emotional and Social Loneliness; and PROMIS-L, Patient-Reported Outcomes Measurement Information System-Loneliness.
*RCT, randomized controlled trial; Soc activity, social activity; LTC, Long term care; and Indvdl, individua.

Characteristics of the included studies

Thirteen RCTs that assessed subjects were included in the meta-analysis. Characteristics of the included studies are summarized in **Table 1**. These studies were from seven different countries and regions: Canada (n = 1; Lai et al., 2020), ISRAEL (n = 2; Shapira et al., 2007, 2021), Taiwan (n = 1; Tsai et al., 2020), United Kingdom (n = 1; Mountain et al., 2014), China (n = 1; Jing et al., 2018), South Africa (n = 1; Jarvis et al., 2019), United States (n = 6; Heller et al., 1991; Hartke and King, 2003; Nelson et al., 2019; Choi et al., 2020; Conwell et al., 2021; Kahlon et al., 2021). The included studies were published between 1991 and 2021, with sample sizes ranging from 32 to 294. Four studies were carried out in long term care (LTC; Shapira et al., 2007; Jarvis et al., 2019; Nelson et al., 2019; Tsai et al., 2020). Six studies used telephone call intervention (Heller et al., 1991; Hartke and King, 2003; Mountain et al., 2014; Nelson et al., 2019; Lai et al., 2020; Kahlon et al., 2021), three studies used video call intervention (Choi et al., 2020; Tsai et al., 2020; Shapira et al., 2021), four studies used the computer or internet-based intervention (Shapira et al., 2007; Slegers et al., 2008; Jing et al., 2018; Jarvis et al., 2019).

Quality of the included studies

Adequate random allocation sequences were used in five studies (Mountain et al., 2014; Lai et al., 2020; Tsai et al., 2020; Kahlon et al., 2021; Shapira et al., 2021). One study inadequate randomization method (Shapira et al., 2007). The randomization methods of the other studies were unclear because the authors only mentioned that allocation was randomized in their studies. One study mentioned allocation concealment (Kahlon et al., 2021), which used envelopes. One study blinded the participants (Lai et al., 2020), and one blinded outcome assessment (Kahlon et al., 2021). Three studies did not use correct blinding methods (Shapira et al., 2007; Mountain et al., 2014; Jarvis et al., 2019). The result of the validity assessment is in **Figure 2**.

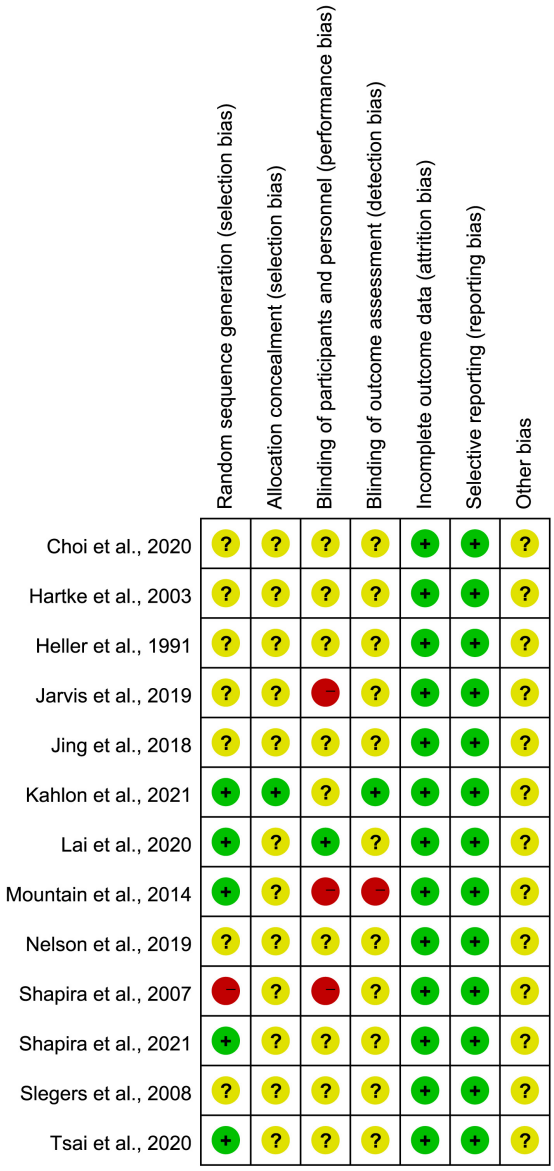

FIGURE 2
Validity of the included RCTs.

Effect of remotely delivered intervention on loneliness in older adults

Thirteen studies were used to produce a random-effects model for loneliness. The remotely delivered intervention group had significantly better overall loneliness scores ($p < 0.01$; SMD = −0.41 [95% CI, −0.70 to −0.13]; $I^2 > 50\%$; **Figure 3**) than the control group (**Figure 3**). There was evidence of high heterogeneity among these studies since the I^2 value is >50%.

Subgroup analysis

Media subgroup analysis

Among the thirteen studies included, six were telephone-based interventions, three were video call-based intervention, and four were computer or internet-based interventions. It showed significantly superior video call- delivered intervention loneliness scores ($p < 0.01$; SMD = −0.54 [95% CI, −0.83 to −0.25]; $I^2 < 50\%$; **Figure 4**). No evidence was found to support the effective ness of telephone call and computer and internet- delivered intervention ($p > 0.05$; SMD = −0.20 [95% CI, −0.56 to 0.15]; $I^2 > 50\%$ and $p > 0.05$; SMD = −0.85 [95% CI, −1.80 to 0.10]; $I^2 > 50\%$, respectively; **Figure 4**). There was high heterogeneity between studies of telephone-based interventions and computer or internet-based interventions, while there was no heterogeneity between studies of video call-based interventions.

Treatment strategy subgroup analysis

One study applied improving social skill interventions, three studies applied enhancing social support interventions, six studies applied increasing opportunities for social contact interventions, and three studies applied addressing maladaptive social cognition interventions. The effectiveness of Enhancing social support strategy and addressing maladaptive social cognition strategy ($p < 0.01$; SMD = −0.47 [95% CI, −0.77 to −0.18]; $I^2 < 50\%$ and $p < 0.05$; SMD = −1.04 [95% CI, −1.98 to −0.10]; $I^2 > 50\%$, respectively; **Figure 5**) were noted. The effectiveness of improving social skill strategy and increasing opportunities for social contact strategy ($p > 0.05$; SMD = −0.48 [95% CI, −1.01 to 0.05] and $p > 0.05$; SMD = −0.13 [95% CI, −0.55 to 0.29]; $I^2 > 50\%$, respectively; **Figure 5**) were not found. There was high heterogeneity between studies of increasing opportunities for social contact interventions and addressing maladaptive social cognition interventions, nevertheless there

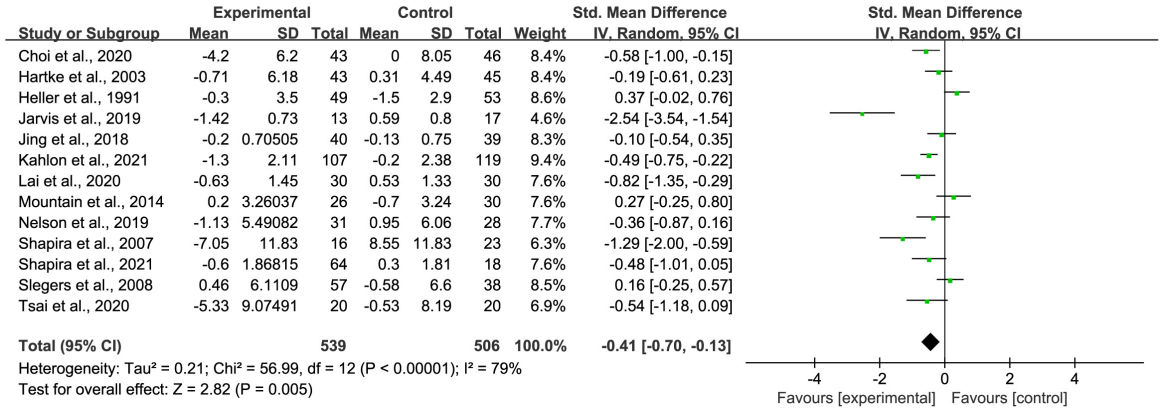

FIGURE 3
Comparisons of remotely delivered intervention and all controls on the basis of loneliness scores.

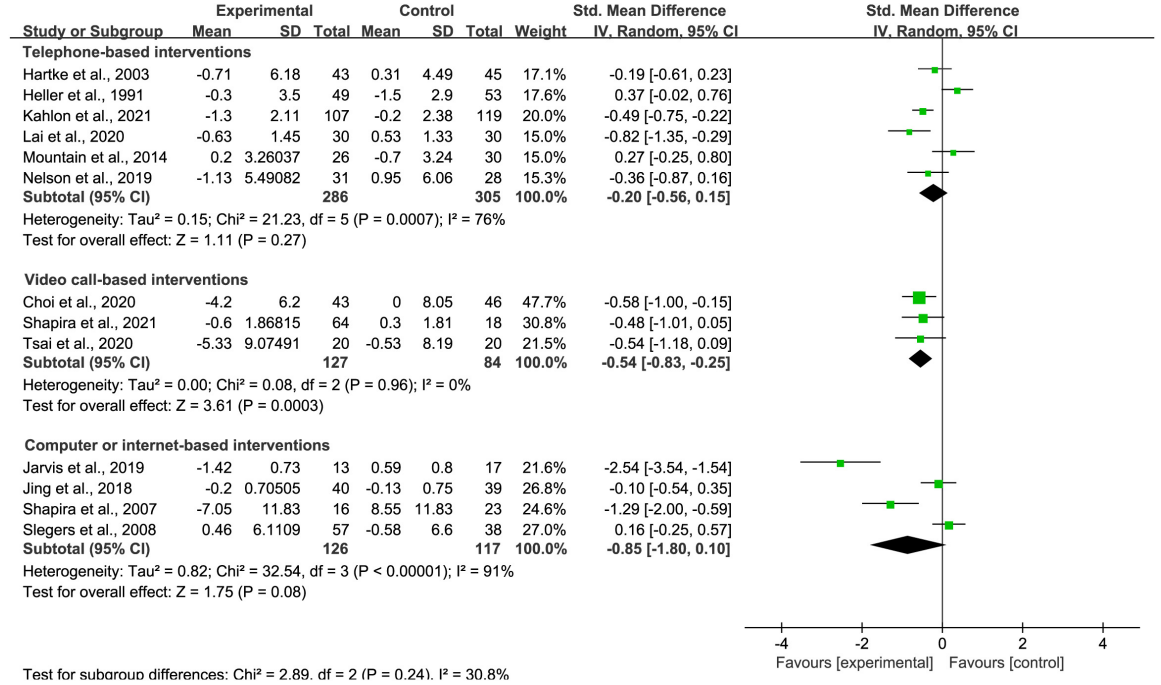

FIGURE 4
Subgroup analysis: comparison of telephone-based interventions, video call-based intervention or computer or internet-based interventions and all controls on the basis of loneliness scores.

was moderate heterogeneity between studies of enhancing social support interventions.

Participants subgroup analysis

Four studies included older adults as community dwellers, three studies included older adults living in long-term care facilities, four studies included older adults living in social isolation, one study included older adults being a caregiver, and one study included older adults living with long-term health conditions. It found significantly superior loneliness reduction for participants in social isolation and living in LTC settings ($p < 0.01$; SMD = −0.55 [95% CI, −0.74 to −0.36]; $I^2 < 50\%$ and $p < 0.01$; SMD = −1.40 [95% CI, −2.43 to −0.36]; $I^2 > 50\%$, respectively; Figure 6). The effectiveness was not found for participants living as community dwellers ($p > 0.05$; SMD = 0.18 [95% CI, −0.03 to 0.40]; $I^2 < 50\%$; Figure 6), being a caregiver ($p > 0.05$; SMD = −0.19 [95% CI, −0.61 to 0.23]; Figure 6), and living with long-term health conditions ($p > 0.05$; SMD = −0.36 [95% CI, −0.87 to 0.16]; Figure 6). There was high heterogeneity between

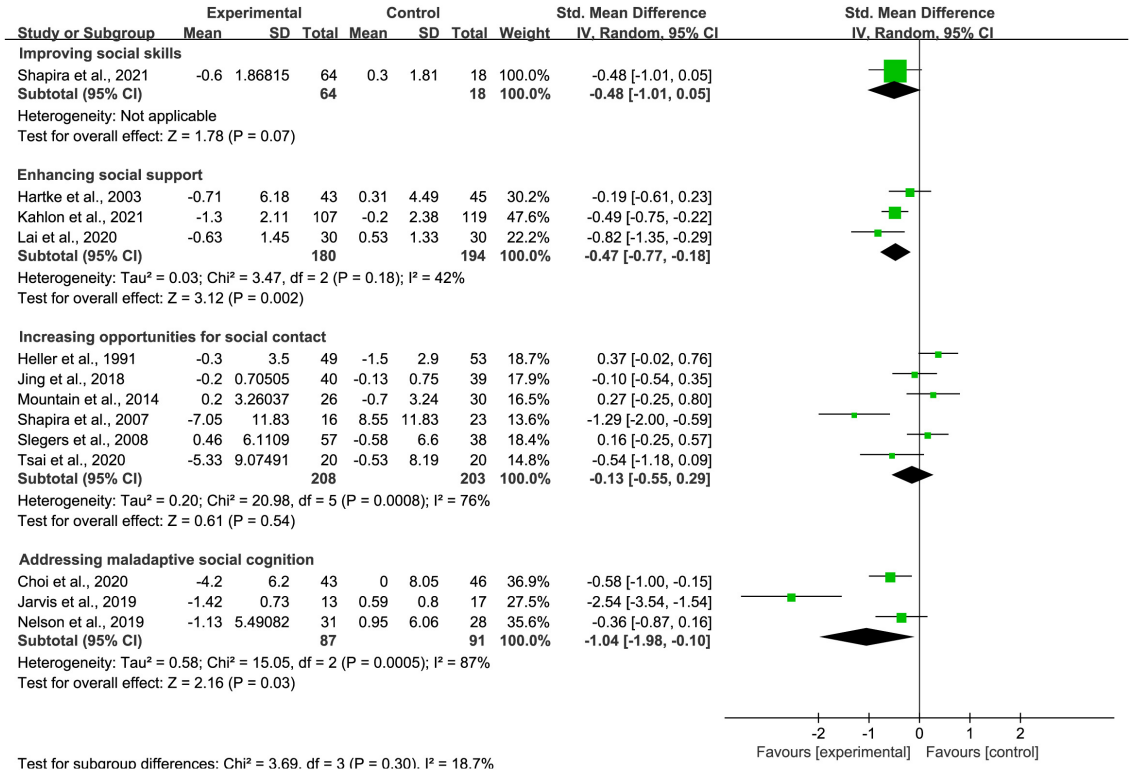

FIGURE 5
Subgroup analysis: comparison of improving social skill interventions, enhancing social support interventions, increasing opportunities for social contact interventions, or addressing maladaptive social cognition interventions and all controls on the basis of loneliness scores.

studies of interventions for older adults living in long-term care facilities, while there was no heterogeneity between studies of interventions for those as community dwellers and living in social isolation.

Group format subgroup analysis

Among the included studies, six interventions were carried out in individual format, five interventions were carried out in group format, and two interventions were carried out in individual and group mixed format. When delivered individually, superior intervention loneliness scores ($p < 0.05$; SMD = −0.39 [95% CI, −0.71 to −0.07]; $I^2 > 50\%$; **Figure 7**) was discovered through the analysis. Intervention delivered in Group and mixed format showed no effective on loneliness reduction ($p > 0.05$; SMD = −0.64 [95% CI, −1.36 to 0.07]; $I^2 > 50\%$ and $p > 0.05$; SMD = −0.10 [95% CI, −0.84 to 0.63]; $I^2 > 50\%$, respectively; **Figure 7**). There was high heterogeneity among these studies.

Measurement time points subgroup analysis

For intervention effect measured at below 3 months stage, between 3 and 6 months stage, and above 6 months stage, superior loneliness scores were found at below 3 months stage ($p < 0.01$; SMD = −0.33 [95% CI, −0.52 to −0.14]; $I^2 < 50\%$; **Figure 8**) and three to 6 months stage ($p < 0.01$; SMD = −0.32 [95% CI, −0.57 to −0.07]; $I^2 > 50\%$; **Figure 8**). When the measurement time point is above 6 months, effectiveness of intervention on loneliness reduction did not exist ($p > 0.05$; SMD = 0.37 [95% CI, −0.02 to 0.76]; **Figure 8**). There was high heterogeneity between studies at measurement time points between 3 and 6 months, but there was low heterogeneity between studies at measurement time points below 3 months.

Sensitive analysis

The sensitivity analyses revealed stable results (**Table 2**); excluding either of the three previously mentioned studies (Shapira et al., 2007; Jarvis et al., 2019; Tsai et al., 2020) did not alter the pooled SMDs.

Publication bias analysis

Egger's test and funnel plot was used to examine the publication bias of the included studies. The shape of the funnel plot shows asymmetry (**Figure 9**). Consistently, Egger's test

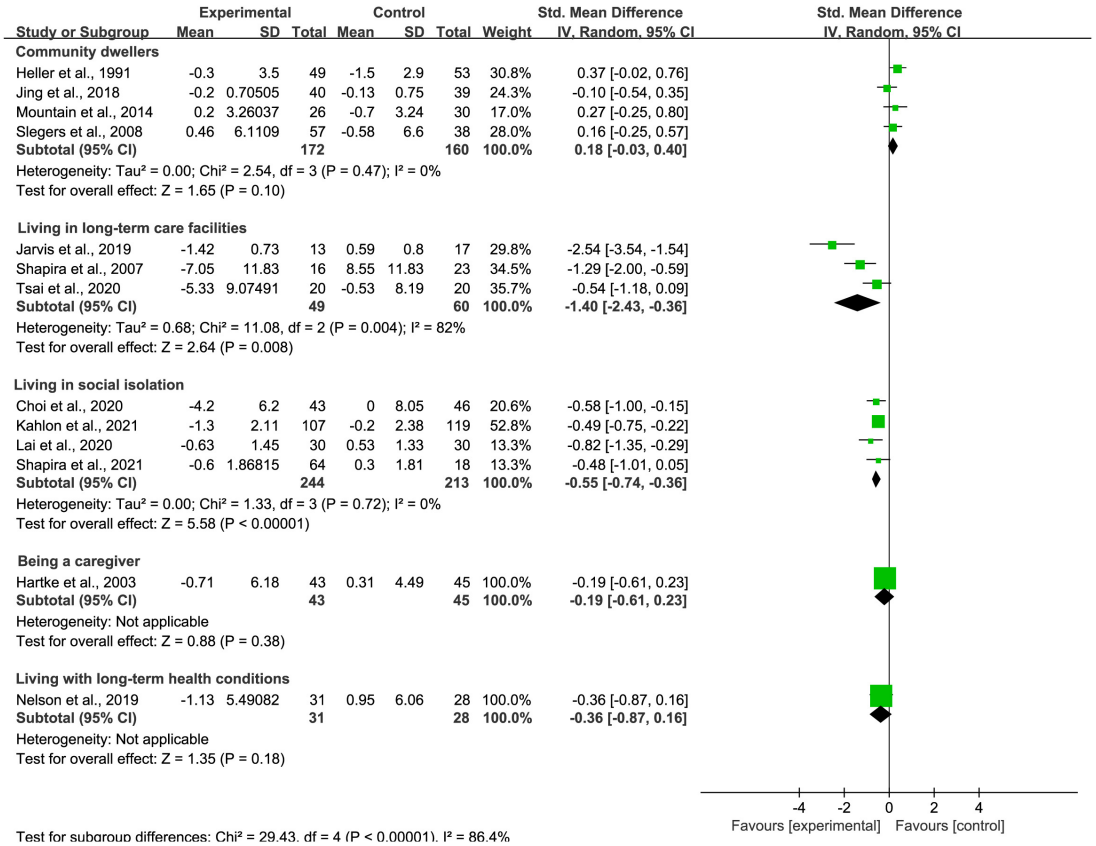

FIGURE 6
Subgroup analysis: comparison of old adults as community dwellers, living in long-term care facilities, living in social isolation, being a caregiver or living with long-term health conditions and all controls on the basis of loneliness scores.

(p = 0.0004) suggested the result of the meta-analysis would be affected by publication bias.

Discussion

This systematic review and meta-analysis demonstrate that remotely delivered intervention can result in loneliness reduction. The subgroup analysis suggested remotely delivered intervention had a superior effect on loneliness when delivered from an individual, by video call, using increasing social support or maladaptive social cognition treatment strategy, to older adults under LTC or social isolation circumstances, with measurement time points below 6 months, when compared with different control groups. These favorable effects of remotely delivered intervention involve complex interactions with the patient, including empathy, intention, care, and attention, that cannot be achieved by medications alone or by no intervention (Kahlon et al., 2021).

The previous meta-analyses have drawn various conclusions depending on the types of study design (Choi et al., 2012; Milner et al., 2015; Noone et al., 2020; Jin et al., 2021). A study showed that the effects of remotely delivered intervention were significantly superior to those of usual care (Choi et al., 2012). This result is in agreement with our findings.

The current study revealed new findings that differ from previous reports through subgroup analysis. First, when the effects of remote delivery methods on loneliness were quantitative compared simultaneously, video call-based intervention was superior to telephone-based intervention and computer or internet-based intervention when treating loneliness. In contrast, previous systematic reviews only qualitatively evaluated the effects of different methods of remote delivery on loneliness (Chen and Schulz, 2016; Gorenko et al., 2021). This study did not support the conclusion of a previous review that showed both video-call and telephone-based intervention would effectively reduce loneliness in older adults (Gorenko et al., 2021). The possible reason for the superior effect of video call-based intervention might be that video call-based intervention would give more social cues than the telephone and internet intervention, making participants feel more supported during the intervention (Noone et al., 2020).

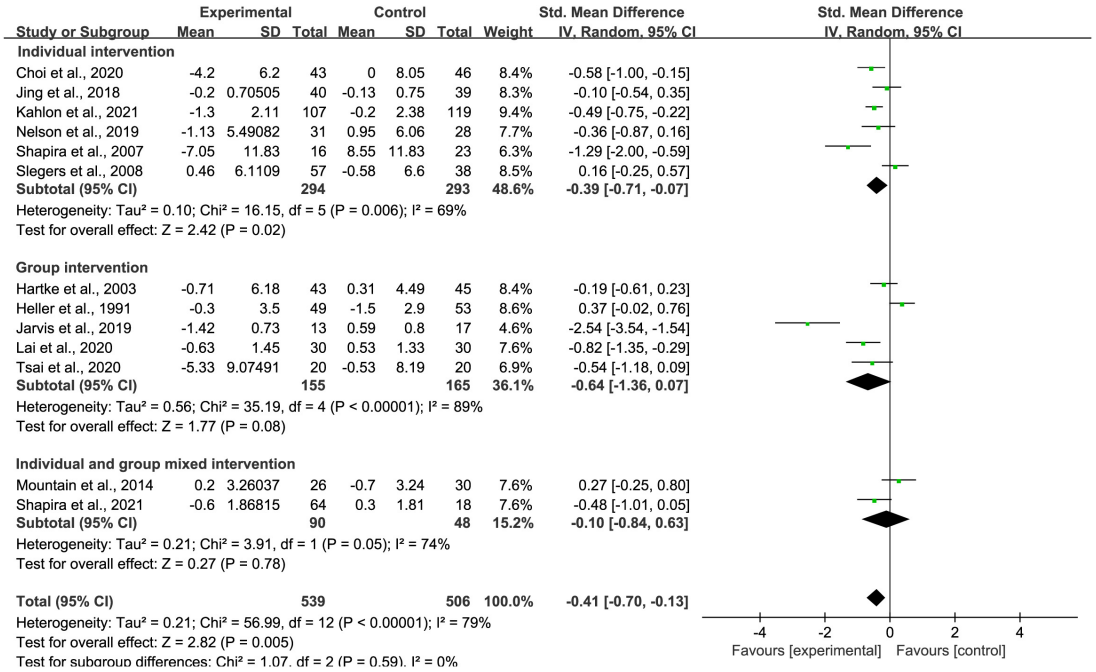

FIGURE 7
Subgroup analysis: comparison of individual interventions, group interventions, or mixed interventions and all controls on the basis of loneliness scores.

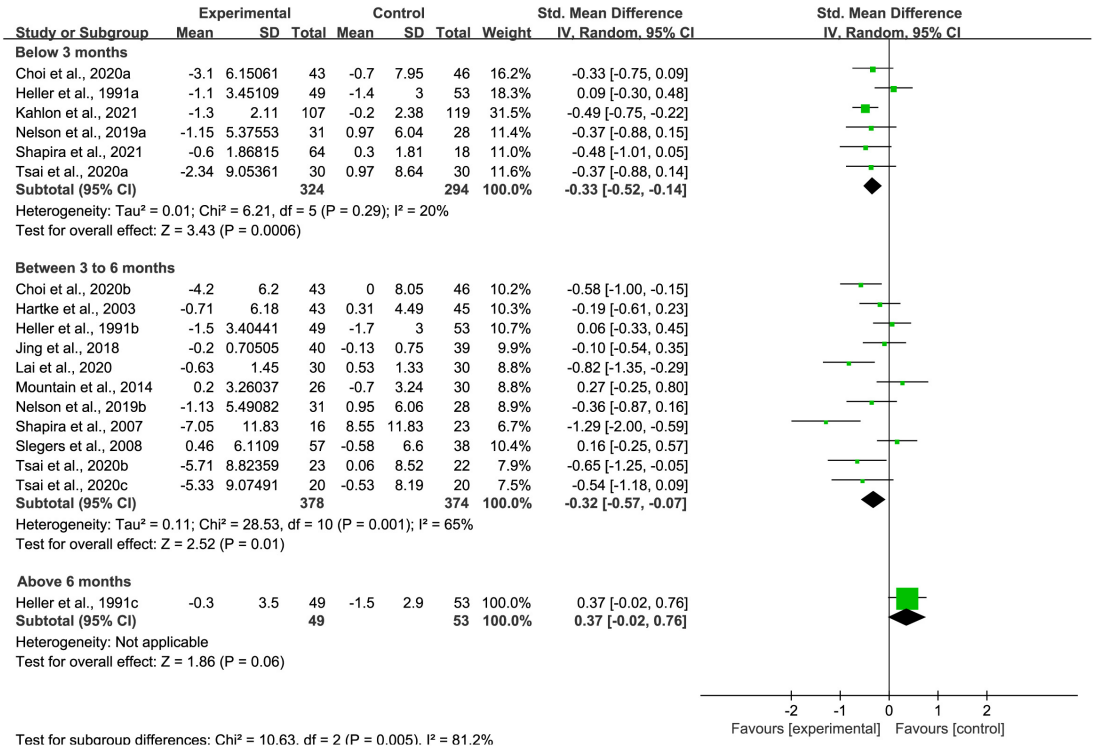

FIGURE 8
Subgroup analysis: comparison of interventions at measurement time points below 3 months, between 3 and 6 months, or above 6 months and all controls on the basis of loneliness scores.

TABLE 2 Sensitivity analysis (omitting a single RCT)*.

	Loneliness SMD (95% CI)
All studies	−0.32 (−0.44 to −0.19)
Selected study omitted	
Jarvis et al., 2019	−0.28 (−0.42 to −0.15)
Shapira et al., 2007	−0.29 (−0.41 to −0.15)
Tsai et al., 2020	−0.30 (−0.44 to −0.18)

*RCT, randomized controlled trial; and SMD, standardized mean differences.

Second, through quantitative comparison between four strategies on loneliness, this study found the effects of remotely delivered intervention addressing maladaptive social cognition and enhancing social support was better than those improving social skills and increasing opportunities for social contact when treating loneliness. In comparison, previous systematic reviews only examined the effectiveness of specific strategies on loneliness in remotely delivered intervention (Cattan et al., 2005; Chen and Schulz, 2016). The effectiveness of intervention addressing maladaptive social cognition (Masi et al., 2011) is supported in this study. However, the effects of intervention focus on social connectedness (Chen and Schulz, 2016) and opportunities for social contact (Cattan et al., 2005) are not supported. According to the cognition-biased model, the possible reason for the superior effect of an intervention addressing maladaptive social cognition and enhancing social support might be that social network effects on loneliness are mediated by social cognition (Larose et al., 2016). Thus, compared with increasing the ability or opportunity to enlarge the social network, changing cognition and giving feels of being socially supported might be more direct and effective for loneliness treatment in older adults.

Third, through a quantitative comparison of remotely delivered intervention on participants under different conditions, the research found the effects of remotely delivered intervention for participants living in social isolation and LTC settings were better than for community dwellers, caregivers, and those with chronic disease. In contrast, the previous studies only qualitatively examined the effectiveness of remotely delivered intervention for older adults in specific settings like LTC (Quan et al., 2020) or COVID-19 (Gorenko et al., 2021; Williams et al., 2021). The effectiveness of remotely delivered intervention for older adults in LTC settings (Quan et al., 2020) was confirmed in this study. Loneliness could be temporal or chronic. People with temporal loneliness are inclined to combat loneliness actively, while people with chronic loneliness are linked with helplessness and face loneliness passively (Perse and Rubin, 1990). The loneliness was temporal for the dwellers who transited to LTC settings or lived in social isolation caused by situation changes like COVID-19. They might find ways to combat transitional loneliness actively through remotely delivered intervention. However, as community dwellers, caregivers, and those with chronic diseases, the older adults might live alone for a long time, and their loneliness was chronic. They would be more passively facing the loneliness. Thus,

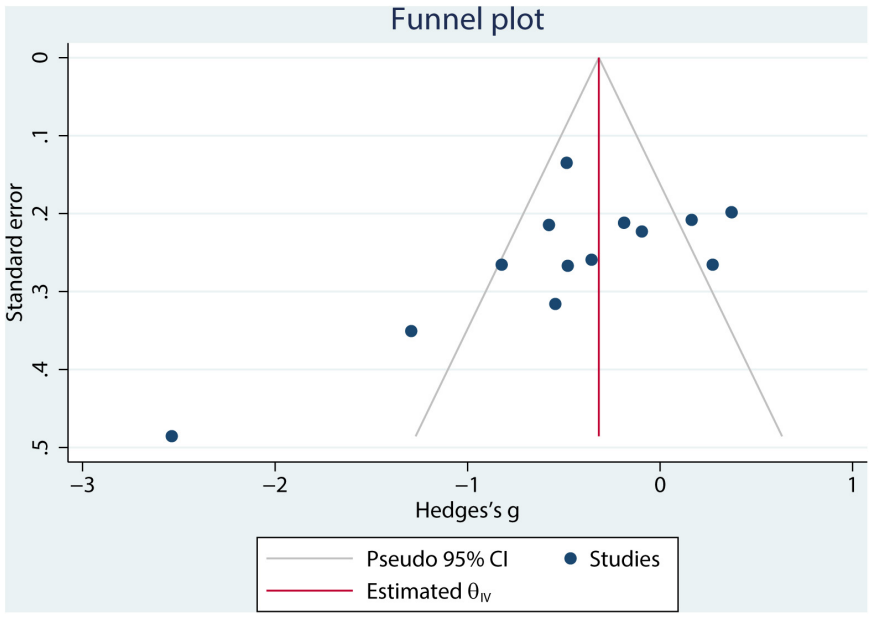

FIGURE 9
Funnel plot for overall studies.

it might be more effective for participants in temporal loneliness than chronic loneliness in front of the remotely delivered intervention.

Fourth, we found that remote intervention delivered individually was better than in a group through quantitative analysis. In comparison, previous research only qualitatively evaluated intervention effects with different group formats (Cohen-Mansfield and Perach, 2015; Poscia et al., 2018). The empathy of callers and their characteristics likely affected participants, which might increase the effectiveness of the treatment (Kahlon et al., 2021). Thus, intervention carried out in an individual format might be more effective.

Fifth, from the quantitative analysis result, the positive effect of remotely delivered intervention on loneliness seemed to be short-term. In contrast, the previous reviews only qualitatively examined and evaluated the effects of the intervention at different time stages (Chen and Schulz, 2016; Gorenko et al., 2021). This study supported the conclusion from a previous review published in 2016 that showed the positive effect of remotely delivered intervention on loneliness could last less than 6 months (Chen and Schulz, 2016). The positive effect could not last for a long time because the included RCT studies are directional treatment, which only focuses on maladaptive cognition change or social network enhancement. However, the loneliness of older adults could result from system reasons. Without combination with other possible solutions for loneliness treatment, like connector interventions, gateway approaches, and system approaches (Lee et al., 2021), the loneliness problem of older adults could only be partially resolved. Thus, the positive effects of remotely delivered intervention on loneliness cannot last long in older adults.

Finally, two high-quality RCTs have been included here for the first time. They showed significant effects of remotely delivered intervention compared with usual care or no treatment. By randomized clinical trial, Kahlon et al. (2021) found that remotely delivered intervention that was carried out by A layperson-delivered, empathy-oriented telephone call program has a significant effect on loneliness and depression. Shapira et al. (2021) used a pilot RCT design, and they found a significant improvement in the intervention group in terms of loneliness compared with the control group. Based on the above data, the findings of the two recent RCTs did support the effectiveness of remotely delivered intervention.

This meta-analysis has some limitations. First, the included RCTs compared various control interventions; therefore, definite conclusions regarding the various control interventions are not possible. Further evidence using large-scale, RCTs must be obtained to inform government and health providers about the efficacy of remotely delivered interventions. Second, to avoid the treatment provider empathy and characteristics effect, future studies should consider the patients' attitudes regarding providers prior to treatment. Third, many studies consisted of older adults from western countries and have limited generalizability. Fourth, theoretical understandings of how successful interventions tackle loneliness are urgently needed. Finally, the lack of remotely delivered intervention protocols standardization also limits our findings.

In conclusion, we believe that remotely delivered intervention can provide superior loneliness relief than brief intervention, usual care, and no intervention. The effect on loneliness reduction appears to be affected by intervention technology, strategy, participants' characteristic, group format, and effect measurement time point. This study highlights the value of remotely delivered intervention in reducing loneliness and warrants a broader usage investigation. These interventions may align with COVID-19 shielding/social distancing measures with minor modifications and help older adults tackle loneliness.

Data availability statement

The original contributions presented in this study are included in the article/**Supplementary material**, further inquiries can be directed to the corresponding author.

Author contributions

ZF designed the study, wrote the first draft of the manuscript, and supervised the manuscript production. ZF, MY, and CM performed the literature search, article selection, quality appraisal, statistical analysis, and participated in the revision of the subsequent draft. All authors read and approved the final manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2022.935544/full#supplementary-material

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Intergenerational relationship quality, sense of loneliness, and attitude toward later life among aging Chinese adults in Hong Kong

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A positive attitude toward later life is crucial for wellbeing among older adults. Maintaining a healthy relationship with adult children can help reduce older parents' sense of loneliness and nurture a positive life attitude. This study aimed to investigate the associations between multidimensional intergenerational relationship quality and attitudes toward later life among aging Chinese adults in Hong Kong and examine the mediating effects of a sense of loneliness. Representative survey data were collected from 801 participants (aged 50 years and over) with at least one adult child. Multiple linear regression was employed to investigate the associations between overall intergenerational relationship quality with a sense of loneliness as well as the attitude toward later life. To examine the mediating effects of a sense of loneliness, causal mediational analyses were performed. Results demonstrated that overall intergenerational relationship quality was positively associated with aging parents' attitude toward later life, and this relationship could be partially mediated by a sense of loneliness. Among the four subdomains of intergenerational relationship quality, the influences of structural-associational solidarity and intergenerational conflict on attitude toward later life were almost fully mediated by a sense of loneliness, whereas the influences of consensual-normative solidarity and affectual closeness were partially mediated. These findings contributed to an improved understanding of the relationship between intergenerational relationship quality, sense of loneliness, and attitude toward later life, and could inform future policies and service programs that promote aging adults' social integration and positive aging.

KEYWORDS

attitude toward later life, aging Chinese adults, sense of loneliness, intergenerational relationships, family

Introduction

With prolonged life expectancy and an increase in retirement years, maintaining wellbeing in later life has become increasingly crucial. In positive psychology, it is argued that positive emotions and attitudes can sustain individual wellbeing over time (Fredrickson, 2001). For older adults, a positive life attitude is a key indicator of successful aging. The attitude toward later life refers to one's perceptions and feelings of his/her life in old age and reflects dispositional characteristics, such as optimistic/pessimistic outlooks (Kato et al., 2012, 2016). The attitude toward later life is a bipolar construct that encompasses both positive and negative views of life. A positive attitude toward later life is characterized by "having a sense of purpose-in-life, and generally feeling content or happy" (Chong et al., 2006). With positive later-life attitudes, older adults could build resources to adapt to life changes and enhance their health and quality of life (Diener et al., 2017). Empirical evidence suggests that older adults with positive life attitudes are more likely to prolong employment (Davies et al., 2017), exhibit a higher level of life satisfaction (Liu et al., 2021), have better physical and psychological wellbeing (Chan et al., 2020), and even live a longer life (Diener and Chan, 2011).

In recent years, growing research has investigated the role of family and intergenerational relationships in shaping later life experiences (e.g., Bai, 2019; Bai et al., 2018; Bai and Liu, 2020). According to life course theory and the concept of "linked lives," dynamics within the family realm play a crucial role in influencing older adults' experiences in later life (Elder, 1998). Family members can positively affect older adults' wellbeing by engaging in retirement planning, serving as anchor points, and facilitating adaptation to retirement life (Szinovacz et al., 2012). In addition to the structure of family relationships, increasing attention has been given to the quality of family relationships (Li and Wang, 2021). It is acknowledged that supportive resources and relationships from family could contribute to positive life attitudes (Yeung and Fung, 2007; Nyqvist et al., 2013; Zhang and Silverstein, 2022). Among all the family members, adult children are increasingly thought to be the closest person by older parents (Lyyra et al., 2010). Studies showed that older parents value their relationship with children and many, particularly older women, expressed the willingness to continue their parental role of supporting children (Nuttman-Shwartz, 2007, 2008; Berkovitch and Manor, 2019). Prior studies also found that positive and strong intergenerational relationships can reduce fearful feelings toward retirement (Sherry et al., 2017) and increase subjective wellbeing (Katz, 2009). It is thus expected that attitude toward later life could be better disentangled through the investigation into the quality of intergenerational relationships with children.

Notably, when examining the influences of intergenerational relationships on later life wellbeing, previous studies mostly treated intergenerational relationship quality as a unidimensional construct and mainly focused on the positive aspect (e.g., Seltzer and Bianchi, 2013). According to the solidarity and conflict models (Bengtson and Roberts, 1991; Clarke et al., 1999), intergenerational relationships have been conceptualized as a multidimensional construct comprising affectual (i.e., positive sentiments and reciprocity of sentiments), consensual (i.e., agreement on values, attitudes, and beliefs), normative (i.e., commitment to performing familial roles and to familial obligation), associational (i.e., interaction in family activities), functional (i.e., exchange of resources), structural (i.e., interaction opportunities), and conflictual (i.e., disagreement and tension) dimensions. Further, based on the solidarity, conflict, and ambivalence models, Bai (2018) has identified a unique four-factor (i.e., affectual closeness, structural-associational solidarity, consensual-normative solidarity, and intergenerational conflict) structure of intergenerational relationship quality that applies to Chinese families. Guided by this theory-guided multidimensional conceptualization (Bai, 2018), this study examined the associations between different domains of intergenerational relationships and attitudes toward later life among aging Chinese parents in Hong Kong.

Furthermore, previous studies have found that the quality of intergenerational relationships as indicated by intergenerational co-residence, contact frequency, and support exchange with children may reduce parents' perceived isolation or loneliness (Iecovich et al., 2004; de Jong Gierveld and Dykstra, 2008; de Jong Gierveld et al., 2012; Chen and Feeley, 2014; Rodrigues et al., 2014). This is because adult children are the core social network members that remain stable during the aging process and can provide instrumental and emotional support. Under circumstances of family dysfunction, however, loneliness usually arises from losing contact or having poor relationships with family members (Perlman and Peplau, 1981; de Jong Gierveld et al., 2018). Strain from children and ambivalent intergenerational feelings can escalate older parents' loneliness (Chen and Feeley, 2014; Hua et al., 2021), possibly because that strained or disappointing relationship with children manifests older parents' unfulfilled generational expectations and thus intensifies loneliness (Tiilikainen and Seppänen, 2017).

Recent evidence shows that the prevalence of loneliness among older adults is surging globally (Luo and Waite, 2014; Wu, 2020). It has been considered a major public health risk for older adults, especially in the context of COVID-19. As a subjective feeling of social isolation, loneliness can arouse an individual's self-preservation, which in turn leads to a series of psychosocial consequences (Cacioppo and Cacioppo, 2014). A recent review has also shown that being alone or lack of social integration with family and friends generates negative effects on older adults' wellbeing and social opportunities (Burholt et al., 2020). Hence, it could be gauged that the effect of intergenerational relationship quality on attitude toward later life is partially operated through the sense of loneliness. Despite increasing efforts in exploring the role of family and social

integration in later life, the question regarding whether and how a sense of loneliness acts in the association between multidimensional intergenerational relationship quality and attitude toward later life remains to be answered.

The present study

In Hong Kong, sociocultural and demographic changes during the past decades have challenged the traditional expectations that older people always enjoy harmonious intergenerational relationships (Bai et al., 2018). The proportion of older adults living with children dropped from 53.4% in 2006 to 48.5% in 2016, whereas the proportion of older adults living alone increased from 11.6 to 13.1% (Census and Statistics Department, 2016). Rising education attainment of younger generations and intensified working and living pressure have also challenged traditional values and practice of filial piety and led to increasing heterogeneity in intergenerational relationships in Chinese society. Moreover, recent social movements may have given rise to more intergenerational conflicts between younger generations and their parents (Shek, 2020). Because of the increasingly diverse intergenerational relationships among Hong Kong families, its association with older parents' attitudes toward later life merits attention and investigation.

Drawing on the four-factor intergenerational relationship model (Bai, 2018), the life course perspective, and the empirical evidence, the present study examined how multiple domains of intergenerational relationship quality are associated with the attitude toward later life through a sense of loneliness, by using a representative sample of aging parents in Hong Kong. Two hypotheses were proposed below:

> **Hypothesis 1:** Intergenerational relationship quality is positively associated with the attitude toward later life.

> **Hypothesis 2:** The effects of overall intergenerational relationship quality and its four subdomains on the attitude toward later life are mediated by the sense of loneliness.

Materials and methods

Participants

Data for the present study were drawn from a citywide representative household survey "Intergenerational Relationship Quality and Care Expectations of Aging Parents in Hong Kong." The inclusion criteria were specified to recruit Chinese adults (a) aged 50 years or older, (b) residing in Hong Kong, and (c) speaking Cantonese or Mandarin fluently. A standard sampling list was solicited from the Hong Kong Census and Statistics Department. The survey adopted a two-stage stratified random sampling approach. Because the sampling frame covered the Register of Quarters and Register of Segments, the records were initially stratified by geographical region and type of quarters. Using a systematic replicated sampling technique, a random sample of 5,000 addresses was retrieved. Trained interviewers then visited each selected household and used the earliest birthday method to randomly select one eligible participant to conduct the face-to-face questionnaire survey. With the exclusion of inaccessible addresses and households dwelling with no eligible participants, 1,966 respondents were approached and 1,001 aging adults completed the questionnaire. In this study, data analysis was based on the final sample of 801 respondents with at least one adult child.

Data collection

During November 2016 and March 2017, face-to-face interviews using structural questionnaires were carried out by trained professional interviewers. To minimize the interviewer bias and entry errors, household questionnaire interviews were facilitated by computer-assisted personal interviewing with a web support system. The average duration of each interview was around 40 min. Invitation letters were mailed to the sampled household addresses. Before the interviews, informed consent forms were obtained from respondents. Amongst 1,966 approachable cases, 1,001 respondents participated in the interviews, resulting in a respondent rate of 50.92%. Ethical approval was obtained from the Hong Kong Polytechnic University's Human Subjects Ethics Sub-Committee.

Measurements

Intergenerational relationship quality

This study used the 13-item Intergenerational Relationship Quality Scale for Aging Chinese Parents (Bai, 2018) to evaluate respondents' relationships with adult children from four domains: (a) structural-associational solidarity; (b) consensual-normative solidarity; (c) affectual closeness; and (d) intergenerational conflict. Structural-associational solidarity was assessed using four items about residential proximity, contact frequency, face-to-face interaction frequency, and house chores help (e.g., "How often have you contacted each other by phone, letter, or email in the past 12 months?"). Consensual-normative solidarity focused on the similarities in attitudes and values regarding overall opinions, opinions on social issues, and opinions on care responsibility (e.g., "How similar are your opinions on social issues?"). Three questions

for affectual closeness asked respondents to rate their general feelings of closeness with, the extent of getting along with, and the frequency of receiving gifts or money from adult children (e.g., "What are your general feelings of closeness to him/her?"). The intergenerational conflict was measured by three items asking questions about the frequency of having tense and strained feelings with, being criticized by, and excessively demanded by adult children (e.g., "How often do you have tense and strained feelings toward him/her?"). All responses were made on five-point Likert scales from 1 to 5. With three items for the intergenerational conflict being reversed, the total score ranged from 13 to 65. For aging parents with more than one child, the average score of the quality of intergenerational relationships with all children was calculated. The reliability coefficient of the scale was 0.776.

Sense of loneliness

Participants' sense of loneliness was assessed by the Chinese version of the De Jong Gierveld Six-item Loneliness Scale (de Jong Gierveld and van Tilburg, 2006; Leung et al., 2008). Unlike other assessment tools focusing on the general state of loneliness, this scale was developed to capture the multidimensionality of loneliness, with three items for emotional loneliness (e.g., "I experience a general sense of emptiness") and the other three for social loneliness (e.g., "There are many people I can trust completely"). Response categories included "Yes," "More or Less," and "No." All items were recoded into dummy variables (1 = Yes/More or Less, 0 = No). The items for social loneliness were reverse coded. The total scores ranged from 0 to 6, with a higher score indicating a stronger sense of loneliness. The reliability coefficient of the total scale was 0.742.

Attitude toward later life

Participants' attitude toward later life was assessed using the Attitudes Toward Retirement Scale (Atchley and Robinson, 1982). To examine their perceptions about and attitude toward current/future retirement life, participants were asked to rate 14 pairs of bipolar adjectives (e.g., happy–unhappy, meaningful–meaningless, relaxed–tense, and sick–healthy) on a seven-point semantic differential scale. The total scores range from 14 to 98, with a higher score indicating a more positive attitude toward later life. The scale demonstrated high internal consistency (Cronbach's alpha = 0.952) in our sample.

Sociodemographic and health characteristics

The study controlled an array of potential confounders, including demographic characteristics, socioeconomic status, family structure, and health situations. Demographic characteristics included age and gender (0 = female; 1 = male). Socioeconomic status were measured by education (illiterate = 1, elementary school = 2, middle school or higher = 3), employment status (0 = in part- or full-time employment; 1 = retired or no longer working), and economic status. Respondents' self-reported economic status, ranging from 1 (very strained) to 5 (very rich), was controlled. Family structure was assessed by marital status (1 = married; 0 = unpartnered if the respondent was separated, widowed, or never married) and number of children. In addition, two indicators of health situations were included. General health was assessed by self-rated health status ranging from 1 (very poor) to 5 (very good). Functional health status was assessed by the Lawton Instrumental Activities of Daily Living Scale (IADL; Lawton and Brody, 1969). The aggregate score of IADL was a continuous variable, ranging from 0 to 8. A dummy variable was created to indicate functional dependence (1 = Dependent if having difficulty in at least one aspect of IADL; 0 = Independent).

Data analysis

The open-source software R (R Core Team, 2021) was used for data analyses. Descriptive analyses were performed

TABLE 1 Descriptive statistics.

Variable	Mean	SD	Min	Max
Age	68.58	10.88	50	102
Gender				
Female (n, %)	453	56.55		
Male (n, %)	348	43.45		
Education (Missing = 7)				
Illiterate (n, %)	166	20.91		
Elementary school (n, %)	343	43.20		
Middle school or higher (n, %)	285	35.89		
Employment status				
Retired (n, %)	203	25.34		
Working (n, %)	598	74.66		
Economic status	2.95	0.60	1	5
Marital status				
Unpartnered (n, %)	327	40.82		
Married (n, %)	474	59.18		
Number of children	2.49	1.40	1	10
Self-rated health	3.26	0.71	1	5
IADL				
Independent (n, %)	644	80.40		
Dependent (n, %)	157	19.60		
Intergenerational relationship quality	44.63	6.79	17	61
Consensual-normative solidarity	8.49	2.38	3	15
Structural-associational solidarity	13.14	3.61	4	20
Affectual closeness	11.01	2.24	3	15
Intergenerational conflict (reversed)	11.98	2.39	4	15
Sense of loneliness (Missing = 2)	2.68	1.87	0	6
Attitude toward later life	70.99	14.25	20	98

N = 801, SD, standard deviation.

to explore the characteristics of key variables. Pairwise correlations between intergenerational relationship quality, sense of loneliness, and attitude toward later life were examined. Following Baron and Kenny's (1986) classic approach for mediation, models for attitude toward later life and sense of loneliness were fitted separately using multiple linear regression to examine the effects of intergenerational relationship quality. The mediation effects of a sense of loneliness in the association between intergenerational relationship quality together with its subdomains and attitude toward later life were estimated using the *mediation* package (Tingley et al., 2014). The average mediation effects (ACME), average direct effects (ADE), and total effect were reported with quasi-Bayesian confidence intervals with 1,000 simulations. All regression models adjusted for age, gender, education, employment status, economic status, marital status, number of children, self-rated health, and functional health. Influential outliers were checked using leverage and Cook's distance and excluded from regression models (n = 56). The outcome model showed no presence of significant multicollinearity (mean variance inflation factor = 1.669) and heteroscedasticity (Breusch-Pagan statistic = 20.120, p = 0.065) issues.

Results

Descriptive statistics

Table 1 presents the participants' socio-demographic characteristics and statistics of all variables. With a mean age of 68.58 years, 56.55% of the participants were female. About 20.90% did not have any formal education, 43.20% finished elementary school, and 35.89% had a middle or higher level of education. Regarding employment status, 25.33% were retired or no longer working. The average self-perceived economic status was 2.95 (SD = 0.60). More than half (59.18%) of participants were in marriage. On average, the number of children of each participant was 2.49. The proportion of respondents with IADL-related difficulties was less than 20%. The mean level of self-rated health was 3.26 (SD = 0.71). Participants scored an average of 44.63 (SD = 6.79) in intergenerational relationship quality. The average score for a sense of loneliness was 2.68 (SD = 1.87). The mean score of the attitude toward later life was 70.99 (SD = 14.25), indicating a generally positive attitude toward later life.

Table 2 presents the results of bivariate correlations among key variables. Attitude toward later life was significantly ($p < 0.001$) and positively correlated with intergenerational relationship quality (r = 0.36) and its sub-domains (consensual-normative solidarity: r = 0.21, structural-associational solidarity: r = 0.27, affectual closeness: r = 0.27, and reversed intergenerational conflict: r = 0.14), but significantly and negatively correlated with sense of loneliness (r = −0.43, $p < 0.001$).

Results of regression predicting sense of loneliness and attitude toward later life

Two models were fitted to estimate the effects of intergenerational relationship quality on the sense of loneliness and attitude toward later life. Both models were adjusted for demographic characteristics, socioeconomic status, family structure, and health situations. As shown in Table 3, Model 1 explained about 31.7% of variance in sense of loneliness (F = 31.97, $p < 0.001$). Model 2 which included intergenerational relationship quality, sense of loneliness, and all covariates contributed to 55.4% of variance explained in attitude toward later life (F = 77.083, $p < 0.001$).

In Model 1, the coefficients of intergenerational relationship quality were negative and statistically significant (sense of loneliness: B = −0.117, SE = 0.010, $p < 0.001$), with demographic, socioeconomic, family-related, and health covariates being adjusted. The model also revealed that loneliness was more common among those who were male, with lower economic status, unpartnered, raised fewer children, and had poor health.

Model 2 shows that the direct effect of intergenerational relationship quality on attitude toward later life was positive

TABLE 2 Correlation matrix.

Variable	1	2	3	4	5	6	7
1. Attitude toward later life	1						
2. Intergenerational relationship quality	0.36***	1					
3. Consensual-normative solidarity	0.21***	0.59***	1				
4. Structural-associational solidarity	0.27***	0.74***	0.31***	1			
5. Affectual closeness	0.27***	0.62***	0.23***	0.31***	1		
6. Intergenerational conflict (reversed)	0.14***	0.41***	0.08*	−0.05	0.17***	1	
7. Sense of loneliness	−0.43***	−0.45***	−0.18***	−0.22***	−0.44***	−0.33***	1

Spearman's correlation coefficients are presented, *$p < 0.05$; ***$p < 0.001$.

TABLE 3 Results of multiple linear regression predicting loneliness and attitude toward later life.

	Sense of loneliness	Attitude toward later life
	Model 1	**Model 2**
Age	−0.016^{+} (0.008)	−0.280*** (0.049)
Gender[a]	0.331* (0.132)	0.746 (0.769)
Elementary school[b]	−0.045 (0.173)	0.401 (1.004)
Middle school or higher[b]	−0.192 (0.202)	−0.788 (1.172)
Employment status[c]	0.253^{+} (0.152)	−2.651** (0.885)
Economic status	−0.339** (0.110)	4.113*** (0.645)
Marital status[d]	−0.547*** (0.127)	0.923 (0.748)
Number of children	−0.293*** (0.048)	−0.309 (0.286)
Self-rated health	−0.321*** (0.092)	4.175*** (0.535)
IADL[e]	0.187 (0.177)	−6.591*** (1.028)
Intergenerational relationship quality	−0.117*** (0.010)	0.214*** (0.062)
Sense of loneliness		−1.731*** (0.216)
Constant	11.814*** (0.803)	62.715*** (5.310)
R^2	0.327	0.562
Adjusted R^2	0.317	0.554
F Statistic	31.971***	77.083***
AIC	2723.015	5308.135
BIC	2782.814	5372.533

N = 735, [a]Female = 0, male = 1. [b]Reference group = illiterate. [c]Retired = 0, working = 1. [d]unpartnered = 0, married = 1. [e]IADL was recoded into a dummy variable (0 = Independent, 1 = Dependent). AIC, Akaike's information criterion; BIC, Bayesian information criterion. Standard errors are in parentheses, $^{+}p < 0.1$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

and significant (B = 0.214, SE = 0.062, $p < 0.001$), when sense of loneliness was introduced. Additionally, sense of loneliness (B = −1.731, SE = 0.216, $p < 0.001$) was negatively associated with attitude toward later life in Model 2. Moreover, the results suggested that participants who were younger, not working, with abundant economic resources, healthy, and functionally independent tended to hold a more positive attitude toward later life.

Results of causal mediation analyses

Causal mediation analyses were performed to further examine the mediating effects of a sense of loneliness on the association between intergenerational relationship quality and attitude toward later life. Table 4 presents the results of mediation analyses. The proportions of indirect effect on attitude toward later life (Prop. Mediated) through sense of loneliness were presented. In general, the effect of intergenerational relationship quality on later life attitude was partially mediated by both sense of loneliness (ACME = 0.202, ADE = 0.216, Total Effect = 0.418, Prop. Mediated = 48.00%).

The total effects of consensual-normative solidarity on attitude toward later life were significant at $p < 0.001$ level and could be partially mediated by sense of loneliness (ACME = 0.255, ADE = 0.504, Total Effect = 0.758, Prop. Mediated = 33.60%; see Figure 1). Similarly, 38.10% of the total effects of affectual closeness were mediated through sense of loneliness (ACME = 0.504, ADE = 0.818, Total Effect = 1.322).

Results suggested that the association between structural-associational solidarity and attitude toward later life was almost fully mediated by sense of loneliness (ACME = 0.220, ADE = 0.119 *n.s.*, Total Effect = 0.340). Similarly, loneliness entirely channeled the effect of intergenerational conflict on attitude toward later life because the direct effect disappeared in the outcome model (ACME = 0.403, ADE = −0.080 *n.s.*, Total Effect = 0.324).

Sensitivity analysis

We performed several sensitivity analyses to check the robustness of the results. First, we examined whether the mediation analysis violated the sequential ignorability assumption (Imai et al., 2010), which requires (a) the independence of error terms in mediator and outcome models and (b) no potential omitted confounders. As shown in Supplementary Figure 1 in the Supplementary material, the estimate of ACME would decrease to zero if the correlation between error terms in the mediator and outcome models (Models 1 and 2 in Table 3) reaches about −0.30. In addition, the estimate of ACME would change sign only if the proportion of total variance in sense of loneliness and attitude toward later life explained by confounders is larger than 0.03. For instance, to invalidate the ACME, a confounder must explain at least 20% of the variance in attitude toward later life and 15% of the variance in sense of loneliness, respectively. It suggests that the indirect effect of intergenerational relationship quality on loneliness through sense of loneliness is moderately robust against the sequential ignorability assumption.

Second, we checked whether the main results were sensitive to age structure. Because our sample included a wide range of older adults, some may concern that the results downplayed the age heterogeneity. It is possible that Chinese parents at older ages may have a higher reliance on adult children for care and support than their younger counterparts. We stratified the analysis by age group. As shown in Supplementary Tables 1, 2, the mediating effect of sense of loneliness strongly persisted with age, although the proportion of indirect effect decreased in older age groups. The association between intergenerational relationship quality and attitude toward later life was moderately mediated by loneliness in both the older (65–79 years) and oldest (aged 80 years and above) groups. Among younger respondents aged 50 to 64 years, the association between intergenerational

TABLE 4 Mediating effects of the sense of loneliness.

Independent variable	Mediator	ACME	ADE	Total effect	Prop. mediated
Intergenerational relationship quality	Sense of loneliness	0.202***	0.216***	0.418***	48.00***
Consensual-normative solidarity	Sense of loneliness	0.255***	0.504**	0.758***	33.60***
Structural-associational solidarity	Sense of loneliness	0.220***	0.119	0.340**	Full mediation**
Affectual closeness	Sense of loneliness	0.504***	0.818***	1.322***	38.10***
Intergenerational conflict (reversed)	Sense of loneliness	0.403***	−0.080	0.324*	Full mediation*

$N = 735$, Prop. Mediated, proportions of indirect effect on attitude toward later life *via* mediators (%). ACME, average mediation effect. ADE, average direct effect. All models adjusted for age, gender, education, employment status, economic status, marital status, number of children, self-rated health, and IADL. Quasi-Bayesian confidence intervals were not reported here, $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

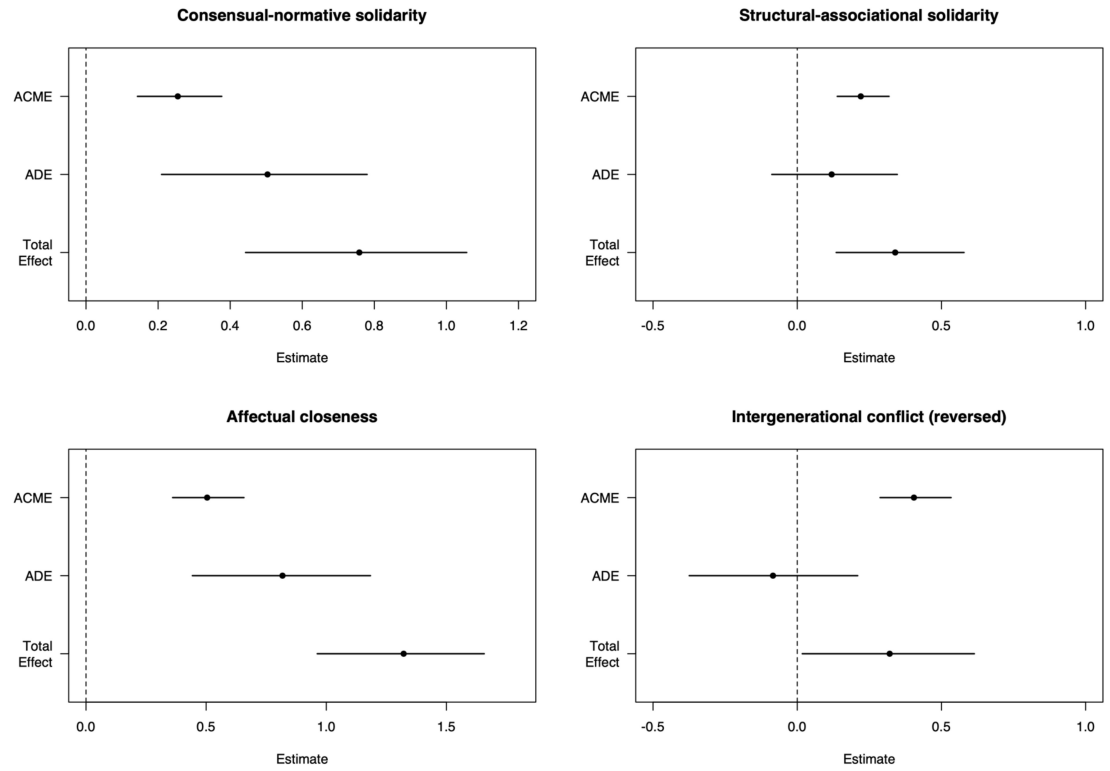

FIGURE 1
Results of the mediation analyses. Error bar shows 95% quasi-Bayesian confidence intervals. ACME, average mediation effect; ADE, average direct effect.

relationship quality and attitude toward later life was almost fully mediated by sense of loneliness.

Third, we further evaluated the influence of outliers on our results (**Supplementary Table 3**). It showed that the associations of intergenerational relationship quality with loneliness and attitude toward later life were robust against outliers.

Discussion and implications

Based on representative survey data collected in Hong Kong, this study examined the direct association between intergenerational relationship quality and attitude toward later life and their indirect associations through the sense of loneliness. Our results demonstrated that the quality of intergenerational relationships and the four subdomains (i.e., consensual-normative solidarity, structural-associational solidarity, affectual closeness, and the reverse-coded intergenerational conflict) were positively associated with aging adults' attitudes toward later life. Meanwhile, the sense of loneliness partially mediated the effects of overall intergenerational relationship quality on attitude toward later life. Among the four subdomains of intergenerational relationship quality, the effects of structural-associational solidarity and intergenerational conflict on attitude toward later life were almost fully mediated by sense of loneliness, whereas

the effects of consensual-normative solidarity and affectual closeness were only partially mediated.

The findings of this study supported that intergenerational relationship quality was significantly associated with aging parents' attitudes toward later life. It is possible that because adult children can provide support during the aging and retirement transition process of their aging parents, thereby reducing parents' fear of future life and emotional distress (Sherry et al., 2017). With close and secure relationships with children, aging parents thus hold a more optimistic view on retirement life. This is also consistent with previous qualitative findings that suggested that the meaning of later life for aging parents is partly defined by the opportunity to continue or strengthen their parental roles (Nuttman-Shwartz, 2007, 2008; Berkovitch and Manor, 2019). In terms of its subdomains, our study found that the aspects of intergenerational solidarity, including consensual-normative solidarity, structural-associational solidarity, and affectual closeness, were associated with a higher level of optimistic attitude toward later life, while the conflictual aspect was associated with an elevated pessimistic attitude toward later life. The different effects of the various aspects of intergenerational relationship quality confirmed the necessity of treating it as a multidimensional phenomenon. The attitude toward later life can be promoted not only by facilitating intergenerational solidarity but also by preventing and managing intergenerational conflicts.

Current research findings indicated that positive intergenerational relationship quality could reduce the level of loneliness, whereas negative relationship quality such as intergenerational conflict (not reversed) exacerbates loneliness. This was also reflected in a previous study which found that greater intergenerational ambivalence was related to increased loneliness among older adults (Hua et al., 2021). Given the crucial role of intergenerational relationships in promoting adaptations in later life, policies and social service programs should be developed to cultivate supportive and harmonious relationships between adult children and older parents, facilitate intergenerational communication and mutual understanding, and deliver strategies to manage intergenerational conflict.

Notably, this study revealed that the association between intergenerational relationship quality and attitude toward later life could be partially mediated *via* the sense of loneliness. A possible explanation might be that under continuous impacts of sociocultural transformation, aging parents who had weakened functional support from children may be more often to be socially isolated and lonely. The results verified Hypothesis 2 and further revealed that the effects of structural-associational solidarity as well as intergenerational conflict on attitude toward later life were almost completely mediated by the sense of loneliness, but the effects of the remaining two subdomains were partially mediated. It suggests that loneliness is an important intermediate factor that largely explains negative life attitudes due to reduced contact and increased strain feelings between older parents and adult children. Such findings imply a direction that interventions targeting retirees from a family perspective should pour efforts into solving loneliness among those living without children in proximity and having conflictual intergenerational relationships. In view of this, to promote later life wellbeing among older adults, social policies and services should pay more attention to their social integration, helping them broaden social participation and expand peer networks, especially for those with poor family relationships. In addition, our sensitivity analysis showed that the mediating effect of sense of loneliness was largest among younger parents (aged 50–64 years) and smallest among oldest parents (aged 80 years and above). The findings may highlight the aged-related variation in response to changes in the quality of intergenerational relationships. When reaching advanced ages, older adults' relationships with children might have a strong and direct effect on their attitude toward later life. Hence, tailored interventions that promote intergenerational solidarity should attend to this age pattern to effectively alleviate loneliness and foster positive life attitudes for older adults.

Limitations and future research

Despite its contributions, some limitations of this study need to be acknowledged. First, this study used a cross-sectional design, so the interpretation of the results should be considered with some caution. To deepen the understanding of causal relationships, researchers could adopt a longitudinal design to trace changes in intergenerational relationships, loneliness, and later-life attitudes. Second, our analysis of the association between intergenerational relationships and attitudes toward later life cannot capture the impacts of recent societal changes. There is concern that intergenerational conflicts have been aggravated in Hong Kong Chinese families due to the social unrest during 2019 to 2020 (Shek, 2020). The social distancing measures, including lockdown, during the COVID-19 pandemic have also increased many older adults' social isolation and loneliness. Future research may further explore how intergenerational relationships and loneliness affect the later-life attitudes of older adults in the post-pandemic era. Finally, this research only focused on the role of intergenerational relationships in the family context. Future research could compare intergenerational relationships with sibling and marital relationships in facilitating positive aging and explore the socio-demographic variation in intergenerational relationships.

Conclusion

This study unveiled the association between multi-dimensional intergenerational relationship quality and attitude toward later life using a representative sample of aging adult

parents in Hong Kong and supported the mediating effects of the sense of loneliness. Among the four subdomains of intergenerational relationship quality, the influences of structural-associational solidarity and intergenerational conflict on attitude toward later life were almost fully mediated by sense of loneliness, whereas the influences of consensual-normative solidarity and affectual closeness were partially mediated. Our sensitivity analyses supported the robustness of the results and revealed the age-related heterogeneity in the mediating roles of sense of loneliness. The findings have implications for developing policies and service programs to promote intergenerational solidarity and social integration for aging adults.

Data availability statement

The original contributions presented in this 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 the Human Subjects Ethics Sub-Committee at The Hong Kong Polytechnic University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

CL contributed to the study design and manuscript revision. SZ did the statistical analyses and wrote the manuscript. XB contributed to the study conception and manuscript revision. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2022.930857/full#supplementary-material

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Childhood adversity and cognitive impairment in later life

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Objectives: This study examined the association between childhood adversity and cognitive impairment in later life and explored the potential moderation effect of gender and race.

Methods: The study sample included 15,133 participants of the Health and Retirement Study (1998–2016 surveys) who had complete data on key study measures and were more than 50. The outcome variable is a dichotomous indicator of cognitive impairment as assessed by the Telephone Interview for Cognitive Status for self-respondents and the 16-item Informant Questionnaire on Cognitive Decline in the Elderly for proxies. A total of six childhood adversity indicators included grade retention, parental substance abuse, physical abuse, trouble with the police, moving due to financial hardship, and receipt of help due to financial hardship in early life. The estimation of the association between childhood adversity and cognitive impairment involved Cox proportional hazards regression. Results: Grade retention had the largest effect on incident cognitive impairment (HR = 1.3, 95% CI = 1.23–1.38, $p < 0.001$), followed by physical abuse by a parent (HR = 1.10, 95% CI = 1.00–1.20, $p = 0.001$). The impact of grade retention was more detrimental to women than men (interaction term HR = 0.89, 95% CI = 0.80–1.00, $p = 0.048$, female as the reference). Parental substance abuse was associated with a lower risk of incident cognitive impairment for most racial groups (HR = 0.89, 95% CI = 0.83–0.95, $p = 0.001$), but this association was reversed in "non-Hispanic other" race, consisting mainly of Asians (HR = 1.54, 95% CI = 1.05–2.26, $p = 0.025$).

Discussion: Some aspects of childhood adversity continue to harm cognitive functioning in later life, while some events may have the opposite effect, with evidence of heterogeneity across gender and race.

KEYWORDS

childhood adversity, adverse childhood events, ACE, cognitive impairment, dementia, life course

Introduction

Cognitive impairment and dementia are leading causes of disability and death worldwide and are a global health challenge in the context of rapid population aging (Nichols et al., 2019). A life course approach to chronic disease epidemiology suggests that the development of cognitive impairment is a dynamic process involving the interplay between psychosocial and biological risk factors over the life span (Lynch and Smith, 2005). Childhood, in particular, is regarded as a pivotal life stage leading to social inequality and, subsequently, differences in adult health. Childhood disadvantages, especially traumatic experiences, are theorized to affect adult health directly and indirectly through adult socioeconomic status, lifestyle choices, and psychosocial resources (Ferraro et al., 2016). An abundance of research has linked childhood disadvantages to an array of health conditions in adulthood, such as depression, anxiety, substance abuse, sexually transmitted diseases, chronic pain, musculoskeletal disorders, gastrointestinal issues, and overall health (Dube et al., 2003; Wade et al., 2016; Dobson et al., 2020; Riedl et al., 2020; Ross et al., 2020). A growing body of research suggests that age-related cognitive decline may originate in early life experiences, prompting recommendations for the early prevention of dementia (Livingston et al., 2020; Patel and Oremus, 2022).

Childhood adversity is an umbrella term to describe a broad set of life events and experiences that cause severe stress or overwhelm the capacity to cope during childhood, ranging from physical and sexual abuse to chronic poverty (Anda et al., 2006; McLaughlin et al., 2014). A plethora of research has associated childhood adversity indicators with a wide range of physical and mental health conditions, unhealthy behaviors and deficits in social relationships, and poor socioeconomic outcomes in adulthood (Hughes et al., 2017; Petruccelli et al., 2019). Animal and human studies have also linked adverse events experienced early in life to impaired cognitive development during childhood and adolescence. In animal studies, maternal deprivation causes the rearrangement of numerous brain structures and functions that have enduring effects in rats and monkeys (Lupien et al., 2009). Human studies have accumulated substantial evidence for a causal relationship between child maltreatment and reduced cognitive performance in institutionalized children (Young-Southward et al., 2020). In community samples, abused and neglected children frequently performed worse on a range of cognitive tests, including spatial working memory tasks (Augusti and Melinder, 2013), intelligence (Kočovská et al., 2012), measures of attention, visual-motor integration, and concept formation (Nolin and Ethier, 2007).

The effect of childhood adversity on cognitive function can be tracked across the life course through several biopsychosocial pathways. The most discussed biological pathway is the glucocorticoid cascade hypothesis, where early adversity evokes atypical development of the hypothalamic-pituitary-adrenal axis stress response, resulting in structural changes in several brain regions, atrophy of the hippocampus, and decreased activity of the prefrontal cortex, and subsequently, affecting learning and memory (Sapolsky et al., 1986; McCrory et al., 2010). Relatedly, early adversity could diminish cognitive reserve, a broad term referring to the adaptability related to the differential susceptibility of cognitive abilities to brain aging and pathology (Stern et al., 2020). Cognitive reserve has been linked to cognitive and functional outcomes later in life (Sardella et al., 2020). Diminished cognitive reserve due to childhood adversity could make individuals more susceptible to cognitive declines later in life (Fors et al., 2009). Exposure to adverse childhood conditions could also affect cognition through psychosocial pathways involving the development of self-esteem and coping strategies, socioeconomic disadvantages in adulthood (e.g., lower academic achievement and social class), health behavior patterns (e.g., smoking), and morbidity (e.g., cardiovascular disease) throughout the life course (Fors et al., 2009; Hughes et al., 2017; Petruccelli et al., 2019).

However, empirical evidence is unclear whether the detrimental impact of childhood adversity on cognition earlier in life persists into older adulthood, with conflicting findings in the extant literature. A British 1946 birth cohort study found a strong association between material and emotional indicators of childhood adversity and lower cognitive ability in childhood and adolescence, but little evidence that these adverse effects persisted over middle age (Richards and Wadsworth, 2004). However, studies using aggregate childhood adversity scales found an increased risk of incident dementia in older adults across cultural contexts (Donley et al., 2018; Tani et al., 2020). Early life food insecurity was also associated with a two-fold increase in the odds of dementia in pooled estimates from a meta-analysis of relevant studies (Wang et al., 2019). Findings are inconsistent among studies examining individual adverse childhood events and cognitive dysfunction (Patel and Oremus, 2022). While some studies reported a significant adverse effect on later-life cognitive performance, particularly in clinical samples of older adults with mental disorders (Kilian et al., 2018; Petkus et al., 2018; Wells et al., 2020), others reported weak or no associations between childhood adversity indicators and cognition (Kobayashi et al., 2020).

Furthermore, in several studies, exposure to some adverse events was associated with better cognitive function or a slower rate of cognitive decline in older adult subgroups (Ritchie et al., 2011; Barnes et al., 2012; Feeney et al., 2013). For example, a population-based study of Irish older adults showed participants with childhood sexual abuse had better global cognition, memory, executive function, and processing speed, despite having poorer mental health outcomes (Feeney et al., 2013). In

another regional sample of community-dwelling older adults in France, parental loss was associated with poorer cognitive performance in later life. In contrast, physical or sexual abuse was associated with a lower risk of cognitive impairment (Ritchie et al., 2011). These findings suggest that the types and severity of adverse events may affect cognition differently.

Emerging evidence also suggests the differential impact of childhood adversity on cognition by gender and race (Ritchie et al., 2011; Zhang et al., 2016; Donley et al., 2018), which may explain the null and mixed findings reported in studies that did not consider moderation effects. Other possible causes of these conflicting findings are variations in study designs, sample characteristics, and childhood adversity measures. More high-quality studies with longitudinal designs are needed to clarify childhood adversity's impact on cognition in later life (Wang et al., 2019).

This study aimed to investigate the association between childhood adversity and incident cognitive impairment in older adults and explore the potential moderation effect by gender and race in a population-based sample of US older adults. We hypothesized that adverse childhood events would be associated with a higher risk of incident cognitive impairment among older adults. The prospective design allowed us to identify long-term effects over 18 years. The population-based and representative samples reduced sample bias and improved generalizability. We included various adverse events covering different childhood environmental dimensions to uncover variations in association patterns. Life course scholars have called for examining multiple domains of childhood disadvantages simultaneously, given their interconnectedness (Ferraro et al., 2016). We further hypothesized that the extent of childhood adversity's adverse impact on cognitive impairment is a function of gender and race.

Materials and methods

Data

Our study sample and data came from the Health and Retirement Study (HRS), a nationally representative study of people over age 50 in the United States, sponsored by the National Institute on Aging (NIA U01AG0097) and housed at the University of Michigan Institute for Social Research. HRS uses a national area probability sample of US households with supplemental oversamples of Blacks, Hispanics, and residents of the state of Florida. The majority of HRS sample population is approaching retirement or already retired, but individuals not in the labor force or who have never worked outside the home are also included (Heeringa and Connor, 1995). HRS employs a multistage area probability design with geographic stratification and clustering and a steady-state design that refreshes the sample every 6 years. Eligible participants undergo biennial interviews. More information about HRS study design and sample selection is available on its website.[1]

Study sample

We analyzed data from the 1998 to 2016 interviews and included all available birth cohorts except for the Late Baby Boomers (added in 2016) due to limited follow-up data. Specifically, we used HRS Biennial Data Products 1998 through 2016 HRS Core files, and the RAND Contributed Files RAND HRS Longitudinal File 2016 (v.2). This study analyzed publicly available, de-identified data and was determined as "not regulated as human subjects research" by the University of Michigan Institutional Review Board.

The study sample included 15,133 HRS participants who met the following inclusion criteria: (a) had no missing data on the childhood adversity measures (described in the section below) and (b) $\geq$51 years at baseline. Study participants completed up to 10 interviews spanning over 18 years. The mean number of interviews completed was 7. By the end of the 18-year follow-up, about 30% of the study sample (N = 4,515) were non-responsive, including 3,057 who died.

Measures

Cognitive impairment

The HRS administers cognitive tests to all self-respondents based on items from the Telephone Interview for Cognitive Status (TICS), a validated cognitive assessment designed for telephone surveys (Brandt et al., 1988). These tests included an immediate and delayed word recall test (0–20 points), a serial 7s test (0–5 points), and a backward counting test (0–2 points), summing up to a 27-point scale. Test administration and procedures are detailed in several HRS reports accessible *via* its website.[2] Based on validation studies, a score of 0–6 indicated dementia, 7–11 indicated cognitive impairment without dementia (CIND), and 12 or over indicated normal (Crimmins et al., 2011; Langa et al., 2017). We combined the CIND and dementia into a single category of cognitive impairment to facilitate data analysis.

The HRS methodology involved proxies, often the spouse or partner of the sampled respondent, to answer questions on behalf of the sampled person who could not participate in the interview. Cognitive performance tests intended for the sampled person are inappropriate for proxy interviews. Instead, proxies responded to the 16-item Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE) that asked about the sample person's change in memory in the last 2 years

1 https://hrs.isr.umich.edu/documentation/survey-design
2 https://hrs.isr.umich.edu/documentation/user-guides

(Jorm, 1994). Based on findings from a systematic review, we used a cut-off of 3.3 on the IQCODE to classify cognitive impairment (Quinn et al., 2014). We combined self-report and proxy cognition measures to create a binary cognitive impairment indicator for the primary analysis. A score of ≤11 on the TICS or ≥3.3 on the IQCODE indicated cognitive impairment.

Childhood adversity

The HRS included comprehensive assessments of childhood adverse events, but these measures were not administered consistently across interviews or the entire sample (Smith et al., 2017). Four items, available between 2006 and 2012, asked about traumas before age 18: (1) "Did you have to do a year of school over again?"; (2) "Did either of your parents drink or use drugs so often that it caused problems in the family?"; (3) "Were you ever physically abused by either of your parents?"; and (4) "Were you ever in trouble with the police?" (the last item was available between 2008 and 2012 only). We also included two items about childhood economic hardship from 1998 through 2016 core surveys. Participants checked whether the following applied when they were growing up, from birth to age 16: (1) "Did financial difficulties ever cause you or your family to move to a different place?" and (2) "Was there a time when you or your family received help from relatives because of financial difficulties?" For each item, we extracted data from all available interviews to generate an indicator of experiencing that even if a "yes" response was ever recorded for the relevant item.

Covariates

Time-invariant demographic characteristics included gender (female and male), race/ethnicity (non-Hispanic White, non-Hispanic African American, non-Hispanic other race or mixed, and Hispanic), and highest educational attainment (less than high school, high school or equivalent, some college but no degree, and a college degree). Time-varying socio-demographic variables included marital status (married/partnered/cohabiting, divorced/separated/widowed, and never married) and household net wealth (divided into quartiles). Time-varying health behavior, health status, and functioning covariates involved a binary indicator of current smoking (yes or no), an indicator of elevated depressive symptoms (a score of 3 or more on the 8-item Center for Epidemiologic Studies Depression Scale), and the count of chronic physical conditions (hypertension, diabetes, heart disease, stroke, lung disease, cancer, and arthritis).

Statistical analysis

We performed descriptive statistics using data from the 2010 interview because all the birth cohorts included in this study had entered the HRS by 2010. We applied the 2010 HRS survey weights and design factors using a Taylor Series Linearization of the estimator to generate nationally representative estimates.

We estimated the unadjusted cumulative incidence function (CIF) of cognitive impairment. The CIF is more appropriate than the Kaplan–Meier curve in the presence of a competing-risk event, defined as an event that can preclude or alter the occurrence of the failure event of interest (Austin et al., 2016). In this study, death is a competing event because participants who died without ever having cognitive impairment are no longer at risk of developing cognitive impairment. For ease of analysis, we used the stcrreg followed by stcurve command in Stata to obtain the CIF of cognitive impairment stratified by each childhood adversity indicator without adjusting for other covariates.

The impact of childhood adversity on cognitive impairment, adjusted for other covariates, was examined in a Cox proportional hazards regression model. We did not rely on subdistribution methods because they may produce more biases than cause-specific hazard ratios (e.g., Cox model) in estimating the causal effects of covariates (Lesko and Lau, 2017). The exploration of the potential moderation effects of gender and race involved entering the relevant interaction terms into the model. We used age as the timescale because it is more appropriate for survival analysis with older adults (Lamarca et al., 1998). We specified the entry time as the age when the participant first joined this study.

Sensitivity analysis

We tested the aforementioned Cox model to predict dementia, defined as a score of ≤6 on the TICS or ≥3.3 on the IQCODE, to check the robustness against a different operationalization of cognitive impairment. We also used the Fine-Gray competing risk model (Fine and Gray, 1999) to check the robustness in the presence of a competing risk. These analyses were conducted using Stata 15 SE Version (College Station, TX: StataCorp LP).

Results

Nearly half of the study sample (n = 7,008 or 46%) met the criteria for cognitive impairment at some point during the study period. About half of the study sample reported at least one childhood adversity, with a mean count of 0.8 (SD = 1.06). As shown in **Table 1**, older adults with childhood adversity experience were more likely to be men, racial and ethnic minorities, and current smokers. They had a lower level of educational achievements and wealth and a higher rate of elevated depressive symptoms and more chronic physical conditions.

The most prevalent childhood adversity was parental alcohol/drug problems or parental substance abuse (19.2%),

TABLE 1 Descriptive statistics of the study sample in 2010 stratified by childhood adversity status.

	All	Any childhood adversity		
Sample characteristics		**No**	**Yes**	***P*-value**
Age in years	66.5 (65.9, 67.0)	67.1 (66.5, 67.7)	65.9 (65.3, 66.4)	<0.001
Gender (%)				<0.001
Female	53.2 (52.3, 54.0)	58.0 (56.5, 59.5)	48.2 (46.8, 49.6)	
Male	46.8 (46.0, 47.7)	42.0 (40.5, 43.5)	51.8 (50.4, 53.2)	
Race/ethnicity (%)				<0.001
White, non-Hispanic	81.7 (79.4, 83.8)	83.4 (81.3, 85.3)	79.9 (77.1, 82.4)	
African American, non-Hispanic	83.8 (7.4, 9.4)	7.8 (6.8, 8.9)	9.0 (7.9, 10.2)	
Other, non-Hispanic	2.9 (2.3, 3.6)	2.7 (2.0, 3.7)	3.1 (2.4, 3.8)	
Hispanic	7.1 (5.4, 9.2)	6.1 (4.7, 7.9)	8.1 (6.1, 10.6)	
Education (%)				<0.001
Less than high school	13.4 (12.1, 14.7)	10.8 (9.3, 12.5)	16.0 (14.7, 17.4)	
High school or equivalent	33.6 (32.3, 34.9)	31.3 (29.7, 33.0)	35.9 (34.3, 37.5)	
Some college but no degree	25.1 (24.0, 26.2)	25.2 (23.9, 26.7)	24.9 (23.2, 26.7)	
College degree	28 (26.1, 30.0)	32.7 (30.2, 35.2)	23.2 (21.3, 25.2)	
Marital status (%)				0.58
Married, partnered, or cohabiting	64.7 (63.4, 66.1)	65.1 (63.4, 66.8)	64.4 (62.9, 65.9)	
Divorced, separated, or widowed	28.8 (27.6, 29.9)	28.3 (26.9, 29.7)	29.3 (27.8, 30.9)	
Never married	6.5 (5.9, 7.2)	6.7 (5.6, 7.9)	6.3 (5.6, 7.2)	
Household net wealth (in 2010 $)	488,739 (457568, 519910)	564,360 (522570, 606150)	410,603 (373388, 447818)	<0.001
Current smoker (%)	13.6 (12.6, 14.7)	10.9 (9.8, 12.1)	16.4 (15.0, 17.9)	<0.001
Has elevated depressive symptoms (%)	20.5 (19.6, 21.4)	16.6 (15.6, 17.7)	24.5 (23.3, 25.7)	<0.001
Count of chronic physical conditions	1.8 (1.8, 1.8)	1.7 (1.6, 1.7)	1.9 (1.9, 2.0)	<0.001

The 2010 HRS survey weights were applied in estimates. "Any childhood adversity" refers to reports of any of the following childhood adversity items: (1) did a year of school over; (2) parental alcohol or drug abuse; (3) physical abuse by either parent; (4) ever in trouble with the police; (5) financial difficulties caused move; and (6) received help from relatives because of financial difficulties.

followed by financial difficulties that caused a move (16.6%), repeated a year of school or grade retention (16.5%), and receipt of help from relatives due to financial difficulties (14.5%). In bivariate comparisons, cognitive impairment was more prevalent among those who repeated a year of school, those who experienced parental substance abuse, and those who reported financial difficulties that caused a move during childhood (Table 2).

Figure 1 presents the cumulative incidence of cognitive impairment with age, stratified by childhood adversity indicators. The cumulative incidence of cognitive impairment had a steeper increase over the lifetime for those who experienced some aspects of childhood adversity, including grade retention and moving due to financial difficulties. The cumulative incidence of cognitive impairment was slightly lower for individuals who experienced parental substance abuse. The unadjusted cumulative incidence did not differ for the remaining childhood adversity indicators.

In the adjusted analysis, individuals who repeated a year of school [Hazard Ratio (HR) = 1.30, 95% CI = 1.23–1.38, $p < 0.001$] and reported physical abuse by a parent (HR = 1.10, 95% CI = 1.00–1.20, $p = 0.001$) were more likely to have incident cognitive impairment as compared to those without the experience. Individuals with parental substance abuse experience were less likely to have incident cognitive impairment (HR = 0.89, 95% CI = 0.83–0.95, $p = 0.001$). The remaining childhood adversity indicators, including trouble with the police and two childhood poverty indicators, were not significantly associated with cognitive impairment in later life (Table 3).

The interaction terms between each of the potential moderators and childhood adversity indicators were entered one at a time. The interaction term between gender and grade retention was statistically significant (HR = 0.89, 95% CI = 0.80–1.00, $p = 0.048$), suggesting the impact of grade retention on cognitive impairment in later life was smaller for men than women (illustrated in Figure 2).

The association of grade retention and incident cognitive impairment also differed by race. The interaction terms "African American*grade retention" (HR = 0.82, 95% CI = 0.71–0.94, $p = 0.004$) and "Hispanic*grade retention" (HR = 0.76, 95% CI = 0.65–0.91, $p = 0.002$) were both statistically significant,

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TABLE 2 Prevalence of cognitive impairment in 2010 by the experience of childhood adversity.

Childhood adversity items	All	% with cognitive impairment	*P*-value
Did a year of school over before the age of 18			<0.001
No	83.5 (82.5, 84.5)	14.7 (13.6, 15.7)	
Yes	16.5 (15.5, 17.5)	27.0 (25.1, 29.0)	
Either parent drank or used drugs so often that it caused problems in the family before the age of 18			0.017
No	80.8 (79.7, 81.9)	17.2 (16.0, 18.4)	
Yes	19.2 (18.1, 20.3)	14.6 (12.9, 16.5)	
Physically abused by either parent before the age of 18			0.756
No	91.1 (90.4, 91.9)	16.6 (15.5, 17.9)	
Yes	8.9 (8.1, 9.7)	17.1 (14.7, 19.8)	
Ever in trouble with the police before the age of 18			0.341
No	92.2 (91.6, 92.8)	16.8 (15.7, 18.0)	
Yes	7.8 (7.2, 8.4)	15.2 (12.5, 18.4)	
Financial difficulties caused a move to a different place through the age of 16			<0.001
No	83.4 (82.4, 84.4)	15.7 (14.7, 16.7)	
Yes	16.6 (15.6, 17.6)	21.8 (19.3, 24.5)	
Received help from relatives because of financial difficulties through the age of 16			0.399
No	85.5 (84.7, 86.3)	16.6 (15.5, 17.7)	
Yes	14.5 (13.7, 15.3)	17.4 (15.5, 19.5)	

The 2010 HRS survey weights were applied in estimates.

suggesting an attenuated effect for these minority groups. Another significant interaction term is between non-Hispanic other race and parental substance abuse (HR = 1.54, 95% CI = 1.05–2.26, $p = 0.025$). In comparison, parental substance abuse was associated with a lower risk of cognitive impairment in other racial groups (HR = 0.89, 95% CI = 0.82–0.97, $p = 0.006$). These racial differences are illustrated in **Figure 3**.

Sensitivity analysis

Estimates from the Cox regression predicting dementia were attenuated but in the expected direction. Repeating a year of school was associated with a higher risk of incident dementia (HR = 1.17, 95% CI = 1.05–1.30, $p < 0.01$). The impact of parental substance abuse (HR = 0.98, 95% CI = 0.86–1.11, $p = 0.729$) and physical abuse (HR = 1.02, 95% CI = 0.86–1.22, $p = 0.798$) were no longer statistically significant. Estimates from the fine-Gray competing risk model predicting cognitive impairment were similar to the Cox model within a difference of up to 0.04 on the exponentiated coefficients.

Discussion

In a nationally representative sample of US older adults, the extent to which exposure to childhood adversity affected incident cognitive impairment was conditional on the type of adverse events, gender, and race. Out of the six adverse childhood events, grade retention had the most considerable impact on cognitive impairment; it was more detrimental to women than men and non-Hispanic whites than racial minorities. Incident cognitive impairment also increased for those exposed to parental physical abuse, and this effect did not differ by gender or race. Parental substance use, unexpectedly, was associated with a lower risk of cognitive impairment for most racial groups except for the "non-Hispanic other race" group (e.g., Asian, American Indian, and Alaska native).

Exposure to some aspects of childhood adversity continued to harm later-life cognitive status, supporting a life-course approach to understanding cognitive impairment etiology. Removing adult factors from the models yielded bigger effect sizes, suggesting a proportion of the effect was mediated through adulthood conditions. Specifically, after removing adulthood socioeconomic, health, and mental health status from the model, the hazard ratio concerning grade retention grew to 1.64 from 1.30, representing a 26% increase. Adding lifetime educational attainment back to the model reduced the hazard ratio from 1.64 to 1.35, suggesting that adverse educational experiences earlier in life lowered lifetime educational achievement, increasing the risk for poor cognitive function in later life. Adjusting for gender and race only, the hazard ratio concerning moving due to financial difficulties also increased and became statistically significant (HR = 1.09).

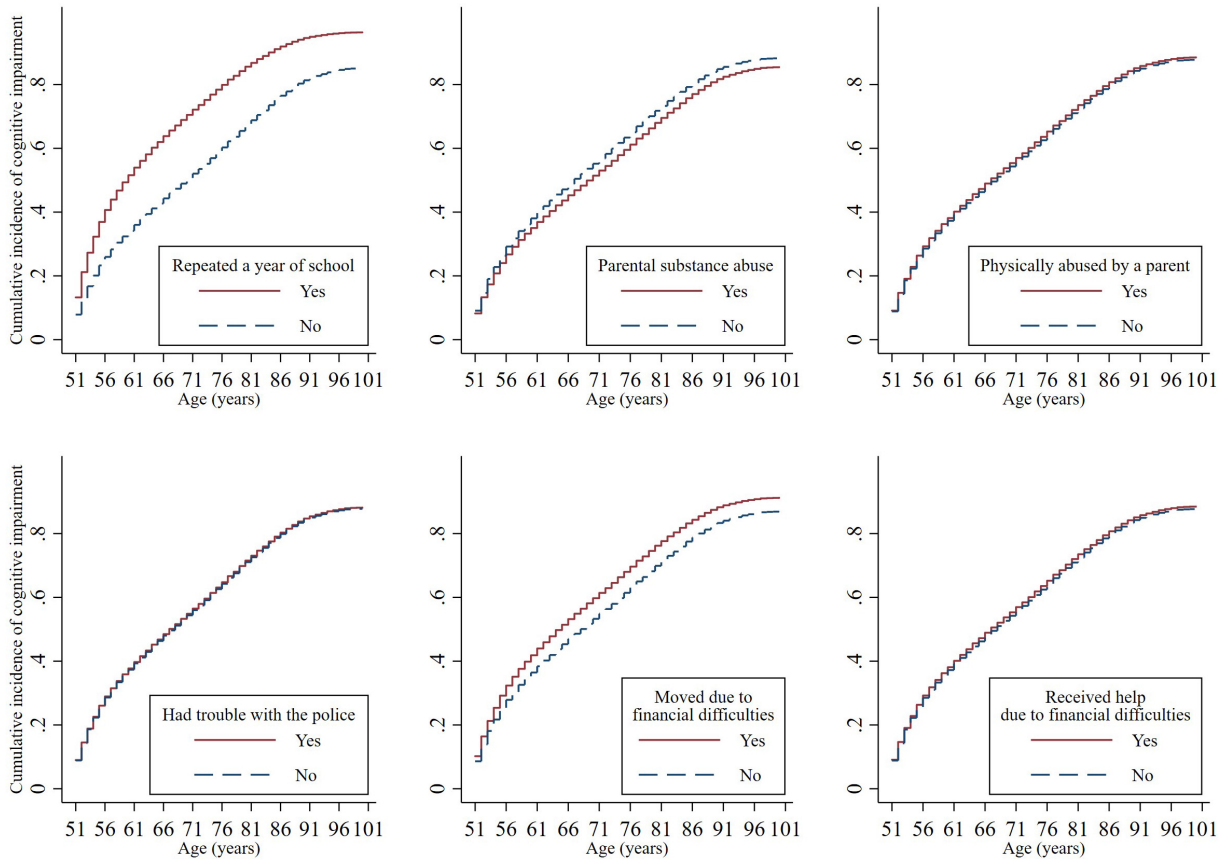

FIGURE 1
Cumulative incidence functions for cognitive impairment by childhood adversities. The cumulative incidence of cognitive impairment differed significantly by repeating a year of school (Subdistribution Hazard Ratio [SHR] = 1.74, 95% CI = 1.64–1.85, $p < 0.001$), parental substance abuse (SHR = 0.90, 95% CI = 0.84–0.96, $p = 0.002$), and financial difficulties that caused a move (SHR = 1.20, 95% CI = 1.12–1.27, $p < 0.001$).

This effect went away when adult household assets were considered. These findings are consistent with several recent studies (Donley et al., 2018; Petkus et al., 2018; Fu, 2019; Tani et al., 2020). As Fors et al. (2009) discussed, these similarities suggest "robust, universal mechanisms" underlying the association between childhood adversity and cognition in later life. These findings also align with the life course approach to health, which suggests that early exposure to disadvantages affects health indirectly through adult socioeconomic status, lifestyle choices, and psychosocial resources (Ferraro et al., 2016).

We found that women were more susceptible to the adverse effect of grade retention on cognitive impairment in later life. Previous studies have not documented a gendered effect of grade retention on cognitive impairment in later life to our best knowledge. Nevertheless, several studies have found a gendered effect of other types of childhood adversity (e.g., early parental loss, physical abuse) on cognition. For example, Ritchie et al. (2011) found that early parental loss was associated with poorer performance on a verbal test among older women but not older men. A recent study of older Japanese found that physical abuse was associated with dementia in men, whereas psychological neglect and abuse were associated with dementia in women (Tani et al., 2020). The Japanese study also reported a gendered dose-response relationship. Each increase in childhood adversity was associated with a higher dementia incidence among women but not among men (Tani et al., 2020). The exact mechanisms underlying these gendered effects are unclear. One possible pathway involves the adverse consequences of childhood adversity on physical and mental health in adulthood, which tend to be more detrimental for women than for men (Haatainen et al., 2003; Thompson et al., 2004). Another potential mediator relates to career achievement. Grade retention has been linked to poor educational career and eventual labor market outcomes (Eide and Showalter, 2001). Women who experienced grade retention may face the double jeopardy of grade retention and gender inequality and subsequently have worse educational and career outcomes. Although we adjusted for lifetime educational attainment in the analysis, we did not measure occupation

TABLE 3 Results from Cox proportional hazard model on cognitive impairment.

Predictors	Hazard Ratio (95% CI)	*P*-value
Gender		
Female	Reference	
Male	1.19 (1.13, 1.26)	< 0.001
Race/ethnicity		
White, non-Hispanic	Reference	
African American, non-Hispanic	2.26 (2.12, 2.41)	< 0.001
Other, non-Hispanic	1.70 (1.47, 1.98)	< 0.001
Hispanic	1.68 (1.55, 1.81)	< 0.001
Education		
Less than high school	Reference	
High school or equivalent	0.54 (0.50, 0.57)	< 0.001
Some college but no degree	0.41 (0.38, 0.44)	< 0.001
College degree	0.27 (0.25, 0.29)	< 0.001
Marital status		
Married, partnered, or cohabiting	Reference	
Divorced, separated, or widowed	1.02 (0.96, 1.07)	0.606
Never married	1.01 (0.89, 1.15)	0.847
Household net wealth in quartiles		
1st quartile (bottom 25%)	Reference	
2nd quartile	0.76 (0.71, 0.81)	< 0.001
3rd quartile	0.63 (0.59, 0.68)	< 0.001
4th quartile (top 25%)	0.52 (0.48, 0.57)	< 0.001
Current smoker	1.23 (1.15, 1.31)	< 0.001
Has elevated depressive symptoms	1.29 (1.23, 1.36)	< 0.001
Count of chronic physical conditions	1.01 (0.99, 1.03)	0.257
Childhood adversities		
Did a year of school over	1.30 (1.23, 1.38)	< 0.001
Parental alcohol or drug abuse	0.89 (0.83, 0.95)	0.001
Physical abuse by either parent	1.10 (1.00, 1.20)	0.041
Ever in trouble with the police	0.90 (0.81, 1.00)	0.060
Financial difficulties caused moving	1.03 (0.96, 1.09)	0.407
Received help from relatives because of financial difficulties	0.99 (0.92, 1.06)	0.711

type and complexity. Occupation attributes have been linked to the location of brain tissue loss or dysfunction in patients with frontotemporal dementia (Spreng et al., 2010). Jobs that require complex social interaction and thinking may increase cognitive reserve and protect against Alzheimer's disease (Boots et al., 2015). In addition, grade retention can negatively affect self-concept aspects among children, and these adverse effects may be more pronounced for girls (Mathys et al., 2019). Finally, the gendered effects observed in our study could reflect the presence of survival bias. Men with a deprived childhood environment may be less resistant to adversities later in life and hence die at younger ages (Tani et al., 2020). As a result, we could have underestimated the association between grade retention and cognitive impairment among men.

Unexpectedly, parental substance abuse was associated with a lower risk of incident cognitive impairment for most racial and ethnic groups, including whites, African Americans, and Hispanics. This finding aligns with a previous study that found a better capacity for problem-solving, abstraction, and planning among neglected children (Nolin and Ethier, 2007). Similarly, the number of childhood maltreatment types was positively associated with cognition among preschool-aged foster children (Pears and Fisher, 2005). These findings suggest the possibility of resilience and post-traumatic growth. Resilience is the ability to use cognitive processing to achieve successful developmental and adaptive outcomes even in an extreme environment (Meschke and Patterson, 2003). Some children growing up in families with substance abuse problems can adapt and achieve better-than-expected outcomes

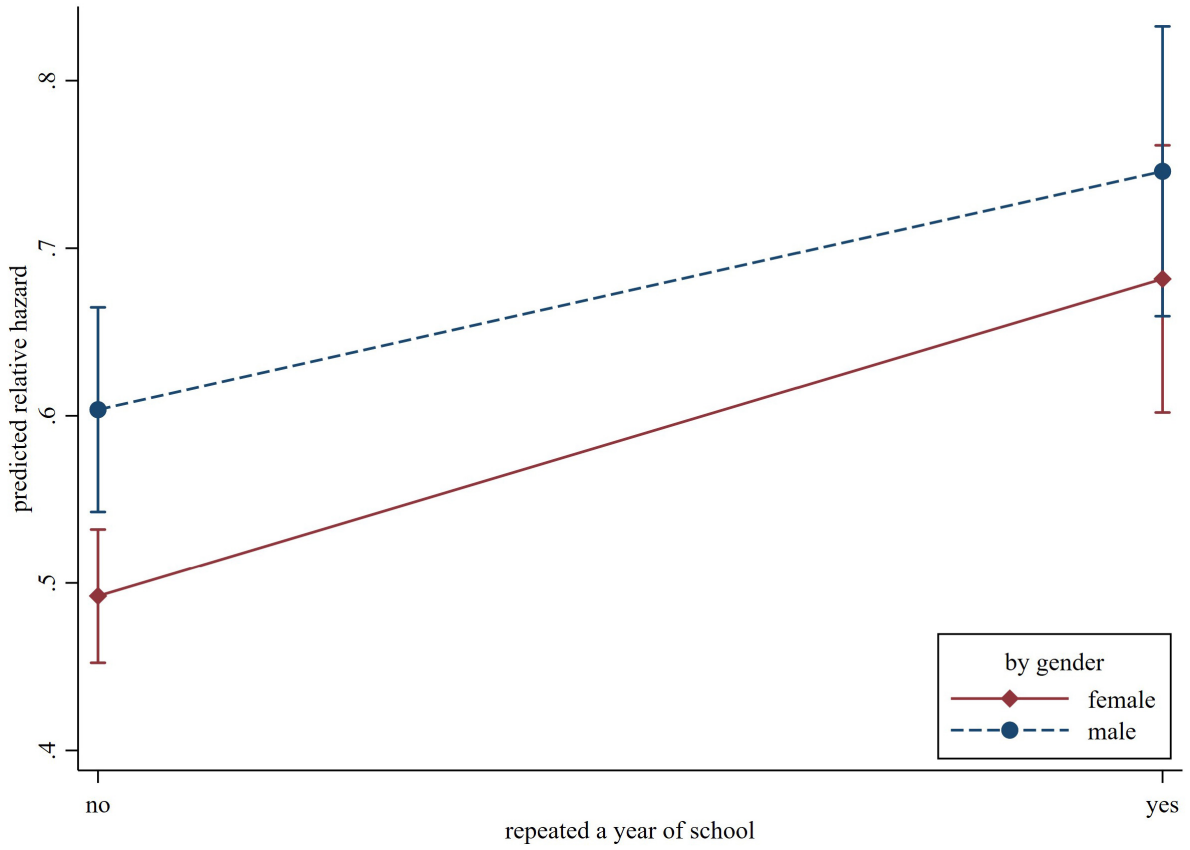

FIGURE 2
The predicted relative hazard of cognitive impairment concerning repeating a year of school, by gender.

(Velleman and Tempeton, 2016). Resilience is associated with many successful aging indicators and may confer cognitive benefits in later life (Wagnild, 2003). Another possible explanation is cohort and period effects. Drug use, particularly marijuana and psychedelic drug consumption, was one essential component of the Hippie counterculture in the 1960s, where drug use was viewed as "self-exploration, transcendental experiences, and spiritual enlightenment" (Wesson, 2011). Along with the anti-Vietnam War movement, the civil rights movement, and the sexual revolution, counterculture might be endorsed by a large number of baby boomers who were teenagers in the 1960s, so using drugs may not be attached with a negative social meaning in this age cohort.

However, the relationship between parental substance abuse and cognition was reversed for the "non-Hispanic other" group, which consisted mainly of Asian Americans. The positive association between parental substance abuse and cognitive impairment in later life among Asian Americans may be due to chance. The small sample size for the "non-Hispanic other" group reduces the reliability of the parameter estimate and increases variability. Cultural difference are also a plausible explanation. More than half of Asian Americans are foreign-born and may not have been subjected to the same period effects of the 1960s movements as native-born individuals. To illustrate, Chinese-origin Asian Americans are the US's largest single Asian origin group. Rates of substance use in China have been relatively low since the founding of the People's Republic of China in 1949, thanks to harsh punitive measures, including the death penalty, for drug-related crimes (McCoy et al., 1997). The new Chinese government was eager to implement extreme measures never to repeat the nation's defeat during the Opium Wars and to control the epidemic of opioid addiction in the aftermath of the Opium Wars. The stigma associated with drug use is still prevalent in China, contributing to drug users' self-stigma (Mak et al., 2015). Therefore, parental substance abuse may carry a more severe stigma and social and health consequences for Asian Americans than their non-Asian counterparts. It is worth pointing out that Asian Americans are underrepresented in the literature on health disparities, and very little research has focused on the cognitive health of older Asian Americans (Tang et al., 2019). Studies focused on other racial minority groups reported inconsistent findings. In one study, the association between cumulative childhood adversity

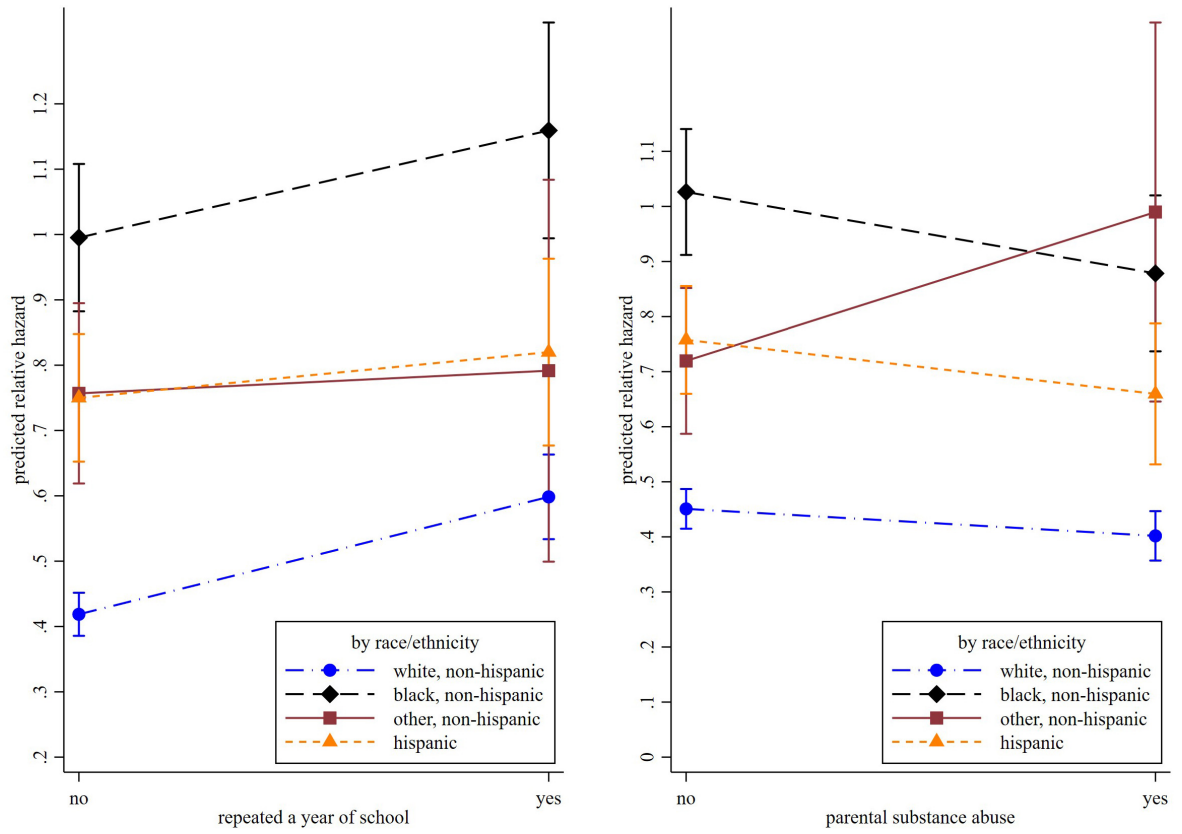

FIGURE 3
The predicted relative hazard of cognitive impairment concerning repeating a year of school and parental substance abuse, by race.

and cognitive impairment was stronger among older African Americans than among whites (Zhang et al., 2016). However, in another study, food insecurity in childhood was associated with a slower cognitive decline rate in African Americans than in whites (Barnes et al., 2012). Our finding that Asians may respond to parental substance abuse in fundamentally different ways than other racial groups warrants more research and calls for more attention to the cognitive health of Asian Americans.

These study findings should be interpreted with some caution. All measures were self-reported and subject to recall bias and reporting errors. Despite its good psychometric properties, the TICS does not assess the full range of cognitive domains nor produce a clinical diagnosis. By including a set of adulthood conditions as covariates, our analyses may have an over-adjustment bias, as these factors can mediate the relationship between childhood adversity and later-life cognition (Ritchie et al., 2011). As discussed, we found partial and complete mediation related to early life educational experience and financial hardship through adult educational attainment and wealth accumulation. These overadjustments likely resulted in underestimates of the effects of childhood adversity on cognitive impairment. Nevertheless, we retained the model with more adjustments to reduce potential bias due to competing risks, which can be resolved only by including common risk factors as covariates (Lesko and Lau, 2017). Finally, we could not pinpoint the specific period when each adverse event occurred other than before age 18. Exposure to adverse events during different life stages (e.g., *in utero*, infancy, adolescence) may differently affect later-life outcomes (Lupien et al., 2009). These subtle effects remained hidden due to data limitations.

Conclusion

Some aspects of childhood adversity continue to harm cognitive functioning in later life. In contrast, some events may have the opposite effect, with evidence of heterogeneity across gender and race. Future inquiries into the long-term impact of childhood adversity on cognition should consider both individual adverse events and aggregate scores of adverse events. More research is needed to explore the mechanisms and mediating factors underlying the gender and racial disparities in associations between early life experiences and cognition in later life.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found here: https://hrs.isr.umich.edu/about.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

Author contributions

XX formulated the research question, designed the study, analyzed the data, and drafted most parts of the manuscript. JC and YS drafted parts of the manuscript and provided edits and feedback on the initial draft. XW advised on the construction of measurements and provided critical feedback on the initial draft. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Vulnerability as determinant of suicide among older people in Northern Indian states

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Older people are confronted with a myriad of challenges throughout the course of their lives in the present society. One of these is the issue of suicidal behaviour among people of older age. This article understands the nature and examines the cause of mortality due to suicide among older people in later life. The author has applied the document analysis method. The information for the current research has been collected using the news content of various Indian newspapers, magazines, and news portals. The researcher was collated 60 occurrences of old-age suicide from the newspapers of Northern Indian states from March 2022 to June 2022. The study has indicated that there is a substantial rise in old-age suicide due to the vulnerable condition of older people in late life. Moreover, the vulnerable condition of older people has led to various factors instrumental in old-age suicide, such as abuse in the family, chronic diseases, depression, poverty, and social rejection that give rise to feelings of committing suicide among the older people.

KEYWORDS

document analysis, older people, suicide, vulnerability, India

Introduction

The population of older people in the world has grown steadily during the last years of the last century. The number of people aged 60 years and over in the world was 673 million in the early years of the 21st century and is expected to increase to 2 billion by 2050 (Shettar, 2013; Kumar and Rathour, 2019). Nearly, one-fifth of the population in more developed countries is over 60, compared to 8% in developing regions (Shettar, 2013; Kumar and Rathour, 2019). Similar to many other countries, India is now observing an increase in the proportion of its aged population (Rajan et al., 2003; Kalavar et al., 2013; Shettar, 2013). In the last 50 years, the Indian population has almost tripled, while the elderly population has expanded by more than fourfold. The number of people aged 60 years and older in India is projected to climb from 100 million in 2011 to 179 million in 2031 and then to 315 million in 2050, which represents a significant increase from the 2011 figure of 100 million (Rajan et al., 2003; Kalavar et al., 2013). The socio-economic and demographic situation of the country is constantly shifting, and as a result, significant changes are being observed in the living conditions of older people throughout the country (Raju, 2011). Not only the number of older people

in the country is increasing but also their life expectancy is reaching new heights on an annual basis because of developments in medical technology, improvements in the quality of life, and general progress made in the country as a whole (Rajan et al., 2003; Raju, 2011). As the population of older people keeps increasing, the number of problems they have is also increasing quickly. The problem of suicide is one of them among older people.

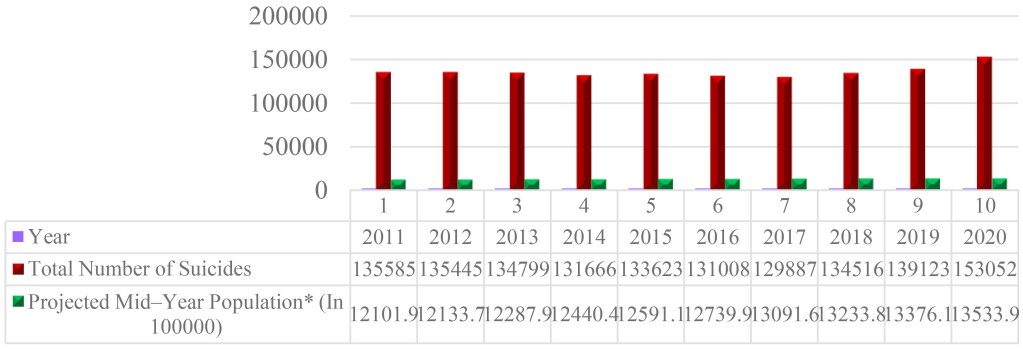
The death of older people caused by suicide is a matter of grave concern across all Indian states in contemporary times. At present, a number of older people in Indian society are taking their own lives because of their vulnerable conditions in later life. Suicide among older people has not been a problem in India because of its congenial social environment and value-based family structure. However, it has been pointed out that the roots of a congenial social environment and value-based family structure are eroding very fast due to changing socio-economic scenarios, such as industrialisation, urbanisation, and globalisation (Jamuna, 2000; Khan, 2004; Raju, 2011). The rapidly increasing number of aged people is compounded by the disintegration of value-based familial structure and the ever-increasing influence of socio-economic changes and new lifestyles. The care for older people has emerged as an important issue in India (Jain, 2008; Shettar, 2013). In such changing situations, the majority of the elderly, who have passed most of their life with their joint families, are on the verge of isolation, alienation, hopelessness, and depression in old age (Khan, 2004). When they need maximum family and social support, they live alone and feel neglected. Sometimes, older people are abused in the family and society. The coping capacities (interpersonal relationships) of older people are now being challenged under various circumstances, causing vulnerable conditions for them in many ways, such as low belongingness and perceived burdensomeness. Consequently, suicide among older people in Indian society is emerging as a social problem.

As the proportion of older people in the population will increase all over the world in the coming decades, the cases of suicide among older people are also expected to be on the rise consequently (Bharati, 2021). World Health Organization [WHO] (1992) pointed out that their vulnerable condition due to low belongingness and perceived burdensomeness in late life implies a significant suicide risk as compared to any other age groups. Suicide ranks in the top 10 causes of death among older people (Blazer et al., 1986; Bharati, 2021). The reason behind more suicides among older people is found that older people face many problems, such as physical, psychological, social, and economic problems in later life, which contribute to increased vulnerability among older people (Behera et al., 2007; Bharati, 2021). In 2019, it was reported globally that 14.25% of people per 100,000 people aged 50–69 years committed suicide, and 24.53% of people per 100,000 people aged 70 years or older did the same (Ritchie et al., 2019). It is reported by the National Crime Record Bureau [NCRB] (2020) in its yearly nationwide survey on suicide that around 1,358,704 people committed suicide from 2011 to 2020 in India (**Figure 1**). National Crime Record Bureau [NCRB] (2020) reported in its annual report on suicide in the country that India has recorded 153,052 cases of suicide, which reports around 418 cases of suicide daily in India. National Crime Record Bureau [NCRB] (2020) indicated that the suicide rate per 100,000 population also increased from 10.4% in 2019 to 11.3% in 2020. National Crime Record Bureau [NCRB] (2020) reported in its yearly report that around 13,126 older people per 100,000 population committed suicide in India. According to National Crime Record Bureau [NCRB] (2020), abuse, alcohol addiction, chronic diseases, family issues, feelings of loneliness, financial loss, mental illnesses, and other factors contribute to suicide among older people in India.

In the last few years, the problem of suicide among older people has attracted social scientists from different regions of the country. Many studies (Tanuj et al., 2009; Shah and Escudero, 2017; Gover et al., 2020; Padmaja and Bharadwaj, 2020; Rana, 2020; Bharati, 2021; De Sousa, 2021; Sourabh et al., 2021) related to suicide among older people have been done and are being done in India. Through these studies, the nature, causes, and effects of suicide have been studied scientifically and are seen as a serious problem among older people in India. It is apparent from these studies that suicide among older people is a matter of grave concern in contemporary Indian society because it is the worst form of death. Many studies on suicide among older people have been conducted from different perspectives to understand the causes and consequences of the suicidal tendency among older people in India. However, these studies have not looked at the causes of suicidal tendencies among older people from a vulnerability approach. In this backdrop, this article attempts to analyse the determinants of suicide among older people through a vulnerability approach. It accesses the nature and magnitude of suicide among older people in India and aims to understand the subjective meaning behind the social fact of suicide among older people.

Vulnerability approach to suicide among older people

Vulnerability states the diminished capacity of an individual who feels that he does not have a strong social and physical ability to protect himself from any problem (personal, family, and social problems) (Hale, 1996; Vandeviver, 2011). There are four groups, namely, older people, women, poor, and ethnic minorities, who feel vulnerable themselves and also confront more problems (personal, family, and social problems) due to their vulnerability (Powell and Wahidin, 2007; On Fung et al., 2009). The vulnerability approach explains the vulnerable conditions of older people due to frailty or weakness, which lead to various problems among them, in which suicide is one of them (Sarvimaki and Hult, 2014). Being vulnerable due to



Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total Number of Suicides	135585	135445	134799	131666	133623	131008	129887	134516	139123	153052
Projected Mid–Year Population* (In 100000)	12101.9	12133.7	12287.9	12440.4	12591.1	12739.9	13091.6	13233.8	13376.1	13533.9

FIGURE 1
Trend of overall suicide in India from 2010 to 2020. Source: National Crime Record Bureau [NCRB] (2020).

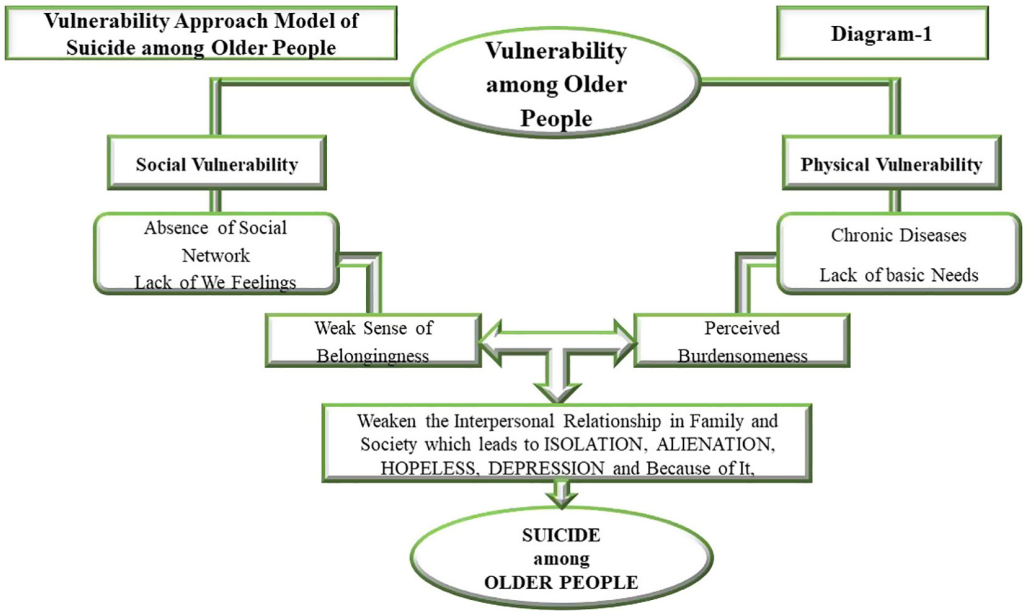


DIAGRAM 1

frailty or weakness refers to the kind of vulnerability among older people that is usually associated with social vulnerability and physical vulnerability (Sarvimaki and Hult, 2014). The vulnerability approach of older people tries to point out negative attitudes due to many factors, such as social and physical factors in later life that lead to suicidal tendencies (Bharati, 2021). On the one hand, the social vulnerability of older people talks about the absence of social networks (attachment, involvement, commitment, and belief) that weaken the sense of belongingness between the older people and family members. On the other hand, the physical vulnerability of older people talks about the poor conditions (illness, lack of care, and basic needs) among them that are perceived as burdensomeness by their family members. Both a weak sense of belongingness and perceived burdensomeness are closely related to the interpersonal relationships of a person and their contribution to suicidal tendency (Joiner, 2005). The nature and problem of suicide among older people in India can be explained and examined by using the vulnerability approach that has been presented in **Diagram 1**.

Patel and Mishra (2018) pointed out that older people believe they are socially vulnerable due to the fact that as they age, they become less involved in social activities and complain that people do not have time for older people and that they do not have a "we feeling" like people did in the past. All these feelings produce isolation and alienation among older people. The materialistic way of life has also had a significant impact on social structure, and it has done its part to contribute to

the worsening of the psychological and social issues that affect older people (Patel and Mishra, 2018). Older people have been left abandoned, uncared for, and lonely as a result of the rise of nuclear families, working couples, and changes in the behaviour of residents in the neighbourhood. The social support of older people has weakened. As a consequence of this, a significant number of elderly individuals are feeble, vulnerable, and unable to help themselves. Due to these factors, elderly adults are more likely to experience feelings of loneliness and isolation, and their sense of connection to their families is diminished. Consequently, older people commit suicide.

Patel and Mishra (2015) found that older people suffer from many physical problems in later life, such as chronic diseases and basic needs. Older people are unable to participate in physically active pursuits because of physical problems, and they must rely on the assistance of other members of their families. As a result of their physical ailments and basic requirements, older people often realise that they are a burden to their family members. Older people, upon coming to terms with the burden of their responsibilities, conclude that their passing will bring their families greater happiness than their continued existence (Joiner, 2005). Consequently, more individuals commit suicide as they grow older.

Document analysis method

The researcher has used the document analysis method, which is basically a kind of content analysis, for the study of suicide among older people in India. The aim of the document analysis was to investigate and analyse any issue that is printed and electronic documents in the form of books, newspaper articles, and magazines (Bowen, 2009). "Document analysis necessitates the examination and interpretation of data to elicit meaning, gain comprehension, and develop scientific knowledge" (Corbin and Strauss, 2008; Bowen, 2009). Basically, in a document analysis study, a researcher utilises quantitative and qualitative analyses to identify the numerous words and ideas in a text, as well as their meaning and connections, and then draw conclusions about the text (Sarantakos, 1998; Sahoo and Patel, 2021). The author of this research mostly relied on secondary data that were gathered from various newspapers (both print and electronic) and magazines based in India. The old-age suicide data for the study have been collected from famous daily Hindi and English language newspapers, such as Amar Ujala, Dainik Bhaskar, Dainik Jagran, Hindustan, Nav Bharat, Naidunia, The Indian Express, and The Times of India. Moreover, the author has also collected old-age suicide cases from news portals, such as ETV Bharat, TV9, News 18, and NDTV. The data were collected from March 2022 to June 2022. The process of document analysis is illustrated in **Diagram 2**.

The data on old-age suicide have been obtained from Northern states of India, such as Bihar, Delhi, Haryana, Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, and Uttarakhand. In view of the fact that instances of suicide committed by older people are often reported and highlighted by newspapers and other news portals in these states. This study's sample cases were acquired manually by reading every suicide-related news article published in newspapers. The researcher discovered typical keywords used by Indian journalists while reporting on a certain topic in newspapers and utilised those keywords to search for information on Internet platforms. The terms such as suicide, suicidal propensity, self-harm, self-killing, chronic illnesses, depression, mental health, and frustration, among others are utilised while doing a web search for information about suicide in India.

Therefore, the researcher has decided to conduct a study on old-age suicide in these states. The author collected around 100 newspaper articles on old-age issues using document analysis. From these 100 news articles, the author chose 60 news articles related to old-age suicide. This study's sample cases were acquired manually by reading every suicide-related news article published in newspapers. The majority of the 60 reported cases of old-age suicide were found in these regions from the age group of 60 years to above 80 years. Each of these incidents of elder suicide has been divided into several themes, such as gender (male and female), causes of suicide among older people (chronic disease, depression, abuse, poverty, and social rejection), and nature of suicide (personal problem-based suicide, family problem-based suicide, and social problem-based suicide). Thus, the researcher has gathered data on old-age suicide from both print and electronic media, and the author has used document analysis to describe the nature and causes of old-age suicide in India.

The problem of suicide is very sensitive in India and people associate suicide with stigma. For this reason, the family members of the affected person do not openly talk about the cause of committing suicide. Due to this, a researcher has to face many difficulties in conducting a primary survey on suicide. Apart from this, the data on suicide collected by the National Crime Record Bureau in India do not show rural–urban differences in suicide in its report. Moreover, N.C.R.B. does not separately publish the causes of old-age suicides in its suicide data, which does not make the understanding of the nature of suicide among older people. For this reason, when a researcher wants to study suicide focused on older people, he does not get the data related to rural–urban differences, causes, and nature of suicide among older people. However, when a researcher collects data on suicide through newspapers, he gets the data easily whatever he wants to examine. Consequently, this method of data collection is chosen as the most suitable for gathering data on old-age suicide within the stipulated time frame. The incidents of old-age suicide have been meticulously collated from news items published in different Indian newspapers

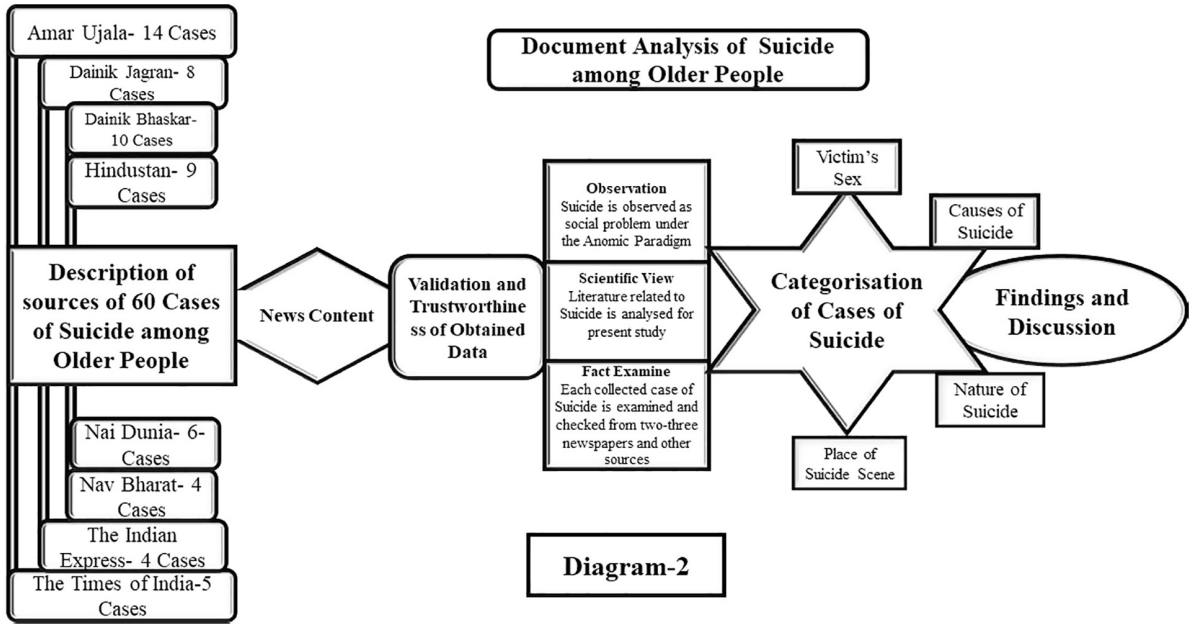


DIAGRAM 2

and news portals. Using observation, scientific view, and fact examination, the researcher has analysed each instance from two or three newspapers and other sources (Sahoo and Patel, 2021). This has assisted the research in proving the validity of obtained data on old-age suicide and assuring the reliability of data collected.

Findings

Place of suicide scene

Table 1 reveals that a total of 37 (61.67%) cases of old-age suicide have been recorded in urban areas, compared to 23 (38.33%) cases of old-age suicide in rural areas. The suicide rate is often reported to be greater in urban areas due to a multitude of urban pressures, such as overcrowding and social isolation (Radhakrishnan and Andrade, 2012).

Victims' sex

Table 2 shows that 34 (56.67%) old men and 26 (43.33%) old women have killed themselves, respectively. The data show a major gap in the number of suicide deaths between the genders. According to the data (National Crime Record Bureau [NCRB], 2020), in 2020, while 3,300 old women died by suicide, the figure for old men was 74.85%, with 9,826 deaths by suicide. A study reveals that men continue to suffer discreetly from mental illness more than women, concealing that social stigma plays a significant role in men committing suicide (Ghosh, 2021).

Causes of suicide

Figure 2 demonstrates that most suicides (28.33%) have been caused by chronic disease, followed by several other causes of suicide, such as depression (21.67%), abuse in family (18.33%), poverty (16.67%), and social rejection (15.00%).

Nature of suicide among older people

This study (**Figure 3**) has found that vulnerable conditions of older people have arisen in three natures of suicide, namely, personal problem-based suicide, familial problem-based suicide, and social problem-based suicide. The study has found that most cases of suicide have been committed due to personal problems (50.00%), followed by familial problems (35.00%) and social problems (15.00%).

Personal problems-based suicide

Personal anomie refers to a condition in which personal problems arise before an individual in society due to the effect of rapid social change and unwanted phenomena. When the

TABLE 1 Place of suicide scene.

Place of suicide scene	Frequency	Percentage (%)
Rural	23	38.33
Urban	37	61.67
Total	60	

TABLE 2 Victim's sex.

Victim's sex	Frequency	Percentage (%)
Male	34	56.67
Female	26	43.33
Total	60	

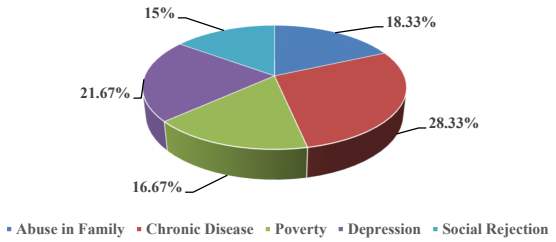


FIGURE 2
Causes of suicide.

person is unable to overcome the problems arising due to these side effects, he is compelled to commit suicide. This study examines the nature of suicide among older people as motivated by personal causes. The researcher has pointed out in his study that personal problems were the underlying cause of suicide in 50.00% of cases. The researcher has found through analysis of news content that older people who had a personal nature of suicide were more likely to suffer from problems, such as chronic disease (28.33%) and depression (21.67%).

For example, based on news content, we may observe two significant suicide occurrences in which an old person took his or her own life due to chronic disease and depression.

Familial problems-based suicide

Familial problems may be defined as any kind of dysfunction within a family due to rapid change and irrelevant incidents. In such a situation, a person does not live up to his or her family's expectations, and his or her family situation becomes unstable. When the person does not see a way out of the family problems, he is forced to commit suicide. The researcher has found in his study that in approximately 35.00% of older people, the nature of suicide was due to familial problems. The study has found that older people who committed suicide were abused (18.33%) by family members and they lived in poverty (16.67%). For instance, based on news content, we may identify two prominent suicide occurrences in which an old person committed suicide as a result of abuse in family and poverty.

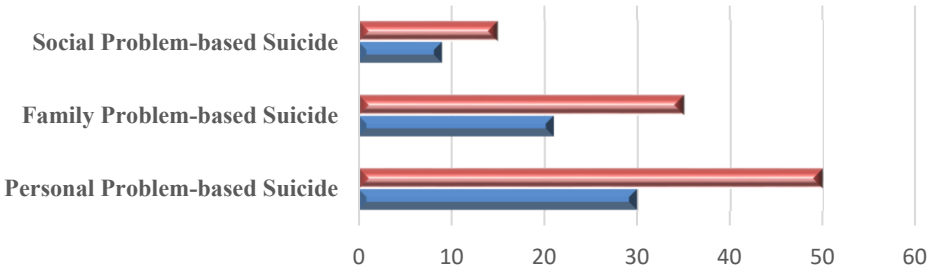
Social problem-based suicide

Social problems are a condition of society in which due to rapid social change and irrelevant phenomena, social norms and values weaken and give rise to many problems. These problems promote a state of deviance affecting the whole society directly and indirectly. In such a situation, when the particular person who is suffering from it is unable to get out of these problems, he is forced to commit suicide. The researcher has found in the study that in the changing socio-economic scenario, approximately 15.00% of the total suicides of older people were committed due to social problems. When the researcher studied suicide among older people based on social problems, it was found that those who committed suicide were more likely to suffer from social rejection (15.00%). For example, we can discuss a case of suicide in which an old person committed suicide due to social rejection in the neighbourhood.

Discussion

There is strong agreement that old age is a time of increasing vulnerability (Joseph and Cloutier-Fischer, 2005; Grundy, 2006; Schroder-Butterfill and Marianti, 2006; Crooks, 2009; Wiersma and Koster, 2013). It is the perception that old age connected with vulnerability is strongly linked to normative expectations of poor health and the increasing need for healthcare as people get older (Joseph and Cloutier-Fischer, 2005; Wiersma and Koster, 2013). Old age is also accompanied by a variety of social and economic changes, including the loss of employment, reduced income, and widowhood for many people (Arber et al., 2003; Crooks, 2009). The combination of these numerous age-related changes contributes to the perception of old age by many as a period of risk and uncertainty. However, older people differ greatly in their biological, physiological, psychological, and social circumstances (Crooks, 2009), laying the foundation for the study of differential vulnerability in old age. In the majority of vulnerability studies, the older people are consistently portrayed as high-risk populations. Vulnerability indicates the possibility of poor results because older people are unable to protect their wellbeing in later years (Crooks, 2009). Consequently, it is considered that older people as a vulnerable group face many social-psychological problems that lead to low belongingness and perceived burdensomeness constituting risk factors, such as suicide among older people.

Rapid socio-economic changes in the era of industrialisation, urbanisation, and globalisation have had positive and negative impacts on human beings and society. On the one hand, the positive impact has given a better



	Personal Problem-based Suicide	Family Problem-based Suicide	Social Problem-based Suicide
%	50.00	35.00	15.00
Number of Cases	30	21	9

FIGURE 3
Nature of suicide among older people.

life in society. On the other hand, the negative impact has weakened interpersonal relationships among family members. The weakened interpersonal relationships due to these socio-economic changes have made a vulnerable condition for older people in the family. The increasing incidents of suicide among older people are the result of this vulnerable condition. At present, all the suicides among older people happening in Indian society are directly or indirectly due to vulnerability in later life. This study has found that older people committed suicide due to social vulnerability and physical vulnerability. Moreover, during the COVID-19 pandemic, people avoided older people in the family and society because they were afraid of fear of contracting the coronavirus (Surjit, 2022). This made the lives of older people worse. Several newspapers have reported that people living in the same house were shunned in the family and society because of the COVID-19 pandemic. It excluded emotionally older people from their families and society as a whole. Older people were abused emotionally and physically in their own homes by their own children during the pandemic (Helpage India, 2021). The researcher has pointed out through news content that older people who committed suicide were suffering from personal problems (chronic disease and depression), family problems (abuse and poverty), and social problems (social rejection). All these problems affected their social bonding, resulting in social vulnerability and physical vulnerability. This study also points out that the rapid changes have featured social integration and regulation, resulting in low belongingness and perceived burdensomeness in the family and society due to the vulnerability of old people. The effect of low belongingness and perceived burdensomeness contribute to isolation, loneliness, hopelessness, and depression which, in turn, leads to old-age suicide in three ways, namely, personal problem-based suicide, familial problem-based suicide, and social problem-based suicide.

Conclusion

This study is based on a content study of a few Hindi and English language Indian newspapers. Only a few states of India are included in the study's sample regions, such as Bihar, Delhi, Haryana, Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, and Uttarakhand. The chosen sample region does not provide a full picture of suicide among older people in India. The study suggests that suicide among older people is an alarming societal problem in contemporary times that may have been caused by a number of factors, such as social vulnerability (abuse in family, poverty, and social rejection) and physical vulnerability (chronic disease and depression) of older people in later life, which led to low belongingness and perceived burdensomeness. According to the data collected from March 2022 to June 2022, older men (56.67%) committed the majority of suicides. In addition, the study indicates that respect, honour, prestige, and authority held by older people in traditional Indian society have begun to decline progressively. In a society undergoing such rapid changes, older people are subject to social-psychological issues, such as loneliness, alienation, helplessness, and despair. All these social-psychological problems have a negative impact on the wellbeing of older people that contributes to the rising suicidal tendency among older people.

Finally, it is of the utmost significance to comprehend that our parents and other senior people are analogous to trees; they play a role in our courtyard, similar to that of providing shade and protection. They also provide us with the benefit of their knowledge and blessings due to that we go ahead smoothly in the journey of life. We owe a debt of gratitude to our elders who have shaped our personality, architected our vision of life, and taught us the ability to keep working after they have passed away. It should be not only our emotional responsibility but also our moral responsibility to provide a friendly environment for our

parents and other older people at the end of their lives so that they can fully enjoy their lives without any problem.

Data availability statement

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

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Patterns of multimorbidity and some psychiatric disorders: A systematic review of the literature

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Objective: The presence of two or more chronic diseases results in worse clinical outcomes than expected by a simple combination of diseases. This synergistic effect is expected to be higher when combined with some conditions, depending on the number and severity of diseases. Multimorbidity is a relatively new term, with the first fundamental definitions appearing in 2015. Studies usually define it as the presence of at least two chronic medical illnesses. However, little is known regarding the relationship between mental disorders and other non-psychiatric chronic diseases. This review aims at investigating the association between some mental disorders and non-psychiatric diseases, and their pattern of association.

Methods: We performed a systematic approach to selecting papers that studied relationships between chronic conditions that included one mental disorder from 2015 to 2021. These were processed using Covidence, including quality assessment.

Results: This resulted in the inclusion of 26 papers in this study. It was found that there are strong associations between depression, psychosis, and multimorbidity, but recent studies that evaluated patterns of association of diseases (usually using clustering methods) had heterogeneous results. Quality assessment of the papers generally revealed low quality among the included studies.

Conclusions: There is evidence of an association between depressive disorders, anxiety disorders, and psychosis with multimorbidity. Studies that tried to examine the patterns of association between diseases did not find stable results.

Systematic review registration: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42021216101, identifier: CRD42021216101.

KEYWORDS

multimorbidity, psychiatric disorders, clustering, aging, patterns

Introduction

The management of chronic diseases is one of the main challenges faced by health care systems today. Chronic conditions, when they happen together, seem to interact and worsen each other's clinical courses (Mendenhall et al., 2017). This effect is expected to be higher with some combinations of conditions more than others, and with number and severity of diseases (Mendenhall, 2017). However, most research done in the relations between chronic conditions consider them in pairs, within a hierarchy (co-morbid). This paradigm is aligned to the way the biomedical model organizes training of health providing professionals, with each medical specialist within the boundaries of their own field (World Health Organization, 2016). This introduces an arbitrary division and ignores patterns of association that may be clinically relevant and could help reduce morbidity if early addressed by practitioners (MacMahon, 2018). On the other hand, the multimorbidity (MM) concept tries to shift toward a system where there are no index conditions, and the subject of interest is rather the interaction between diseases.

This shift toward the MM concept has implications in several areas. It requires that specialists interact and communicate efficiently with staff from other background training (Sinyor et al., 2019). This type of more integrative care is costly (Valderas et al., 2009), may require reorganizing mental health and general practices (Sinyor et al., 2019) to a more holistic care (arguably simplified in places where a universal health system exists, such as in UK), and impacts research itself, as traditional association statistical methods are better suited for comparisons between two variables.

Most of the studies consider MM as the presence of two or more disorders. MacMahon (2018) declared MM a health priority, as its prevalence is increasing in many regions of the world over the past 20 years. The prevalence is also expected to grow with the increase in life expectancy (MacMahon, 2018). Patients affected by MM have more disability, tend to use more medications (van Oostrom et al., 2014), have worse quality of life (Ralph et al., 2013), more cognitive impairment (Koyanagi et al., 2018; Wang et al., 2020), and may die earlier than non-affected peers (Wei and Mukamal, 2018). Multimorbidity is also linked to increased use and costs of health services (van Oostrom et al., 2014).

The first two major documents on this subject are a summary of a roundtable meeting by The Academy of Medical Sciences (2015) and a report by World Health Organization (2016). This was followed by the Lancet series on Syndemics (Mendenhall et al., 2017), the creation of the Medical Subject Heading (MeSH) term for multimorbidity in National Library of Medicine (2018), the multimorbidity report by the American Academy of Medical Sciences the same year (MacMahon, 2018), and the Lancet Psychiatry Commission Blueprint for protecting the physical health of people with mental illness in 2019 (Firth et al., 2019). This impacts the slow transition of the literature into methods that more accurately assess the interactions between chronic diseases and development, or use of more suited methods to this end (like clustering methods). Furthermore, mental disorders in the context of multimorbidity have been less studied, as clinical conditions have become the main subjects of the field.

The complex relations of mental disorders and chronic diseases is not entirely understood. It is certainly expected to happen, as mental disorders are linked to worse adherence to clinical treatments (Patel and Chatterji, 2015), to lack of physical activity (Bueno-Antequera and Munguía-Izquierdo, 2020), and antipsychotics are linked to metabolic syndromes (Hálfdánarson et al., 2017). The hypothesized mechanisms through which mental disorders may be associated with chronic diseases include: (A) the metabolic syndrome resulting from psychiatric medication; (B) direct inflammatory process from harmful drug/alcohol/tobacco use; (C) childhood adversities as environmental factors for both non-communicable diseases and mental disorders (Patel and Chatterji, 2015); and (D) inflammatory mechanisms such as higher concentration levels of C-reactive protein, interleukin 6 and 12 and tumor necrosis factor in acute depression (Osimo et al., 2020). Additionally, individuals with mental disorders usually make poor lifestyle choices (with less exercises, unhealthy eating habits, tobacco use) and have less access to prevention policies and health care (Patel and Chatterji, 2015). So far studies have found high prevalence of MM with mental disorders among young individuals from deprived backgrounds compared to those resident of more affluent areas (Barnett et al., 2012), and higher rates of multimorbidity with mental disorders in women (Barnett et al., 2012). The majority of studies on MM are concentrated on older individuals from high income countries (MacMahon, 2018). More studies on younger individuals, from more deprived backgrounds are necessary to understand the association between socioeconomic drivers and MM with mental disorders. Previous systematic reviews found higher rates of MM and specific psychiatric disorders, like depression (Read et al., 2017) and schizophrenia (Rodrigues et al., 2021). However, evidence is still fragmented, lacks investigation of trends over time, and rarely uses methods that can estimate the effect of mechanisms.

This review aims at investigating the association between five prevalent mental disorders and non-psychiatric diseases (including the chronic infectious diseases: tuberculosis, and HIV), and the pattern of association between them. It also will organize information in a descriptive synthesis including studies

that had multimorbidity as a focus from the start, avoiding those exclusively linked to co-morbidity.

Methods

We reported this systematic review according to the PRISMA 2020 guideline (Page et al., 2021). The protocol of this review was registered at PROSPERO (registration number CRD42021216101). The search strategy included MeSH terms with the final expression: (multimorbidity[MeSH Terms]) AND (mental disorder[MeSH Terms] OR anxiety[MeSH Terms] OR depressive disorder[MeSH Terms] OR psychotic disorders[MeSH Terms] OR substance related disorders[MeSH Terms] AND ("2015/01/01"[Date - Entry]: "3000"[Date - Entry])). We searched PubMed and Scielo databases on 31/05/2021 for original articles published in the last 6 years (2015–2021) that studied multimorbidity and at least one of the mental disorders we listed above. We chose studies published from 2015 because that was the year that the Medical Science Academy held the meeting, which led to the "Multimorbidity: a priority for global health research" report in 2018. We also reviewed references from relevant prior systematic reviews, in order to identify any other eligible studies. We selected original studies published in English, Portuguese or Spanish. Furthermore, we report results in a descriptive synthesis, including a quality assessment of the studies.

Eligibility criteria

Any quantitative article that analyzed the association between five psychiatric disorders (depression, anxiety, post-traumatic stress disorder-PTSD, substance use disorder and psychosis) and chronic physical conditions (infectious or non-communicable) were included. In addition to this, studies analyzing multimorbidity patterns that included mental disorders were also added. We excluded gray literature, studies focused on statistical models with no mention of multimorbidity patterns or association and studies that examined prevalence only. Therefore, the minimal definition of MM for this review was the presence of one chronic condition plus one of the five psychiatric disorders listed above.

Screening and data extraction

We performed screening of title and abstract, full text review and data extraction with the Covidence web tool (Veritas Health Innovation, 2021). Two reviewers (NTSF and FC) independently

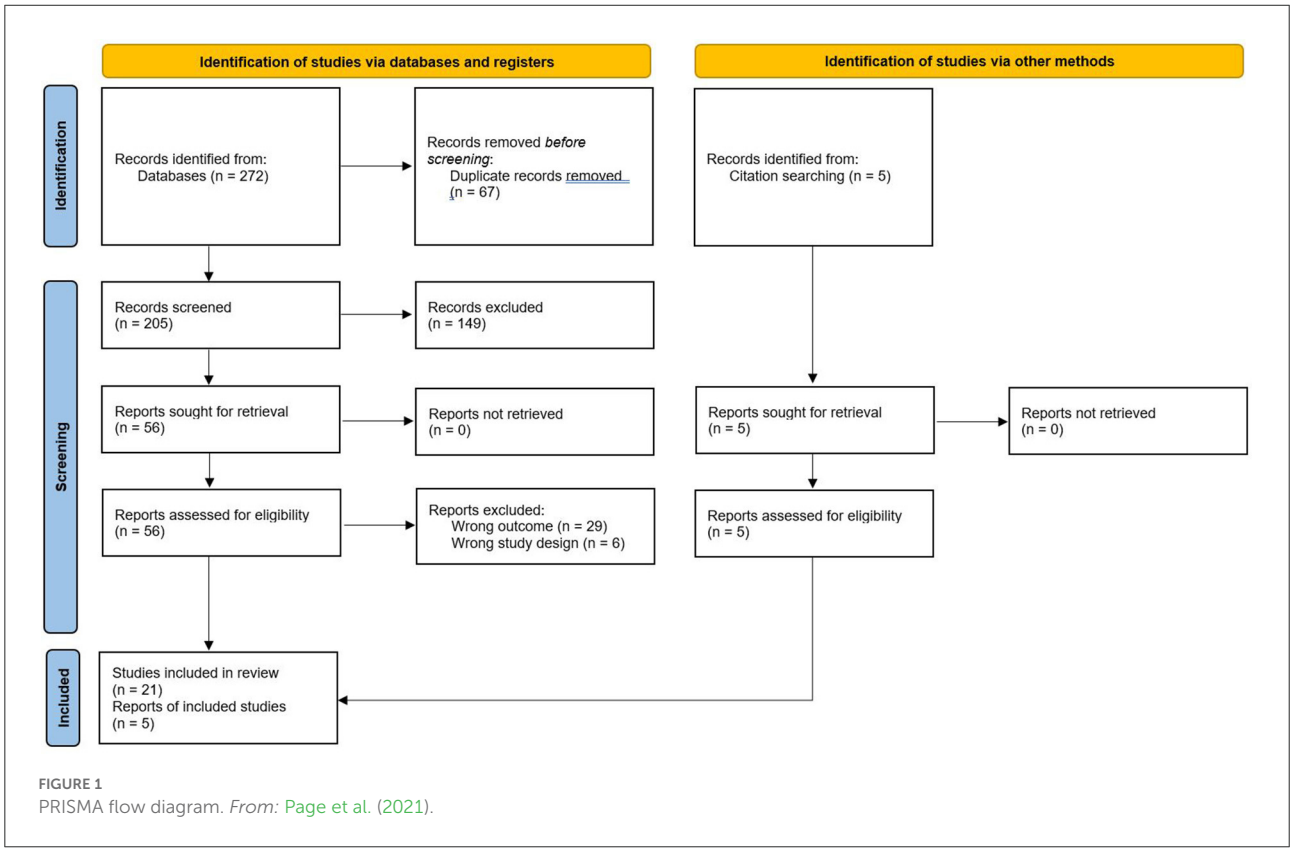

FIGURE 1
PRISMA flow diagram. *From:* Page et al. (2021).

screened titles and abstracts. We discussed the disagreements to reach a consensus. The full text screening followed the same approach. Reasons for exclusion were: wrong outcome (studies reporting only prevalence) or wrong study design (modeling study).

Data extraction and risk of bias

Two reviewers (NTSF and FC) independently extracted data from included studies, with a third reviewer (JAPA) establishing comparison and consensus. We created a data extraction form including information on study characteristics, participant characteristics, setting, statistical method, outcomes, main conclusions and limitations.

We assessed the quality of each included article using the Newcastle-Ottawa Scale (NOS) (Wells et al., 2000) for observational studies. For cohort studies, we used the thresholds for converting the Newcastle-Ottawa scales to Agency for Health Research and Quality (AHRQ) standards: good, fair, and poor quality. We did not assign scores for cross-sectional studies. For these studies, we adapted the scale and included bias listed by the study authors. We did not evaluate the quality of systematic reviews and meta-analysis.

Data analysis

We tabulated our findings as a narrative synthesis, describing the main characteristics of the studies and critical findings. Furthermore, we focused on the association between multimorbidity and psychiatric disorders by using crude and/or adjusted relative risk (RR), risk difference (RD) or odds ratio reported by the studies.

Results

We screened 205 titles and abstracts for eligibility. After reviewing the full text of 56 articles, we included 26 studies in our review (Figure 1). Six articles (23%) were multi-country studies; five (19%) from the USA, two (8%) from China, South Africa and Spain. One (4%) from each Bahrain, Brazil, Canada, Croatia, UK, Italy, Netherlands, Pakistan, and Switzerland. The papers included discussed the following psychiatric conditions: depression, anxiety, bipolar disorder, dysthymia, adjustment and personality disorder, psychosis, schizophrenia, post-traumatic stress disorder (PTSD), dementia, eating disorder dissociative and somatoform disorders, intellectual disabilities, impulse-control, premenstrual dysphoria, insomnia, alcohol abuse, tobacco and substance use disorders. The most common chronic conditions were cardiovascular, respiratory and renal diseases, diabetes, hepatitis and obesity (Table 1). Table 2 summarizes the main findings for the association between multimorbidity and psychiatric disorders. We provided a narrative synthesis below according to specific psychiatric disorders.

Overall results

Most articles discussing multimorbidity and mental disorders were cross-sectional studies (20.76%). Two studies included were systematic reviews and meta-analysis (Read et al., 2017; Rodrigues et al., 2021). Most of the papers were multi-country studies (23%). The single country with more studies was the USA (19%). The study with the largest sample had 3,759,836 individuals (Lenzi et al., 2016) and the smaller had 240 individuals (Jahrami et al., 2017). Fifteen percent of the studies included exclusively older adults (50 years and above). Depression was the psychiatric disorder most evaluated in the reviewed studies (42%), followed by anxiety (23%), and substance abuse (19%). Only four studies addressed multimorbidity among individuals with psychosis. Samples were very heterogeneous and comprised specific groups (veterans, people living with HIV, general population of a region, patients of a psychiatric hospital, patients of primary care units, patients of tuberculosis clinic, etc.). Most study samples came from high income countries (European countries: Italy, Netherlands, Spain, Croatia and Switzerland).

Patterns of multimorbidity

The shift from co-morbidity to the multimorbidity framework resulted in more papers being published aiming at detecting patterns of association between conditions. In particular, it seems that studies that grouped diseases together were the most common. There are a number of these methods and the ones recovered in our systematic review included factor analysis and latent class analysis (Lenzi et al., 2016; Filipčić et al., 2018; Aubert et al., 2019), but there also were papers using non-supervised clustering methods (Violan et al., 2018). In this section, we present the clusters or groupings found through these methods. Only Lenzi et al. (2016) presented *ad hoc* tests between groups and age, and Filipčić et al. (2018) performed tests between classes and an outcome. Peltzer (2018) identified three patterns of multimorbidity through a factor analysis where the third factor (eigenvalue = 1.10), named substance use disorders, had high loading on daily or almost daily tobacco use (0.81) and alcohol-use disorders (0.81). Aubert et al. (2019) identified five groups as patterns of multimorbidity, Group 5 ("psychiatric diseases") included

TABLE 1 Study characteristics.

References	Country	Psychiatric disorder	Physical chronic conditions	Study population Age range	Sample size	Study design
Li et al. (2015)	China	Depression	NR	• Adults residing in rural villages • Age range: 60–101	3,824 individuals	Observational: cross-sectional
Arokiasamy et al. (2015)	Multi-country	Depression	Angina pectoris, arthritis, asthma, chronic lung disease, diabetes mellitus, hypertension, stroke, vision impairment	• Adults aged 50 and older, with a smaller cohort of respondents aged 18–49 • Age range: 18+	42,236 individuals	Observational: cross-sectional
Stubbs et al. (2016)	Multi-country	Psychosis or subclinical psychosis	Arthritis, angina pectoris, asthma, diabetes, chronic back pain, visual impairment, hearing problems, edentulism, tuberculosis	• Adults with a valid home address • Age range: 18–65	242,952 individuals	Observational: cross-sectional
Gould et al. (2016)	USA	Anxiety and depression	Arthritis, cancer, diabetes, heart condition, high blood pressure, lung disease, stroke	• Individuals randomly selected to complete the Psychosocial Questionnaire in the Health and Retirement Study • Age range: 65+	4,219 individuals	Observational: cross-sectional
Lenzi et al. (2016)	Italy	Schizophrenia and psychosis, bipolar disorder, depression, dysthymia, anxiety, dissociative and somatoform disorders, personality disorders, substance use disorders, intellectual disabilities, other mental disorders	Myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, hypertension, dementia, including Alzheimer's disease, chronic pulmonary disease, rheumatic disease, liver disease, diabetes, paralysis, other neurological disorders, renal disease, any malignancy, including lymphoma and leukemia, except malignant neoplasm of skin, metastatic solid tumor and AIDS/HIV.	• Adults residents of Emilia-Romagna region on 31 December 2012 • Age range: 18+	3,759,836	Observational: cross-sectional

(Continued)

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TABLE 1 (Continued)

References	Country	Psychiatric disorder	Physical chronic conditions	Study population Age range	Sample size	Study design
Read et al. (2017)	Multi-country	Depression	NR	• Individuals with and without multimorbidity and with no chronic condition • Age range: 15+	40 studies	Systematic review and meta-analysis
Stubbs et al. (2017)	Multi-country	Depression	Tuberculosis, visual impairment, hearing problem, chronic back pain, edentulism, arthritis, angina, asthma and diabetes.	• Individuals with a valid home address • Age range: 18+	190,593 individuals	Observational: cross-sectional
Holvast et al. (2017)	Netherland	Depression	AIDS and HIV infection, malignancy, visual disorders, hearing disorders, congenital cardiovascular anomaly, disorders of endocard/valvular heart disease, heart failure, coronary heart disease, arrhythmias, stroke, rheumatoid arthritis, peripheral arthritis, chronic neck and back pain, osteoporosis, Parkinson's disease, epilepsy, migraine, chronic obstructive pulmonary disease, asthma, diabetes mellitus	• Patients with late-life depression in primary care • Age range: 60+	4,477 individuals	Observational: cross-sectional
DiNapoli et al. (2017)	USA	Mood Disorders: depressive and anxiety disorders	Endocrine, digestive, circulatory, respiratory	• Veterans who received primary care through the VA Pittsburgh Healthcare System (VAPHS) • Age range: 50+	34,786 individuals	Observational: cross-sectional

(Continued)

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TABLE 1 (Continued)

References	Country	Psychiatric disorder	Physical chronic conditions	Study population Age range	Sample size	Study design
Gabilondo et al. (2017)	Basque Country (Spain)	Schizophrenia, dementia	Hypertension, ischemic heart disease, Parkinson, diabetes, viral hepatitis, HIV, chronic pulmonary disease, migraine, osteoarticular disorders, cardiovascular conditions, among others.	• Individuals covered by public health insurance in 31st August 2011 and who had been covered for at least 6 months in the previous year • Age range: 16+	2,255,406 individuals	Observational: cross-sectional
Jahrami et al. (2017)	Bahrain	Schizophrenia	Cardiovascular disease, type 2 diabetes, hypertension, obesity, musculoskeletal Disorder	• Cases: recruited from Psychiatric Hospital, Bahrain • Controls: recruited from primary health centers, and were free from serious mental illness • Age range: 20–60	240 individuals	Observational: case-control
Vancampfort et al. (2017)	Multi-country	Anxiety	Angina, arthritis, asthma, chronic back pain, diabetes, edentulism, hearing problem, tuberculosis, and visual impairment	• Community-dwelling adults • Age range: 18+	181,845 individuals	Observational: cross-sectional
Jacob et al. (2018)	UK	Post-traumatic stress disorder, alcohol dependence, drug use, disordered eating, anxiety and depression as mediators	Cancer, diabetes, epilepsy, migraine, cataracts/eyesight problems, ear/hearing problems, stroke, heart attack/angina, high blood pressure, bronchitis/emphysema, asthma, allergies, stomach ulcer or other digestive problems, liver problems, bowel/colon problems, bladder problems/incontinence, arthritis,	• English adult population, residing in private households • Age range: 18+	7,403 individuals	Observational: cross-sectional

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TABLE 1 (Continued)

References	Country	Psychiatric disorder	Physical chronic conditions	Study population Age range	Sample size	Study design
			bone/back/joint/muscle problems, infectious disease, and skin problems			
Filipčić et al. (2018)	Croatia	Any psychiatric disorder	Hypertension, urinary incontinence, obesity, spine and back pain, neck spine, allergies, asthma, diabetes, chronic obstructive pulmonary disease, kidney problems, cirrhosis of the liver, myocardial infarction, arthrosis, stroke, coronary heart disease	• Patients diagnosed with any psychiatric disorder who were treated in a psychiatric hospital as in-patients or outpatients and have permanent residency in the city of Zagreb or Zagreb County. General population of Croatian citizens living in private households in the city of Zagreb and Zagreb County • Age range: 18+	1,897 individuals	Observational: cross-sectional
Peltzer (2018)	South Africa	Tobacco and Alcohol-use disorder, anxiety or depressive disorders, symptoms of post-traumatic stress disorder	Myocardial infarction or angina pectoris, arthritis, asthma, chronic lung disease, type 2 diabetes, hypertension, dyslipidaemia, malignant neoplasms, tobacco and alcohol-use disorder	• New and retreatment tuberculosis patients within 1 month of anti-TB treatment being initiated from high TB caseloads primary health care facilities • Age range: 18+	4,207 individuals	Observational: cross-sectional
MacLean et al. (2018)	USA	Alcohol use disorder and tobacco use disorder, dementia, schizophrenia, bipolar disorder, major depression, other depression, post-traumatic stress disorder, anxiety disorder, adjustment disorder, personality disorder, and other psychiatric diagnosis, substance use disorder	Hepatitis and renal disease	• All veterans who had received a diagnosis of either alcohol or tobacco use disorders or both during 2012 • Age range: not informed	988,674 individuals	Observational: Cohort

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TABLE 1 (Continued)

References	Country	Psychiatric disorder	Physical chronic conditions	Study population Age range	Sample size	Study design
Violan et al. (2018)	Spain	Mental and behavioral disorders due to psychoactive substance use, stress-related and somatoform disorders	Metabolic disorders and other physical conditions: non-inflammatory disorders of female genital tract, hypertensive disease, other soft tissue disorders, disorders of thyroid gland, benign neoplasms	• Patients with multimorbidity attended in primary care centers • Age range: 45–64	408,994	Observational: cross-sectional
Farooq et al. (2019)	Pakistan	Anxiety and depressive symptoms	Hypertension, obesity, dyslipidaemia, diabetes, heart diseases, stroke, migraines, asthma and chronic obstructive pulmonary disease, anemia, thyroid disease, diseases of bones and joints, dyspepsia/peptic ulcer, hepatitis B or C, chronic kidney diseases including stones, cancer, disability	• Adults living in the Gulshan-e-Iqbal town of Karachi, Pakistan • Age range: 30+	3,250 individuals	Observational: cross-sectional
Han et al. (2019)	USA	Substance use: cannabis, cocaine, methamphetamine, heroin, inhalants, hallucinogens, and prescription drug misuse and substance use disorder	Asthma, bronchitis, chronic obstructive pulmonary disease, cirrhosis, diabetes, heart conditions, hepatitis, high blood pressure, cancer, kidney disease, and HIV/AIDS	• Non-institutionalized individuals with substance use disorder (SUD) and past-year use • Age range: 18+	85,701 individuals	Observational: cross-sectional

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TABLE 1 (Continued)

References	Country	Psychiatric disorder	Physical chronic conditions	Study population Age range	Sample size	Study design
Crawford and Thornton (2019)	USA	Alcohol use, depression, anxiety disorder, and bipolar disorder	HIV	• People living with HIV patients of an urban infectious disease clinic • Age range: not informed	1,635 individuals	Observational: cohort
Romain et al. (2019)	Canada	Major depressive episode, mood disorders and anxiety disorders	Obesity	• People with obesity • Age range: 18+	1,315 individuals	Observational: cross-sectional
Petersen et al. (2019)	South Africa	Depression and alcohol use disorders	Hypertension, diabetes	• Patients attending three large health facilities in the Dr Kenneth Kaunda district • Age range: 18+	2,549 individuals	Observational: cross-sectional
Wang et al. (2019)	Brazil	Anxiety, mood, impulse-control, and substance use disorders, plus premenstrual dysphoria (in women) and heavy drinking.	Cardiovascular diseases, hypertension, diabetes mellitus, arthritis, chronic musculoskeletal pain, headache or migraine, digestive, respiratory, neurological diseases, and cancer.	• Urban sample of non-elderly adults • Age range: 18–64	2,713	Observational: cross-sectional
Aubert et al. (2019)	Switzerland	Mood disorders, substance-related disorders, anxiety disorders	Chronic heart disease, Cerebrovascular disease, Hematological malignancy, chronic kidney disease, chronic obstructive pulmonary disease and bronchiectasis, pulmonary heart disease, peripheral and visceral atherosclerosis, paralysis, arthropathy and arthritis,	• Adults discharged from general hospital • Age range: not informed	42,739	Observational: cohort

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TABLE 1 (Continued)

References	Country	Psychiatric disorder	Physical chronic conditions	Study population Age range	Sample size	Study design
			cerebrovascular disease, acute and unspecified renal failure, solid malignancy, other nervous system disorders, other and ill-defined heart disease, thyroid disorders, nephritis, nephrosis and renal sclerosis, diseases of white blood cells			
Wong et al. (2020)	China	Depression, anxiety, insomnia	NR	• Older adults who had ≥ 2 chronic conditions, recruited from four public primary care clinics. • Age range: 60+	583 individuals	Observational: cohort
Rodrigues et al. (2021)	Multi-country	Psychotic disorders	NR	• Individuals with psychotic disorders • Age range: not informed	14 studies	Systematic review and meta-analysis

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TABLE 2 Study results.

References	Main outcome	Statistical method	Results
Li et al. (2015)	Association between depressive symptoms and chronic conditions and socioeconomic status	Multilevel logistic regression, odds ratio	Unadjusted model Association depressive symptoms and chronic conditions OR = 1.379 (95% CI: 1.291 to 1.473), $p < 0.001$
Arokiasamy et al. (2015)	Association between multimorbidity and four primary health outcomes: lower self-rated health, depression, limitation in activities of daily living, and poorer quality of life	Multilevel multinomial logit model, odds ratio, beta coefficient	Disease count on depression Unadjusted model 1 disease: OR = 1.77 (95% CI: 1.57 to 2.01) 2 diseases: OR = 2.80 (95% CI: 2.48 to 3.18) 3 diseases: OR = 4.74 (95% CI: 4.12 to 5.46) 4+ diseases: OR = 8.75 (95% CI: 7.53 to 10.12) All $p < 0.01$ Adjusted model 1 disease: OR 1.62 (95% CI: 1.42 to 1.84) 2 diseases: OR 2.44 (95% CI: 2.14 to 2.82) 3 diseases: OR 4.05 (95% CI: 3.47 to 4.75) 4+ diseases: OR 7.33 (95% CI: 6.24 to 8.61) All $p < 0.01$
Stubbs et al. (2016)	Association between psychosis and multimorbidity	Multivariable logistic regression, odds ratio	Adjusted model Subclinical psychosis: OR = 2.20 (95% CI: 2.02 to 2.39) Psychosis diagnosis: OR = 4.05 (95% CI: 3.25 to 5.04) All $p < 0.001$
Gould et al. (2016)	Association between the number of medical conditions and elevated anxiety or depression	Multiple logistic regression analysis, odds ratio	Unadjusted model 1 condition and anxiety: OR = 1.24 (95% CI: 0.70 to 2.21), non-significant 2 conditions and anxiety: OR = 1.96 (95% CI: 1.13 to 3.41), $p < 0.001$ 3 or more conditions and anxiety: OR = 3.49 (95% CI: 2.05 to 5.95), $p < 0.001$ Wald F (3,4181) = 22.46 Adjusted model 1 condition and anxiety: OR = 1.21 (95% CI: 0.67 to 2.16), non-significant 2 conditions and anxiety: OR = 1.79 (95% CI: 1.02 to 3.12), $p < 0.001$ 3 or more conditions and anxiety: OR = 3.04 (95% CI: 1.77 to 5.21), $p < 0.001$ Wald F (3,4181) = 17.08

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TABLE 2 (Continued)

References	Main outcome	Statistical method	Results
Lenzi et al. (2016)	Descriptive analysis of differences in the prevalence of multimorbidity in relation to age, gender, and citizenship	Exploratory factor analysis, tetrachoric correlation matrix for factor analysis	Multimorbidity pattern—(1) Psychiatric disorders: Schizophrenia and psychosis 0.60, Anxiety, dissociative, and somatoform disorders 0.54, Depression 0.44; (4) Liver diseases, AIDS/HIV and substance use: Substance use disorders 0.55
Read et al. (2017)	Risk of depressive disorder in people with and without multimorbidity	Meta-analysis risk and odds ratios	Risk for depressive disorder for people with multimorbidity compared to those without multimorbidity RR = 2.13 (95% CI: 1.62 to 2.80), $p < 0.001$ Risk of having depressive disorder in people with multimorbidity compared to those with no chronic physical condition RR = 2.97 (95% CI: 2.06 to 4.27), $p < 0.001$ Odds of having a depressive disorder with increasing number of chronic physical conditions OR = 1.45 (95% CI: 1.28 to 1.64), $p < 0.001$ Correlation between number of chronic physical conditions and depressive symptoms: r = 0.26 (95% CI: 0.18–0.33), $p < 0.001$
Stubbs et al. (2017)	Association between the whole depressive spectrum and multimorbidity	Multivariable logistic regression, odds ratio	Unadjusted model Subsyndromal depression: OR =2.62 (95% CI: 2.17 to 3.15) Brief depressive episode: OR = 2.14 (95% CI: 1.84 to 2.48) Depressive episode: OR = 3.44 (95% CI: 3.12 to 3.79) All $p < 0.0001$ Adjusted model Overall (43 countries): OR = 3.26 (95% CI: 2.98 to 3.57); I-squared=58.1%, p=0.000
Holvast et al. (2017)	Associations between patients diagnosed with late-life depression in primary care and multimorbidity and polypharmacy	Multivariable, multilevel, negative binomial regression, prevalence ratio and odds ratio	Adjusted model Association depression and multimorbidity: OR = 1.55 (95% CI: 1.33 to 1.81), $p < 0.001$ Association psychological diagnoses and multimorbidity : OR = 1.34 (95% CI: 1.15 to 1.57), $p < 0.001$

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TABLE 2 (Continued)

References	Main outcome	Statistical method	Results
DiNapoli et al. (2017)	Prevalence of and relationship between mood disorders and multimorbidity in middle-aged and older veterans	Binary logistic regression, odds ratio chi-square, Wald chi-square	Unadjusted model Predictors of Having a Depressive and/or Anxiety Disorder, organ system with chronic disease count (reference: 0–2) 3–5 chronic diseases: OR = 1.70 (95%CI: 1.21 to 2.40), $p = 0.002$ 6–7 chronic diseases: OR = 2.56 (95%CI: 1.83 to 3.59), $p < 0.001$ 8–9 chronic diseases: OR = 4.05 (95%CI: 2.89 to 5.66), $p < 0.001$ 10–13 chronic diseases: OR = 6.62 (95%CI: 4.73 to 9.25), $p < 0.001$
Gabilondo et al. (2017)	Epidemiology of comorbidities with chronic physical conditions in schizophrenia	Cluster analysis, chi-square test	Unadjusted model Comorbidities with physical conditions, schizophrenia vs. controls 1 chronic physical illness: OR = 1.64 (95% CI: 1.56 to 1.73) 2 chronic physical illnesses: OR = 1.63 (95% CI: 1.53 to 1.75) 3 or more chronic physical illnesses: OR = 1.12 (95% CI: 1.05 to 1.19) All $p < 0.001$ Specific diseases OR (95% CI) Parkinson: 47.89 (44.49–51.55) Dementia: 4.86 (4.37–5.40) Viral hepatitis: 3.31 (2.87–3.82) HIV: 2.25 (1.66–3.05) Diabetes: 2.23 (2.06–2.40) Chronic pulmonary disease: 2.10 (1.88–2.35) Chronic liver or pancreatic disease: 2.06 (1.79–2.36) Psoriasis or eczema: 1.81 (1.35–2.42) Hypothyroidism: 1.72 (1.57–1.88) Dyspepsia: 1.55 (1.41–1.70) Epilepsy (currently treated): 1.44 (1.11–1.88) Heart failure: 1.37 (1.09–1.73) Blindness & low vision: 1.20 (1.02–1.42) Asthma (currently treated): 0.84 (0.72–0.98) Hypertension: 0.78 (0.73–0.84) Ischemic heart disease: 0.78 (0.65–0.94) Cancer: 0.76 (0.65–0.88) Prostatic hypertrophy: 0.75 (0.61–0.91)

(Continued)

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TABLE 2 (Continued)

References	Main outcome	Statistical method	Results
			Peripheral neuropathy: 0.72 (0.62–0.83) Diverticular disease of intestine: 0.66 (0.51–0.87) Gout: 0.66 (0.53–0.84) Atrial fibrillation: 0.65 (0.52–0.81) Degenerative joint disease: 0.63 (0.55–0.73) Rheumatoid arthritis and autoimmune and connective tissue diseases: 0.53 (0.40–0.70) Osteoporosis: 0.51 (0.42–0.63) Migraine: 0.36 (0.20–0.64) All $p < 0.001$
Jahrami et al. (2017)	Impact of the presence of one or more dietary and lifestyle risk factors on the comorbidities among patients with schizophrenia in comparison to controls	Logistic regression, odds ratio	Schizophrenia vs. controls 1 comorbidity: OR = 3.7 (95%CI: 2.0 to 6.9) 2 comorbidities: OR = 3.3 (95%CI: 1.8 to 6.0) ≥3 comorbidities: OR = 3.2 (95%CI: 1.4 to 7.7) All statistically significant Specific diseases Type 2 diabetes mellitus: OR = 4.7 (95% CI: 1.8 to 13.0) hypertension: OR = 3.1 (95% CI: 1.4 to 7.2) MSD: OR = 2.0 (95% CI: 1.1 to 4.0) Obesity: OR = 1.7 (95% CI: 0.9 to 3.3) All statistically significant
Vancampfort et al. (2017)	Associations of each chronic physical condition and number of chronic physical conditions with anxiety	Multivariable logistic regression, odds ratio	Associations between chronic physical conditions and anxiety Model 1: adjusted for sex, age, wealth, and country 1 physical condition: OR = 2.08 (95% CI: 1.90 to 2.27) 2 physical conditions: OR = 3.10 (95% CI: 2.79 to 3.45) 3 physical conditions: OR = 4.54 (95% CI: 3.90 to 5.30) 4 physical conditions: OR = 6.79 (95% CI: 95.44 to 8.47) 5+ physical conditions: OR = 9.66 (95% CI: 6.88 to 13.57)

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TABLE 2 (Continued)

References	Main outcome	Statistical method	Results
			All $p < 0.001$
			Model 2: adjusted for sex, age, wealth, depression, and country
			1 physical condition: OR = 1.94 (95% CI: 1.76 to 2.13)
			2 chronic physical conditions: OR = 2.63 (95% CI: 2.34 to 2.96)
			3 chronic physical conditions: OR = 3.56 (95% CI: 3.00 to 4.22)
			4 chronic physical conditions: OR = 4.69 (95% CI: 3.64 to 6.04)
			5+ chronic physical conditions: OR = 5.49 (95% CI: 3.73 to 8.09)
			All $p < 0.001$
			Specific diseases
			Model 1
			Angina: OR = 2.35 (95% CI: 2.16 to 2.54)
			Arthritis: OR = 1.74 (95% CI: 1.59 to 1.90)
			Asthma: OR = 1.78 (95% CI: 1.57 to 2.02)
			Chronic back pain: OR = 2.67 (95% CI: 2.41 to 2.97)
			Diabetes: OR = 1.99 (95% CI: 1.69 to 2.34)
			Edentulism: OR = 1.14 (95% CI: 1.01 to 1.29)
			Hearing problems: OR = 1.63 (95% CI: 1.42 to 1.87)
			Tuberculosis: OR = 2.29 (95% CI: 1.84 to 2.84)
			Visual impairment: OR = 4.12 (95% CI: 3.36 to 5.04)
			All $p < 0.001$
			Model 2
			Angina: OR = 1.97 (95% CI: 1.79 to 2.16)
			Arthritis: OR = 1.54 (95% CI: 1.39 to 1.70)
			Asthma: OR = 1.56 (95% CI: 1.36 to 1.79)
			Chronic back pain: OR = 2.23 (95% CI: 1.99 to 2.50)
			Diabetes: OR = 1.83 (95% CI: 1.50 to 2.22)
			Edentulism: OR = 1.13 (95% CI: 0.97 to 1.31)
			Hearing problems: OR = 1.50 (95% CI: 1.29 to 1.74)
			Tuberculosis: OR = 1.85 (95% CI: 1.29 to 1.74)
			Visual impairment: OR = 3.96 (95% CI: 2.95 to 4.62)
			All $p < 0.001$

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TABLE 2 (Continued)

References	Main outcome	Statistical method	Results
Jacob et al. (2018)	Association between post-traumatic stress disorder and physical multimorbidity	Multivariable logistic regression, mediation analyses, odds ratio	Associations of PTSD and physical multimorbidity OR = 2.47 (95% CI: 1.71 to 3.56), $p < 0.001$ Without individuals taking antipsychotics or antidepressants OR = 2.72 (95% CI: 1.80 to 4.10), $p < 0.001$
Filipčić et al. (2018)	Differences in the prevalence and patterns of chronic physical illness and multimorbidity in the general and psychiatric population	Latent class analysis, difference in prevalence between groups, Mann-Whitney U test, I-square test, absolute risk increase and relative risk increase	Any chronic physical illness (CPI) ARI: 15% RRI: 25% All $p < 0.001$ Number of CPI ($\geq$2) ARI: 11%; RRI: 28 Specific CPI, ARRI, RRI, *p*-value Hypertension: 11%, 41%, < 0.001 Urinary incontinence: 8%, 102%, < 0.001 Obesity: 7%, 36%, 0.01 Spinal and back pain: 7%, 19%, 0.003 Neck spine: 6%, 23%, 0.005 Allergies: 5%, 27%, 0.004 Asthma: 4%, 129%, < 0.001 Diabetes: 4%, 48%, 0.007 COPD: 3%, 43%, 0.04 Kidney problems: 2%, 33%, 0.1 Cirrhosis of the liver: 1%, 78%, 0.17 Myocardial infection: 0%, −16%, 0.51 Arthrosis: −1%, −12%, 0.38 Stroke or its chronic consequences: −1%, −28%, 0.18 Coronary heart disease or angina pectoris: −3%, −50%, 0.001

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TABLE 2 (Continued)

References	Main outcome	Statistical method	Results
Peltzer (2018)	Prevalence of non-communicable disease multimorbidity, its pattern and impact on adverse health outcomes among patients with tuberculosis in public primary care	Multinomial logistic regression, odds ratio	Unadjusted model Multimorbidity and psychological distress 1 NCDs: OR = 1.02 (95% CI: 0.87 to 1.19), non-significant 2 NCDs: OR = 1.29 (95% CI: 1.06 to 1.55); $p < 0.01$ 3 or more NCDs: OR = 1.51 (95% CI:1.16 to 1.98); $p < 0.01$ Multimorbidity and Post-Traumatic Stress Disorder 1 NCDs: OR = 1.26 (95% CI: 1.07 to 1.48); $p < 0.01$ 2 NCDs: OR = 1.58 (95% CI: 1.30 to 1.92); $p < 0.01$ 3 or more NCDs: OR = 1.40 (95% CI: 1.05 to 1.86); $p < 0.05$ Adjusted model Multimorbidity and psychological distress 1 NCDs: OR = 0.95 (0.80 to 1.13) 2 NCDs: OR = 1.22 (0.99 to 1.50) 3 or more NCDs: OR = 1.34 (0.99 to 1.79) All non-significant Multimorbidity and Post-Traumatic Stress Disorder 1 NCDs: OR = 1.42 (1.18 to 1.69) 2 NCDs: OR = 1.79 (1.44 to 2.22) 3 or more NCDs: OR = 1.77 (1.30 to 2.41) All $p < 0.001$
MacLean et al. (2018)	Association between Alcohol Use disorder and Tobacco Use Disorder with hepatic disease	Multivariate multinomial logistic regression, odds ratio	Unadjusted model AUD+TUD vs. TUD Hepatic disease: 2.18 (2.13 to 2.2) Diabetes mellitus: 0.81 (0.80 to 0.83) Renal disease: 0.71 (0.68 to 0.74) All $p < 0.0001$ AUD+TUD vs. AUD Hepatic disease: 1.14 (1.11 to 1.17) Diabetes mellitus: 0.60 (0.59 to 0.61) Renal disease: 0.76 (0.73 to 0.79) All $p < 0.0001$

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TABLE 2 (Continued)

References	Main outcome	Statistical method	Results
Violan et al. (2018)	Multimorbidity patterns using a non-hierarchical cluster analysis	K-means cluster analysis	Cluster 1 (40% pop): centrality 0.8; median number of diagnoses 3; Patterns of multimorbidity similar for males and female: Metabolic disorders, Hypertensive diseases, Mental and behavioral disorders due to psychoactive substance use, other dorsopathies and Other soft tissue disorders.
Farooq et al. (2019)	Prevalence of and association between anxiety and depressive symptoms with multimorbidity	Univariate and multivariate binary logistic regressions and crude and adjusted odds ratio	Unadjusted model Presence of multimorbidity associated with anxiety and depressive symptoms COR (95% CI): 1.39 (1.18 to 1.64) Anxiety and depressive symptoms with number of chronic diseases. COR (95% CI) 1 chronic diseases: 0.95 (0.74 to 1.21) 2 chronic diseases: 1.05 (0.81 to 1.34) 3 chronic diseases: 1.30 (0.99 to 1.71) 4 chronic diseases: 2.24 (1.58 to 3.17) 5+ chronic diseases: 3.06 (1.99 to 4.7) Adjusted model Presence of multimorbidity associated with anxiety and depressive symptoms AOR (95% CI): 1.33 (1.11 to 1.58) Anxiety and depressive symptoms with number of chronic diseases AOR for all variables with p-value <0.250 in univariate analysis. AOR (95% CI) 1 chronic diseases: 0.98 (0.69 to 1.14) 2 chronic diseases: 0.98 (0.76 to 1.27) 3 chronic diseases: 1.20 (0.90 to 1.59) 4 chronic diseases: 1.92 (1.33 to 2.78) 5+ chronic diseases: 2.62 (1.66 to 4.13)

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TABLE 2 (Continued)

References	Main outcome	Statistical method	Results
Han et al. (2019)	Correlates of past-year substance use among adults with chronic conditions	Bivariable and multivariable logistic regression, odds ratio	Unadjusted model Correlates of past-year substance use (reference 2 conditions) OR (95%CI), *p*-value 3–4 conditions: 0.97 (0.82, 1.15), 0.70 > 5 conditions: 0.57 (0.36, 0.91), 0.02 Adjusted model OR (95%CI), *p*-value 3–4 conditions: 1.16 (0.97, 1.39), 0.11 > 5 conditions: 0.67 (0.39, 1.15), 0.15
Crawford and Thornton (2019)	Presence of multiple comorbid conditions after an HIV diagnosis	Modified Poisson regression Crude and adjusted incidence rate ratios	Unadjusted model Alcohol use among HIV patients Former vs. Never IRR (95% CI): 2.17 (1.45 to 3.24) Current vs. Never IRR (95% CI): 1.95 (1.56 to 2.43) Drug use (yes vs. no) IRR (95% CI): 1.22 (1.01 to 1.47) Adjusted model Alcohol use: Former vs. Never aIRR (95% CI): 1.49 (0.99 to 2.24) Current vs. Never aIRR (95% CI): 1.70 (1.35 to 2.14), $p < 0.05$ Drug use (yes vs. no) aIRR (95% CI): 1.11 (0.90 to 1.38)
Romain et al. (2019)	Association between physical multimorbidity and the severity of obesity with mental health and with mental disorders	Logistic regressions, odds ratio	Adjusted model when obesity classes and physical multimorbidity were considered, the latter was preferentially associated with Poor perceived mental health: OR = 3.58 (95% CI 2.07 to 6.22) Psychological distress: OR = 3.71 (95% CI 2.14 to 6.42) Major depressive episode: OR = 5.16 (95% CI 2.92 to 9.13) Mood disorders: OR = 2.31 (95% CI 1.41 to 3.78) Anxiety disorders OR = 2.46 (95% CI 1.46 to 4.16)

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TABLE 2 (Continued)

References	Main outcome	Statistical method	Results
Petersen et al. (2019)	Association between depression and Alcohol Use Disorder (AUD) in chronic care patients	Logistic regression, odds ratio	Unadjusted model Association between HIV and depression OR = 2.08 (95% CI: 1.53 to 2.83) Association between HIV and AUD OR = 2.19 (95% CI: 1.38 to 3.48) Association between hypertension, diabetes and depression OR = 0.45 (95% CI: 0.23 to 0.89)
Wang et al. (2019)	Patterns of physical-Mental Multimorbidity	Intraclass correlation coefficient	Pattern matrix of 12-month multimorbidity of psychiatric disorders and general medical conditions Women **Factor 1 Irritable mood and headache** Premenstrual dysphoria 0.66 Mood disorder 0.64 Anxiety disorder 0.61 Impulse-control disorder 0.47 Headache/migraine 0.43 **Factor 2 Chronic diseases and chronic pain** Hypertension −0.72 Cardiovascular disease −0.60 Diabetes mellitus −0.59 Arthritis −0.54 Musculoskeletal pain −0.37 **Factor 3 Substance use disorders** Heavy drinking 0.76 Substance use disorder 0.69 Men **Factor 2 Psychiatric disorders** Mood disorder 0.57 Anxiety disorder 0.47 Impulse-control disorder 0.66 Heavy drinking 0.39 Substance use disorder 0.61

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TABLE 2 (Continued)

References	Main outcome	Statistical method	Results
			Factor 3 Chronic diseases
			Hypertension 0.69
			Cardiovascular disease 0.55
			Diabetes mellitus 0.68
Aubert et al. (2019)	Identify and quantify the most prevalent combinations of chronic co-morbidities in multimorbid patients hospitalized in internal medicine wards	Latent class analysis	Probability of patient in Group 5—psychiatric (23%) to have the multimorbidity: Cerebrovascular diseases: 1%
			Paralysis: 2%
			Chronic heart disease: 19% Other nervous system disorders: 12%
			Epilepsy, convulsions: 7%
			Chronic kidney disease: <1%
			Solid malignancy: 9%
			Hematological malignancy: <1%
			Diseases of white blood cells: <1%
			Nephritis, nephrosis and renal sclerosis: <1%
			Peripheral and visceral atherosclerosis: 3%
			Arthropathy and arthritis: 12%
			COPD and bronchiectasis: 15%
			Pulmonary heart disease: 4%
			Substance-related disorders: 30%
			Mood disorders: 19%
			Anxiety disorders: 10%
Wong et al. (2020)	Association between independent variables (sociodemographic data and number of chronic conditions) and dependent outcome	Univariable analysis, multiple linear regression, generalized estimating equation, odds ratio	Adjustment of pre-COVID-19 scores Multiple regression Generalized Anxiety Disorder and chronic conditions
			>4 chronic conditions: $\hat{I}^2 = 0.33$ (95% CI: 0.32 to 0.98); not significant
Rodrigues et al. (2021)	Risk of multimorbidity among people with and without psychotic disorder	Meta-analysis, risk ratio	RR = 1.69; 95% CI: 1.37 to 2.08;
			I-squared = 99.7%

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psychiatric and neurological disorders, along with chronic heart disease, COPD and bronchiectasis, and arthropathy and arthritis, corresponding to 23% of patients.

Wang et al. (2019) reported patterns of multimorbidity using principal component analysis (PCA) as a clustering method. They used data from a local survey in a large city of Brazil, including 2,713 subjects. The clusters of chronic conditions were distinct among women and men. Among women, the first component was labeled "irritable mood and headache" and encompassed premenstrual dysphoric, mood, anxiety, impulse-control disorders, and headache/migraine. The second component was "chronic diseases and pain" and included hypertension, cardiovascular illnesses, arthritis, diabetes, and musculoskeletal pain. The third component, "substance use," included heavy drinking and substance use disorders (SUD). For men, the first component was labeled "chronic pain and respiratory disease," and included headache/migraine, musculoskeletal pain, arthritis, respiratory, and digestive illnesses. The second component was named "psychiatric disorders" and included impulse-control, mood, anxiety disorders, SUD, and heavy drinking. Finally, the third component described a dimension of "chronic diseases" that contained hypertension, cardiovascular illnesses, and diabetes. Of note is their finding that age was not significantly related to the "irritable mood and headache cluster" in women and to the "chronic pain and respiratory disease" cluster in men, whereas age was significantly associated to all other clusters. Furthermore, they report area level (complementing the individual level findings just described) effect sizes and significance for some variables, notably the area violence was significantly associated with the "chronic diseases" cluster in women and with the "chronic pain" cluster in men.

Violan et al. (2018) also defined patterns of multimorbidity by sex using Multiple Correspondence Analysis (MCA) and K-means clustering. In the first cluster, in women had an exclusivity value (fraction of patients with the disease included in the cluster over the total strata of patients with the disease) of 46.1% and included mental and behavioral disorders due to psychoactive substance use (tobacco); in men, the first cluster had an exclusivity value of 35.3% and included metabolic disorders. It also found that the main cluster, for men and women, included the following chronic diseases: metabolic disorders, hypertensive diseases, mental and behavioral disorders due to psychoactive substance use, other dorsopathies and other soft tissue disorders.

Lenzi et al. (2016) using exploratory factor analysis identified 5 patterns of multimorbidity: (1) psychiatric disorders, (2) cardiovascular, renal, pulmonary and cerebrovascular diseases, (3) neurological diseases, (4) liver diseases, AIDS/HIV and substance abuse and (5) tumors. As for the association between factor scores and demographic characteristics, we found that the only correlation coefficient close to 0.30 was that between multimorbidity pattern 2 and age (Spearman's $\rho = 0.27$, $p < 0.001$), indicating that the presence of cardiovascular, renal, pulmonary and/or cerebrovascular diseases was more common among older than younger age groups (Spearman's $\rho = 0.27$, $p < 0.001$), indicating that the presence of cardiovascular, renal, pulmonary and/or cerebrovascular diseases was more common among older than younger age groups.

Filipčić et al. (2018) report results from self-reports of presence of chronic physical conditions. The authors performed a latent class analysis (LCA) to identify grouping patterns in their data and found that psychiatric patients had 27% higher age-standardized relative risk for chronic physical illness. The LCA identified four groups, labeled as follows: "Relatively healthy," "Musculoskeletal," "Hypertension and obesity," and "Complex multimorbidity." But the authors report no significant differences in multimorbidity patterns.

These findings will be discussed in more length below. However, it was remarkable how varied results were regarding the clusters recovered. For example, arthritis and other painful conditions have been reported to co-occur with depressive disorders (Miguel et al., 2012), but the algorithms used only grouped arthritis with mental disorders in one (Wang et al., 2019) of the studies. Similarly, only one study grouped mental disorders with metabolic syndrome (Violan et al., 2018), which is one association expected to be found widely due to mechanisms of metabolic alterations via psychiatric medication use. It is important to notice that the list of diseases that were actually included in any of the above papers differed between them, this further hinder comparisons between the clusters reported in these works.

Depression

Seven studies evaluated MM in patients with depression. The studies covered the risk of depression in patients with chronic diseases in general (Li et al., 2015; Holvast et al., 2017); the association between depression and HIV, hypertension and diabetes (Petersen et al., 2019) or obesity (Romain et al., 2019) the risk of depression according to the number of chronic diseases (Arokiasamy et al., 2015) the risk of multimorbidity according to the severity of depression (Stubbs et al., 2017) and the risk of depression in patients with and without multimorbidity (Read et al., 2017).

A systematic review and meta-analysis found that individuals with multimorbidity had more than twice the risk (RR 2.13 95% CI: 1.62 to 2.80; $p < 0.001$) of having a depressive disorder compared to individuals without multimorbidity (Read et al., 2017). In our review, we found two studies investigating the association between depressive symptoms and chronic diseases among people 60 years or older. In China, a cross-sectional study showed significant association (OR = 1.379 [95% CI: 1.291 to 1.473]) (Li et al., 2014) and in the Netherlands, they found a significant association in a primary care sample (OR = 1.55 [95% CI: 1.33 to 1.81]) (Holvast et al., 2017).

We also found one study investigating the association of depression with a chronic infectious disease. In South Africa, HIV was associated with depression (OR = 2.08 [95% CI: 1.53 to 2.83]) while patients with hypertension and diabetes were less likely to have depression (OR = 0.45 [95% CI: 0.23 to 0.89]) (Petersen et al., 2019). In Canada, individuals with physical multimorbidity had higher odds of major depressive episode (OR = 5.16 [95% CI 2.92 to 9.13]) (Romain et al., 2019). Arokiasamy et al. (2015) performed a multi-country study in the adult population (most aged 50 years or older) showing that the odds of depression increased significantly according to the number of chronic diseases (adjusted OR increased from 1.62 [95% CI: 1.42 to 1.84] for one disease to 7.33 [95% CI: 6.24 to 8.61] for four or more diseases) (Arokiasamy et al., 2015). Another multi-country study found that the severity of depression influenced the odds of multimorbidity. Compared with patients with no depression, the odds of multimorbidity was 2.62 times higher (95% CI: 2.17 to 3.15; $p < 0.0001$) for patients with subsyndromal depression and 3.44 times higher (95% CI: 3.12 to 3.79; $p < 0.0001$) for patients with depressive episode (Stubbs et al., 2017).

Anxiety

Four studies addressed anxiety and multimorbidity with three of them evaluating the risk of anxiety according to the number of chronic diseases (Vancampfort et al., 2017; Romain et al., 2019; Wong et al., 2020). A fourth study assessed the risk of anxiety in individuals with obesity. In the USA, anxiety was associated with an increased number of medical diseases in adults aged 65 or older (two medical conditions, adjusted OR = 1.79 [95% CI: 1.02 to 3.12]; three or more medical diseases, adjusted OR = 3.04 [95% CI: 1.77 to 5.21]; all $p < 0.001$) (Gould et al., 2016). Vancampfort et al. (2017) performed a multi-country cross-sectional study with findings indicating that individuals with five or more physical diseases had higher odds of anxiety (adjusted OR 9.66 [95% CI: 6.88 to 13.57]; $p < 0.001$) compared to those with one physical condition (adjusted OR 2.08 [95% CI: 1.90 to 2.27]; $p < 0.001$) (Vancampfort et al., 2017). In China, a study conducted during COVID-19 outbreak found no significant association between generalized anxiety disorder and having more than four chronic diseases (reference group: 2 to 4 chronic conditions) (Wong et al., 2020). In Canada, individuals with obesity and physical multimorbidity were more likely to report anxiety disorders (OR = 2.46 [95% CI 1.46 to 4.16]) (Romain et al., 2019).

Anxiety and/or depression

Two studies looked at the association of anxiety and/or depression with multimorbidity. In Pakistan (Farooq et al., 2019), found that the presence of multimorbidity (hypertension, obesity, dyslipidaemia, diabetes, heart diseases, stroke, migraines, asthma and chronic obstructive pulmonary disease [COPD], anemia, thyroid disease, diseases of bones and joints, dyspepsia/peptic ulcer, hepatitis B or C, chronic kidney diseases including stones, cancer, and/or disability increased 33% the odds of having anxiety and depressive symptoms (adjusted OR 1.33 [95% CI: 1.11 to 1.58]). Additionally, adults with more than five chronic diseases had increased odds of these symptoms (adjusted OR 2.62 [95% CI: 1.66 to 4.13]) when compared with those with one chronic disease (adjusted OR 0.98 [95% CI: 0.69 to 1.14]) (Farooq et al., 2019). In the USA, DiNapoli et al. (2017) evaluated predictors of having depressive and/or anxiety disorder among middle-aged and older veterans. The study also found significant increased odds of depressive and/or anxiety disorder according to the number of chronic diseases (3–5 chronic diseases: OR = 1.70 [95%CI: 1.21 to 2.40]; 10–13 chronic diseases: OR = 6.62 [95%CI: 4.73 to 9.25]) (DiNapoli et al., 2017).

Psychosis

Four studies addressed the association between psychosis and multimorbidity. In the Basque Country (Spain), Gabilondo et al. (2017) analyzed a data set of 2,255,406 individuals covered by public health insurance. Of these, 7,331 (0.3%) had a diagnosis of schizophrenia. Compared with individuals without diagnosis of schizophrenia, individuals with schizophrenia had 1.64 odds (95% CI: 1.56 to 1.73; $p < 0.001$) of having one chronic physical illness. Similar odds were found for two (OR 1.63 [95% CI: 1.53 to 1.75], $p < 0.001$; three or more (OR 1.12 [95% CI: 1.05 to 1.19], $p < 0.001$). In addition, the authors found that patients with schizophrenia were more likely to have a diagnosis of hepatitis, HIV, diabetes and any pulmonary disease (Gabilondo et al., 2017). In Bahrain, a case control study compared patients with schizophrenia with those with no serious mental illness. Compared with controls, cases were significantly more likely to have physical comorbidities, but the odds ratio did not vary according to the number of diseases (one disease OR 3.7 [95%CI: 2.0 to 6.9]; two diseases OR 3.3 [95% CI: 1.8 to 6.0]; three or more diseases OR 3.2 [95%CI: 1.4 to 7.7]). In addition, cases were more likely to have obesity, type 2 diabetes, hypertension, cardiovascular disease and musculoskeletal disorders (Jahrami et al., 2017). In a multi-country study, Stubbs et al. (2016) evaluated the risk of multimorbidity according to the severity of psychosis. The findings indicated that patients with a diagnosis of psychosis had higher odds of multimorbidity (4.05 [95% CI: 3.25 to 5.04], $p < 0.001$) compared to those with subclinical psychosis (OR 2.20 [95% CI: 2.02 to 2.39], $p < 0.001$) (Stubbs et al., 2016). In a systematic review and meta-analysis, Rodrigues 2021 found that individuals with psychotic disorder had 1.69 increased risk (RR 1.69 [95% CI: 1.37 to 2.08]) to have

multimorbidity, compared with individuals without psychotic disorder (Rodrigues et al., 2021).

Post-traumatic stress disorder (PTSD)

Two studies assessed the association between PTSD and multimorbidity (Jacob et al., 2018; Peltzer, 2018). In a study conducted in the UK, Jacob et al. (2018) found that PTSD had adjusted odds of 2.47 (95% CI: 1.71 to 3.56, $p < 0.001$) to be associated with physical multimorbidity (cancer, diabetes, epilepsy, migraine, cataracts/eyesight problems, ear/hearing problems, stroke, heart attack/angina, high blood pressure, bronchitis/emphysema, asthma, allergies, stomach ulcer or other digestive problems, liver problems, bowel/colon problems, bladder problems/incontinence, arthritis, bone/back/joint/muscle problems, infectious disease, and skin problems). The number of PTSD symptoms was also associated with increasing odds of multimorbidity (OR 1.14 [95%CI = 1.09–1.20], $p < 0.001$). The authors found that anxiety, depression, and eating disorders were mediators in the association between PTSD and physical multimorbidity (Jacob et al., 2018). In South Africa, a study among patients with tuberculosis found that PTSD was significantly associated with multimorbidity. The association did not change substantially according to the number of non-communicable diseases (one non-communicable disease, adjusted OR 1.42 [95% CI: 1.18 to 1.69]; two non-communicable diseases, adjusted OR 1.79 (1.44 to 2.22); three or more non-communicable diseases, adjusted OR 1.77 [95% CI: 1.30 to 2.41]) (Peltzer, 2018).

Substance use disorders

Four studies (MacLean et al., 2018; Crawford and Thornton, 2019; Han et al., 2019; Petersen et al., 2019) addressed the association between substance use disorders and multimorbidity. One study included alcohol use disorder (AUD), one was on alcohol and tobacco use disorder (TUD), one on AUD and drug use disorder, and one on drug use disorder (e.g., cannabis, cocaine, methamphetamine, heroin, inhalants, hallucinogens, and prescription drug misuse).

In chronic care patients in South Africa, patients with HIV had twice the odds of having AUD (OR = 2.19 [95% CI: 1.38 to 3.48], $p < 0.001$) compared with those with no HIV (Petersen et al., 2019). MacLean 2018 et al. performed a comparative cohort study of veterans who had received a diagnostic of AUD or TUD in 2012 in the USA. Compared to patient with AUD only, veterans with concurrent conditions had significantly higher odds of hepatic disease (OR 1.14 [95% CI: 1.11 to 1.17]), diabetes mellitus (OR 0.60 [95% CI: 0.59 to 0.61]) and renal disease (OR 0.76 [95% CI: 0.73 to 0.79]). Compared to veterans with TUD only, those with AUD and TUD had significantly higher odds of hepatic disease (OR 2.18 [95% CI: 2.13 to 2.2]), diabetes mellitus (OR 0.81 [95% CI: 0.80 to 0.83]) and renal disease (OR 0.71 [95% CI: 0.68 to 0.74]) (MacLean et al., 2018). In the USA, Han et al. (2019) analyzed the data of a national survey on drug use. Past-year substance use was reported by 16% of adults with one chronic disease and by 13% of adults with two or more chronic diseases. The correlates of past-year substance use among adults with chronic conditions showed an adjusted odds ratio of 1.16 (95% CI: 0.97, 1.39, $p = 0.11$) among adults with 3–4 chronic diseases and 0.67 (95% CI: 0.39, 1.15, $p = 0.15$) among adults with more than five conditions. Results showed lower substance use in individuals with multimorbidity (Han et al., 2019). Another study in the USA among individuals living with HIV found that current alcohol users had a significantly increased risk of multimorbidity compared to never drinkers (adjusted IRR: 1.70 [95% CI: 1.35 to 2.14], $p < 0.05$). The model was adjusted for age, drug use, smoking status, insurance status, HIV duration, cd4 + cell counts, and log viral load. The unadjusted model showed that drug use was also associated with multimorbidity (IRR: 1.22 [95% CI: 1.01 to 1.47], $p < 0.05$) (Crawford and Thornton, 2019).

Quality assessment

We assessed the quality of three cohorts studies and one case control study. One cohort study obtained fair quality and the remainder were evaluated as poor quality. All cohort studies limited the study population to a selected group of users. The common bias of poor-quality studies were no statement on the comparability of cohorts and adequacy of follow-up. The case-control study was classified as fair quality.

Regarding the cross-sectional studies (20), exposure was assessed through structured interview (55%) or secure record (30%). Outcome was assessed through self-report (65%) or record linkage (35%). The main limitations listed by the authors were cross-sectional study design, self-report data, number, severity and duration of comorbidities included, and other risk factors not included. Details can be found in Table 1.

Discussion

This systematic review included 26 articles that were published since 2015, the year major publications on the definition of multimorbidity first appeared. Our aim was to frame the relationship between mental disorders and chronic diseases within the multimorbidity framework, in other words, a non-hierarchical framework with multidirectional associations. Such complex structure is harder to fully detect in research and what we found is that we are in a transitional phase

where studies are still being designed in a one-to-one type of associative inference, and the studies that ultimately evaluated patterns/groups/clusters reported so distinct groupings that resulted in a very heterogeneous research landscape.

The definition of multimorbidity is still not agreed among researchers. Most studies use a definition based on the number of disorders (2 or more) but some studies use different values (4 or 5 disorders). Even when authors use the same number, there is a problem concerning what diseases are studied. Most studies use a list of conditions, which varies in length and content. Some studies only include chronic conditions, others include acute disorders. The severity of the condition is also not always included. It should be noted, however, that the heterogeneity in our findings can be explained by the broad variety of study types included.

From the small number of studies including mental disorders, the majority (42%) focused on only one disorder (depression). Half the studies only included older individuals (above 50 years), leaving out the young subjects, which are of concern due to high incidence of mental disorders (Ralph et al., 2013). This is surprising given this is a known and important issue acknowledged by the Academy of Medical Sciences in *2015* and the Lancet Psychiatry Commission Blueprint in 2019 (Firth et al., 2019).

The results of this review suggest a strong relationship between depression and multimorbidity. Individuals with multimorbidity had higher odds of having depression or depressive symptoms, with OR ranging between 1.379 (Li et al., 2014) and 1.62 (Arokiasamy et al., 2015). Also, in a systematic review and meta-analysis on multimorbidity and depression, Read et al. (2017) found a risk two times higher of depressive episode in multimorbid patients. The inverse relation was also found, with a multi-country study finding that having depression (subsyndromal or episodic) influenced the odds of having multimorbidity (Stubbs et al., 2017). Although most of these studies were concentrated in samples of older (more than 60 years of age) individuals, they included samples from diverse countries with different income ranges and ethnic groups (Table 1). There is a disproportion of studies concentrated in depression compared to other mental health conditions. Although depression is a highly prevalent disorder (Smith, 2014), there is high comorbidity with other mental health disorders with probable consequences on prevalence of chronic conditions (Steel et al., 2014).

Studies in anxiety disorders found inconsistent results. Whereas, two studies found association between number of chronic conditions and anxiety, with OR that ranged between 1.79 (Gould et al., 2016) and 9.66 (Vancampfort et al., 2017) for more than 5 chronic diseases, another study from China, during the COVID pandemic, found no significant relation between generalized anxiety disorder and more than four chronic diseases (Wong et al., 2020). Two studies focused on anxiety and depression, and both found higher odds of anxiety and depressive symptoms with more chronic diseases (33% in Pakistan and OR of 1.7 in the USA for 3 to 5 chronic conditions) (DiNapoli et al., 2017; Farooq et al., 2019). These studies included younger adults and older individuals.

Individuals with schizophrenia have higher odds of presenting a chronic disease (Gabilondo et al., 2017; Jahrami et al., 2017). Having psychosis increased the chances of having multimorbidity compared to subclinical psychosis (Stubbs et al., 2016). Rodrigues et al. (2021) meta-analysis found a 1.69 risk of multimorbidity among people with psychosis. Studies accounted for different groups of chronic conditions, but diabetes was present in two of them (Gabilondo et al., 2017; Jahrami et al., 2017). These findings are aligned with the large literature showing higher mortality in those with schizophrenia (Walker et al., 2015; Ko et al., 2018; Richmond-Rakerd et al., 2021), which was also observed during the COVID pandemic (Karaoulanis and Christodoulou, 2021).

Both studies with PTSD showed high OR for multimorbidity (Jacob et al., 2018; Peltzer, 2018). The number of PTSD symptoms was related to higher odds of having multimorbidity (Jacob et al., 2018). PTSD was the mental disorder that had fewer studies in this review, its lifetime prevalence in upper-middle income and lower-middle income countries is 2.3 and 2.1 percent, respectively, according to the WHO (Koenen et al., 2017). A previous study reported 17% frequency of comorbidity between PTSD and other coexisting psychiatric disorders, with worse occupational problems, disability and poorer social support among these patients (Solomon and Davidson, 1996). For this reason, the small number of studies evaluating this condition was striking.

Substance use was the subject of four studies. Patients living with HIV had two times the odds of alcohol use disorder (Peterson et al., 2020). In the USA, a study comparing patients with alcohol use disorder and tobacco use disorder showed that the use of both was related with higher odds of having diabetes, renal disease and hepatic disease (MacLean et al., 2018). Koenen et al. (2017) reported that 13% of adults with 2 or more chronic diseases had reported substance use in the last year (Han et al., 2019). Their study found lower rates of substance use among individuals with multimorbidity. This might happen because chronic diseases are more common among older people who are less likely to use substances, and because these individuals stop using substances when they realize they are sick. People in the US living with HIV and current use of alcohol had higher risk of multimorbidity compared to non-drinkers (Crawford and Thornton, 2019). There are not enough studies about the association of substance use and MM. This is particularly important in MM in younger individuals. There is evidence that middle age (40–59) adults with multimorbidity are 1.71 times more likely to be current smokers than non-smokers (Taylor et al., 2010). Tobacco use is related to increased risk for depression, suggesting possible synergistic relation.

This paper should be interpreted in context with its limitations. Comparisons between studies might be hindered due to differences (1) in statistical methods used, (2) in monitored conditions included in each paper, (3) in measuring the conditions, (4) in study type, and (5) due to the broad target population used in the review. Heterogeneity can be in part due to these reasons. This review, as all systematic reviews, only accessed articles published within a specific time frame defined by the authors. Our work is the first to focus on a stricter definition of MM. Previous reviews included primary studies that used MM as a synonym to co-morbidity. Those studies were designed with a notion of hierarchy between disorders that is not compatible with the current MM definition (MacMahon, 2018).

Medicine is organized in specialities that often do not interact seamlessly. Multimorbidity will present a challenge to health service organizations, as it will require better integration of primary care. Furthermore, it will also require changes in how studies are performed. The present review revealed that one approach researchers are taking is to use clustering methodologies. These methods are identifying clinically significant groups, and the non-supervised clustering methods among these have the advantage of becoming starting points to medical automation tools, because of their predictive nature. These algorithms are largely dependent on what conditions are included in the analysis, therefore some kind of standardization will be required in the future, so we can achieve more comparable results. Because of this, we think this field would benefit from the creation of an instrumental scale of diseases/disorders that accounts for number, severity, and weights for clusters that offer higher risk of morbidity/death in multimorbid individuals.

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

Material preparation, data collection, and analysis were performed by LC-d-A, FC, NTSF, and ER. The first draft of the manuscript was written by JA, LC-d-A, FC, NTSF, ER, and DM. Contributed reviewing and editing the final version by GL, SD, and MB. All authors contributed to the study conception and design, commented on previous versions of the manuscript, read, and approved the final manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2022.940978/full#supplementary-material

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Psychotherapy for late-life psychopathology – Updates to promote aging in place

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Psychopathology in late life does not always meet the criterion for a psychiatric diagnosis. Nevertheless, it affects the aging person, their family, employers, and society as a whole. Making psychotherapy accessible for older adults, allowing aging in place, must overcome barriers of mobility, stigma, and emotional difficulty to ask for help. Hence, dedicated counseling and treatment centers should be established in the local authorities for the older adults and their caregivers. Such a local center is described, providing low-cost psychotherapy within an academic environment, accompanied by research to promote suitable therapy of older adults, as well as training programs for professional therapists, not just psychologists, with unique emphasis on late-life psychopathology. This model should be implemented, the more the merrier.

KEYWORDS

psychotherapy, aging in place, community, centers, late-life

Introduction

Psychopathology in late life may sometimes look different. The criterion for clinical depression is often not met, but sub-clinical depression occurs more frequently than in the rest of the population (Murri et al., 2022), also related to higher risk of death (Lyness, 2008). Research on late-life depression had shown that psychotherapy is highly efficient in assisting older patients (Tegeler et al., 2020). Psychotherapy was found to have similar effects as pharmacotherapies and with less side effects (Blackburn et al., 2017). Psychological well-being in old age is important both for the aging person and for his/her family that accompanies and suffers psychological distress by itself (Lyness et al., 2009). Furthermore, higher life quality in old age promotes aging in place (Carver et al., 2018) and is important for the welfare and economy of the society. Family members who share the emotional, physical, and even technical process of an aging loved-one, often suffer from psychological distress themselves, in addition to work-day loss for medical visits. This, in addition to health costs for the aging person, also influences the national economy (see Dieleman et al., 2017 for example).

The current healthcare system is not aimed or designed for cost-effectively providing the needs of older individuals living in the community. "Aging in place" is defined as "the ability to live in one's own home and community safely, independently, and comfortably, regardless of age, income, or ability level" (American Planning Association and the National Association of County and City Health Officials, 2009). That is, aging in place is the accessibility of the necessary resources for older adults to remain in their own environment, maintaining their independence, autonomy, and social network (Wiles et al., 2012).

Most adults age in the community and in fact, there is a very large population that can benefit from psychotherapy at late life, but does not seek treatment, due to a number of barriers:

- Difficulty in mobility, which must be addressed by geographical accessibility of services within the community and not just in hospitals and regional clinics.
- Emotional difficulty in contacting psychiatric departments and clinics associated with mental health.
- Mental difficulty involving misconception and dated perception for psychological treatments and psychotherapy, having negative stereotypes due to cohort and cultural beliefs.

These barriers becoming more and more acknowledgeable (Tegeler et al., 2020). Currently, the common pathways to receive psychotherapy are either by registration in the personal medical file and attending mental health and psychiatry clinics, or by seeking private treatment at a very high cost per session.

Vision

Accomplishing aging in place requires substantial innovation in the incorporation of advanced technologies, behavioral science, community design, and policy (Kim et al., 2017). Importantly, home health services were indicated as significantly delaying nursing home admission (Chen and Berkowitz, 2012; Young et al., 2015). Hence, dedicated counseling and treatment centers should be established in the local authorities for the older adults and their caregivers. They may not all meet the DSM criterion for a psychiatric diagnosis, but they need a helping hand through the process of their aging.

Such centers should include unique expertise that requires dedicated training. Academic centers where this type of academic training, such as master's degree programs in clinical psychology of adulthood and aging, should establish a counseling, treatment and research center right on campus. This appealing location may reduce objections and stereotypes and promote referral. The academic setting allows overcoming stigma that creates barriers. That is, when attending a facility within the academy that offers diverse activities (treatment among them), the barrier of entering a mental health hospital or psychiatric clinic is diminished. Such a progress will also contribute to creating a connection between the community and academia, as follows:

1. Providing low-cost professional and accurate psychotherapy for older adults, increasing mental well-being in old age, dealing with life transitions such as retirement, widowhood, decreased health, loss, etc.
2. Providing guidance and support to family members who act as caregivers or accompany the aging process of a parent or spouse.
3. Training professionals and therapists for dedicated work with the old population, based on the extensive knowledge and expertise in the field of treatment for older adults and their family.
4. Conducting up-to-date ecological research on various types of therapy for older adults. Accompanying research should be part of the ongoing process of conducting therapy and management. For example, when providing cognitive behavioral therapy (CBT), relevant frameworks for scientific studies are available and should be implemented. This will contribute to assessing efficiency of treatment and creating more suitable protocols for the older population.

Another possibility is to cooperate with existing treatment services, allowing them to address the older population under the guidance and supervision of relevant professionals in the center, to increase the variety and accessibility of different therapy approaches to the older population.

A counseling and treatment center designed for aging families and an aging population exists in too few nations around the world, and it is important to encourage its establishment as an accessible center in several geographical areas in each country. Such a center is currently being established at the Ruppin Academic Center in Emek Hefer, Israel. The center is located at the country-side Academic Campus, in a non-threatening environment. This center is an accessible and inviting place where older adults, family members and caregivers can come, to enjoy variety of services offered. That is, aside from the psychotherapy provided, the center offers academic courses and participation in academic conferences and activities, as part of being a member and receiving services. Interestingly, groups of older adults, friends, and former colleagues are requesting group attendance to learn various therapeutic techniques, as mindfulness for example.

Conclusion

Improving the psychological well-being of older adults cannot be put just in the hands of the well-known one-on-one psychotherapy. That is, clinical psychologists should not be the only ones to offer treatment. Working with the multi-generational family requires various professionals to assist in various domains. Social workers, art therapists, nurses, and caregivers should also be part of the treatment team and receive proper training. Moreover, a wider system needs to be involved. This refers to policy makers, national welfare bodies, and region councils, that should invest in making these services accessible, to promote aging in place. This is a world-wide national mission, that requires psycho-education for young, old, caregivers and patients, as well as for authority and policy makers. This is an interdisciplinary effort to make psychotherapy accessible to the pocket and the mind.

Data availability statement

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

Author contributions

DA-S wrote the text, representing her work as the head department of clinical psychology of adulthood and aging, and leading the foundation of the treatment and counseling center for older adults and their family members in Israel.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Intent disclosure in late-life suicide: Age group differences in correlates and associations with suicide means

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Age-adjusted suicide rates declined from 2018 to 2020. However, suicide rates among older adults, particularly males 75 and older, have continued to rise, and the evidence base for effective interventions to prevent suicide in late life remains limited. One strategy to prevent older adults' suicidal behavior is to intervene when they reveal suicide intent. Previous research found that a significant proportion of older suicide decedents disclosed their suicide intent close to the fatal incident. In this study, based on the 2017–2019 United States National Violent Death Reporting System (NVDRS) data, we examined: (1) correlates of intent disclosure among three age groups (65–74, 75–84, and 85+) of older suicide decedents (*N* =17,917; 14,856 men and 3,061 women); and (2) associations of suicide means with intent disclosure and suicide contributing factors. The results show that 19.9% of all suicide decedents aged 65+ (18.7%, 21.0%, and 22.0% in the 65–74, 75–84, and 85+ age groups, respectively) disclosed their suicide intent to their partner, family/friends, and healthcare providers within a month of their death. Multivariable analyses using generalized linear models for a Poisson distribution with a log link showed that physical and mental health, substance misuse, addiction problems, and relationship/other life stressors were associated with a higher likelihood of intent disclosure in the 65–74 and 75–84 age groups. However, only physical health problems were associated with a higher likelihood of intent disclosure among those aged 85 and older. Intent disclosure was not associated with using firearms and poisoning as suicide means but with a lower likelihood of hanging or suffocation. Mental health and substance misuse problems were associated with higher odds of hanging or suffocation and poisoning, and physical health problems and male sex in the 85+ age group were associated with higher odds of firearm use. Suicide prevention strategies for those who have disclosed their suicide intent or are at risk of suicidal behavior should include more patient-centered comfort and palliative care, mental health/substance misuse/addiction treatment, and restriction of access to potential suicide means. More research on older adults who disclose suicide intent and late-life suicide prevention strategies is needed.

KEYWORDS

late-life suicide, suicide means, suicide prevention, intent disclosure, physical and mental health, relationship/other life stressors

Introduction

Recent suicide mortality data from the United States Centers for Disease Control and Prevention (CDC) shows that after increasing from 2000 through 2018, age-adjusted suicide rates declined from 2018 (14.2 per 100,000) to 2020 (13.5 per 100,000; Garnett et al., 2022). Despite the overall decreasing trend, rates among men 75 years and older continued to increase and have been the highest of all age groups (e.g., 40.1 per 100,000 in 2020) over the past two decades (Garnett et al., 2022). High late-life suicide rates are attributed to a greater intent to die, greater premeditation, use of more deadly means and giving fewer warnings to others of their suicidal intentions among older adults compared to younger age groups (Conwell et al., 1998; Conner et al., 2019).

Systematic reviews identify risk factors for completed late-life suicide to include male sex, violent methods of self-harm (e.g., firearms, hanging/suffocation), any psychiatric disorders (e.g., depression, anxiety, and bipolar disorders), physical health problems (e.g., cancer, chronic diseases, chronic pain), neurological disorders, functional disability, stressors/bereavement, living alone, and limited social connectedness (Fässberg et al., 2012, 2016; Beghi et al., 2021). Systematic and narrative reviews also identified psychiatric comorbidity (e.g., depression and anxiety, mental disorders with substance use problems), psychiatric and physical multimorbidity, cognitive impairment, neurocognitive disorders, reduced social support, and loneliness as contributors to suicidal ideation and behaviors in late life (Conejero et al., 2018; Xiong et al., 2020; Fernandez-Rodrigues et al., 2022). A recent study of Medicare fee-for-service beneficiaries 65 and older also found significantly increased suicide rates following a diagnosis of Alzheimer's and related dementia, especially among those age 65–74 years and during the first 90 days after diagnosis (Schmutte et al., 2022). Other studies showed that among depressed older adults, suicidal individuals performed significantly worse than non-suicidal individuals on the cognitive tests, and deficits in executive functioning and other cognitive domains predicted serious suicidal behavior, suggesting that in some cases, late-life suicidal behavior is possibly reflective of a dementia prodrome (Szanto et al., 2020; Gujral et al., 2021; Richard-Devantoy et al., 2021).

Given high rates of late-life suicide, early detection of suicidal ideation and provision of mental health treatment and other support for older adults who suffer from psychiatric, physical, and social health problems is essential for preventing late-life suicide. One way to reduce premature mortality from suicides is also to intervene and manage risks when individuals in distress disclose suicidal intent. Studies have shown that one reason for such disclosure, to mostly one's confidants and others in the informal social support network, is help-seeking (Fulginiti et al., 2016; Fulginiti and Frey, 2019). However, severe suicide attempters [i.e., those whose injuries necessitated intensive care unit (ICU) admission], compared to suicide ideators and mild suicide attempters (i.e., those who did not require ICU admission), tend to lack willingness to self-disclose (Apter et al., 2001).

A majority of older adults intending to die by suicide may deny suicidal ideation and do not disclose their intent, especially to healthcare providers (Smith et al., 2013; Husky et al., 2016), but some may still want to inform their informal support systems about their intension for various reasons. In-depth interviews with Dutch older adults deliberating on ways to end their lives at a self-chosen moment (i.e., rational suicide, self-chosen death) revealed their struggle with ambiguities and ambivalences between intending and actually performing self-directed death (or not; van Wijngaarden et al., 2016). Even after they made a putatively rational decision for suicide as a way to spare them further suffering from health problems, a majority had certain attachments to life, concerns about the emotions of family members, a dilemma associated with their spiritual beliefs, and worry and fear about the dying process (van Wijngaarden et al., 2016).

To our knowledge, little research has been done on the characteristics of older adults who disclosed their suicide intent. A study of suicide decedents 50 years and older in the 2005–2014 United States National Violent Death Reporting System (NVDRS) showed that nearly a quarter of them disclosed their suicidal intent, mostly to an intimate partner or other family members, within the last month of their life and that both depressed mood and physical health problems were associated with increased disclosure odds (Choi et al., 2017). The study also found that controlling for depressed mood, physical health problems, and other stressors that contributed to suicide, individuals age 80 and older had higher odds of intent disclosure than those age 50–59. With unabated rates of suicide among those age 75 and older, more research is needed to examine potential age group differences in intent disclosure rates and correlates of intent disclosure among older adults who died by suicide.

In this study based on the 2017–2019 NVDRS, we first examined mental health, substance misuse/addiction, physical health, and other suicide precipitants as correlates of suicide intent disclosures in three age groups (65–74, 75–84, and 85+) of older suicide decedents. We then examined associations of suicide means with intent disclosure and suicide contributing factors. We posited a hypothesis that mental health/substance misuse/addiction problems, relationship problems, and other life stressors would be significant correlates in the 65–74 age group, while physical health problems would be significant correlates in the 75–84 and 85+ age groups. Previous studies of older suicide decedents showed that significantly higher proportions of those age 65–75 than those age 75+ had mental health/substance use problems, while significantly higher proportions of those age 75+ than those age 65–74 had physical health problems as suicide precipitants (Choi et al., 2019; Schmutte and Wilkinson, 2020). These health problems as suicide precipitants may also be significant correlates of intent disclosure.

We also hypothesized that intent disclosure would be associated with suicide means; however, given the lack of

previous research on the relationships among suicide means, intent disclosure, and the circumstances of death, we did not posit any directional hypothesis. Most previous research on suicide attempters found no association between suicide intent and choice of suicide means (Peterson et al., 1985; Plutchik et al., 1989), as other factors such as the availability and acceptability of methods and attempters' knowledge of the likely lethality of a given method also play a role (Harvard T.H. Chan School of Public Health, n.d.). However, other studies found that higher levels of intent were associated with use of more lethal means (Hamdi et al., 1991; Townsend et al., 2001; Brown et al., 2004). Older adults with a high degree of suicide intent may decide to choose more lethal means; however, as discussed, intent disclosure may not be a good indicator of the degree of intent. Better understanding of health and other factors associated with intent disclosure and potential associations between intent disclosure and suicide means is needed for more effective suicide prevention. The findings will provide insights into the demographic and clinical characteristics of older-adult suicide decedents who disclosed their suicide intent and associations of suicide means with intent disclosure and suicide contributing factors in late life.

Materials and methods

Data source

We focused on older-adult suicide decedents in the 2017–2019 NVDRS [$N = 17{,}917$, ages 65–105 at the time of death; 14,856 men (82.9%) and 3,061 women (17.1%)]. NVDRS is the only state-based violent death reporting system in the United States that provides information and context on when, where, and how violent deaths occur and who is affected (National Center for Injury Prevention and Control, 2021). NVDRS links data from death certificates and reports from coroners/medical examiners (CME) and law enforcement (LE) agencies on cases of violent deaths--suicides, homicides, deaths from legal intervention (i.e., victim killed by LE acting in the line of duty), deaths of undetermined intent, and unintentional firearm deaths. CME/LE reports are from the injury/death scene, ongoing investigations, or family/friend accounts and often serve as the basis of the circumstances of death and the NVDRS variables that were "calculated" (coded "Yes" when endorsed by the CME and/or LE reports vs. "No/not available/unknown"). When available, crime lab and toxicology reports included in CME reports are also abstracted and entered in NVDRS. During the 3-year study period, 43 states, the District of Columbia, and Puerto Rico participated in NVDRS; however, not all states provided complete data for all 3 years (see NCIPC (2021) for a detailed list of participating states in each year). The authors of this study were granted access to de-identified NVDRS data for this study by the CDC's NVDRS-Restricted Access Data (RAD) review committee. This study based on deceased individuals was exempt from the authors' institutional review board's review.

Measures

Intent disclosure

In NVDRS, disclosure was defined as either (1) disclosure of suicidal thoughts or intent to die by suicide to another person *via* verbal, written, or electronic communications within a month (or recently) before suicide, whether explicitly (e.g., "I plan to go to my cabin with my gun and never come back") or indirectly (e.g., "I know how to put a permanent end to this pain"); or (2) a separate suicide attempt within a month of the suicide. If the decedent disclosed intent to die by suicide only at the moment of the suicide (i.e., when there was no opportunity to intervene to stop the suicide), the NVDRS classifies this as a suicide note rather than a disclosure (CDC, 2021). Nondisclosure was defined as absence of disclosure or unknown disclosure status. NVDRS also includes data on the persons to whom decedents disclosed.

Suicide means

These were identified from the International Classification of Diseases 10th Revision (ICD-10) codes for intentional self-harm (X60-X84) for underlying cause of death in death certificates and/or from the underlying cause descriptions in CME reports. They included the following: firearms; hanging/suffocation; poisoning due to any type of alcohol/drug/medicine/chemical overdose or with gas (e.g., carbon monoxide, nitrogen); laceration/sharp instruments; blunt objects; jumping from heights; contact with moving objects (train/other vehicles); drowning; and other (fire, hypothermia, electrocution, starvation, dehydration, not adhering to or refusing medical care, or undetermined causes). We classified them into four categories in this study: firearms, hanging/suffocation, poisoning, and other.

History of suicide attempts

This referred to any previous suicide attempt before the fatal incident (i.e., including any in the past month), regardless of the severity and injury status.

Mental health and substance misuse/addiction (without the need for any indication that they directly contributed to the death): Mental health problems included: (1) depressed mood at the time of death (without the need for a clinical diagnosis); and (2) any diagnosed mental health problem [disorders and syndromes listed in DSM-5 (American Psychiatric Association, 2013)] at the time of death. Substance misuse/addiction problems included: (1) alcohol problem/addiction; and (2) other substance misuse/addiction (e.g., prescription drug misuse, chronic/abusive/problematic marijuana use, any use of other illicit drugs or inhalants). Additionally, we included any other addiction (e.g., gambling, sex) that appears to have contributed to the death. We also reported any history of mental health/substance use treatment for descriptive purposes only [as the data on treatment status are likely to be incomplete as they were reported by family/friends/other informants, not from healthcare professionals or official medical records (email communication with the NVDRS-RAD team; April 19, 2022)].

Contributing physical health problem

In NVDRS, this was recorded "Yes" if any diagnosed or perceived physical health problem (e.g., terminal disease, debilitating condition, chronic pain) was relevant to the death (e.g., "despondent over recent diagnosis of cancer" or "complained that he could not live with the pain associated with a condition" even if the condition may not have been diagnosed or existed).

Contributing relationship and other life stressors

These included: (1) relationship problems (conflict with an intimate partner and/or other family members, arguments, other family stressors, caregiver burden, or abuse by a caregiver); (2) recent suicides or other deaths of family/friends or traumatic anniversary; (3) job/finance/housing problems; and (4) criminal/civil legal problems.

Number of crises

NVDRS provides a variable that is the count of crises ("current/acute event within two weeks of death") that the decedent faced with respect to mental health, substance misuse/addiction, physical health, and relationship and other life stressors discussed above.

Demographic variables

Data on age at the time of death, sex, race/ethnicity, level of education, marital status, and military service status were from the death certificates and CME/LE reports. Census region of residence was examined for descriptive purposes only.

Analysis

All statistical analyses were performed using Stata/MP 17. First, single variable multinomial logistic regression analyses were used to examine any differences between the 65–74 age group and two older age (75–84 and 85+) groups in demographic and other variables of interest. Second, to test the study hypothesis regarding correlates of suicide intent disclosure in each age group, we fit three generalized linear models (GLMs) for a Poisson distribution with a log link. We fit GLMs rather than logistic regression models because odds ratios exaggerate the true relative risk to some degree when the event (i.e., intent disclosure in this study) is a common (i.e., >10%) occurrence (Grimes and Schulz, 2008). The independent variables for all three GLM models were mental health problems, substance misuse/addiction problems, contributing physical health problems, relationship/other life stressors, and demographics. Third, to examine associations between intent disclosure and suicide means, we also fit three GLMs for firearm use, hanging/suffocation, and poisoning as the dependent variables. As a preliminary diagnostic, we used variance inflation factor (VIF), using a cut-off of 2.50 (Allison, 2012), from linear regression models to assess multicollinearity among covariates. VIF diagnostics indicated that multicollinearity was not a concern. GLM results are reported as incidence rate ratios (IRRs) with 95% confidence intervals (CIs). Significance was set at $p < 0.05$.

Results

Demographic characteristics, intent disclosure, and suicide means by age group

Table 1 shows that of the study sample, 54.7% were age 65–74, 31.2% age 75–84, and 14.1% age 85+. Compared to those age 65–74, two older groups of decedents had significantly higher percentages of men but lower percentages of Black/African Americans, and the 85-and-older group also had significantly lower percentages of Hispanics and the residents of the Southern region but a higher percentage of Asian/Pacific Islanders. Two older groups included lower percentages of divorced/separated/never married and college-educated individuals but higher percetages of widowed individuals, veterans, and those who died at home.

Table 1 also shows that 18.7%, 21.0%, and 22.0% in the 65–74, 75–84, and 85+ age groups, respectively, disclosed their suicide intent, and the average for all decedents 65 years and older was 19.9%. The difference in the percentages between those age 65–74 and two older groups was statistically significant. Two thirds to three quarters of disclosures were to a previous or current intimate partner and/or other family members. A little over 10% of the disclosers in the 85+ age group disclosed their intent to a healthcare provider. In all three age groups, a little less than a third left a suicide note, but a significantly lower proportion of the 75–84 age group the 65–74 age group did so. Additional analysis showed no significant difference between those who disclosed intent and those who did not in leaving a suicide note in all three age groups. Additional analysis also showed significant regional differences in intent disclosure [12.0%, 26.0%, 27.5%, 33.7%, 0.8% in the Northeast, Midwest, South, West, and Puerto Rico/other territories/unknown, respectively, Pearson $\chi^2(\text{df}=4)=96.09$, $p<0.001$].

With respect to suicide means, 62.7%, 74.7%, and 74.3% in the 65–74, 75–84, and 85+ age groups, respectively, used firearms. The rates were 14.6%, 9.6%, and 9.7% for hanging/suffocation; 15.7%, 10.4%, and 10.5% for poisoning; and 7.0%, 5.3%, and 5.5% for other means. However, Table 2 shows that sex differences in suicide means were significant in all three age groups. More women used poisoning (41.0%, 39.6%, and 43.2% in the 65–74, 75–84, and 85+ age groups, respectively) than firearms, whereas most men (70.2%, 88.8%, and 80.3% in the 65–74, 75–84, and 85+ age groups, respectively) used firearms. Additional analyses showed no significant difference in suicide means by age group among women [Pearson $\chi^2(\text{df}=6)=6.26$, $p=0.392$], but significant difference by age group among men [Pearson $\chi^2(\text{df}=6)=224.35$, $p<0.001$].

TABLE 1 Demographic characteristics, intent disclosure, and suicide means of suicide decedents age 65+: Results from single-variable multinomial logistic regression models.

	65–74 years $N = 9,797$ (54.7%)	75–84 years $N = 5,592$ (31.2%)	85+ years $N = 2,528$ (14.1%)	75–84 years vs. 65–74 years RRR (95% CI)	85+ years vs. 65–74 years RRR (95% CI)
Demographics					
Sex (%)					
Female	20.7	13.2	11.6	–	–
Male	79.3	86.8	88.4	1.71 (1.56–1.87)***	1.98 (1.74–2.26)***
Race/ethnicity (%)					
Non-Hispanic White	90.5	91.5	93.0	–	–
Black/African American	2.9	2.4	1.5	0.81 (0.65–0.99)*	0.50 (0.36–0.71)***
Hispanic	3.8	3.3	2.3	0.86 (0.72–1.03)	0.59 (0.45–0.79)***
Asian/Pacific Islander	1.9	2.2	2.7	1.12 (0.89–1.42)	1.34 (1.01–1.78)*
Other	0.9	0.6	0.5	0.71 (0.48–1.05)	0.61 (0.35–1.08)
Marital status (%)					
Married	44.3	47.3	34.5	–	–
Divorced/separated	30.2	21.5	11.4	0.66 (0.61–0.72)***	0.48 (0.42–0.56)***
Widowed	12.2	25.	49.9	1.91 (1.75–2.09)***	5.23 (4.70–5.82)***
Never married/single-unspecified	11.8	5.2	3.7	0.42 (0.36–0.48)***	0.41 (0.33–0.51)***
Unknown	1.5	1.0	0.5	0.63 (0.46–0.85)**	0.43 (0.24–0.75)**
Education (%)					
=<High school	47.8	56.1	58.7	–	
Some college/associate's degree	23.0	17.6	13.9	0.65 (0.60–0.71)***	0.49 (0.43–0.56)***
Bachelor's degree or higher	26.0	23.4	24.9	0.77 (0.71–0.83)***	0.78 (0.70–0.87)***
Unknown	3.2	2.9	2.5	0.77 (0.63–0.93)**	0.63 (0.47–0.83)**
Military service (%)					
No, not available, unknown	68.5	55.6	36.4	–	–
Yes	31.5	44.4	63.6	1.74 (1.62–1.86)***	3.80 (3.47–4.16)***
Injury location (%)					
Not at home or unknown	21.3	16.3	12.6	–	–
At home	78.7	83.7	87.4	1.39 (1.27–1.51)***	1.87 (1.65–2.12)***
Census region of residence					
Northeast	16.4	16.2	17.8	–	–
Midwest	25.7	25.6	26.4	1.01 (0.91–1.12)	0.95 (0.83–1.08)
South	27.9	27.3	23.9	0.99 (0.89–1.10)	0.79 (0.69–0.90)**
West	28.6	29.7	31.0	1.05 (0.95–1.16)	1.00 (0.87–1.14)
Puerto Rico/other United States territories/ unknown	1.4	1.2	0.9	0.85 (0.63–1.15)	0.57 (0.36–0.90)*
Disclosed suicidal intent within last month (%)					
No, not available, unknown	81.3	79.0	78.0	–	–
Yes	18.7	21.0	22.0	1.16 (1.07–1.26)***	1.23 (1.11–1.37)***
Disclosed to whom (among those who disclosed; $N = 3,564$) (%)					

(Continued)

TABLE 1 (Continued)

	65–74 years $N = 9,797$ (54.7%)	75–84 years $N = 5,592$ (31.2%)	85+ years $N = 2,528$ (14.1%)	75–84 years vs. 65–74 years RRR (95% CI)	85+ years vs. 65–74 years RRR (95% CI)
Previous or current intimate partner	34.9	33.9	24.6		
Other family member	32.4	41.6	44.9		
Friend/colleague	11.0	7.4	8.1		
Neighbor	3.1	3.2	4.1		
Healthcare worker	7.1	6.5	10.4		
Other disclosure *via* social media/other electronic means	0.1	0	0.2		
Other	11.8	8.2	9.5		
Unknown	5.4	4.8	5.0		
Left suicide note/electronic message (%)					
No, not available, unknown	67.1	70.7	68.8	–	–
Yes	32.9	29.3	31.2	0.84 (0.79–0.91)***	0.92 (0.84–1.02)
Suicide means (%)					
Firearms	62.7	74.7	74.3	–	–
Hanging, strangulation, or suffocation	14.6	9.6	9.7	0.55 (0.49–0.61)***	0.56 (0.48–0.65)***
Drug, other chemical, or gas poisoning	15.7	10.4	10.5	0.56 (0.50–0.62)***	0.57 (0.50–0.66)***
Other[1]	7.0	5.3	5.5	0.63 (0.55–0.73)***	0.66 (0.54–0.79)***

[1]Jump from a high place, blunt force from moving vehicle/train/other, sharp or blunt object, drowning, smoke/fire/flame/electrocution/hypothermia, other means, or unknown.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Mental disorders, substance misuse/addiction, physical health problems, and other contributing factors

Table 3 shows that compared to those age 65–74, the two older groups included lower percentages of individuals with a history of suicide attempt (s). About a third in all three age groups were reported to have shown depressed mood at the time of death, although the proportion was significantly higher in those age 75–84 than those age 65–74. However, two older groups had significantly lower percentages of individuals with mental disorders than in those age 65–74 (32.2% in those age 75–84 and 23.9% in those age 85+ vs. 41.6% in those age 65–74). Depressive disorder/dysthymia and anxiety disorders were most common in all three age groups. The two older groups also had smaller proportions of individuals with other substance misuse/addiction problems than the 65–74 age group. Overall, 51.2%, 64.5%, and 74.8% in the 65–74, 75–84, and 85+ age groups, respectively, did not have any reported depressed mood, mental disorders, or substance misuse/addiction problems. At the time of their injury, 22.7%, 16.0%, and 9.6% in the 65–74, 75–84, and 85+ age groups, respectively, were receiving mental health/substance use treatment.

Those age 85 and older included the highest percentage (59.7%) of individuals with physical health problems as a contributing factor, followed by those age 75–84 (56.8%) and those age 65–74 (41.9%). The two older groups also included higher percentages of individuals with death/suicide of a family/friend or traumatic anniversary as a contributing factor, but lower percentages with other contributing factors. The average numbers of crises were small in all three age groups. Additional analysis showed that 76.7%, 75.2%, and 77.6% in the 65–74, 75–84, and 85+ age groups, respectively, had no crisis at the time of death.

Correlates of intent disclosure in each age group: GLM results

Table 4 shows that depressed mood and physical health problems were significant correlates of intent disclosure in all three age groups: IRR = 1.44, 95% CI = 1.30–1.58 for those age 65–74, IRR = 1.42, 95% CI = 1.26–1.60 for those age 74–84, and IRR = 1.50, 95% CI = 1.26–1.79 for those age 85+ for depressed mood; and IRR = 1.42, 95% CI = 1.29–1.56 for those age 65–74, IRR = 1.61, 95% CI = 1.42–1.84 for those age 74–84, and IRR = 1.67, 95% CI = 1.38–2.04 for those age 85+ for physical health problems.

TABLE 2 Suicide means by age group and sex (%).

	All ($N = 17,917$)		65–74 years ($N = 9,797$)		75–84 years ($N = 5,592$)		85+ years ($N = 2,528$)	
	Male $n = 14,856$	Female $n = 3,061$	Male $n = 7,770$	Female $n = 2,027$	Male $n = 4,852$	Female $n = 750$	Male $n = 2,234$	Female $n = 294$
Firearm	75.2	33.7	70.2	33.9	88.8	35.0	80.3	28.2
Hanging/suffocation	11.6	15.9	14.4	15.5	8.6	15.7	8.4	19.4
Poisoning	7.6	40.8	9.0	41.0	5.9	39.6	6.3	43.2
Other[1]	5.6	9.6	6.4	9.6	4.7	9.7	5.0	9.2
Sex difference: p-value (Pearson χ^2)	$p < 0.001$		$p < 0.001$		$p < 0.001$		$p < 0.001$	

[1]Including sharp or blunt object (2.2% of all decedents); jump from a high place (1.7%); drowning (0.9%); blunt force from moving vehicle/train/other (0.8%); smoke/fire/flame/electrocution/hypothermia (0.4%); medical device discontinuation (0.03%); intentional starvation/dehydration (0.01%); unspecified (0.2%); and other means (0.06%).

Additionally, history of suicide attempt (s), mental disorder/substance misuse/addiction, relationship problems, death/suicide of family/friend, and the total number of crises were significant correlates in the 65–74 and 75–84 age groups.

In terms of demographic correlates, male sex and widowhood were associated with a lower likelihood of disclosure in the 85+ age group only; Asians/Pacific Islanders had a lower likelihood of disclosure in the 65–74 age group only; and those with a college or higher degree had a lower likelihood of disclosure in the 75–84 age group only.

Associations between suicide means and intent disclosure and other characteristics

Table 5 shows that intent disclosure was not associated with firearm use and poisoning, but it was associated with a significantly lower likelihood of hanging/suffocation (IRR = 0.76, 95% CI = 0.68–0.86). Depressed mood was associated with a higher likelihood of hanging/suffocation and a lower likelihood of poisoning. Mental disorders, with or without substance misuse/addiction problems, and history of suicide attempt were associated with a lower likelihood of firearm use but a higher likelihood of hanging/suffocation and poisoning. Substance misuse/addiction problems were associated with a higher likelihood of poisoning.

Physical health and relationship problems were associated with a higher likelihood of firearm use but lower likelihood of hanging/suffocation, whereas legal problems were associated with a lower likelihood of firearm use but a higher likelihood of hanging/suffocation. Death/suicide of family/friends was associated with a higher likelihood of poisoning only. Job-related, financial, or housing problems were associated with a higher likelihood of hanging/suffocation only, and more crises were associated with a lower likelihood of hanging/suffocation only.

The 75–84 age group was associated with a higher likelihood of firearm use but a lower likelihood of hanging/suffocation and poisoning. Male sex was associated with 1.89 (95% CI = 1.77, 2.02) likelihood of firearm use but 0.24 (95% CI = 0.22–0.26) likelihood of poisoning. Compared to non-Hispanic Whites, Hispanics and Asians/Pacific Islanders were less likely to have used firearms but 3–4 times more likely to have used hanging/suffocation. Asians/Pacific Islanders were also less likely to have used poisoning. Compared to married individuals, divorced/separated and never married individuals were less likely to have used firearms, but they and widowed individuals were more likely to have used poisoning. Never married individuals were also more likely to have used hanging/suffocation. Compared to those with high school or less education, those with a college or higher degree were less likely to have used firearms but more likely to have used poisoning.

Discussion

We examined correlates of intent disclosure in three age groups of older suicide decedents and the associations between suicide means and intent disclosure and other characteristics. One out of five decedents 65 and older disclosed their suicide intent, but the 75–84 and 85+ age groups included slightly but statistically significantly higher proportions of disclosers than the 65–74 age group. Most disclosures were to family/friends, but one out of 10 disclosers age 85+ disclosed to a healthcare provider. As expected, an absolute majority of men, especially in the 75–84 and 85+ age groups, used firearms, but a higher proportion of women used poisoning than firearms.

Multivariable analysis results show that along with physical health problems, mental health/substance misuse/addiction problems, relationship problems, and death/suicide of family friends, and the number of crises were significant correlates of intent disclosure in the 65–74 and 75–84 age groups. On the other hand, for those age 85 years and older, only physical health problems were associated with a greater likelihood of intent disclosure. The findings partially support the study hypothesis. In the 65–74 and 75–84 age groups, sex was not a significant factor for intent disclosure; however, in the 85+ age group, men were significantly less likely to have disclosed their suicide intent. Significance of race/ethnicity and level of education also varied by age group. Multivariable analysis results show that intent

TABLE 3 Mental disorders, substance misuse/addiction, and other contributing factors among suicide decedents age 65+: Results from single-variable multinomial logistic regression models.

	65–74 years $N = 9,797$ (54.7%)	75–84 years $N = 5,592$ (31.2%)	85+ years $N = 2,528$ (14.1%)	75–84 years vs. 65–74 years RRR (95% CI)	85+ years vs. 65–74 years RRR (95% CI)
History of suicide attempt (%)					
No, not available, unknown	87.4	92.1	94.5	–	–
Yes	12.6	7.9	5.5	0.60 (0.53–0.67)***	0.40 (0.33–0.48)***
Mental health and substance use problems					
Depressed mood at the time of injury (%)					
No, not available, unknown	68.3	66.5	68.1	–	–
Yes	31.7	33.5	31.9	1.08 (1.01–1.16)*	1.01 (0.92–1.11)
Current mental health disorder[1] (%)					
No, not available, unknown	58.4	67.8	76.1	–	–
Yes	41.6	32.2	23.9	0.67 (0.62–0.72)***	0.44 (0.40–0.49)***
Types of disorder (among all decedents) (%)					
Depressive disorder/ dysthymia	32.6	23.8	17.7		
Bipolar disorder	4.0	1.5	0.4		
Anxiety disorder	8.8	6.3	3.7		
Post-traumatic stress disorder	2.6	0.5	0.7		
Schizophrenia	1.3	0.6	0.1		
Dementia	0.3	0.6	0.7		
Other and unknown types of disorder	5.8	7.1	5.7		
Alcohol problem/addiction (%)					
No, not available, unknown	88.0	95.3	97.9	–	–
Yes	12.0	4.7	2.1	0.36 (0.31–0.41)***	0.16 (0.12–0.21)***
Other substance misuse[2] (%)					
No, not available, unknown	95.0	98.5	99.4	–	–
Yes	5.0	1.5	0.6	0.30 (0.24–0.37)***	0.11 (0.06–0.18)***
Other addiction problem[3] (%)					
No, not available, unknown	99.4	99.7	99.9	–	–
Yes	0.6	0.3	0.1	0.43 (0.24–0.77)**	0.20 (0.06–0.65)**
Summary of mental disorder[4] and/or substance misuse/ other addiction (%)					
No mental disorder or substance misuse/addiction	51.2	64.5	74.8	–	–
Substance misuse/addiction only	7.2	3.3	1.3	0.36 (0.31–0.43)***	0.12 (0.08–0.17)***
Mental disorder only	33.4	29.4	22.5	0.70 (0.65–0.75)***	0.46 (0.42–0.51)***
Both mental disorder and substance misuse /addiction	8.2	2.8	1.4	0.27 (0.22–0.32)***	0.12 (0.08–0.16)***
Mental health/substance misuse treatment receipt[5] (%)					
At the time of injury	22.7	16.0	9.6	0.63 (0.58–0.68)***	0.36 (0.32–0.41)***

(Continued)

TABLE 3 Continued

	65–74 years $N = 9,797$ (54.7%)	75–84 years $N = 5,592$ (31.2%)	85+ years $N = 2,528$ (14.1%)	75–84 years vs. 65–74 years RRR (95% CI)	85+ years vs. 65–74 years RRR (95% CI)
History of mental health treatment	28.5	20.0	12.5	0.65 (0.60–0.71)***	0.36 (0.34–0.42)***
Contributing physical health problem[6] (%)					
No, not available, unknown	58.1	43.2	40.3	–	–
Yes	41.9	56.8	59.7	1.82 (1.70–1.95)***	2.05 (1.88–2.24)***
Contributing relationship and other life stressors					
Relationship problem[7] (%)					
No, not available, unknown	82.7	88.8	93.4	–	–
Yes	17.3	11.2	6.6	0.60 (0.54–0.66)***	0.34 (0.28–0.40)***
Death/suicide of family/friend or traumatic anniversary (%)					
No, not available, unknown	91.1	88.1	86.3	–	–
Yes	8.9	11.9	13.7	1.37 (1.24–1.53)***	1.63 (1.42–1.86)***
Job-related or financial problem or eviction/loss of housing (%)					
No, not available, unknown	88.4	92.6	95.2	–	–
Yes	11.6	7.4	4.8	0.61 (0.54–0.69)***	0.39 (0.32–0.47)***
Criminal or civil legal problem (%)					
No, not available, unknown	95.3	97.9	99.3	–	–
Yes	4.7	2.1	0.7	0.43 (0.35–0.52)***	0.15 (0.09–0.23)***
Number of crises[8], *M* (SE)	0.28 (0.01)	0.28 (0.01)	0.25 (0.01)	1.00 (0.94–1.06)	0.89 (0.82–0.97)**

[1]Including disorders and syndromes listed in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) with the exception of alcohol and other substance dependence.
[2]Including illicit drug use, except marijuana, even if addiction or abuse is not specifically mentioned. For marijuana, the use must be noted as chronic, abusive, or problematic.
[3]An addiction other than alcohol or other substance that appears to have contributed to the death (e.g., gambling, sexual).
[4]Including any mental health diagnosis.
[5]Inclusive of pharmacotherapy, psychotherapy/counseling, any class (e.g., anger management) attendance, any facility-based care, and alcohol or narcotics anonymous.
[6]Including any terminal/other illness, debilitating condition, chronic/acute pain, or other physical/functional issue (perceived, or diagnosed) that were relevant to suicide.
[7]Problems with intimate partner and/or other family/relatives, other family stressors, caregiver burden, arguments, or abuse by a caregiver.
[8]Total number of contributing factors that posed a crisis within 2 weeks of death.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

disclosure was not associated with firearm use or poisoning as suicide methods but associated with lower odds of hanging/suffocation. Physical health problems, age 75–84 (compared to age 65–74), and male sex were associated with higher odds of firearm use, and mental health and/or substance misuse problems were associated with higher odds of hanging/suffocation and poisoning.

The overall disclosure rate in this study is lower than the disclosure rate found in the 2005–2014 NVDRS, as about a quarter of decedents age 70+ were found to have disclosed their intent during those earlier years (Choi et al., 2017). It is not clear if the lower rate in the present study reflects an actual decrease in disclosure in recent years or stems from some other factors related to NVDRS. We speculate that the lower disclosure rate in the present study may be due in part to the fact that most states in the Northeastern region began to participate in NVDRS in 2015 and, as described earlier, the disclosure rate was significantly lower in the region. Research is need to examine the reasons for regional variations in disclosure rates. Given that the number of NVDRS-participating states more than doubled between 2014 and 2017, the present study's disclosure rate is likely to be more representative of the actual United States rate.

More importantly, the significance of physical health problems as a correlate of intent disclosure in all three age groups of older adults shows that intent disclosure (to mostly their family members) was a way of communicating their wish to end further physical suffering. Those who disclosed their intent to their healthcare providers may have done so to seek any medical advice; however, the data set does not contain details about the circumstances of the disclosure. A previous NVDRS-based study found that bodily pain and cancer were the most frequently mentioned physical health-related problems among older suicide decedents and that these older

TABLE 4 Correlates of intent disclosure (vs. no disclosure) in each age group: Results from generalized linear models with Poisson and log link.

	65–74 age group IRR (95% CI)	75–84 age group IRR (95% CI)	85+ age group IRR (95% CI)
History of suicide attempt	1.36 (1.20–1.54)***	1.47 (1.22–1.77)***	1.26 (0.91–1.74)
Depressed mood	1.44 (1.30–1.58)***	1.42 (1.26–1.60)***	1.50 (1.26–1.79)***
Mental disorder/substance misuse/other addiction: vs. no disorder/ substance misuse			
Substance misuse/addiction only	1.36 (1.14–1.62)**	1.50 (1.14–1.97)**	1.05 (0.52–2.13)
Mental disorder only	1.31 (1.18–1.46)***	1.27 (1.11–1.44)***	1.19 (0.99–1.45)
Both mental disorder and substance misuse/addiction	1.35 (1.15–1.59)***	1.25 (0.91–1.72)	0.86 (0.40–1.83)
Physical health problem	1.42 (1.29–1.56)***	1.61 (1.42–1.84)***	1.67 (1.38–2.04)***
Relationship problem	1.28 (1.14–1.44)***	1.25 (1.05–1.49)*	1.32 (0.97–1.79)
Death/suicide of family/friend	1.22 (1.05–1.42)*	1.21 (1.01–1.44)*	1.19 (0.93–1.54)
Criminal or civil legal problem	1.13 (0.92–1.39)	1.23 (0.84–1.79)	1.68 (0.42–1.03)
Job-related, financial, or housing problem	1.04 (0.90–1.19)	0.94 (0.76–1.16)	0.66 (0.42–1.03)
No. of crises	1.13 (1.05–1.22)**	1.20 (1.09–1.33)***	1.05 (0.89–1.24)
Male	1.05 (0.93–1.19)	0.92 (0.77–1.10)	0.70 (0.53–0.93)*
Racial/ethnic group: vs. Non-Hispanic White			
Black/African American	0.84 (0.62–1.15)	0.82 (0.53–1.26)	1.41 (0.77–2.57)
Hispanic	0.92 (0.71–1.18)	0.74 (0.51–1.07)	0.88 (0.48–1.62)
Asian/Pacific Islander	0.61 (0.39–0.95)*	0.86 (0.56–1.32)	1.23 (0.76–1.99)
Other	0.97 (0.58–1.62)	0.74 (0.33–1.66)	0.74 (0.18–2.99)
Marital status: vs. Married			
Divorced/separated	1.01 (0.91–1.13)	1.03 (0.89–1.19)	1.02 (0.77–1.35)
Widowed	1.02 (0.87–1.19)	0.89 (0.76–1.04)	0.81 (0.67–0.99)*
Never married/single-unspecified	0.93 (0.79–1.09)	0.94 (0.70–1.25)	0.85 (0.52–1.39)
Unknown	0.81 (0.50–1.32)	0.98 (0.51–1.90)	0.59 (0.14–2.49)
Education: vs. =<High school			
Some college/associate's degree	0.90 (0.81–1.02)	0.92 (0.78–1.07)	1.22 (0.96–1.54)
Bachelor's degree or higher	0.97 (0.87–1.09)	0.85 (0.73–0.98)*	1.10 (0.91–1.35)
Unknown	1.02 (0.75–1.38)	1.04 (0.70–1.52)	0.91 (0.49–1.69)
Military service	1.02 (0.91–1.13)	0.92 (0.81–1.05)	0.97 (0.79–1.19)
	$N = 9,797$	$N = 5,592$	$N = 2,528$

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

adults had often expressed their feelings of hopelessness and perceived burdensomeness, and longing for rest (Choi et al., 2019). Earlier studies of middle-aged and older individuals who attempted suicide also found a desire to escape from an unbearable situation, perceived burdensomeness, depression, experiences of defeat/powerlessness (especially among men), and lack of meaning in life were reasons/motivations for attempted suicide (Van Orden et al., 2015; Alessi et al., 2019). Unremitting pain and terminal illnesses can understandably trigger a sense of powerlessness and escape/rest motives. Under the circumstance, older adults, those age 85 years and older in particular, may feel that ending life on their own terms now rather than later (which is seen as inevitable) is justified and disclosing their suicide intent is one last willful act where they can exert control. A previous study of beliefs about late-life suicide showed that both older and younger adults rated suicide precipitated by physical health problems most positively as a rational, acceptable, and courageous act (Winterrowd et al., 2017). However, men age 85+ also had a lower likelihood of intent disclosure, suggesting that they tend to lack willingness to self-disclose.

The significant associations of intent disclosure with mental health/substance misuse problems, relationship problems, death/suicide of family/friend, and number of crises, in addition to physical health problems, in the 65–74 and 75+ age group also suggest a help-seeking motive among these older adults who were under multiple stressors. According to Alessi et al. (2019), interpersonal conflict and loss can engender anger, perceived loss of control, sense of defeat and abandonment, and grief, which can be aggravated by poor psychological resources and coping among those with mental health/substance misuse problems. Some older adults may welcome opportunities to receive support for reexamining their decision to die by suicide. The relatively small numbers of crises, on average, in all three age groups in the present study also show that most contributing factors were likely to have been an ongoing problem rather than a crisis.

TABLE 5 Association between intent disclosure and suicide means: Results from generalized linear models with Poisson and log link.

	Firearm vs. No firearm IRR (95% CI)	Hanging/suffocation vs. No hanging/suffocation IRR (95% CI)	Poisoning vs. No poisoning IRR (95% CI)
Disclosure of suicide intent	1.03 (0.98–1.08)	0.76 (0.68–0.86)***	1.06 (0.96–1.17)
History of suicide attempt	0.64 (0.59–0.70)***	1.43 (1.27–1.0)***	1.51 (1.36–1.67)***
Depressed mood	0.99 (0.95–1.03)	1.16 (1.06–1.27)**	0.88 (0.81–0.97)**
Mental disorder/substance misuse/other addiction: vs. no disorder/substance misuse			
Substance misuse/addiction only	0.96 (0.88–1.04)	0.91 (0.74–1.11)	1.46 (1.22–1.74)***
Mental disorder only	0.88 (0.85–0.92)***	1.36 (1.24–1.49)***	1.13 (1.03–1.25)**
Both mental disorder and substance misuse/addiction	0.83 (0.76–0.91)***	1.14 (0.95–1.37)	1.62 (1.40–1.88)***
Physical health problem	1.11 (1.07–1.16)***	0.67 (0.61–0.74)***	1.07 (0.98–1.17)
Relationship problem	1.09 (1.03–1.15)**	0.72 (0.63–0.83)***	1.12 (0.99–1.26)
Death/suicide of family/friend	1.00 (0.94–1.07)	0.94 (0.81–1.09)	1.14 (1.00–1.30)*
Criminal or civil legal problem	0.88 (0.79–0.98)*	1.62 (1.33–1.97)***	1.24 (0.98–1.56)
Job-related, financial, or housing problem	0.95 (0.89–1.02)	1.36 (1.19–1.54)***	0.95 (0.82–1.10)
No. of crises	1.02 (0.99–1.06)	0.91 (0.83–0.99)*	0.93 (0.85–1.01)
Age group: vs. 65–74 years			
75–84 years	1.06 (1.02–1.10)**	0.79 (0.71–0.87)***	0.86 (0.78–0.96)**
85+ years	1.00 (0.95–1.06)	0.96 (0.83–1.12)	0.95 (0.82–1.10)
Male	1.89 (1.77–2.02)***	1.09 (0.98–1.22)	0.24 (0.22–0.26)***
Racial/ethnic group: vs. Non-Hispanic White			
Black/African American	0.89 (0.79–1.00)	1.19 (0.92–1.54)	0.87 (0.67–1.14)
Hispanic	0.50 (0.43–0.57)***	3.42 (2.98–3.91)***	0.79 (0.61–1.03)
Asian/Pacific Islander	0.27 (0.21–0.35)***	4.31 (3.71–5.01)***	0.48 (0.34–0.68)***
Other	0.89 (0.72–1.10)	1.55 (1.03–2.35)*	1.05 (0.67–1.63)
Marital status: vs. Married			
Divorced/separated	0.93 (0.89–0.97)**	1.03 (0.93–1.15)	1.38 (1.25–1.53)***
Widowed	0.96 (0.91–1.01)	0.97 (0.85–1.10)	1.40 (1.25–1.57)***
Never married/single-unspecified	0.85 (0.79–0.91)***	1.27 (1.10–1.46)**	1.32 (1.13–1.54)***
Unknown	0.84 (0.69–1.02)	0.90 (0.60–1.34)	1.47 (0.98–2.22)
Education: vs. =<High school			
Some college/associate's degree	0.98 (0.94–1.03)	1.03 (0.92–1.16)	1.07 (0.96–1.19)
Bachelor's degree or higher	0.89 (0.85–0.93)***	1.09 (0.99–1.21)	1.37 (1.25–1.50)***
Unknown	0.98 (0.86–1.10)	1.07 (0.83–1.38)	0.92 (0.69–1.22)
Military service	1.11 (1.07–1.15)***	0.56 (0.50–0.63)***	0.80 (0.71–0.90)***
	$N = 17,917$	$N = 17,917$	$N = 17,917$

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

The lack of significant association between intent disclosure and firearm and poisoning use is likely due to the fact that sex, regardless of the intent disclosure status, was the most significant determinant of these two methods of suicide. Sex was not a significant factor for hanging/suffocation, although race/ethnicity was. Hispanics and Asian/Pacific Islanders were significantly less likely than Non-Hispanic White to use firearms but they were 3–4 times more likely to use hanging/suffocation. These may be a reflection of the overall lower gun ownership rates among Hispanics and Asian/Pacific Islanders compared to non-Hispanic Whites (Pew Research Center, 2021). More research is needed to better understand the negative association between intent disclosure and hanging/suffocation.

As opposed to silent suicidal behaviors, intent disclosure provides a significant opportunity to prevent suicide. Although only one out of five older suicide decedents disclosed suicidal intent, this is not an insignificant proportion as timely interventions may have been able to prevent suicide. The higher likelihood of intent disclosure among all three age groups of older suicide decedents with physical health problems and mental health/substance misuse/addiction in the 65–74 and 75+ age groups have the following implications for suicide prevention. First, patient-centered/directed comfort and palliative care, including better pain management, is needed for older adults who perceive physical health problems as immutable and suicide as the only way to spare them further suffering. Special attention should be paid to older men suffering from physical health problems who may be at risk of suicide. As most of them may not disclose their suicidal intent, it may be necessary to thoroughly screen for and intervene against suicidal behavior.

Healthcare services that recognize and support informal caregivers of older adults are also needed to equip those caregivers with practical tools and skill sets for detecting suicidal ideation/intent in their loved ones and implementing suicide prevention steps. Programs like Applied Suicide Intervention Skills Training (ASIST) have been found to save lives (Ashwood et al., 2015).

Second, older adults with mental health/substance misuse/addiction problems should be helped to access appropriate mental health and/or substance use treatment. A recent systematic review showed that suicide decedents who were men, under 25 years or 65 years and older, racial/ethnic minorities, residents in rural areas, and experienced stressors and used violent means of suicide were less likely to have received mental health services (Tang et al., 2022). Untreated depression in late life, especially among older adults with physical health problems and disability, has been associated with increased and persisting depressive symptom trajectories, further deterioration of physical function and cognitive health, and increased mortality (Andreescu et al., 2008; Kaup et al., 2016; Mirza et al., 2016; Agustini et al., 2022). Given the inconclusive evidence of effectiveness of antidepressants for late-life suicide prevention, mental health treatment should include physical activity and collaborative management for reduction of suicidal behaviors at integrated physical and behavioral health settings (Laflamme et al., 2022).

At-risk and problem alcohol use and/or other substance misuse/addiction can also aggravate depression and cognitive decline in late life (Blow et al., 2007; Topiwala and Ebmeier, 2018). Healthcare providers should screen for substance use and make treatment referrals. A study found that individuals age 65–69 were more likely to complete treatment successfully than those 75 or older; however, with age appropriate treatment, the latter group is also likely to have positive treatment experience (Sahker et al., 2015).

Third, for those who are despondent over relationship/other life stressors, mental health treatment should involve strengthening their coping skills and promoting positive psychological factors. Research has shown that interventions that emphasize reasons for living and meaning in life have positive impact on enhancing psychological well-being and protecting against suicidal behavior (Heisel et al., 2016).

Finally, older adults who disclosed suicidal intent or ideation should be restricted from accessing suicide means. Given the possibility of substitution of means (Florentine and Crane, 2010), both informal and formal caregivers should talk with the older adults and ideally, find mutually agreed-upon ways that can limit the older adults' access to potential suicide means. Concurrently, older adults should also receive appropriate treatment and services for the conditions that triggered suicidal intent and thoughts. Formal and informal caregivers should pay special attention to men in their 80s suffering from physical health problems as they are less likely to self-disclose suicidal intent and significantly more likely to use lethal means, compared to older women.

This study had limitations. First, NVDRS data on intent disclosure was collected from the memory of older adults' family and other informants, and thus, may have been subject to recall bias. Also, it was not possible to distinguish between those who did not disclose and those whose information on disclosure was not available. Second, NVDRS data on physical and mental health and substance misuse were also collected from decedents' family/friends and other informants and/or suicide notes, not from healthcare providers. Without diagnosis data and input from older adults' healthcare providers, the validity of these data may also be questionable. NVDRS allowed that contributing health problems may have been perceived and psychosomatic (influenced by depression and/or other affective or cognitive disorders) rather than formally diagnosed. Third, although a majority of states participated in the 2017–2019 NVDRS, some states did not provide data on all 3 years and others provided only partial data limited to some counties. Thus, the findings are not representative of all United States older-adult suicide decedents. Fourth, any theory testing had to be precluded given the lack of quantitative measures of any psychological state measures including hopelessness, thwarted belongingness, and perceived burdensomeness. NVDRS also does not include variables on whether or not any suicide prevention steps had been applied, especially by healthcare providers, following the intent disclosure prior to the fatal injury and the nature of the prevention, if any. The information would have been helpful to better understand the circumstances of the older adults' suicide and provide further insights into potentially effective prevention strategies.

Conclusion

This study found that one fifth of suicide decedents 65 years and older disclosed their suicide intent within a month of fatal injury. Both physical and mental health/substance misuse/addiction problems, relationship/other life stressors were associated with higher likelihood of intent disclosure among those under 85, but only physical health problems were associated with higher likelihood of intent disclosure among those 85 and older. Although sex was not a significant correlate of intent disclosure in those under 85, men 85 and older had lower likelihood of suicide intent disclosure, indicating the need for thorough screening and prevention strategies for older men with physical health problems who may be at risk of suicidal behavior. Intent disclosure was not associated with use of firearms and poisoning as suicide means but associated with lower likelihood of hanging/suffocation. Late-life suicide prevention strategies should include more patient-centered comfort and palliative care, mental health/substance misuse/addiction treatment, and restriction of access to potential suicide means for those who disclosed suicidal intent. More research is needed on older adults who disclose suicide intent and late-life suicide prevention strategies.

Data availability statement

The data analyzed in this study is subject to the following licenses/restrictions: The authors received permission to use the

United States CDC-collected data set based on a data use agreement. The data set is not publicly available. Requests to access these datasets should be directed to nvdrs-rad@cdc.gov.

Ethics statement

This study based on de-identified/deceased individuals was exempt from the authors' Institutional Review Board's review. Ethical review and approval was not required for this study in accordance with the local legislation and institutional requirements. Written informed consent was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

Both authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The relationship between gender, marital status and depression among Chinese middle-aged and older people: Mediation by subjective well-being and moderation by degree of digitization

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The purposes of this study were to investigate the effects of gender and marital status on depression among middle-aged and older people in China, and to explore the mediating effect of subjective well-being and the moderating effect of degree of digitization in the relationship between subjective well-being and depression. A total of 15,586 Chinese middle-aged and older people (≥45years old) were included in the study using data from the 2018 China Health and Retirement Longitudinal Survey (CHARLS). *T*-test, ANOVA, hierarchical regression and Bootstrap methods were adopted to test the mediating role of subjective well-being and the moderating role of degree of digitization. The results showed that middle-aged and older women were more likely to suffer from depression than men, and married middle-aged and older people were less likely to be depressed than those who were separated or divorced, widowed and never married. Subjective well-being partially mediated the relationship between gender and depression, and masked the relationship between marital status and depression, and all five dimensions it contains also played a mediating role. Degree of digitization moderated the effect of subjective well-being on depression. Simple slope tests indicated that the effect of subjective well-being on depression increased as degree of digitization increased. In conclusion, to address the mental health problems of middle-aged and older people brought about by the ageing and digital society, we should start by improving their subjective well-being and promoting their integration into the digital society.

KEYWORDS

depression, subjective well-being, degree of digitization, marital status, gender, middle-aged and older people

Introduction

The ageing population has become one of the common challenges faced by every country (United Nations, 2019). According to a recent United Nations report, one in six people worldwide is expected to be over the age of 65 (16%) by 2050, and the proportion of older people will double in some regions over the next 30 years, including North Africa, Asia and Latin America (United Nations, 2020). With the highest population and the largest number of older people in the world, China is now one of the countries with the fastest growing ageing population. According to the data of seventh national census of China, the population aged 65 years and above accounted for 13.50% of the total population in 2020, and it is estimated that it will reach 480 million by 2050, and the ageing level will rise to 15.5% (Lin, 2021). As can be seen, China's older population is increasing dramatically. In this context, the mental health and digital divide of middle-aged and older people (MAOP) have become two hot topics of global and society concern, and whether or not depression is an important evaluation indicator of mental health (Luijendijk et al., 2008; Wu et al., 2018). According to the 2019 report of the World Health Organization, it was estimated that about 350 million people worldwide suffer from depression, and the number of people with depression in China was close to 100 million (Wang et al., 2020). Domestic studies showed that MAOP are one of the populations with the highest prevalence of depression (World Health Organization, 2017). From 1980 to 2000, the prevalence rate of depressive in MAOP in China ranged from about 4.14 to16.55% (Cui et al., 2000; Meng and Tang, 2000), while by 2018, it was found that approximately 23.61% of MAOP surveyed had different degrees of depressive symptoms (Nianwei et al., 2021). Depression not only has an impact on the quality of life, ability of daily living, and cognitive ability of MAOP, but also increases the prevalence of cardiovascular disease (Seligman and Nemeroff, 2015) and suicide rates (Cui, 2015). The World Health Organization classified depression as one of the major factors leading to disability (Smith, 2014).

Among the factors influencing depression in MAOP, gender is one of the most frequently studied variables. The results of several studies showed that there are gender differences in depression, with women being significantly more likely to suffer from depression than men (Hyde et al., 2008; Nianwei et al., 2021). As of 2018, 43.61% of middle-aged and older women in China had depressive symptoms (Ye et al., 2021), that is, more than one-third of middle-aged and older women had depressive symptoms. During the COVID-19 pandemic, women exhibited more severe anxiety, depression, and acute stress symptoms than men (Garcia-Fernandez et al., 2020; Sampson, 2020) and older women may be in greater need of additional mental health support (Kirkman, 2020; Stevens, 2020). In addition, marital status is also a major influencing factor on the physical and mental health of MAOP. Although some studies have shown that married respondents are less likely to be highly happy, they have higher subjective well-being and lower depression than respondents who are divorced, separated, widowed, and never married (Ye et al., 2018; Becchetti and Conzo, 2022). Most studies on depression have treated subjective well-being as a significant predictor variable, whether it can cause a direct or indirect effect. Studies showed that high levels of subjective well-being not only promote physical and mental health and reduce loneliness and depressive symptoms in MAOP, but also can serve as an important indicator of successful aging and contribute to healthy aging (Kleineidam et al., 2019). Lower subjective well-being was the main risk factor for depression in MAOP. Meanwhile, it was found that subjective well-being of MAOP was influenced by factors such as gender, marital status, and education level (Patel et al., 2021). In terms of gender, middle-aged and older women may have lower subjective well-being than men. Compared with MAOP with spouses, those without spouses may have strong feelings of loneliness and lower subjective well-being due to the lack of emotional communication and spiritual comfort (Purol et al., 2021).

In addition, with the advent of the electronic information age, the Internet has penetrated into every aspect of people's lives, and the popularity of the Internet among MAOP is also increasing. According to the 47th China Internet Development Statistics Report released by the China Internet Network Information Center, as of December 2020, the proportion of older Internet users in China was about 260 million, accounting for 18.4% of the total population. It was predicted that at least a quarter of China's older population will be internet users by 2030, and Internet will be widely used among the older population by the middle of the 21st century (Zhai et al., 2016). The popularity of the Internet had a great impact on the lifestyles of MAOP, which not only broadened the contact between MAOP and their children, but also diversified their social participation and lifestyle entertainment. Studies showed that the use of the Internet could help alleviate loneliness among MAOP (Song et al., 2019), improve life satisfaction and subjective well-being (Shapira et al., 2007), and reduce risk of depressive symptoms (Chopik, 2016; Xiang et al., 2020). However, some studies found that the use of the Internet increased individuals' negative emotions such as anxiety and depression (Zhang et al., 2017, 2018), which was not significantly related to well-being.

Although there are many studies on depression in MAOP, most empirical studies mainly focused on the influencing factors of depression, and further investigation of the mechanisms and pathways of the role between gender, marital status and depression in MAOP is lacking. Therefore, by constructing a moderated mediation model, this paper proposed five hypotheses to explore the effects of gender and marital status on depression in MAOP through two pathways: the mediating role of subjective well-being and its five dimensions (life satisfaction, health satisfaction, marital satisfaction, child satisfaction, and air satisfaction) in it, and the moderating role

Abbreviations: MAOP, middle-aged and older people.

of degree of digitization between subjective well-being and depression. To better construct our research hypotheses, we began the analysis with a comprehensive literature review, summarized the current state of development of depression in MAOP globally and nationally, as well as existing results in terms of gender, marital status, subjective well-being and degree of digitization.

Theory and hypothesis

A cross-national epidemiological study covering the United States, Canada, France, Italy, New Zealand, Puerto Rico, West Germany, Lebanon, Taiwan, and South Korea showed that women were significantly more likely to suffer from depression than men (Weissman et al., 1996). Despite the influence of regional culture, most countries reported that in adulthood, the number of women with depression was about twice that of men (Nolen-Hoeksema, 2001; Lucht et al., 2003; Simo-Noguera et al., 2015; Iranpour et al., 2022). And a study during the COVID-19 pandemic showed that older women were 2.07 times more likely than men to report depressive symptoms and more likely to report anxiety and loneliness (Reppas-Rindlisbacher et al., 2022). According to emotional intensity theory, women reported higher levels of positive and negative emotions, had higher emotional intensity and reacted more strongly to the same events than men (Brehm, 1999). In reality, women were more negatively affected than men, had higher sensitivity to positive or negative events in life, and needed to take more time to recover to their previous level of health after experiencing negative shocks (Becchetti and Conzo, 2022). Therefore, depressive symptoms are easily triggered during prolonged negative emotions (Bullinger, 1989; Hewitt et al., 1992; Marques and Lima, 2011). Domestic studies showed that age has an "inverted U" parabolic shape on depressive symptoms in women. The peak age of onset of depression in women is 52 years old. With the increase of age, the symptoms of depression first aggravate and then alleviate. The peak age of onset is 50–60 years old (Li and Ma, 2017), that is, middle-aged and older women were more likely to have depressive symptoms (Wu et al., 2019). The study found that married women showed more mental symptoms, and their positive mental health level and perceived health status were lower than those of men (Shek, 1995). In most countries, people who were separated or divorced were markedly more likely to suffer from major depression than married people. Middle-aged and older men living alone showed more severe loneliness, depressive symptoms and suicidal ideation than women of the same age (Kim, 2017; Park and Choi, 2020), and widowed MAOP would have a stronger sense of loneliness (Ye et al., 2018; Van Tilburg and Suanet, 2019; Pan and Liu, 2021). The subjective well-being of MAOP who had never been married or had no children was not significantly different from that of married peers (Van Tilburg and Suanet, 2019). Subjective well-being was negatively and dramatically associated with depression. Therefore, based on the above research, we proposed the following hypotheses:

> *Hypothesis 1*: Middle-aged and older women are more likely to suffer from depression than men.

> *Hypothesis 2*: Married MAOP are less likely to suffer from depression than those who are separated, divorced, widowed, and never married.

Subjective well-being referred to a comprehensive and integrated assessment of the quality of life by individuals based on their own standards (Diener et al., 1999). It was an important indicator to measure people's quality of life and mental health (Oswald and Wu, 2010). Currently, instruments such as the Subjective Well-being Scale (Pavot and Diener, 1993), the Subjective Well-being Questionnaire for the Older (Chen, 2009), and the General Well-being Scale (Fazio, 1977) have been used to measure subjective well-being. According to the 2018 national baseline questionnaire of the China Health and Retirement Longitudinal Survey (CHARLS), the measures of subjective well-being in this study included "life satisfaction," "health satisfaction," "marriage satisfaction," "children satisfaction" and "air satisfaction." According to psychoanalytic theory, the main source of individual's happiness was their instinctive feelings, especially the great satisfaction of sexual instincts. Needs satisfaction theory suggested that subjective well-being depends on the satisfaction of one's physiological and psychological needs. Positive feelings were most associated with social and respect needs, and negative feelings were most associated with basic, respect and autonomy needs. Social need fulfillment exceeded an individual's fulfillment of their own needs in predicting subjective well-being (Tay and Diener, 2011). Therefore, considering the global gender inequality (United Nations Development Programme, 2016), women have lower subjective well-being than men on average (Richardson, 2021). However, it was also shown that there was no significant difference in subjective well-being between older men and women (Liu, 2011). Emotional support theory suggested that social networks could reduce stress and increase personal well-being through connections with family, relatives, friends and neighbors (Leung et al., 2011), while MAOP could have their social networks shrink due to retirement, declining health and the deaths of family members and friends (Bruce, 2002). In these circumstances, spouses often become the primary and important emotional supporter. Thus, MAOP with a spouse had significantly higher subjective well-being than those who were widowed (Lucas et al., 2003), divorced and separated (Perelli-Harris et al., 2019). Due to the decline of physical health and social support, MAOP may be more prone to strong feelings of loneliness and lower subjective well-being, which could lead to depressive symptoms. Therefore, it is important to investigate how subjective well-being maintains the psychological health and improves the quality of life of MAOP. Based on the above study, we made the following hypotheses:

> *Hypothesis 3*: Subjective well-being of MAOP plays a mediating effect between gender and depression.

> *Hypothesis 4*: Subjective well-being of MAOP plays a mediating effect between marital status and depression.

In 1999, the World Health Organization introduced the slogan "active aging" on the basis of "healthy aging," which aimed to prolong healthy life expectancy and improved the quality of life. In order to realize "active aging," the second World Assembly on Ageing proposed that older people should learn information technology to integrate into the digital society more quickly. Nowadays, digital society and the ageing population are two parallel trends, and the integration of older people and digitalization has gradually become a hot topic of general concern worldwide. The popularity of the Internet had a great impact on the lifestyle of MAOP. It not only expanded the mode of interaction with relatives and friends, but also improved their social adaptability (Wu and Peng, 2018). According to reinforcement theory, positive feedback on the consequences of people's behavior helped people to reinforce their behaviour (Skinner, 1958; Huang, 2012). The use of the Internet enriched the social interactions of MAOP, enhanced their social support, and increased their subjective well-being, thus accelerating the integration between them and digital society (Kraut et al., 2002). Therefore, Internet was a technological tool that enhances subjective well-being of MAOP (Pantic, 2014). Meanwhile, the use of Internet could help them build new friendships, maintain social engagement (Chen and Schulz, 2016), and reduce loneliness (Fokkema and Knipscheer, 2007; Khalaila and Vitman-Schorr, 2018). There was a significant positive association between loneliness and depression (Domenech-Abella et al., 2017). Consequently, the use of the Internet could improve the mental health of MAOP (Heo et al., 2015) and reduce the possibility of depression (Cotten et al., 2012; Reneland-Forsman, 2018; Hajek and Koenig, 2021). Based on the above research, we made the following hypothesis:

> *Hypothesis 5*: Degree of digitization plays a moderating role between subjective well-being and depression in MAOP.

In summary, based on the above five research hypotheses, the following model were constructed (see Figure 1).

Materials and methods

Data source

This paper uses the 2018 national baseline survey data of China Health and Retirement Longitudinal Survey (CHARLS) (Zhao et al., 2020). CHARLS, hosted by the National Development Institute of Peking University, aims to collect a set of high-quality micro data representing the MAOP aged 45 and above and their families to analyze China's ageing population. The CHALRS questionnaire was designed with reference to international experience from the Health and Retirement Survey (HRS) in the U.S., the Elderly Longitudinal Survey (ELSA) in the U.K., and Survey of Health, Aging and Retirement in Europe (SHARE). The questionnaire adopted multi-stage PPS sampling and used the electronic mapping software (CHALRS-GIS) technology pioneered by CHARLS to create a village-level sampling frame using the map method to list all dwelling units in a community, and then randomly selected a certain number of dwelling units. CHARLS was approved by the Biomedical Ethics Committee of Peking University (IRB00001052-11015), and each subject signed an informed consent form. The 2018 CHARLS survey interviews involved 17708 individuals from 10257 families, and was publicly released on September 24, 2020. Cross-sectional data were analyzed in this study, and MAOP aged 45 years and older were selected for the study, which ultimately included 15,586 individuals after removing a large number of missing data. The CHARLS data was used in this study not only because it has the required variable settings for the study, but also because it is strictly based on a sampling method and a large sample of MAOP, which made the results more representative.

Variable description

Variable selection

This paper first studied the differences in depression among MAOP by gender and marital status, and then explored the mediating effect of subjective well-being and the moderating effect of degree of digitization between subjective well-being and depression. Thus, the dependent variable is depression, and the independent variables are sex and marital status. We converted sex to a dummy variable, denoted by 0 (female) and 1 (male), and marital status to a multicategorical variable, categorized as married, separated or divorced, widowed, and never married. The mediating variable is subjective well-being, the moderating variable is degree of digitization, and the control variables are age, address and education level. Both independent variables are definite class variables, the mediating and dependent variables are quantitative variables, and the mediating variable is a definite order variable. The variables are assigned as shown in Table 1.

Depression

In this paper, the Epidemiological Survey Depression Scale (CES-D-10) was used for measurement. The CES-D 10-item short scale overcomes the problems of long response time and high refusal rate of respondents during the measurement of the original CES-Delderly 20-item scale. The scale has been widely used and has good reliability and validity in Chinese population (Huang et al., 2015). The Cronbach's alpha of this study was 0.805, and the reliability and validity were good. CES-D-10 consists of 10

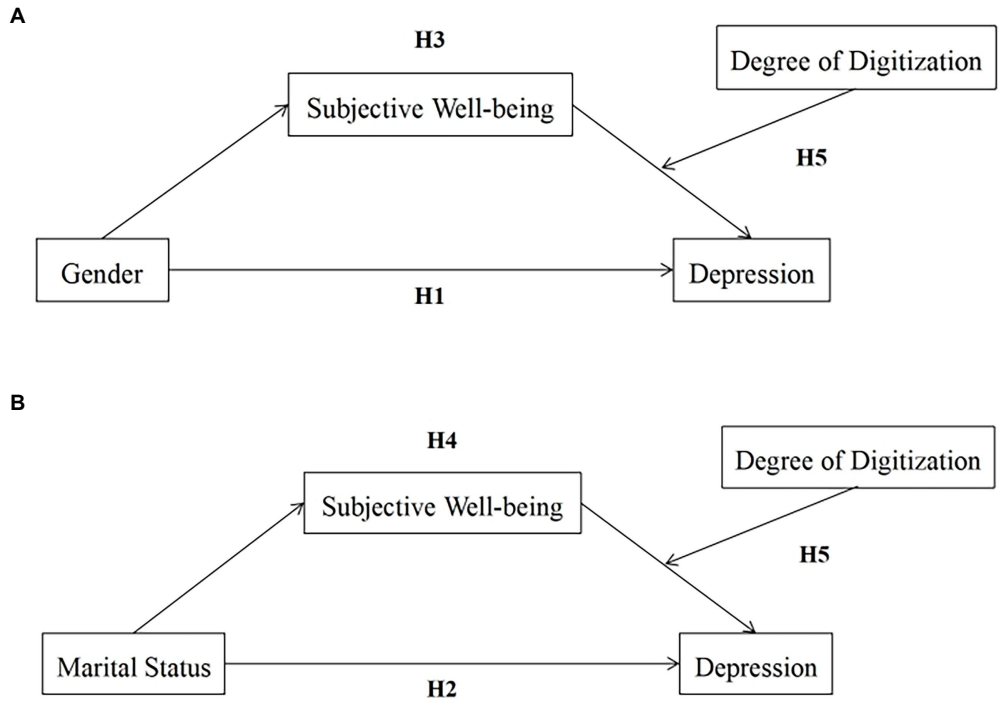

FIGURE 1
The hypothesized model: **(A)** Hypothetical model between sex and depression; **(B)** Hypothetical model between marital status and depression.

questions about the participant's past week experience, with consistent answers for each entry, including 0 points for little or none (<1d), 1 point for not too much (1-2d), 2 points for sometimes or half of the time (3-4d), and 3 points for most of the time (5-7d), with reverse scoring used for entries 5 and 8. The summary score ranges from 0 to 30, with higher scores associated with stronger depressive symptoms.

Subjective well-being

Based on the satisfaction questions included in the CHARLS questionnaire, this paper used five of these items in the questionnaire to measure subjective well-being, namely "DC028 How satisfied are you with your life-as-a-whole?," "DC042_W3 How satisfied are you with your health?," "DC043_W3 How satisfied are you with your marriage (relationship with spouse)?," "DC044_W3 How satisfied are you with your relationship with children?" and "DC046_W4 How satisfied are you with the air quality this year?" "Life satisfaction," "health satisfaction" and "air satisfaction" are measured on a Likert five-level scale, including "not satisfied at all "(1 point), "not very satisfied" (2 points), "quite satisfied" (3 points), "very satisfied" (4 points) and "extremely satisfied" (5 points). We, respectively, added "No spouse now" and "No child now" (0 point) to "marital satisfaction." The Cronbach's alpha for the five items was 0.653, which was higher than the minimum of 0.6, and is therefore reliable for measuring subjective well-being (Kline, 2011). We used a five-item summation method with scores ranging from 3 to 25, the higher the score, the greater the subjective well-being.

Degree of digitization

Five questions in CHARLS were used to measure degree of digitization. They are "DA056_10 Have you used the Internet in the last month?" "DA057_10 How often in the last month did you use the Internet?" "DA056_W4_2 Do you use mobile payments, such as Alipay and WeChat pay?" DA056_W4_3 Do you use WeChat?" "DA056_W4_3 Do you use WeChat?" and "DA056_W4_4 Do you post WeChat moments?" The answers to items 1, 3, 4 and 5 are "yes" (1 point) and "no" (0 point). The answers to Item 2 include "almost every day" (3 points), "almost every week" (2 points) and "not often" (1 point). The scores of the five answers were added together. The summary score ranges from 0 to 7, with the higher the score, the higher the degree of digitization.

Statistical analysis

SPSS 26.0 and R Statistical language 4.1.3 were used to analyze the data. First, we used independent samples t-tests, one-way ANOVA and chi-square tests to explore differences in depression, subjective well-being, and degree of digitization by sex and by marital status. A value of p of less than 0.05 indicated a significant difference. Then, mediating and moderating effects were tested by hierarchical regression. We examined the mediating effect of subjective well-being using PROCESS v3.5, which was indicated if the 95% confidence interval did not include 0. Second, we examined the moderating effect of the degree of digitization,

TABLE 1 Variable assignment.

Variables	Original question	Codes
Age	What's your date of birth on ID card or Household register?	1 = 45–54 years old; 2 = 55–64 years old; 3 = 65–74 years old; 4 = 75 years old and above
Address	What was the type of your address?	1 = The center of city/town; 2 = Combination zone between urban and rural areas; 3 = Village; 4 = Special area
Education	What's the highest level of education your have now (not including adult education)?	1 = No formal education (illiterate) or did not finish primary school; 2 = Sishu/home or Elementary school; 3 = Middle school; 4 = High or vocational school; 5 = Two-/Three-Year College/Associate or Four-Year College/Bachelor's degree and above
Sex	Interviewer record the Respondent's gender.	1 = Male; 0 = Female
Marital status	What is your marital status?	1 = Married; 2 = Separated or divorced; 3 = Widowed; 4 = Never married
Degree of digitization	(1) Have you used the Internet in the last month? (2) How often in the last month did you use the Internet? (3) Do you use mobile payments, such as Alipay and WeChat pay? (4) Do you use WeChat? (5) Do you post WeChat moments?	0 = No; 1 = Very weak; 2 = Weak; 3 = A little weak; 4 = general; 5 = A little strong; 6 = Strong; 7 = Very strong
Life satisfaction	Please think about your life-as-a-whole. How satisfied are you with it?	1 = Completely satisfied; 2 = Very satisfied; 3 = Somewhat satisfied; 4 = Not very satisfied; 5 = Not at all satisfied
Health satisfaction	How satisfied are you with your health?	1 = Completely satisfied; 2 = Very satisfied; 3 = Somewhat satisfied; 4 = Not very satisfied; 5 = Not at all satisfied
Marriage satisfaction	How satisfied are you with your marriage (relationship with spouse)?	0 = No spouse now; 1 = Completely satisfied; 2 = Very satisfied; 3 = Somewhat satisfied; 4 = Not very satisfied; 5 = Not at all satisfied
Child satisfaction	How satisfied are you with your relationship with children?	0 = No child now; 1 = Completely satisfied; 2 = Very satisfied; 3 = Somewhat satisfied; 4 = Not very satisfied; 5 = Not at all satisfied
Air satisfaction	How satisfied are you with the air quality this year?	1 = Completely satisfied; 2 = Very satisfied; 3 = Somewhat satisfied; 4 = Not very satisfied; 5 = Not at all satisfied

using the interaction term (subjective well-being × degree of digitization) to test whether it was significant, and if the interaction term showed significance, then a moderating effect of the degree of digitization was demonstrated. Finally, we performed a simple slope analysis and plotted the graph using R statistical language and ggplot2.

Results

Common method deviation test

Because the data in this study were obtained from subjects' self-reports, the data results are susceptible to common method bias. We used the Harman one-way ANOVA test for the presence of common method bias before data analysis (Podsakoff et al., 2003), and an exploratory factor analysis was performed on all topics of the study variables. The results showed that there were four factors with eigenvalues greater than one, and the explained variance of the first principal factor was 24.796%, which was below the critical value of 40%, indicating that there was no significant common method bias.

Descriptive statistics and analysis of variance

A total of 15,586 MAOP were included in this study. Among them, women (51.06%) were slightly more than men (48.94%). The majority of MAOP have a low level of education, with 38.77% of them indicating that they had not received education (illiterate) or not finished primary school. Most of MAOP (87.63%) were currently married and their spouses were still alive. The degree of digitization of them was low, and 85.08% of them did not surf the Internet. The overall subjective well-being of MAOP was good, with an average score of 16.116. The differential analysis of

TABLE 2 A differential analysis of sex, marital status, subjective well-being and depression (n=15,586).

		Depression			Subjective well-being		
		$\bar{x} \pm s$	t	p	$\bar{x} \pm s$	t	p
Sex	Male	7.30 ± 5.88	21.485**	0.000	16.43 ± 2.86	−13.087**	0.000
	Female	9.50 ± 6.85			15.82 ± 3.01		
		$\bar{x} \pm s$	F	p	$\bar{x} \pm s$	F	p
Marital status	Married	8.14 ± 6.32	73.025**	0.000	16.48 ± 2.72	719.453**	0.000
	Separated or divorced	9.74 ± 7.02			12.70 ± 3.07		
	Widowed	10.51 ± 7.27			13.82 ± 3.13		
	Never married	11.19 ± 7.22			9.45 ± 2.28		

*p < 0.05; **p < 0.01.

variables was given in Table 2. As shown in Table 2, MAOP of different sex showed significant differences for depression [t(15586) = 21.485, p < 0.01], and middle-aged and older women (M = 9.50, SD = 6.85) were more depressed than man (M = 7.30, SD = 5.88). Hypothesis 1 held. MAOP by marital status also showed significant differences for depression [F(3) = 73.025, p < 0.01], and *post hoc* multiple tests indicated that married MAOP (M = 8.14, SD = 6.32) were less depressed than those who were separated or divorced (M = 9.74, SD = 7.02), widowed (M = 10.51, SD = 7.27) and never married (M = 11.19, SD = 7.22), and Hypothesis 2 held. Both sex and marital status showed significant differences on subjective well-being among MAOP [t(15586) = −13.087, p < 0.01; F(3) = 719.453, p < 0.01]. Male (M = 16.43, SD = 2.86) had significantly higher subjective well-being than female (M = 15.82, SD = 3.01), and married MAOP (M = 16.48, SD = 2.72) had significantly higher subjective well-being than separated or divorced (M = 12.70, SD = 3.07), widowed (M = 13.82, SD = 3.13) and never-married (M = 9.45, SD = 2.28). Because sex, marital status and the five dimensions included in subjective well-being are categorical variables, we conducted chi-square tests before testing for mediating effects and plotted the distribution of responses for the five dimensions using R-4.1.3 and ggplot2 (as shown in Figure 2). As shown in Table 3, significant differences (p < 0.01) were observed across sex and marital status for life satisfaction, health satisfaction, marital satisfaction, child satisfaction, and air satisfaction.

The test of mediating effects of subjective well-being and its five dimensions

Because sex was a dichotomous variable in this study and both the mediating and dependent variables were continuous variables, a hierarchical regression was used to test for mediating effects. As shown in Table 4, the first time control variables (age, address, education level) and sex were added, and the results showed that sex had a significant effect on depression in MAOP (β = −0.136, p < 0.01). The second time, the dependent variable was changed to subjective well-being, and the results showed that sex also had a significant effect on subjective well-being (β = 0.644, p < 0.01); the third time, subjective well-being was added to the first time, and the results showed that subjective well-being also had a significant effect on depression (β = 0.879, p < 0.01). Therefore, subjective well-being partially mediated the effect between sex and depression, and Hypothesis 3 held. We used relative and overall mediators to analysis the mediating role of subjective well-being between marital status and depression (Fang et al., 2017). Model 4 in PROCESS v3.5 was used, with different marital status coded as dummy variables, bootstrap set to 5000, confidence interval set to 95%, and control variables, independent variables, mediating variable, and dependent variable were sequentially placed in the box to obtain the analysis results. As shown in Table 5, using the married group as a reference, the relative indirect effect of subjective well-being between the separated or divorced group and depression was 3.517, with a 95% bootstrap confidence interval of [3.144, 3.895], excluding "0," indicating a significant relative indirect effect. After adding the subjective well-being, the relative direct effect of separation or divorce on depression was −1.292, with a 95% bootstrap confidence interval of [−2.045, −0.539], excluding "0," indicating that the relative direct effect was also significant, but the two effect values were different, suggesting that subjective well-being played a masking role between the separation or divorce and depression. The relative indirect effect of subjective well-being on depression in the widowed group was 2.553, with a 95% bootstrap confidence interval of (2.371, 2.742), excluding "0," indicating a significant relative indirect effect. After the inclusion of mediating variables, the relative direct effect of widowhood on depression was −0.643, with a 95% bootstrap confidence interval of (−1.007, −0.279), excluding "0," indicating that the relative direct effect was also significant, but the two effect values were different, suggesting that subjective well-being played a masking role between widowhood and depression. The relative indirect effect of never married group on depression through subjective well-being was 6.643, with a 95% Bootstrap confidence interval of (6.100, 7.194), excluding "0," indicating a significant relative indirect effect. After adding subjective well-being, the relative direct effect of never married on depression was −4.376,

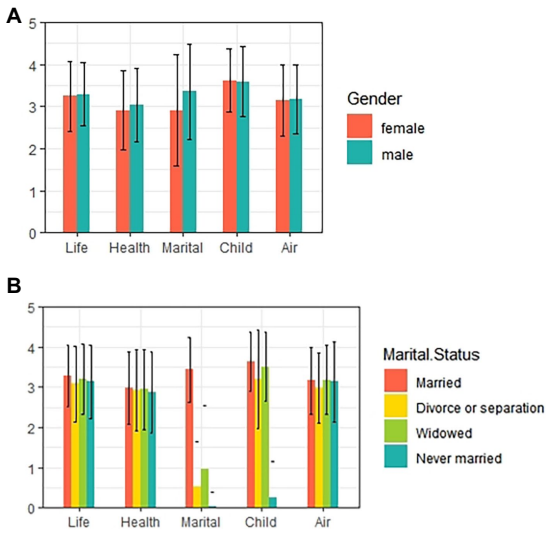

FIGURE 2
The distribution of five dimensions of subjective well-being: **(A)** Distribution in sex; **(B)** Distribution in marital status.

TABLE 3 The chi-square test between sex, marital status and the five dimensions of subjective well-being (n=15,586).

	Sex			Marital status		
	χ^2	p	Lambda	χ^2	p	Lambda
Life satisfaction	79.797	0.000**	0.000	90.378	0.000**	0.000
Health satisfaction	127.568	0.000**	0.000	49.512	0.000**	0.000
Marriage satisfaction	660.362	0.000**	0.024	10849.646	0.000**	0.126
Child satisfaction	80.100	0.000**	0.000	7835.912	0.000**	0.010
Air satisfaction	31.215	0.000**	0.000	45.498	0.000**	0.000

*p < 0.05; **p < 0.01.

with a 95% bootstrap confidence interval of (−5.975, −2.777), excluding "0," indicating that the relative direct effect was also significant, but the effect values were also different, indicating that subjective well-being also played a masking role between never married and depression, and Hypothesis 4 held.

To further investigate which dimensions of subjective well-being played a mediating role, we conducted chi-square tests between the independent variables and the five dimensions, and ANOVA between the five dimensions and depression. As shown in Table 6, significant differences (p < 0.01) were found across sex and marital status for life satisfaction, health satisfaction, marital satisfaction, child satisfaction, and air satisfaction. Because all five dimensions are fixed-order variables, the effect sizes were looked at according to Lambda indicators. The Lambda values between the variables were all less than 0.2, and the magnitude of the differences was small. The results of the ANOVA between the five dimensions and depression showed that all five dimensions showed significant differences (p < 0.01) for depression, with the η^2 for life satisfaction and health satisfaction for depression being greater than 0.14, which is a large difference. Thus, life satisfaction, health satisfaction, marital satisfaction, child satisfaction and air satisfaction all played a mediating role.

The test of the moderating effect of the degree of digitization

Model 1 in the PROCESS was used to test the moderating effect of the degree of digitization. Because both subjective well-being and degree of digitization are quantitative variables, they were centralized. The moderating effect was tested controlling for age, address, and education level (Table 7). The results showed that the product of subjective well-being and degree of digitization had a significant predictive effect on depression when degree of digitization was put into the model (t = 3.861, p < 0.01), indicating that degree of digitization played a moderating role in the prediction of depression by subjective well-being and that Hypothesis 5 was valid. To further examine the nature of the moderating effect, we conducted a simple slope analysis, as shown in Figure 3. The negative predictive effect of subjective well-being on depression was higher when MAOP were less digital (M-1SD), simple slope = −0.952, p < 0.01, and lower when MAOP were more digital (M + 1SD), simple slope = −0.836, p < 0.01, suggesting that the predictive effect of subjective well-being on depression diminished as the degree of digitization level increased.

Discussion

Gender, marital status and depression in MAOP

This study confirmed that there was a significant correlation between gender, marital status and depression in MAOP, with women being more likely to be depressed than men, and the married being less likely to be depressed than those who were separated or divorced, widowed, and never married, which is consistent with previous studies (Cheng and Jiang, 2017; Perelli-Harris et al., 2019; Reppas-Rindlisbacher et al., 2022). On the one hand, this may be due to the influenced by the differences of Chinese traditional culture, most MAOP live in the division of labor mode of "the woman stayed at home and the man earned the money." Compared to men, women are required to perform more domestic work and bear the stress of childbirth and childcare (Yang, 2014), and stress is a significant predictor of depression. In addition, the findings of this study are also consistent with the role conflict problem for women in role theory (Guoan, 2009). A study on feminism in China showed that when women encounter the

TABLE 4 The test of the mediating effect of subjective well-being between sex and depression (total and direct effects).

Variables	Depression				Subjective well-being				Depression			
	B	*SE*	*t*	*β*	*B*	*SE*	*t*	*β*	*B*	*SE*	*t*	*β*
Age	0.202**	0.054	3.732	0.030	−0.202**	0.025	−7.951	−0.060	0.025	0.050	0.502	0.004
Address	0.705**	0.066	10.750	0.089	0.082**	0.031	2.683	0.023	0.777**	0.060	13.005	0.099
Education	−0.900**	0.050	−17.961	−0.157	−0.021	0.023	−0.902	−0.008	−0.919**	0.046	−20.115	−0.160
Sex	−1.766**	0.104	−16.942	−0.136	0.644**	0.049	13.190	0.109	−1.200**	0.096	−12.561	−0.092
Subjective well-being									−0.879**	0.016	−56.399	−0.400
R^2				0.072				0.016				0.229
F				303.027**				61.657**				928.061**

*$p < 0.05$; **$p < 0.01$ and $N = 15586$.

TABLE 5 The mediating effects test of subjective well-being (direct and indirect effects).

Mediating effect path	Effect	Boot LLCI	Boot ULCI
Sex→Subjective well-being→Depression	−0.566[a]	−0.656	−0.479
Sex→Depression	−1.200[a]	−1.387	−1.013
Married group as control			
Separated or divorced→Subjective well-being→Depression	3.517[a]	3.140	3.900
Separated or divorced→Depression	−1.292[a]	−2.017	−0.566
Widowed→Subjective well-being→Depression	2.553[a]	2.371	2.738
Widowed→Depression	−0.643[a]	−0.965	−0.321
Never married→Subjective well-being→Depression	6.643[a]	6.097	7.195
Never married→Depression	−4.376[a]	−5.702	−3.050

LLCI, lower 95% level confidence interval; ULCI, upper 95% level confidence interval. a indicates that the direct effect or indirect effect is significant ($p < 0.01$). $N = 15586$.

problem of dual role conflict between family and work, women's work role often has to be subordinated to their family role, resulting in losing job and promotion opportunities, lowering their social status and sense of self-worth and making them more likely to become depressed (Xiong, 2010). On the other hand, women need to spend more time than men in alleviating the negative impact (Becchetti and Conzo, 2022). Therefore, middle-aged and older women are significantly more likely to suffer from depression than men. Previous studies showed that MAOP were at risk of shrinking social networks and social isolation after experiencing retirement or unemployment, and that the care and support of their spouses was an important resource to alleviate their psychological fallout and loneliness and reduced the probability of depression, so MAOP with spouses were less likely to suffer from depression than the divorced and the widowed (Eun and Hong, 2015; Cheng and Jiang, 2017), and our findings are consistent with this. For the separated or divorced, they feel little support in an unhappy marital relationship. The widowed are immersed in sadness and pain for a long time, and they all show more psychological symptoms such as depression and anxiety (Cheng and Jiang, 2017). Unmarried MAOP also experience strong feelings of loneliness and depressive symptoms due to the absence of a spouse and children. In the current COVID-19 pandemic, frequent fear and loneliness due to isolation make people experience more severe stress, anxiety and depression symptoms, especially women and older people (Gebhard et al., 2020; Liu et al., 2020; Mauvais-Jarvis et al., 2020) and therefore more social support is needed for them to maintain their mental health.

The mediating role of subjective well-being

The results suggest that subjective well-being partially mediates the relationship between gender and depression, i.e., gender not only has a direct effect on depression but can also have an indirect effect on it through the mediating role of subjective well-being, which is consistent with the majority of previous studies (Senik, 2017; Chen et al., 2019). Previous studies showed that gender was an important factor in subjective well-being, especially after middle age, when the subjective well-being gap between the sexes became more pronounced (Meisenberg and Woodley, 2015; Senik, 2017). In this study, middle-aged and older men had higher subjective well-being than women, consistent with previous findings (Richardson, 2021). A study that included 95 countries showed that subjective well-being was higher for women in 50 countries and for men in 45 countries, with women having higher subjective well-being than men on average, which correlated with the level of gender equality in the country (Arrosa and Gandelman, 2016). In recent years, the status of women in China has gradually increased, as has the degree of gender equality, and women are trying to move away from the traditional female role of "merely assisting their husbands and raising their children" and move more towards their own

careers. However, some studies found that high female employment rates or adherence to the value system of female employment may reduce women's well-being and subjective well-being (Meisenberg and Woodley, 2015), which may explain the findings of this study. Some studies also showed that there was no significant difference in subjective well-being between MAOP of different genders (Liu, 2011). Thus, the relationship between gender and subjective well-being is influenced by a number of factors. In this study, subjective well-being played a masking role between marital status and depression, that is, the effect of marital status on depression became stronger after the introduction of subjective well-being. This suggests that people's subjective well-being is an important antecedent of depression in different marital status. To our knowledge, this is the first study to find a masking effect of subjective well-being between marital status and depression. Numerous previous studies showed that marital status had a significant impact on subjective well-being (DeMaris and Oates, 2022). Married or cohabiting MAOP had higher subjective well-being than those who were widowed, divorced or living alone (Cheng and Yan, 2021; Jing et al., 2021), with good interpersonal relationships and family support being the main positive factors (Xing et al., 2010). However, some studies found that no significant difference in subjective well-being between MAOP who live alone, are unmarried, and have no children, and those who are married or cohabiting (Koropeckyj-Cox, 1998; Matsuura and Ma, 2021). Therefore, the relationship between marital status and subjective well-being is also somewhat controversial. In this paper, subjective well-being had a significant negative effect on depression, which is consistent with previous studies (Wood and Joseph, 2010; Chen et al., 2019). It has been suggested that an individual's physical and mental health is closely related to subjective well-being, and that the stronger the subjective well-being, the more positive the experience and the less affected by depression (Zhang et al., 2020). A longitudinal study found that people with low positive well-being were more than twice as likely to be depressed 10 years later than normal (Wood and Joseph, 2010). Therefore, improving the subjective well-being of MAOP is an effective means of reducing and preventing depression.

TABLE 6 ANOVA between the five dimensions of subjective well-being included and depression.

	Depression		
	F	*p*	Eta^2
Life satisfaction	910.897	0.000**	0.190
Health satisfaction	891.328	0.000**	0.186
Marriage satisfaction	305.316	0.000**	0.089
Child satisfaction	168.921	0.000**	0.051
Air satisfaction	56.04	0.000**	0.014

*$p < 0.05$; **$p < 0.01$.

Moderating effect of degree of digitization

This study confirmed that the degree of digitization plays a moderating role between subjective well-being and depression in MAOP, and that the effect of subjective well-being on depression increases with the increase of the degree of digitization, which is consistent with previous studies (Song et al., 2019; Jiang and Chen, 2021). This is mainly because on the one hand, with the continuous optimisation and upgrading of the Internet infrastructure and the deep integration of transport, healthcare and financial sectors with the Internet, the lives of MAOP are becoming more convenient and intelligent, which has improves their quality of life and subjective well-being (Yuqi and Tamura, 2020). On the other hand, the use of the Internet may enable MAOP to maintain close intergenerational ties and increase their sense of belonging to the community, thus contributing to their subjective well-being

TABLE 7 The moderating effect test of degree of digitization.

Variables	Model 1				Model 2			
	B	*SE*	*t*	*β*	*B*	*SE*	*t*	*β*
Age	−0.122*	0.050	−2.423	−0.018	−0.125*	0.050	−2.493	−0.018
Address	0.618**	0.060	10.254	0.078	0.611**	0.060	10.134	0.077
Education	−0.976**	0.046	−21.2	−0.170	−0.977**	0.046	−21.226	−0.17
Subjective well-being	−2.658**	0.046	−57.921	−0.410	−2.65**	0.046	−57.73	−0.408
Degree of digitization	−0.382**	0.051	−7.506	−0.059	−0.385**	0.051	−7.561	−0.059
Subjective well-being × degree of digitization					0.185**	0.048	3.861	0.027
ΔR^2				0.224				0.001
F				901.996**				14.908**

ΔR^2 refers to the added value of the proportion of the variation in the dependent variable that is explained by the regression equation as the new independent variable continues to enter the model. *$p < 0.05$; **$p < 0.01$.

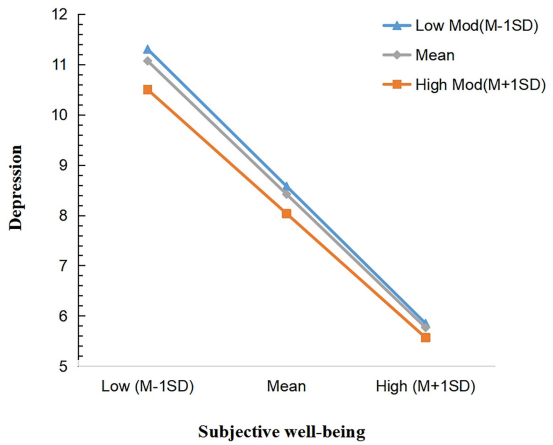

FIGURE 3
Simple slope analysis. The blue line represents a low level of degree of digitization and the orange line represents a high level of degree of digitization.

(Li and Zhou, 2021). Studies in some other countries also found that the use of the Internet has a positive impact on the subjective well-being of MAOP and helps to reduce their feelings of loneliness and depression (Jin and Zhao, 2019; Song et al., 2019; Li and Zhou, 2021). According to data from the 2016 Social Tracking Survey of Older People in China, watching news, chatting, and watching movies and dramas are the top functions most frequently used by older people. However, studies found that Internet use for learning is positively associated with subjective well-being, but Internet use mainly for gaming and leisure is positively associated with perceived stress, depression and anxiety (Prizant-Passal et al., 2016; Paez et al., 2020). Therefore, we suggest that MAOP should control the amount of time they spend online and use the Internet more for chatting, reading news and studying, and less for playing games and relaxing.

Strengths and limitations

This study had several strengths. First, to our knowledge, this study was the first to explore the mediating effect of subjective well-being between gender and depression, between marital status and depression, and the moderating effect of degree of digitization between subjective well-being and depression in MAOP. Our findings added information for effective prevention and intervention of depression in MAOP. Secondly, this study used a nationally representative sample, which better represented the real situation of MAOP in China and enabled the results to be generalised to MAOP across the country. There were some limitations in this study. Firstly, this study was a cross-sectional study. Despite the sample size of this study was both large and broad, it was difficult to dynamically reflect the relationship between sex or marital status and depression in MAOP. The findings of this study verified the differences and correlations between variables, but could not lead to a causal relationship between variables. Therefore, in future studies, longitudinal data can be used to examine the interaction between variables and whether sex and marital status have a persistent effect on depression, so as to better understand the causes of depression in MAOP. Secondly, the data included in this study were collected in a self-report format, and the use of self-report measures alone predisposes the findings to bias from recall and social expectations. Future studies should use multiple sources of information (such as children, spouses, friends, etc.) to collect data to enhance the reliability of the research results. Finally, in this study, subjective well-being played a partial mediating effect between gender and depression and a masking role between marital status and depression. Therefore, other mediating variables and moderating variables need to be considered in future studies to find more factors affecting depression, so as to prevent and reduce depression in the middle-aged and older.

Conclusion

This study focused on the relationship between sex, marital status and depression in MAOP, as well as the mediating role of subjective well-being and the moderating role of degree of digitization in the relationship between subjective well-being and depression. The results showed that sex and marital status had significant effects on depression in MAOP, and that sex and marital status could have an effect on depression through subjective well-being. The results also confirmed that the degree of digitization could moderate the effect of subjective well-being on depression, and the higher the degree of digitization, the stronger the effect of subjective well-being on depression, which was generally consistent with the results of earlier studies. Our study helps to expand the factors influencing depression in MAOP and reveal its mechanism of action, especially the effect of degree of digitization. It also helps policy makers and mental health therapists to better address depression among MAOP in China, and has important theoretical and practical guidance for preventing and reducing depression among MAOP.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found at: http://charls.pku.edu.cn/.

Author contributions

LZ: conceptualization, methodology, data analysis, writing-original draft, and visualization. YG: data analysis, methodology, formal analysis, supervision, writing-review and editing, project administration, and funding acquisition. KZ: data analysis and visualization. ZJ: data analysis and formal analysis. SH: conceptualization. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The effects of aging and perceived loneliness on lexical ambiguity resolution

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Language is central to the interactional nature of the social life within which it is situated. To react or respond in a particular situation, we must be able to recognize the social situation. Growing evidence has demonstrated the negative impact of perceived loneliness on late-life executive functions. Yet little is known about how social factors impact language processing for older people. The current study aims to fill this gap, first by assessing age-related changes in lexical processing during Chinese word reading, second, by examining whether older adults' individual differences, such as processing speed and verbal abilities, modulate meaning retrieval and, third, by investigating whether perceived loneliness can hinder word reading. The use of compound words in Chinese enables significant sublexical ambiguity, requiring varying executive load during word recognition: when a word's constituent characters carry multiple meanings, readers must consider the meaning contributions of both constituent characters and use top-down word information to determine the most accurate meaning of the ambiguous character, a process termed "sublexical ambiguity resolution." In this study, adults read real Chinese words (including both sublexically ambiguous and unambiguous words) and pseudowords, and they were asked to make lexical decisions. Older adults exhibited greater lexicality effects (i.e., real words were easier to be identified than pseudowords) and similar sublexical ambiguity effects compared with young adults. Among older participants, processing speed could account for their ability to differentiate between words and pseudowords. In contrast, the level of perceived loneliness modulated the efficacy of sublexical ambiguity resolution: the participants with higher perceived loneliness displayed a greater sublexical ambiguity disadvantage effect. These results indicate that perceived loneliness may affect the use of contextual information in meaning retrieval during reading. The findings provide an important link between social connections and language processing.

KEYWORDS

aging, perceived loneliness, sublexical ambiguity, reading, Chinese compounds

Introduction

As a social species, humans rely on a safe, secure social environment to survive and thrive. Language plays a prominent role in social interactions because we communicate our thoughts and feelings to others with language. Reading, as one of the language skills, not only has a great impact on communication and learning but is also one of the most appreciated leisure activities of older adults—one that could help them maintain functional independence. Therefore, reading ability has a significant impact on quality of life for older people.

Reading is a multifaceted process that spans sensory pattern recognition, memory access and attention control for meaning selection. As such, reading depends both on crystallized semantic intelligence that grows or is maintained through healthy aging, and on components of fluid intelligence such as information transformation and attention control that decline with age (Stine-Morrow, 2007). In line with this, aspects of reading that mainly rely on word-level knowledge, such as word associations and semantic priming, have been shown to remain stable with age (e.g., Burke and Peters, 1986; Burke et al., 1987). In contrast, more demanding processes, such as rapidly integrating lexical information to form coherent representations, have been found to be substantially altered in older adults (Meyer and Federmeier, 2010; Huang et al., 2012).

Ambiguity resolution in word reading involves not only recognizing the word but also recalling multiple potential meanings and eliminating contextually inappropriate interpretations. One orthographic form can be associated with multiple meanings, leading to a one-to-many relationship between a form and its referents. A deficit in ambiguity resolution would therefore be detrimental to daily language tasks, as lexical ambiguity is one of the most distinguishing features of written language (Rodd et al., 2002; Huang C. Y. et al., 2011). Many studies on word recognition in alphabetic languages in young adults have reported that words with multiple unrelated meanings hinder the word recognition process compared with unambiguous words, a phenomenon termed the ambiguity disadvantage effect (Frazier and Rayner, 1990; Klepousniotou, 2002; Rodd et al., 2002; Beretta et al., 2005; Pylkkänen et al., 2006; Klepousniotou et al., 2012). Given the well-recognized decline in older adults' executive function, one might expect that they would experience increased difficulty when resolving ambiguity compared with younger adults. Indeed, behavioral studies have shown that older adults have increased difficulty inhibiting contextually inappropriate meanings of homonyms (e.g., bank) compared with younger adults (Faust et al., 1997) when ambiguous words are embedded in a sentence. Studies of event-related brain potentials (ERPs) have further demonstrated that older adults are less likely to engage in controlled processes to revise an existing interpretation of ambiguous words to adapt to a change in contextual focus (Meyer and Federmeier, 2010). In Chinese, most words are compounds, and the constituent characters within a word can have different meanings on their own. When a Chinese compound word is visually presented, the semantic representations of both the entire word and the constituent characters are considered (Zhou and Marslen-Wilson, 1994, 1995). Thus, readers need to solve ambiguity at the character (sublexical) level using information derived from the other constituent characters and the whole word, termed "sublexical ambiguity resolution" (Huang C. Y. et al., 2011; Huang H. W. et al., 2011; Huang and Lee, 2018). Studies of Chinese word recognition in young adults have suggested that semantically unrelated morphemes are represented as separate entries (Huang H. W. et al., 2011; Huang and Lee, 2018). When retrieving the meaning of a sublexically ambiguous word, a competitive process occurs between multiple meanings. And thus, results have demonstrated a sublexical ambiguity disadvantage effect in reading (Huang H. W. et al., 2011; Huang and Lee, 2018)—words with multiple meanings at the sublexical level delay word recognition relative to words with one meaning. However, research into the effects of aging on Chinese word recognition remains limited.

Healthy older adults experience a general decline in physical and cognitive abilities with age. Yet, the rates of decline in behavioral and neurocognitive abilities have been shown to be highly variable within the older population (Li, 2003; Goh et al., 2012; Fan et al., 2019), highlighting the importance of considering such individual differences when studying aging populations. In addition to vocabulary, category verbal fluency, and processing speed, factors typically considered to influence word recognition performance (Shao et al., 2014), education has been suggested by the neurocognitive reserve hypothesis as a protector against the negative effect of aging (Stern, 2009; Cabeza et al., 2018; Huang and Huang, 2019). Many studies on the older population have observed the facilitatory impact of education on various language abilities, ranging from the lexical to the sentence level. At the lexical level, individuals with higher education perform better in picture naming (Inouye et al., 1993; Acevedo et al., 2007; Welsh-Bohmer et al., 2009; Constantinidou et al., 2012), demonstrate better word knowledge (Denney and Thissen, 1983; Inouye et al., 1993; Barnes et al., 2004; Acevedo et al., 2007; Welsh-Bohmer et al., 2009; Constantinidou et al., 2012), and show a smaller frequency effect in word recognition (Tainturier et al., 1992) than less educated individuals. At the sentence level, highly educated individuals respond to sentence stimuli more accurately (Mungas et al., 2005; Carvalho et al., 2009; Ferreira et al., 2015) than their less educated counterparts.

Perceived loneliness, or the perception of being socially isolated (Hawkley and Cacioppo, 2010), has been identified as a significant concern among elderly populations (Cacioppo et al., 2006, 2010). Forty percent of adults over 65 years of age report being lonely at least occasionally, and this number increases with age (Pinquart and Sorensen, 2001). The sudden COVID-19 outbreak and the prolonged pandemic that followed severely disrupted normal human social interactions and cultivated a heightened sense of loneliness (Kokou-Kpolou et al., 2020; Voitsidis et al., 2020; Wu, 2020). Research has shown that greater perceived loneliness is associated with reduced cognitive function in aging populations, particularly in terms of working memory and processing speed (Boss et al., 2015). A negative correlation has

TABLE 1 Participant characteristics.

Measure	Young ($N = 38$)	Older ($N = 50$)
Age (years)	22.21 (2.51)	66.38 (4.86)
Sex	20/38 women	36/50 women
Length of education (years)	—	14.62 (3.12)
Montreal Cognitive Assessment	—	24.66 (2.66)
Geriatric Depression Scale	—	6.12 (4.28)
WAIS-III (vocabulary)	—	49.56 (7.82)
Category verbal fluency	—	17.31 (2.23)
WAIS-III (digit-symbol coding)	—	68.68 (14.27)
UCLA Loneliness Scale	—	38.54 (8.22)

Means and standard deviations are reported. The standard deviation values are in parentheses. Data from young participants were extracted from Huang and Lee (2018). WAIS-III, Wechsler Adult Intelligence Scale, Third Edition.

also been reported between perceived loneliness and executive function (e.g., planning; Sin et al., 2021). Moreover, studies have reported a negative relationship between loneliness and verbal fluency (Schnittger et al., 2012), suggesting that a decrease in daily social interactions reduces language processing abilities. However, whether perceived loneliness influences ambiguity resolution in older adults has not yet been explored.

Therefore, to examine the effects of aging and loneliness on word recognition, we adapted the materials and procedures from Huang and Lee (2018) for use with neurologically normal older adult participants aged between 60 and 80. A lexical decision task (i.e., differentiating words versus pseudowords) was used, allowing us to differentiate age-related differences at both the word (lexicality effect) and sublexical (sublexical ambiguity effect) levels. Specifically, the lexicality effect refers to differences in response time and accuracy when differentiating between words and pseudowords. In contrast, the sublexical ambiguity effect refers to such differences between sublexically ambiguous words and sublexically unambiguous words. Given the general decline in physical and cognitive abilities that have been observed with age, we hypothesize that both the lexicality and sublexical ambiguity effects increase in older adults compared with younger adults. We then examined whether individual variations in word recognition and resolution of sublexical ambiguity are driven by differences in verbal abilities, processing speeds, or education levels among the elderly population. Finally, we examined whether perceived loneliness negatively impacts word recognition and sublexical ambiguity resolution.

Materials and methods

Participants

Fifty healthy, right-handed older adults participated in this study (for their demographic information, see Table 1). They were recruited from the local community. All of the participants were native Chinese speakers. The participants' psychological conditions were assessed using the Montreal Cognitive Assessment (MoCA; Nasreddine et al., 2005) and Geriatric Depression Scale (GDS; Yesavage et al., 1983). The participants who had a cognitive condition no worse than "mildly impaired" (i.e., scoring higher than 18 points in the MoCA, which is the cutoff point between "mild cognitive impairment" and "moderate cognitive impairment") and depression no worse than "mildly depressive" (i.e., scoring lower than 19 points in the GDS, which is the cutoff point between "mildly depressed" and "severely depressed") were included in the study. All participants passed the cognitive screening. This study was approved by the Institutional Review Board of Academia Sinica, Taiwan.

Lexical decision task

One hundred and twenty Chinese disyllabic compound words (i.e., words whose meanings are contributed to by the meanings of their constituent characters) were selected as experimental stimuli from the Academia Sinica balanced corpus (Huang and Chen, 1998). As an indicator of sublexical ambiguity, these words were evenly divided into two subsets according to the number of meanings (NOM) of their first character (one vs. multiple meanings; the NOM of the multiple-meaning subset ranged from 2 to 7). For example, 光腳 (kuang1 jiao3, *barefoot*) is a sublexically ambiguous word, whereby the first character 光 (kuang1) has at least three meanings (*light*, *naked*, and *simply*). In contrast, 糖漿 (tang2 jiang1, *syrup*) is a sublexically unambiguous word, as the first character 糖 (tang2) has only one meaning (*sugar*). The NOMs were collected from the Academia Sinica Chinese Wordnet. Potential confounding factors, including word frequency (WF) and orthographic neighborhood size[1] of the first character (NS1), orthographic neighborhood size of the second character (NS2)[2], and the NOMs corresponding to the second character were controlled (see Table 2). One hundred and twenty pseudowords were created by concatenating two real characters in such a way that the generated combinations did not appear in the word corpus or resemble real words in pronunciation. A list

1 Orthographic neighborhood size is the number of words that share the same constituent character at the same position. For example, 花園 (hua1 yuan2, *flower garden*) is an orthographic neighbor of 花市 (hua1 shi4, *flower market*), sharing the first character, and 都市 (du1 shi4, *city*) is an orthographic neighbor of 花市 (hua1 shi4, *flower market*), sharing the second character.

2 Although previous literature has suggested that the first constituent character plays a much more important role than the second one in reading Chinese words (Huang et al., 2006), we still try to match the orthographic neighborhood size of the second character. However, the NS2 for sublexically unambiguous condition (NOM=1) is slightly smaller than that for sublexcially ambiguous condition (NOM>1) in the stimulus set.

TABLE 2 Descriptive statistics of the lexical decision task.

Category	NOM	WF	NS1	NS2
NOM = 1	1.00	16.05	21.95	16.15
NOM > 1	3.05	16.20	23.75	21.55

Means are reported. NOM, number of meanings; WF, word frequency; NS1, orthographic neighborhood size of the first character; NS2, orthographic neighborhood size of the second character.

containing 10 real words and 10 pseudowords was constructed for the practice session.

Neuropsychological tests

A range of neuropsychological tests were used to assess the participants' verbal abilities, processing speeds, and perceived loneliness. Verbal ability was assessed using the vocabulary subtest of the Wechsler Adult Intelligence Scale-III (WAIS-III; Wechsler, 1997) and a category verbal fluency test (Chung et al., 2007). In the vocabulary test, the participants were asked to provide definitions for 33 words presented to them consecutively. The test would be terminated if a participant could not define six consecutive words. The score was calculated based on the number of correctly defined words and the quality of the definitions. In the category verbal fluency test, the participants were asked to produce as many words as possible in 1 min belonging to the categories of animals, fruits, colors, and place names in Taiwan, in separate sessions. The score was the number of correct and non-repeated words.

Processing speed was assessed with the WAIS-III digit-symbol coding subtest (Wechsler, 1997). In this test, the worksheet contained blank squares each paired with a number ranging from 1 to 9. Above these squares was a key row matching each number with a unique symbol. The participants were asked to write the symbol corresponding to the number associated with each blank square within 2 min.

Perceived loneliness was measured using the 20-item University of California, Los Angeles (UCLA) Loneliness Scale (Russell et al., 1980; Liu, 1993). This scale uses a 4-point Likert scale (1 = never to 4 = always), with higher scores indicating a higher level of perceived loneliness.

Procedure

A demographic questionnaire was used to collect the participants' age, job and length of education. Then, a set of neuropsychological tests and a lexical decision task were completed consecutively with intermissions.

For the lexical decision task, the participants were seated in front of a monitor in a soundproof room. They were instructed to put their index finger and middle finger on two designated buttons of a response box and look at the displayed words for comprehension and make a lexical decision (i.e., decide whether the displayed word was a real word or pseudoword, and press the corresponding button on the response box to indicate their decision) as quickly and accurately as possible.

Before each trial, a white plus sign appeared in the center of the monitor for 500 ms. The participants were instructed to focus on the plus sign and minimize blinking and eye movements. A blank screen was then displayed for a random period between 300 and 700 ms. Next, a word was displayed for the participants to make a lexical decision by pressing the button under their index or middle finger to indicate a real word or pseudoword, respectively. This display ended when the participants pressed a button or after 2000 ms if the participants made no judgment. After the word disappeared, a blank screen was displayed such that the total display time of the word and the blank screen was 2000 ms. The intertrial interval was 2,500 ms.

The experimental part contained 240 randomized trials and was evenly divided into four blocks. The participants spent around 5 min on each block and took a short break between blocks. Before the experimental trials, the participants completed a short practice session containing 20 trials to familiarize themselves with the task.

Statistical analysis

To examine the effect of aging, data from Huang and Lee (2018) describing 38 young adults were extracted and the performance of the older adults in this study were compared (for demographic information, see Table 1). These young adults carried out the same lexical decision task as in the present study. All of the participants were right-handed undergraduate students and native Chinese speakers. Mixed multi-factorial analysis of variance (ANOVA) was used to examine the effect of aging on the lexicality and sublexical ambiguity effects. These analyses each included two ANOVAs, with each ANOVA using either accuracy or reaction time in the lexical decision task as the dependent variable. Only the data corresponding to correct responses were included in the analyses. In terms of the lexicality effect, the two ANOVAs used age (older vs. young) as the between-subjects independent variable and lexicality (real word vs. pseudoword) as the within-subjects independent variable. Each participant's performance was averaged within each level of lexicality. The two ANOVAs for the sublexical ambiguity effect used age (older vs. young) as the between-subjects independent variable and sublexical ambiguity (unambiguous (NOM = 1) vs. ambiguous (NOM > 1)) as the within-subjects independent variable. Only the data corresponding to real words were used, and each participant's performance was averaged within each level of sublexical ambiguity. In cases where the interaction effect was significant, paired t-tests were conducted for each age group to determine whether the within-subjects variable varied significantly with age.

To assess the influence of individual differences such as education, verbal abilities, processing speed, and perceived loneliness on word recognition and resolution of sublexical

TABLE 3 Descriptive statistics of participants' lexical decision performance, grouped by age and lexicality.

Lexicality	Young		Older	
	Accuracy	Reaction time (ms)	Accuracy	Reaction time (ms)
Real word	0.96 (0.02)	627.09 (84.93)	0.91 (0.05)	921.16 (132.07)
Pseudoword	0.95 (0.06)	701.74 (92.35)	0.73 (0.24)	1306.28 (200.01)

Means and standard deviations are reported. The standard deviation values are in parentheses.

TABLE 4 Descriptive statistics of participants' lexical decision performance, grouped by age and sublexical ambiguity (i.e., NOM).

NOM	Young		Older	
	Accuracy	Reaction time (ms)	Accuracy	Reaction time (ms)
= 1	0.96 (0.02)	621.85 (80.33)	0.97 (0.05)	911.04 (132.29)
> 1	0.96 (0.03)	631.80 (91.51)	0.97 (0.05)	931.03 (134.18)

Means and standard deviations are reported. The standard deviation values are in parentheses. NOM, number of meanings.

ambiguity among older adults, multiple linear regression analyses were conducted using the length of education (ED), vocabulary test scores (VC), category verbal fluency test (VF), digit-symbol coding test (DSC), and UCLA Loneliness Scale (LS) as predictors. As higher education has become more desirable and valued in job recruitment in recent decades, a correlation between age and length of education may exist (i.e., younger people have received more education), potentially making age a confounding factor when examining the effects of education. Therefore, age was included as an additional predictor when constructing the regression models to allow us to examine whether the potential effects of education can be accounted for by age alone. Three dependent variables were incorporated to reflect word recognition performance: reaction time to real words, reaction time to pseudowords, and the sublexical ambiguity effect (the difference in reaction times to sublexically ambiguous words (NOM > 1) and sublexically unambiguous words (NOM = 1)). For each dependent variable, a multiple linear regression analysis was carried out using the forward hierarchical method. In this method, the predictor with the strongest correlation with the dependent variable enters the model first, and a newly entered predictor is retained if it adds significantly to the model. Otherwise, the predictor is excluded. Model comparisons were done using the *anova* function in *r*.

Results

Age-related differences in lexicality and sublexical ambiguity

When examining how aging affects the lexicality effect, a mixed multi-factorial ANOVA using accuracy as the dependent variable (see Table 3) indicated a significant between-subjects difference in age (F (1,86) = 25.748, p < 0.001), with older adults' accuracy being significantly lower than that of younger adults. Within-subjects differences in lexicality were also significant (F (1,86) = 38.643, p < 0.001), with the accuracy of the participants' responses to real words being significantly higher than those for pseudowords. Moreover, a significant interaction was seen between age and lexicality (F (1,86) = 31.124, p < 0.001). Further examination using *post hoc* tests for each age group showed a significant lexicality effect in older adults (t (49) = −6.91, p < 0.001), while this was negligible in younger adults (t (37) = −1.40, p > 0.05). The mixed multi-factorial ANOVA using reaction time as the dependent variable revealed similar results (see Table 3). The main effects of age and lexicality were significant (F (1,86) = 293.939, p < 0.001; F (1,86) = 231.732, p < 0.001, respectively), with older adults reacting more slowly and pseudowords prompting slower responses. The interaction between age and lexicality was also significant (F (1,86) = 105.667, p < 0.001). Further examination within each age group revealed significant lexicality effects for both age groups. However, the effect size (measured by Cohen's d) in older adults was larger than that in younger adults (t (49) = 15.1, p < 0.001, d = 2.14; t (38) = 8.56, p < 0.001, d = 1.39, respectively).

To examine how aging modulates the sublexical ambiguity effect, a mixed multi-factorial ANOVA using accuracy as the dependent variable (see Table 4) was used and showed that neither age, sublexical ambiguity, nor their interaction significantly affected accuracy (F(1,86) = 1.558, p > 0.05; F(1,86) = 0.064, p > 0.05; F(1,86) = 0.973, p > 0.05, respectively). In contrast, a mixed multi-factorial ANOVA using reaction time as the dependent variable (see Table 4) revealed significant effects of age and sublexical ambiguity (F(1,86) = 143.078, p < 0.001; F(1,86) = 19.937, p < 0.001, respectively), with older adults reacting significantly slower and sublexically ambiguous words prompting slower responses. The interaction between age and sublexical ambiguity was not significant (F(1,86) = 2.247, p > 0.05).

Individual differences in word recognition and resolution of sublexical ambiguity among older adults

To explore the effects of individual differences on word recognition, linear regression models were constructed to predict reaction times to real words and pseudowords. The resulting significant linear regression model in predicting reaction times to real words (F(1,48) = 17.87, p < 0.001, R^2 = 0.271, Adj. R^2 = 0.256) included only DSC as a predictor (β = −4.822, t = −4.228, p < 0.001). Interestingly, the inclusion of additional predictors did not significantly improve model performance. Similarly, the significant model in predicting reaction times to pseudowords (F(1,48) = 8.812, p < 0.01, R^2 = 0.156, Adj. R^2 = 0.138) also included DSC as its only predictor (β = −5.521, t = −2.968, p < 0.01). These

results suggest that a faster processing speed (i.e., better DSC score) can predict the speed of recognition of real words and rejection of pseudowords.

We similarly constructed a linear regression model to explore the effects of individual differences on sublexical ambiguity resolution. The resulting significant linear regression model in predicting the sublexical ambiguity effect ($F(1,48) = 4.483$, $p < 0.05$, $R^2 = 0.085$, Adj. $R^2 = 0.067$) only included LS as a predictor ($\beta = 1.179$, $t = 2.117$, $p < 0.05$). As such, the higher the loneliness score, the greater the sublexical ambiguity effect. This result suggests that loneliness significantly impacts efficacy in resolving sublexical ambiguity when reading.

Discussion

Visual word recognition across the human lifespan

At the word level, the results showed lexicality effects were significant in both younger and older populations. However, this effect was more pronounced in older adults. Greater lexicality effects in older adults may relate to the prolonged cognitive processes involved in discriminating words from pseudowords, as opposed to ambiguity resolution itself. This age-related difference is consistent with the common finding that older adults rely more on top-down lexical information during word recognition (Cohen-Shikora and Balota, 2016). Reading real words activates the word-level representations of these words in the mental lexicon, whereas reading pseudowords does not, as pseudowords do not have such representations. This word-level representation provides older adults with top-down information to aid the activation and recognition of constituent characters, improving their ability to recognize real words, in contrast to rejecting pseudowords, leading to a greater lexical effect. Our results are consistent with previous empirical findings from spoken word recognition: when older adults heard only the initial part of a word without any context, their recognition of this word was less accurate than young adults. However, providing context could narrow these differences between age groups (Wingfield et al., 1991).

At the sublexical level, ambiguity effects were similar among younger and older adults. Based on the behavioral results, this finding may suggest that older readers access the semantic representations of Chinese compound words through the morphemic representations of their constituent characters in a similar way to younger adults. When a constituent character has multiple meanings, the mapping of its orthographic to semantic representation is one-to-many, leading to the activation of multiple morphemic representations. This activation and the subsequent selection process cause a delay in word recognition. Initially, our observation of no significant age-related differences in the sublexical ambiguity effect appeared inconsistent with the results of previous studies (Faust et al., 1997). However, most studies have addressed ambiguity effects at the word level rather than at the sublexical level. The similarity in the sublexical ambiguity effect found between the two age groups indicates that older adults (as a group) can use whole word information efficiently to select the appropriate meaning for words containing an ambiguous first character. This overall pattern suggests that age-related changes in ambiguity resolution do not extend to the sublexical level.

Individual differences among older adults

When individual differences were considered among the older participants, predictors of visual word recognition at the word level and the sublexical level were significantly different. For real word recognition and pseudoword rejection, the only significant predictor was processing speed. In contrast, for sublexical ambiguity resolution, the only significant predictor was perceived loneliness.

Our finding that faster processing speed robustly predicts faster general word recognition (i.e., real word recognition and pseudoword rejection) is consistent with the findings of previous studies showing that processing speed accounts for variations in reaction times across a wide range of cognitive tasks (Verhaeghen and Salthouse, 1997; Yap et al., 2012), including age-related declines in language performance and processing (Kwong See and Ryan, 1995). It should be noted that although verbal abilities such as vocabulary and category verbal fluency did not significantly predict the speed of word recognition in our models, this does not mean that they are unrelated to word recognition. As our models were constructed with a forward hierarchical method, they only included predictors with independent contributions. Verbal abilities have long been known to be associated with word recognition performance, and this relationship would be evident if processing speed was controlled for prior to model construction (Yap et al., 2012; Shao et al., 2014).

It was surprising that education did not significantly predict general word recognition performance or sublexical ambiguity resolution, despite it being reported as a protector against the negative effects of aging (Stern, 2009; Cabeza et al., 2018; Huang and Huang, 2019) and a good predictor of various language functions (Denney and Thissen, 1983; Tainturier et al., 1992; Inouye et al., 1993; Barnes et al., 2004; Mungas et al., 2005; Acevedo et al., 2007; Carvalho et al., 2009; Welsh-Bohmer et al., 2009; Constantinidou et al., 2012; Ferreira et al., 2015). One possible explanation for this result may be that the length of education in our study (14.6 years on average) was slightly higher than in most previous studies examining the effect of education on language functions (Table 5). The reason may be that basic education in Taiwan was set at 6 years in 1943, while the 9-year compulsory education system was implemented in 1968. Furthermore, research has shown that children with 6 years of education in Taiwan can recognize 66% of high-frequency characters (Wang et al., 2008). Although we found no studies assessing children's literacy several

decades ago, the constituent characters of our word stimuli were of high frequency, and most of the word stimuli in the present research were likely to be familiar to our participants, which could explain why education was not a reliable predictor of word recognition in general and was not a sensitive measure for disentangling individual differences in the use of whole word knowledge while resolving sublexical ambiguity.

As education was not included in any of our regression models because of its insufficient independent contribution, we could not determine whether the potential effects of education were linked to age. However, the correlation between age and length of education among our participants was not significant ($r = 0.05$, $p > 0.05$), indicating that age is not likely to account for the effect of education on word recognition performance. This low correlation may be attributed to the age range of our participants, which was not wide enough to capture the changes in educational attainment over time.

The impact of perceived loneliness on visual word recognition

As for the level of perceived loneliness, it had no impact on the general response times for word recognition or pseudoword rejection. It did, however, uniquely modulate the sublexical ambiguity effect. The non-significant effect of processing speed on sublexical ambiguity effect suggests that it affects the recognition of words with different levels of ambiguity to a similar degree. When reading a sublexically ambiguous Chinese word, readers need to consider the meaning of both characters, form a coherent whole word meaning, and select the most appropriate meaning of the first character. Alternatively, our findings may suggest that insufficient social connections limit language use and may harm an individual's ability to inhibit irrelevant linguistic information. This view is consistent with the finding of Cacioppo et al. (2000) that lonely individuals display deficits in voluntary control of their attention and inhibition of distracting information. In their dichotic listening task in which the participants were asked to focus on the information presented to their subdominant ears, while the control participants made more correct responses to the information presented to their subdominant ears than to their dominant ears, the lonely participants' accuracy on the two kinds of information was not significantly different.

Perceived loneliness has been shown to have negative effects on the planning and working memory components of executive function in older adults (Sin et al., 2021); however, studies of its influence on other components of executive function relating to language processing (such as inhibition control) are scarce and their findings are inconclusive (O'Luanaigh et al., 2012; Schnittger et al., 2012; Shankar et al., 2013; Sin et al., 2021). Although perceived loneliness was shown to impact the efficiency of sublexical ambiguity resolution, indicating that it may affect the use of contextual information and inhibition processes in reading Chinese, the present study could not provide evidence on whether perceived loneliness has an impact on meaning activation or selection in ambiguity resolution. Given the prominent role of language in social interaction, more studies are needed to examine how social isolation and perceived loneliness impact language processing and its neural mechanisms.

TABLE 5 Descriptive statistics of length of education in previous studies.

Articles	*N*	Years of education
Verhaeghen (2003)	321	15.0 (1.4)
Acevedo et al. (2007)	89	11.9 (3.8)
Barnes et al. (2004)	664	15.0 (3.0)
Constantinidou et al. (2012)	231 (younger)	8.3 (4.3)
	128 (older)	7.2 (3.8)
Welsh-Bohmer et al. (2009)	507	13.4
Tainturier et al. (1992)	10 (high education level)	18.0
	10 (low education level)	10.7
Mungas et al. (2005)	527	9.3 (5.8)
The present study	50	14.6 (3.12)

In the "Years of Education" column, means, and standard deviations are reported. The standard deviation values are in parentheses.

Strengths and limitations

Our results showed that loneliness can have an adverse effect on visual word recognition. This finding advances our understanding of the role played by social factors in the cognitive vitality of older adults and underscores the importance of maintaining older adults' mental health. Older adults undergo transitions in their social lives after retirement or bereavement, which in many cases lead to social isolation and loneliness. Most recently, quarantine during the global COVID-19 outbreak led to prolonged social isolation, which may increase feelings of loneliness; therefore, loneliness is a critical public health concern that must be considered when using social isolation to combat the spread of the virus (Heidinger and Richter, 2020).

In our multiple linear regression analyses, we examined five predictors. According to Tabachnick et al. (2007), for such analyses the sample size should be at least 50 plus an additional eight participants per predictor. This suggests that our sample size of 50 was insufficient. To account for this, we used a forward hierarchical method when constructing our linear regression models so as to only include predictors with significant independent contributions. This means that the resulting models were parsimonious in terms of the number of predictors included. To check whether the power

of these models was adequate (i.e., above 0.8) with our current sample size ($N = 50$), we used G*Power (Faul et al., 2009). The power of our models in predicting reaction times to real words and pseudowords was adequate (0.99 and 0.84, respectively). However, the power of the model predicting the sublexical ambiguity effect was inadequate (0.56). With the current effect size of the predictor (LS in this case), we would need 86 participants to obtain a model with adequate power. Further work involving a larger study population is thus needed to construct a more accurate model for predicting sublexical ambiguity.

Conclusion

Overall, this study demonstrated that older adults as a group show a greater lexicality effect and a similar sublexical ambiguity effect in reading Chinese words when compared with young adults. We found that individual characteristics can influence basic visual word recognition, such that processing speed affects general word recognition times, but does not appear to affect the sublexical ambiguity resolution of Chinese words. The negative association between the level of perceived loneliness and the efficiency of sublexical ambiguity resolution found in the current study provides an important link between subjective distress and lexical processing, highlighting the importance raising awareness of the negative effects of loneliness in older adults, especially during the global COVID-19 pandemic, which led to prolonged social isolation.

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 Institutional Review Board of Academia Sinica, Taiwan. The patients/participants provided their written informed consent to participate in this study.

Author contributions

NZ analyzed, interpreted the data, and wrote the paper. C-MH allocated the funding, designed the study, interpreted the data, and wrote the manuscript. QC interpreted the data, and wrote the manuscript. OT allocated the funding, and interpreted the data. H-WH allocated the funding, designed the study, collected, analyzed, interpreted the data, and wrote the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Talking really does matter: Lay perspectives from older people on talking about suicide in later life

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Background: The cumulative body of research on suicidality in later life describes its unique and complex features in older people when compared with that in other population groups. Yet significant gaps exist in how research informs the further development of suitable interventions. The perspectives of older people are also limited in research findings.

Aims: Therefore, this exploratory study aimed to (1) identify potential barriers and enablers in discussing suicidal thoughts and their expression in later life from the perspectives of lay older people and (2) explore where opportunities might occur in approach, place, relationships, and language with older people to discuss suicidal thoughts and their expression.

Method: We conducted in-depth qualitative individual interviews with 15 people aged 70–89 years. This method helped explore older peoples' own lay perspectives on suicidal thoughts in later life and how these are expressed, and their understanding of where and how people might seek support.

Results: A total of three themes were generated from the dataset: (1) intergenerational and socio-cultural differences in suicide expression, (2) the normalization of suicidal thoughts in later life, and (3) the importance and difficulties of everyday discussion and opportunities to express suicidal thoughts.

Conclusion: Suicidal thoughts and their expression appear commonly and are normalized in later life yet remain taboo and hidden. The participants revealed how such thoughts and behaviors are typically expressed through colloquial or "off-hand" remarks and comments and the importance of authentic listening. The findings highlight the importance of more informal discussions around these topics and how care professionals, practitioners, and providers might frame opportunities for dialogue with people who may want to access support. Further engagement with community-informed participatory research methods in which older people provide their own perspectives and experiences is important in addressing these gaps. There is a need for

co-designing in developing screening, assessment, and signposting outside of clinical settings that can be used in everyday caring relationships with people in later life.

KEYWORDS

aging, suicidal thought, later life, self-harm, social care, health care, mental health, lay perspectives

Introduction

Suicidal behavior in later life remains a major public health concern (De Leo, 2022; Laflamme et al., 2022). Despite the decline in the suicide incidence globally, older adults continue to have the highest rates of suicide worldwide (Naghavi, 2019; World Health Organization, 2019). The high rates of suicide observed in later life is thought to be a consequence of the aging population demonstrating more determined and planful suicide acts, coupled with fewer warnings or detection of suicidal intent (Lachman et al., 2015). Prevalence may also be under-estimated and under-recorded due to its unique presentation in later life. Indeed, deaths in older people that result from more passive acts such as the voluntary stopping of eating and drinking (VSED) and suspending/refusing medication are unlikely to be formally investigated as potential suicide deaths or recorded in official statistics (Deuter et al., 2016; Hafford-Letchfield et al., 2020; De Leo, 2022). Unlike other regions of the world, in the United Kingdom, where this study was conducted, suicide is not a criminal act (*Section 2 of the Suicide Act 1961*), and assisted suicide and euthanasia are illegal (UK Parliament, 2015).

There is a cumulative body of theoretical and conceptual research exploring the topic of suicide and aging. This includes extensive reviews of the literature, which have examined, among other themes, the risk factors and characteristics of suicide and self-harm in older adults living both in the community and long-term care (Murphy et al., 2015; Wand et al., 2018; Gleeson et al., 2019; Troya et al., 2019). Reviews have also addressed our understanding of suicide intentions in older adults (Diehl-Schmid et al., 2017) and self-injurious behavior (Mahgoub et al., 2011), as well as the role of social factors in suicidal behavior (Chang et al., 2017). However, gaps remain in relation to how research can inform further development of prevention, intervention, and postvention in suicide expression in later life, given its unique and complex features, compared with suicide expression in other groups (Van Orden and Conwell, 2011). Later life can be a period when people experience dramatic changes in social status and role (Bernier et al., 2020; Hafford-Letchfield et al., 2020). Some researchers have engaged with the interpersonal theory of suicide (Joiner, 2005), which refers to thwarted belongingness and perceived burdensomeness, combined with an acquired capability for suicide (Van Orden et al., 2010). The need for a better understanding of processes leading to suicidal thoughts as separate to suicidal behavior has more recently been informed by the current drivers of suicide research toward the development of ideation-to-action frameworks (Bayliss et al., 2021). One key message is that recognizing triggers that cause older people to "give up" on life can be difficult (Azulai and Walsh, 2015; Hafford-Letchfield et al., 2020). A recent conceptual model described several (so-called "gray area") suicidal behaviors that might be considered unique to suicide expression in later life (Hafford-Letchfield et al., 2022a). Yet, these expressions are viewed by many as "normal" part of aging, with such behaviors often described as a "rational" response to an age-related decline in physical or mental function (De Leo, 2022). The conceptual model presented by Hafford-Letchfield et al. (2022a) described how an older adult viewing their life as "completed" could lead to the development of a wish to die and subsequently motivate engagement with a range of behaviors that either are self-destructive (e.g., self-neglect and problematic substance use) or hasten death (e.g., voluntary stopping of eating or drinking and refusing necessary medication).

Studies have also shown that many older people who had died by suicide had consulted a medical practitioner in a period close to their death, and that they had commonly presented with somatic or physical health issues (Harwood et al., 2000; Neufeld and O'Rourke, 2009). These physical health issues may mask psychological difficulties including suicidal thought. At the same time, however, people with an existential sense of completed life, or a wish to die, are less likely to be in touch with professionals, particularly clinicians (van Wijngaarden et al., 2019; Hafford-Letchfield et al., 2020). Further qualitative research on age-related factors on the traumatic impact of suicide bereavement (Hybholt et al., 2020) has demonstrated the relationship between grief and the lack of motivation to carry on and adapt to the physical and psychological effects of growing older. These impacts are also known to trigger suicidal thoughts and/or the wish for the hastening of the end of life (Hafford-Letchfield et al., 2022b).

The use of psychometrically sound screening tools is recommended as the best practice for targeting suicidal thoughts, allowing clinicians to effectively engage and uniformly assess those at significant risk (Rudd, 2021). However, the aforementioned "gray area" behaviors presented by older people may lead to missed opportunities for healthcare providers

to talk to these individuals about their suicide ideation and behavior (Shah and Erlangsen, 2014), particularly if the person has not received a diagnosis of depression. Gleeson et al.'s (2022) review of screening measures found that none of them actively included older people themselves in their development beyond item development (e.g., Edelstein et al., 2009; Carmel, 2017). Whilst the measures frequently included questions on social connectedness and support, none fully engaged with the theoretical issue of burdensomeness as a factor in determining suicide ideation. Furthermore, there is a question about how far the screening tools developed could be applied in the community and other groups of older people outside of clinical health settings, where the majority of people are living (Gleeson et al., 2022). In summary, the existing research highlights the need to raise more awareness of the breadth of suicide expression in later life and to foster greater sensitivity to how it might present. This understanding will serve to provide greater opportunities to recognize and respond to suicide-related expression and behaviors (Frost and Cowie, 2019). Further engagement with community participatory research methods in which the voices of older people can be heard based on their own perspectives and experiences is important in addressing these gaps. Likewise, moving toward co-design of any tools or models of practice could support practice with their utility and application (Gleeson et al., 2022).

Therefore, this research study aimed to directly explore older people's views and perspectives in response to the following research questions: (1) what are the potential barriers and enablers in discussing suicidal thoughts in later life from the perspectives of lay older people; (2) are there any unique factors associated with suicidal thoughts in later life that could aid recognition; and (3) what opportunities might occur in relation to approach, place, relationships, and language to discuss suicidal thoughts?

Methods

Study design

An exploratory design was used to determine and better understand the nature of suicidal thoughts in everyday life experienced by older adults. In-depth one-to-one interviews with lay older people through semi-structured interviews were conducted to gather information from key informants with personal experiences, attitudes, perceptions, and beliefs related to the key topics (DeJonckheere and Vaughn, 2019).

Ethics

All participants were from the United Kingdom, lived in their own homes in the community, and provided informed consent before participation. The study was approved by the local Ethics Committee (Ref: UEC21/67). Conducting research associated with suicide ideation and behavior can be challenging for participants and researchers, and careful consideration was given to minimize harm and, where possible, to maximize benefits to participants. Most of the researchers in our research team were registered professionals in social work, psychology, and mental health, and we paid attention to relational, embodied, and reflexive practice during the process of actual interview. The protocol included training for two team members from an approved provider on "talking about suicide" (Scottish Association of Mental Health), which was then cascaded to the team. This training was used to inform the protocol on how to respond and follow up with any participants who expressed suicide ideation or who had expressed suicide loss (see also Hafford-Letchfield et al., 2022b). A resource leaflet was developed signposting to organizations that provided support, and this was sent to all the participants by e-mail or post immediately after the interview. After 1 week of interview, all participants received a handwritten thankyou card and were reminded again of the resources provided and the importance of self-care.

For the participants, talking about suicide and aging can be sensitive, potentially stigmatizing and distressing (Jovicic and McPherson, 2020). The interview topics were designed to allow the participants to say as much as or as little as possible about their own experiences by framing questions in the third person and using open language, for example, "How would you describe?," "What is your understanding of?," and "What do you think would help?" (Naughton-Doe et al., 2022). The progression and timing of questions considered any potential for interview fatigue. The interview closed with a debriefing question "how did you find the interview today?", and participants were invited to contact author 2 if they wanted any more information after the interview had ended.

For the research team members, the protocol built in capacity for debriefing after interviews and self-care (SAMH, 2020). All team members were encouraged to share a one side briefing of key reflective points with colleagues following each interview to support debriefing. The team had access to a clinical psychologist outside of research supervision.

Recruitment and sampling

As the team was interested in lay perspectives, we recruited from the public *via* purposive and opportunity sampling. Lay people were targeted as we aimed to capture a broad range of insights and opinions from older people, irrespective of whether they had any direct or personal experience of suicidal thoughts and behaviors. Secondly, our aims encompass understanding how everyday interactions encourage more open conversations about suicidal thoughts. No prior personal experience in the

topic was required to participate. The team particularly targeted people aged 70 years and older, from a diverse range of backgrounds as these tend to be less represented in suicide research (Wiktorsson et al., 2016).

A poster describing the research and its purpose was drawn up and circulated both electronically and in a paper form. Recruitment information was disseminated through Twitter, e-mail, and by post to colleagues, acquaintances, and networks in the third sector and local public venues. The participants were offered a £20 gift voucher in recognition of the time they gave in participation. Recruitment took place over 4 months in 2021. Anyone who made contact was provided with a participant information sheet and invited to ask any questions. Subject to giving formal consent, the participants were invited to a one-to-one in-depth interview. The team faced several challenges in recruitment, which is not unusual in suicide research (Lakeman and Fitzgerald, 2009). For example, one community organization, working with people in later life, did not want to put the call for participants in their regular newsletter. They said that they only wanted to "promote positive news", given that people had been through a difficult time during the COVID-19 lockdown. Some contacts said that they did not want to pass the information on to people they knew as they anticipated that people would find the topic too upsetting to talk about, despite reassurances about the design and approval of the study. This was an important reference for the team in relation to the way in which society talks about and/or silences suicide and further highlighted the challenges in providing opportunities for older people's voices to be heard in suicide research.

Participants

A total of 15 participants aged 70 years and older were recruited to participate in the research (male = 10/15).

Interview data collection

Pre-interview participants were asked to complete a short online demographic questionnaire to capture their key characteristics. The interview topic guide comprised open-ended questions informed by the research questions and literature review and were framed to facilitate sensitive conversations and engagement, which included topics such as people's immediate thoughts and reflections on what is meant by suicidal thoughts in later life, what might trigger them, how they might be expressed, and why people talk about it or not. We also explored what people understood by the term "self-harm", what this looked like in later life, as well as the barriers and enablers for talking about these issues, and who could help, when, where, and how? We did not adopt any definition of self-harm in terms of intent or otherwise. Questions were framed to capture an everyday lay understanding and observations from people's experience. During the interviews, the participants were asked not to mention any identifiable names or places.

The topic guide was piloted with one person (aged 82). The data from the pilot was included in the data analysis as no changes to the topic guide were made following the pilot interview.

All interviews took place remotely due to COVID-19 restrictions. The participants were given the choice of Zoom, WhatsApp, or telephone. Interviews were audio recorded with consent and ranged in duration from 30 to 74 (mean = 53) min.

Approximately one-third of participants wrote spontaneously to various team members by e-mail following the interview stating that they wished to provide further information. These communications appeared to be triggered by not having been used to talking about the topic, with participants realizing that they had since had more to say. Permission was sought to use these further data in the analysis/write up.

Data analysis

The interview data were professionally transcribed and anonymized and subject to inductive reflexive thematic analysis (Braun and Clarke, 2012; Clarke and Braun, 2017), which was a theoretically flexible interpretative approach to analysis. A total of two team members (THL and TE) read every transcript separately to familiarize themselves with the interview data and made some initial notes on potential data items of interest, questions, connections between data items, and other preliminary ideas. Then, they manually coded the data, initially by using open coding, noting common phrases and words. Discussion took place after these phases to identify potential categories and subcategories of data ground in the participants' voices. Finally, having gone back to identify linkages across the transcripts and between different categories, further discussion and refinement of these resulted in the identification of three broad themes. The team retained audit trails evidencing decision-making throughout the analytical process. This approach was in line with quality criteria reporting (COREQ; Tong and Sainsbury, 2007) and was undertaken to improve the trustworthiness and credibility of the research process (Shaw et al., 2019). Figure 1 describes the thematic schema from the data with a brief description of the theme and some of the key areas developed from the coding categories.

Results

Table 1 shows the characteristics of the 15 participants. One-third of the participants were 85 years or older, two-thirds were

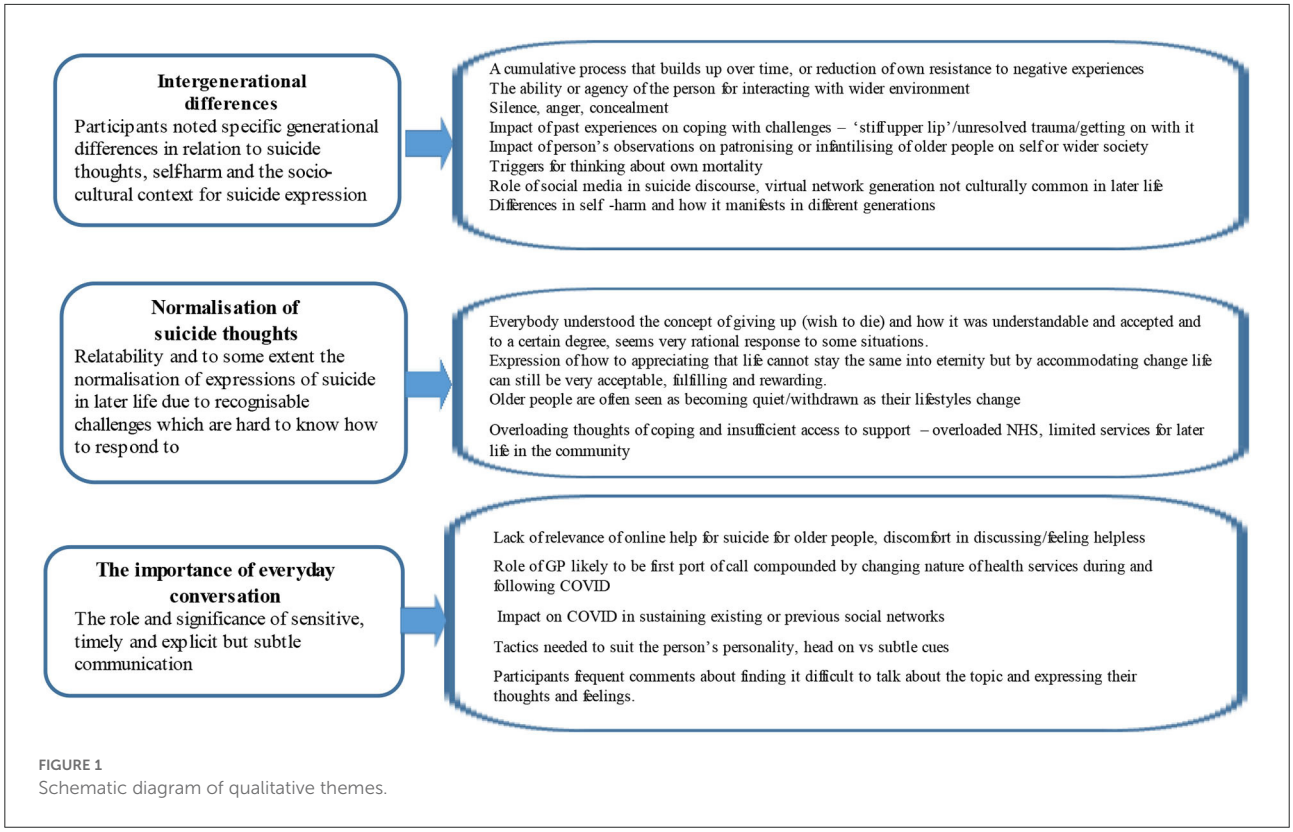

FIGURE 1
Schematic diagram of qualitative themes.

TABLE 1 Characteristics of sample ($n = 15$).

Country of resident in UK		Age range		Ethnic origin		Religion	
England	11	70–79 yrs	5	Asian Indian	1	Christian	9
Scotland	3	80–84 yrs	5	White English	6	Judaism	2
N. Ireland	1	85–89 yrs	5	White Scottish	3	Protestant	1
		White British	2	Agnostic	3		
		White other (American/Jewish)	3				
Sex		**Gender identity**		**Sexual identity**		**Disability**	
Male	10	Cisgender	15	Lesbian	1	Yes	5
Female	5			Gay	2	No	10
				Bisexual	2		
				Heterosexual	10		

male, and one-third of the sample identified as lesbian, gay, or bisexual.

A total of three themes were identified: (1) intergenerational and socio-cultural differences in suicide expression; (2) the normalization of suicidal thoughts in later life, and (3) the difficulties and importance of discussion (described by some participants as everyday informal conversation), in spaces and relationships where suicidal thoughts are expressed.

Theme 1: Intergenerational and socio-cultural differences in suicide expression

The first theme captured participants' observations about the specific generational differences in relation to suicidal thoughts, presentation of self-harm, and the socio-cultural context for expressing suicidal thoughts and any behaviors that follow. It

was clear that participants viewed suicide expression in older adults to be unique when compared with other age groups.

Firstly, participants discussed the intergenerational differences in the triggers of suicide expression. The participants spoke about how suicidality in younger generations may be more likely to reflect a "crisis situation", whereas in older adults, this may be more likely to reflect an existential recognition that one's life is "coming to an end". The participants spoke about how they felt that suicidal thoughts in older adults are more likely to be the consequence of a prolonged or chronic life stressor, rather than an acute response to an acute stress. Commonly discussed examples included chronic pain, disability, and loneliness. As one participant said,

> *I think there comes a time for most people that they feel they're coming to the end, that they've done enough, and it's their sort of time. [. . .] Purpose and meaning always comes up for me in life.* (70–74 yrs)

The participants gave many examples of commonly used phrases that older people used to express suicidal thoughts when interacting with their peers. Some were explicit such as "I'm ready to go now," "I'm tired of life," or "What's the point anymore?" How and when to pick up on these phrases were discussed by the participants as a crucial but challenging step in helping to identify those at risk for suicide and starting a conversation around these topics. The participants also discussed ambiguity around making the distinction between throwaway comments made to start a discussion and statements of serious intent:

> *I do sort of feel in older people, really, that, well there must be two things, there must be those people who feel, now is my time, and I really want to go, and there must be the other people who, it is a cry for help, and they're wanting an opportunity to discuss it.* (70–74 yrs)

Another clear difference related to the specific behaviors that older people would engage in if they sought to harm themselves and how this might not be easily observable when compared with behaviors observed in other age groups is quoted as follows:

> *Self-harming, I think, people self-harm in different ways, they don't have to cut themselves, but they do like to get drunk, I would call that a self-harm. It's getting out of what's happening now. I don't know, they might take some tablets that might make them go to sleep for a while and keep doing that. But, self-harming with kids, where they get the razor and cut their arms, and such things like that, yeah, that's a little different.* (80–84 yrs)

An "overt" range of expression of self-harm (e.g., cutting oneself) noted in younger people was contrasted with non-overt, self-neglectful expressions of self-harm in older adults. Here, participants were more likely to include terms such as "giving up", "shutting the world out," deliberately not looking after oneself, stopping eating or drinking, refusing to take important medication, or otherwise engaging in unsafe or destructive behaviors, for example, excessive drinking or alcohol or knowingly eating high-sugar foods if the person was diabetic and at risk of developing complications. Whilst these may not lead to suicide directly, these were seen as an expression of suicide. The participants felt that a whilst a direct intent to end one's life might not be evident, the cumulative effect or a lack of care for one's life could nonetheless hasten death. However, as these expressions are often difficult to identify and spot identifying this expression, identifying these "*. . . would take someone who knows them well and perceives the change in their behavior and attitude*" (80–85 yrs).

Furthermore, generational differences in expressing suicidal thoughts and associated actions were perceived to be influenced by the role of social media in the suicide discourse where the (younger) virtual network generation is active in engaging with information online, exchanging experiences with people they may not personally know. These were noted as being culturally alien for people in later life, not only because of lesser access or familiarity with virtual networking but also due to a cultural influence. Older people were seen as stalwart and more resilient and would be expected to manage or cope without involving others unnecessarily. It was commonly stated that older people might take their feelings and problems to somewhere more familiar and that suicidal thoughts may manifest in different ways.

The experience of stigma was also evident within this theme. Some participants shared their observations of how the patronizing or infantilizing of older people can increase their vulnerability if they were already experiencing suicidal thoughts. One participant particularly noted the vital importance of *how* a professional demonstrated empathy. Again, there were intergenerational differences as "*professionals have never actually experienced being old, they can only say what they think is best for people in later life whereas at the other end, most people have been a teenager themselves*" (75–79 yrs). Another example was given of the random "cruelty in older life" (80–84 yrs). This individual spoke of his own reaction to receiving the standard letter from the U.K. Government Driving Vehicle Licencing Authority sent to all people aged 70 years removing license for driving in all categories of vehicle, except cars. As a recipient, he found the letter arbitrary and "stark" with a message that people his age are "now useless and losing their freedom". This was described as one of the messages from society to older people that not only is a personal loss of potential independence but signals how people by merit of their chronological age alone are cut off by society.

Many participants also highlighted the importance of past experience of trauma in influencing mental health and suicidal thoughts in later life:

> *Secrets are like stones, they weigh you down, and if you… get rid of them, you'll float. But otherwise, you'll drown, and yeah, I mean, people say, oh, I deal with it by hiding it away. Well, no, it's going to come back and bite you. One day, sooner or other, you'll pay the price for that. I think of some of the people that I've worked with through Citizens Advice who've had dreadful experiences in their early years and continuing into adulthood that have not been addressed. It's that late disclosure of stuff that went on earlier, and that can happen right up'til much older people. There's been stuff recently, hasn't there, about the women whose babies were adopted when they're against what they wanted, and they've carried that through forever.* (70–74 yrs)

The references to past trauma from participants, which may be very much seen as taboo, were again described as a generational difference. Older people may not have had access to support, which is more commonly within the reach of younger generations, such as talking therapies, support groups, and through media or social media. This was thought to be more a potential cause of a person becoming silenced, experiencing anger turned in on themselves, and subsequent concealment of suicidal thoughts in later life.

Many of the participants touched on the pandemic by talking about having their wings clipped when time is limited. This led to a need to go out and make the most of opportunities, where possible, post-pandemic because of having glimpsed the potential restrictions that had disproportionately impacted on those in later life and the public response to it. Some participants spoke in detail about the lockdown experiences and the homogenization of older people that had exacerbated any vulnerabilities, and the inevitable overloading thoughts combined with less coping strategies and insufficient access to support. One participant who spent 46 years in an unhappy marriage said,

> *he really has destroyed my morale, and with what's gone on in the past 18 months, I don't feel like I want to go on very much further, to be very honest, I don't want to kill myself, but I get to some days where, is this really worth it? And I don't know how many people out there feel like that at my age, but I'm sure there are.* (80–84 yrs)

Theme 2: Normalization of suicidal thought in later life

This theme concerned the relatability and, to some extent, the normalization of expressions of suicide in later life. Whilst only a few participants shared some of their own experiences of suicidal thoughts, the majority provided many examples of their interactions with peers who experienced suicidal thoughts. Whilst this was experienced as a challenge that they felt very unsure about, the participants generally agreed that suicidal thoughts were understandable and even acceptable in later life. The participants also discussed how, to a certain degree, such thoughts seemed a very rational response to some situations that people faced. For example, as one participant said,

> *Giving up, giving in. They're different, but when does one actually lead into the other? And at what point does the idea of keeping on, keeping on, keeping going… which I think many older people have this tremendous capacity to keep going, but does there comes a point at which this seems to be too much of an effort, it seems counterproductive.* (75–79 yrs)

This normalization of suicidal thoughts came from participants' frequent observations of friends and older family members making "off-hand" comments, such as "you don't need me around anymore" or "my time is up", which they believed to imply that the individual was engaging in suicidal thoughts. Whilst the participants acknowledged that suicidal thoughts are less likely to be recognized in professional interactions between older people and carers or healthcare providers, these thoughts were more commonly recognized in their peer groups such as within friendships and social circles. Indeed, some participants spoke about openly discussing suicide and suicide ideation with their friends:

> *The conversation ranges quite widely, and I'm trying to think if we've talked about suicide, and whether we should? And I certainly have a group of friends I know would not be uncomfortable discussing suicide, in the way you and I are now, as another life option, although that might sound a silly thing to say. We're very aware that we have physical problems that have changed our lives, and I think particularly, I'm 75, I think we're noticing very much that our life changes quite dramatically at this age.* (80–84 yrs)

Throughout the interviews, it was apparent that discussions about suicidal thoughts among peer members appeared normalized. Another participant who e-mailed the interviewer post-interview clearly illustrated some of these introspective and prospective considerations of these life course changes and a natural sense of finitude and the inevitabilities of how suicidal thought becomes normalized:

> *For me as I have entered each new decade there have been changes. Looking back to my 20's, 30's, 40's, I had boundless energy, and it was easy to follow my dreams. Jobs were plentiful, opportunities there for the taking, no internet to absorb time or influence one. Lifelong friends were established, and discussions focused on planning experiences together, having fun and traveling to explore the world. It felt as if you could achieve whatever you chose to follow. Entering my 7th decade felt like a real marker in terms of thought*

> *processes, and discussions with friends of similar age turn to the inevitable time limit of years ahead of me. I no longer see time stretching out before me but have a realization that years are limited which focuses my mind on how to use the time I have left, and I have concentrated on living in the moment as much as I can. There is a sense of loss, grief and change with this decade and with that some feelings of depression and giving up.* (70–74 yrs)

This expression of appreciation that life cannot stay the same but by accommodating change, one's expectations would have to change, was a theme that ran throughout several interviews. Whilst there was some degree of othering, the participants were easily able to be in the shoes of their peers, and this relatability to experiencing suicidal thoughts was very much present. These findings are in line with the life review literature that has highlighted that it is the important role of personal meaning that is attributed to past events that are relevant to how we regulate our identity and wellbeing (e.g., Butler, 1963; Bluck, 1998; Westerhof, 2014; Adler et al., 2015).

A 77-year-old man referred to how losing a loved one or friend was very common in later life and could be more devastating if a person had not developed a wider range of friends, diverse interests, and hobbies separate to their relationship with a partner. He spoke of having experienced the death of his wife and how focusing his energy on following his own interests had helped him through the grieving process (75–79 yrs).

Theme 3: The difficulties and importance of discussion

Despite the apparent normalization of suicidal thoughts, many participants made frequent comments about finding it difficult to talk about suicide and to express their thoughts and feelings surrounding suicide, especially in a formal setting. The key message within this theme was the importance of both being able to adapt to the individuals' personality and being able to pick up on subtle cues when discussing suicide-related thoughts and behaviors. The participants particularly highlighted the importance of everyday informal talk. These allowed the discussant both to acknowledge the personal as an individual and to tread the fine line between their right to autonomy and their right to support. These difficulties and importance of discussing suicidal thoughts with older adults appeared related to generational issues about discussing "feelings" and "emotions", due to "stiff upper lip upbringings". For example,

> *Well, I suppose it can be quite difficult for older people who are not used to sharing their emotions or talking about their emotions. They find that very difficult. They've been brought up to keep a stiff upper lip and not to think too much about themselves really. Well, a lot of them don't even understand their feelings.* (86–89 yrs)
>
> *I think with us older generation, we came up just after the war, like 70s above, we're what we call the war babies. And the people above us are the people that lived through the war and whatever went on. And in those days, you got on with it. [. . .] you got on with life, you had to.* (80–84 yrs)

The participants spoke about many older people feeling "stigma" and "shame" when discussing mental health, and how asking for help is seen as a "sign of weakness". Those participants who had experienced mental health problems said how stigmatized they were within their own generation even though mental health was now commonly talked about in the media. Despite this, the importance of tackling these difficult points of discussion was highlighted throughout the dataset. Just because some older people may find it difficult to discuss these topics, it does not mean that they do not want to seek help:

> *The younger ones can be prepared to reach out. Again, they've not had the upbringing where it's a sign of weakness to reach out. That is the important one, with the caveat being that, again, the older person can still have the feelings, emotional feelings, deep down that they do want help.* (75–79 yrs)

The participants referred to a lack of relevance of online help for suicidality for older people, and the discomfort in discussing/feeling helpless. Most of them cited the role of GPs who were likely to be first port of call compounded by the changing nature of health services during and following COVID. Whilst the GP was commonly cited as a source of help-seeking across the interview, there were some reservations about the limitations of places where people could go:

> *No, I don't actually, because in the first place, being absolutely cynical, I think they'd find out after a lifetime of GPs that, really, they're not going to get much help, are they, from the National Health Service side of things, or there is a very limited help available. And what they perceive that they need is perhaps not a medical. . . they don't consider themselves as being medically needing help, so they wouldn't sort of say to their GP. Because you know, if you go to your GP and you say, I'm depressed, well, she'd just write you out a prescription for tranquilizers, won't she? But she won't go into deeper detail, but why are you depressed; because the reason you're depressed and you're lonely is because you haven't got enough money, where you live is perhaps inadequate, and you don't have enough social interaction with other people. And your GP can't do anything about that, can she?* (80–84 yrs)

The participants spoke about using "person-centred" and easy-to-understand language to initiate these conversations. Prompts such as "I've noticed that you seem quite low, have I got that right?" and "Come on a walk with me, I want to hear how you have been recently" were identified as potentially useful ways to broach these potentially challenging topics. Friends, family members, and carers/staff members working in sheltered housing schemes were all identified as suitable people to initiate such discussions. For instance,

> *I think, probably they (older people) are not so much used to talking about their feelings… maybe it is more dependent on those who are looking after them to pick up on it, and to raise the question. […] I mean, I think with staff, one has to look at who gives up? I think sometimes there's two things going on. Sometimes it's the staff that don't want to listen and don't want to hear, and don't want to observe what's going on, and it's the old person that's crying out to be heard and listened to. So, I think their staff need the support, to know how to talk to someone, what to say at that level maybe, what to say, what language to use, how to engage the person? And to know that it's important to do so, and you can't just be happy all the time.* (70–74 yrs)

This individual focused on some of the dynamics between older people and their carers and how both experienced discomfort and challenges in giving and responding to cues. He spoke about the importance of being able to stay in the moment when these cues come up and the potential for thwarting any fruitful dialogue:

> *I can remember my dad saying, oh, you know, he was looking really bad, he'd lost a lot of function. And he said, oh, what a life. And obviously clearly depressed, but in a way, I didn't want to hear it. But I think for me at that point, it's several years ago now, but at that point I had a sense of doing, I had to do. And I think staff and families need to have a sense of being, you know, that you have a conversation that's about being with the person, hearing, listening, you know, exploring. It's not necessarily about leaping off and doing things, or changing. Or trying to change the situation I mean.* (70–74 yrs)

Many participants described that responding to suicidal thoughts in later life was very much part of their experience and something they felt they understood and were able to empathize with. However, they also acknowledged that it remained challenging for them to know how and where to provide support. Some participants specifically noted the economic disparities and weaknesses in healthcare and other support systems since the COVID-19 pandemic. These participants expressed pessimism about the ongoing tensions in prioritizing resources across different generational groups and acknowledged that this is a difficult issue for those in decision-making roles.

Discussion

This exploratory study of suicidal thoughts in later life, from the perspective of lay older people, provides further insights into how public health and suicide prevention efforts can effectively support older people who are dealing with these situations. With the growing emphasis in public policy on positive or successful aging, stigmatized or taboo topics such as suicidal thoughts are often ignored, or discussed to a lesser degree (Clarke et al., 2012; Hafford-Letchfield et al., 2022a). Within the three themes identified here, the notion of suicidal thoughts and their passive expression appear to be common among aging peer groups and also, to some degree, normalized. As an enabling factor, it may be that this awareness of finitude (Marshall, 1986) could be better acknowledged and discussed, given that those who express a desire to talk about or discuss end-of-life plans are often silenced and/or dismissed as being overly morbid (Kjølseth et al., 2010; Hafford-Letchfield et al., 2022a).

Improving opportunities for disclosure and authentic discussion

In terms of unique factors associated with suicidal thoughts in later life that could aid recognition, one of the key findings of this work relates to the informal and "off-hand" comments used by older people to express their feelings and engagement with suicidal thoughts. For example, the participants spoke about such thoughts using terms such as being "fed up" or "tired" with life or making statements such as "what's the point anymore?" In line with earlier work (Frey et al., 2018; Calear, 2019), the stigma surrounding mental health and suicide-related topics in later life appeared to mean that these individuals felt more comfortable discussing these topics in colloquial ways through informal (e.g., friends), rather than formal, networks (e.g., GPs or other healthcare providers). Older people progressing from more passive (e.g., suicidal thoughts or wishes to die) to active suicidal expressions (e.g., neglect or self-harm with intent) are also more likely to engage in implicit, rather than explicit, expressions/behaviors (Wand and McKay, 2022). For example, these individuals may begin deliberately not looking after themselves, stopping eating or drinking, refusing to take important medication, or otherwise engaging in unsafe or destructive behaviors, for example, excessive drinking and eating high-sugar foods if the person was diabetic, or not seeking help

for serious medical conditions. However, as these expressions are often difficult to identify, particularly where individuals are presenting with complex health conditions and multi-morbidities, participants reported that the recognition of these requires someone who knows the individual well so that subtle changes in their behavior and attitude can be identified.

Further complexity involving ethical considerations may occur, for example, where there are advanced directives and/or mental capacity in death-hastening behavior (Wax et al., 2018; Trowse, 2020; Hafford-Letchfield et al., 2022b). Wand et al. (2018) suggested that self-neglect should be conceptualized as a defensive behavior that has maladaptive outcomes and can also be associated with attempts to regain control over personal freedom and/or living arrangements, or in response to threats to self-identity. Instances where an older person seeks to hasten death such as those that commonly occur in care homes (Hafford-Letchfield et al., 2020) require skilled, detailed assessment to respond to risks alongside improved training and support for paid carers to achieve a more holistic strategy, which capitalizes on significant relationships within a wider context. This raises an important question: who is best placed therefore to identify and support older people experiencing suicide-related thoughts and behavior?

The wider impact of ageism

The participants in this study identified everyday ageism (ageism that is embedded, is taken-for-granted, and informs day-to-day interactions and experiences of people in later life) to be one of the key barriers to obtaining help for suicidal thoughts (Angus and Reeve, 2006; Bodner et al., 2018; Voelkner and Caskie, 2022). More research is needed to investigate how everyday ageism may be associated with health disparities within the older adult population, and specifically what helps to moderate associations between everyday ageism and suicidal thoughts. Allen et al. (2022a) found that the odds of negative health outcomes increased significantly in individuals experiencing everyday ageism, with this affecting health outcomes *via* multiple pathways, including hampering the quality of older adults' interactions with health clinicians. Everyday ageism, defined as "brief verbal, nonverbal, and environmental indignities that convey hostility, a lack of value, or narrow stereotypes of older adults" (Allen et al., 2022b), may be subtle and not intentionally discriminatory but includes being patronized (Hehman and Bugental, 2015) or subject to communication, which disregards wellbeing and equal access to support and services with other age groups. The taboo of talking about suicide and silence, sometimes by taking a protective stance, was illustrated in some of the challenges the team faced in engaging organizations that were reluctant to circulate details of recruitment to this research study as they genuinely believed that engaging in conversations about the issues would pose some sort of risk to older people in itself.

There is some consensus in the literature on self-perceptions of age and value held by older people that contributes toward internalized ageism (Kydd and Fleming, 2015; Diehl et al., 2021). These self-perceptions were evident in the "throwaway" comments our participants referred to in their peer networks (e.g., "I'm ready to go now" or "my time is up"). Such statements highlight the further need for compassion and high-quality care that pays attention to the nuancing or tailoring of mainstream suicide prevention and mental health therapies for people in later life (Hafford-Letchfield et al., 2022a,b). Validated screening tools used in suicidality with older people tend not to address these wider issues (Gleeson et al., 2022).

In the context of these findings, relationship and language are absolutely key in enabling the discussion of suicidal thoughts. Studies have shown that many older people are in contact with health services shortly before the suicide, but without the subject of suicidality being taken up during the consultation (Harwood et al., 2000; Luoma et al., 2002). This supports the argument that training of general practitioners in how to recognize and treat depression or suicidality is a vital part of multilevel suicide prevention strategies (e.g., van der Feltz-Cornelis et al., 2011; Claassen et al., 2014). Our findings highlight the importance of professionals learning to identify implicit/passive suicidal expressions in later life and being willing to address it. There is significant variability in suicidal thoughts that the informal "natter" does really matter in providing ongoing support, as opposed to a one-time screening where older people may be either unwilling or unable to reveal active suicide thinking when responding to direct questions about suicide (Hawton et al., 2022; Rudd and Bryan, 2022). Internal and external influencing factors (e.g., trauma, stigma, and loss of autonomy) may result in fleeting non-specific thoughts with no significant (active) wish to die or reflect chronic yet passive suicidal thoughts that do not elevate risk of actual suicide. Further studies comparing bereavement experiences of those bereaved by suicide in later life with other traumatic bereavements and losses will also help understand the individual experiences and pathways within suicide research to help inform and enrich assessments and interventions in aging care (Hybholt et al., 2020; Hafford-Letchfield et al., 2022b).

Key access points to life-sustaining conversations may be important for those using home- and community-based services as these individuals often face additional barriers to accessing mental healthcare (Qiu et al., 2010; Wyman and Shiovitz-Ezra, 2018). There appears to be a relatively unexplored potential for peer support among older people, given how our participants recognized the common ground shared and acknowledged how isolating it can be for people who are not able to access professional services or feel stigmatized in doing so. There is a level of understanding and relatability with peers that could form a valuable source of support to help people talk more

openly about it. Indeed, the participants in the present study revealed regularly discussing these topics with their friends and peers. Some studies in suicide research have found that people may perceive their end of life positively and are open to discussing the issues (Van Der Geest, 2002; Gilleard, 2022). Innovative approaches to suicide prevention that bring care into the home have been recommended (Salvatore, 2015; Westcott et al., 2022). This could involve training carers or volunteers who interact on a regular basis with socially isolated older people in the role for what Westcott et al. (2022) terms "natural helpers". They referred to those who have access to people at risk of suicide by virtue of a role (e.g., occupation) and personal characteristics (i.e., empathy) that equip them to connect with those people. Furthermore, research on any outcomes following such low-level interventions would be useful to inform suicide prevention strategies.

Conclusion

This study brings the unique perspective of lay people with respect to suicidal thoughts and ideation in later life, describing their views and experiences of suicidal thoughts and the everyday interactions that might bring these to the fore and enable more open discussion. A better understanding of the transition from thinking about suicide to engaging in suicidal behavior is critical. Current developments in idea-to-action frameworks will be important in developing theories to inform interventions and postventions for people in later life. This distinction between idea to action is important as the majority of individuals who experience suicidal ideation do not necessarily make the progression to suicide attempt (Klonsky and Saffer, 2018). Additionally, frequently identified risk factors for suicidal ideation, such as depression, trauma, and hopelessness, do not differentiate between suicide ideation and suicide (Rudd, 2021).

The present findings highlight the importance for professionals and providers to be more open to discuss topics related to suicide in later life, acknowledging and communicating a willingness to talk about these matters in an informal setting. Training those staff with improved awareness at the everyday level where discussion takes place, such as personal care or the persons' own home environment, supported by improved signposting and assessment is another area for development. Given the elevated risk of suicide in later life and the conceptual frameworks available (Hafford-Letchfield et al., 2022b), innovative approaches to suicide prevention are important to a public health approach to suicide that involves people in later life as stakeholders.

Study limitations

Some of the findings of this study reflected the U.K.-specific context. There are context-specific discourses about older people's access to healthcare, which may be different than other countries with different health and care systems. There is no euthanasia legislation in the United Kingdom, which may influence debates. This study was based on a small sample, and the challenges in recruiting people from more diverse backgrounds to discuss this topic is acknowledged.

Data availability statement

The raw data supporting the conclusion of this article can be made available by direct request to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by University of Strathclyde Central Ethics Committee. The patients/participants provided their written informed consent to participate in this study (Ref: UEC21/67).

Author contributions

TH-L conceptualized and designed the study and secured funding. JH and TH-L obtained ethical approval. JH coordinated participant recruitment and the majority of qualitative interviews with input from TH-L, TE, NC, PW, and HG. TH-L and TE analyzed the data. TH-L drafted the manuscript with substantial input from TE and HG. JH, NC, SR, and JG edited the manuscript. PW, MQ, and SM contributed to the wider research team discussions and tasks. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Improving depressive symptoms and maintaining cognitive abilities of seniors within the nursing homes: A pilot study of brief mindfulness-based interventions for seniors in a semi-randomized trial

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Introduction: Seniors in nursing homes are at higher risk for depression and emotional distress. The COVID-19 crisis and isolation have even increased the risk for cognitive decline and suicidality. Since social media is often unfamiliar to older adults, their treatment options were diminished during quarantine. Recently, studies showed the potential for Mindfulness-Based Intervention in improving cognitive functioning and psychological well-being among healthy older adults. Standardized courses such as MBSR and MBCT are not suited to the majority of seniors for several reasons. First, the interventions are too long and demanding, physically and cognitively. Second, they require an instructed counselor for delivery, which makes it almost impossible in times of quarantine, and third, very expensive. Hence, the purpose of this study was to examine whether similar improvements in emotional distress and cognitive functioning can be achieved through a brief intervention, that can be delivered by workers in nursing homes.

Methods: A course of 8 half-hour sessions each (MBIS: Mindfulness-Based Intervention for Seniors) was employed in two versions: (1) An 8-week course with weekly meetings (2) A 4-week course with 2 sessions per week and compared to a control care-as-usual group. Depression and mood were measured, as well as cognitive abilities in the Simon task. In addition, the level of Mindfulness skills was measured before and after the interventions.

Results: We showed that brief interventions succeeded in improving mindfulness *Non-reactivity* and produced changes in the facets *Acting with awareness* and *Non-judging*. More importantly, the brief intervention, in both frequency versions, improved the level of depression and mood (BDI and PHQ-9). At the cognitive level, an adaptive sequential effect appeared after the intervention only in the 8-week MBIS group.

Discussion: These findings indicate the effectiveness of this pilot of a short, simple, mindfulness-based intervention, in improving depression and psychological distress, as well as improving cognitive control over time. This may enhance significant developments in the field of treatment solutions for seniors, with a ready-to-use protocol to administer in nursing homes.

KEYWORDS

mindfulness, cognitive control, emotional distress, depression, nursing homes

Introduction

The process of aging involves many challenges, more than at any other stage in life. The aging individual is exposed to deaths, separations, and a decline in emotional and cognitive functioning. The COVID-19 crisis enforced the isolation of seniors, putting them at higher risk for depression and emotional distress (Armitage and Nellums, 2020). Since social media is often unfamiliar to the older adults, their treatment options were diminished during quarantine. This situation increased age-related effects and even cognitive changes. The exercise of Mindfulness has been found to improve psychological wellbeing and other cognitive measures among both young individuals and seniors. Standard mindfulness-based interventions (MBI) are lengthy and demanding and are largely unsuitable for seniors. This research suggests a pilot study of a brief mindfulness-based intervention appropriate for seniors (Mindfulness Based Intervention for Seniors: MBIS), for administration in nursing homes or retirement communities.

Emotional distress and depression in old age are influenced by a complex combination of factors (Lomas et al., 2016). The decline in mobility, the increase in social isolation, the increase of physical and cognitive disease, and the loss of close relationships increase the risk for depression (Rodda et al., 2011). There is an international increase in the percentage of individuals suffering from depression. One of the reasons for this increase in depression is the increase in longevity (World Health Organization, 2017), as more than half of those suffering from depression in old age have experienced their first outbreak late in life. Some results of depression include a decrease in life satisfaction, avoidance of social relationships, isolation, an increased need for 24/7 care, cognitive decline, disability in daily functioning, and suicide (Fiske et al., 2009). Emotional distress and cognitive decline have a strong mutual influence on one another in old age. Depression and distress accelerate cognitive decline among those aging (Engmann, 2011), while cognitive decline influences the emotional state and is very damaging to the quality of life of the aging individual (Park et al., 2003).

Cognitive control is the brain's capacity to actively create information that will guide behavior in accordance with a set goal (Posner and Snyder, 1975). This is the process that allows an individual to choose a certain behavior and reject an inappropriate behavior. The ability to delay or inhibit responding is one of the necessary features of cognitive control. It was found that the performance efficacy of tasks that require cognitive and inhibitory control declines with age (Hasher and Zacks, 1988; West and Alain, 2000; Maylor et al., 2011; Diamond, 2013). A task that requires cognitive and inhibitory control, and is often used in research on seniors is the Simon task (Simon and Small, 1969; Bialystok et al., 2004; Proctor et al., 2005; Castel et al., 2007; Germain and Collette, 2008; Juncos-Rabadán et al., 2008; Kubo-Kawai and Kawai, 2010; Tse et al., 2010; Maylor et al., 2011). In the Visual Simon task (Craft and Simon, 1970; Proctor and Lu, 1994), the participant is requested to identify colored circles that appear on a computer screen and press the appropriate key, on the left or right side. In this task, the colored circle can appear on the same side on which the participant is supposed to press the key (congruent condition) or on the opposite side (incongruent condition). The Simon effect is defined as the gap in response times (RTs) between the congruent and incongruent conditions. Research has shown that seniors have longer RTs and a larger Simon effect when compared to younger adults (Van der Lubbe and Verleger, 2002; Aisenberg et al., 2014). The Simon effect among seniors is significant even after a statistical correction that considers the generally slow motor functioning associated with aging processes (Van der Lubbe and Verleger, 2002). Aisenberg et al. (2014) compared the performance of senior participants and young participants in the Simon task, using neutral trials (a colored circle in the middle, above or below), as well, and found that the Simon effect is greater among senior participants, due to a difficulty performing incongruent trials. When examining sequential effects, which relate to the influence of the previous trial on the performance in the current trial, the Gratton effect was found among young participants (Gratton et al., 1992). The Gratton effect is the decline that appears in the Simon effect after the response to an incongruent condition, rather than after the response to a congruent condition (Wühr and Ansorge, 2005; Aisenberg and Henik, 2012). Botvinick et al. (2001) suggested that this sequential effect reflects the functioning of dynamic cognitive control of the reactive type. Aisenberg et al. (2014) found that the Gratton effect does not appear in senior participants, reflecting damage to the dynamic mechanism of inhibited responding. There is, however, a debate in the literature regarding the significance of the effect (e.g., see the explanation of repetition priming in Maylor et al., 2011).

As long as the population ages, there is great importance in developing interventions that can influence the psychological distress and cognitive functioning of seniors. In this study, we chose to examine the influence of a mindfulness-based intervention on psychological well-being and cognitive capacity in old age.

The beneficial influence of mindfulness exercises on psychological and physical health has been known in the East for thousands of years. Jon Kabat-Zinn defined Mindfulness as, "The awareness that arises through paying attention, on purpose, in the present moment, non-judgementally" (Kabat-Zinn, 1994, p. 4).

He developed the Mindfulness-Based Stress Reduction program (MBSR), intended to treat stress and pain (Kabat-Zinn, 1994). Based on this program, Mindfulness-Based Cognitive Therapy (MBCT) was developed to treat depression (Segal et al., 2012). A plethora of mindfulness-based intervention courses were developed to treat different issues (Eating Awareness—Kristeller et al., 2006; Elder Care—Mcbee, 2008). The goal of these courses is to develop and cultivate mindfulness in meditation and in day-to-day life. This is done *via* the practice of non-judgmental attention to internal events (i.e., breathing, body sensation, emotions, and thoughts) and external events (i.e., sound, smell, taste, and touch). Such practice is accompanied by psychoeducation. Course participants are also asked to exercise two types of practice every day at home: formal practice and informal practice. The formal practice includes a repetition of the exercise done at the course session, and the informal practice includes daily behaviors of mindful attention. One of the most popular questionnaires for measuring mindfulness is the Five Facets Mindfulness Questionnaire (FFMQ), developed by Baer et al. (2006). This questionnaire is a self-report questionnaire, and it measures the five facets of mindfulness: Observing; Describing; Acting with awareness; Nonjudging of inner experience; and Nonreactivity to inner experience (elaboration of this tool is in the methods section of this paper).

In seniors, MBI interventions have consistently been shown to improve emotional distress in seniors (Geiger et al., 2016). A significant influence was found for anxiety, depression, and stress—a similar influence to that found in young, healthy participants (Khoury et al., 2015). Ernst et al. (2008) reported an improvement in quality of life and depression as a result of participation in an appropriate MBSR program, when compared to senior participants on the waiting list. The positive influence of meditation on attention has been found in both, cross-sectional and longitudinal studies. In research that compared the attention of senior participants that have practiced meditation for years with the attention of senior participants that have never practiced meditation, there was a significant difference between the groups (Van Leeuwen et al., 2009). In addition, Moynihan et al. (2013) examined the influence of meditation on executive functioning after participation in an MBSR course and found a significant improvement in executive functioning (Trails B/A ratio). Sun et al. (2013) found that seniors that completed a course on meditation improved in their performance of the Forward Digit Span (though, not in their performance of the Backward Digit Span), which can point to an improvement in working memory.

Gard et al. (2014) analyzed research studies that examined the influence of different meditation techniques on the cognitive functions of senior participants and found many limitations. Most of the studies were preliminary pilot studies and included a small number of participants. Some of the studies did not include a control group that participated in a different intervention. Another limitation was that the different meditation interventions were not standardized, which makes it difficult to draw clear conclusions from the group of studies that were analyzed. The researchers concluded that the preliminary results reflect the potential of meditation on the delay of cognitive decline among seniors. The researchers simultaneously emphasized the need for further research on the topic.

A varied range of results regarding MBI's capacity to improve mindfulness in seniors has been found. Morone et al. (2009) did not see any change in mindfulness levels in senior participants that suffered from chronic back pain and participated in an MBSR course. Also, Mularski et al. (2009) did not find a difference in mindfulness levels between the group of senior MBI participants and the control group, after the intervention. Both these research studies hypothesized that the reason for no apparent change is due to the fact that the average score of participants on the mindfulness questionnaire prior to participation in the course was particularly high. In contrast, Lenze et al. (2014) found an improvement in mindfulness levels among senior participants after their participation in the MBSR course. These studies made use of self-report questionnaires.

The need for brief Mindfulness courses arises since the standard MBI course (e.g., MBSR and MBCT) that lasts for a duration of 8 weeks, includes 2 3-h sessions, a retreat, which lasts 6 h, and a requirement to complete 40 min of daily practice at home. Research has shown that the main reason for dropout in Mindfulness-Based Meditation courses (MBCT and MBSR) is the amount of time they require of the participants (Carmody et al., 2008). This has led to an exploration of different ways of abbreviating the MBI interventions. Shortening interventions is especially important in the senior population, as sessions that last about 2 hours or that require practice for more than half an hour at home, are not appropriate for a majority of individuals in this age group (Mcbee, 2014; Helmes and Ward, 2017).

In a meta-analysis conducted by Carmody and Baer (2009), for young adults, they did not find support that shorter versions of MBSR sessions are less efficacious than the standard format (2 ½ hours) in decreasing psychological distress. Klatt et al. (2009) found that after an MBSR intervention that was 6 weeks long and included weekly sessions of an hour (total class-time: 6 h + 20 min a day of practice at home), there was an improvement in mindfulness and psychological distress. Tang et al. (2007) reported an improvement in attention management, mood, and physiological measures of stress, after participation in a short meditation course intended for young participants. The course only included 2.5 h of class-time. The control condition in this research participated in a relaxation course with a similar time allotment. Attention management was measured *via* the Attention Network Test (ANT; Fan et al., 2002). Change in mood was measured *via* the Profile of Mood States questionnaire (POMS; Shacham, 1983). This course included a special set of exercises, which included body relaxation, guided imagery, and mindfulness meditation with background music. The course did not include any instruction to rid the mind of thoughts, as the researchers believed this instruction to be too difficult for inexperienced meditators to implement. There have also been attempts at appropriating MBSR courses for the senior population. Such

courses have shown improvement in psychological and cognitive measures. However, the appropriated courses were still lengthy and demanding and, largely, inappropriate for the senior population. For example, they included weekly 2-h sessions, instead of 2 ½ hours, with no retreat (Ernst et al., 2008), or a weekly session of a 1 ½ hour instead of 2 ½ hours, with no retreat (Foulk et al., 2014).

The aim of the present study was to examine whether a brief mindfulness-based intervention (eight 30-min sessions), delivered in nursing homes, improves measures of emotional distress and cognitive control in seniors. Thus, the Mindfulness-Based Intervention for Seniors (MBIS) course was established (see Description in the methods section of this paper). In addition, and in light of findings by Tang et al. (2007) that showed improvement in a concentrated course, we examined the influence of session frequency on the efficacy of the course. Therefore, the MBIS was offered in two versions which differed in session frequency though maintained an equivalent total class-time of 4 h:

Version A: An 8-week course, one session per week (MBIS-1*8).
Version B: A 4-week course, two sessions per week (MBIS-2*4).

MBIS groups were compared to a third care-as-usual control group who had weekly gatherings following a joint breakfast, with no programmed intervention.

We hypothesized:

1. A main effect of time in all three groups for the reaction time in the cognitive task (repeating the task effect).
2. A significant difference in cognitive and emotional effects between both MBIS groups and the control group. Considering that participants in this study are seniors, time alone is not expected to have a positive influence on cognitive abilities and emotional distress. Test re-test effects will be examined using the control group, without experimental manipulation.

Within the MBIS groups:

3. Significant effect of time for:
   3.1. Mindfulness measures, such that the interventions will encourage improvement in all measures of mindfulness.
   3.2. Emotional distress, such that the interventions will improve measures of mood and depression.
   3.3. Cognitive control. The measure expected to change is the Simon effect, such that the slowed response time in the incongruent condition will decrease as a result of the intervention. Likewise, and in accordance with Colzato et al. (2015) findings, we hypothesized that there will be a Gratton type sequential effect, following the interventions.
4. An interaction between time and group in the emotional measures, due to the change in the length and frequency of the sessions. We did not hypothesize a specific direction, as the high frequency in the MBIS 2*4 course can be exciting and encourage a fast change, while the lengthier duration of the MBIS 1*8 course can encourage a more stable improvement in one's emotional experience.

Materials and methods

The study received IRB approval from the ethics committee of the School of Social and Community Sciences at Ruppin Academic Center (pre-registration: clinicaltrials, NCT04165005, 15/11/19). The courses were conducted during November and December 2017, before pre-registration was a restriction, so the study registered as part of a bigger project in 2019, declaring that the data was already collected.

Participants

Power analysis was made using *G*Power* (3: Faul et al., 2007), yielding *N* of 65, which were invited to participate. Following the recruitment process, 35 healthy seniors (31 women; $M = 80.9$, $SD = 3.9$; Range = 72–91) were administered from four assisted living facilities in Israel. Out of these, 19 were semi-randomly allocated to the MBIS course in one of its two versions (MBIS-2*4 or MBIS-1*8). All participants met with an experimenter, underwent a Mini Mental State Examination (MMSE; Folstein et al., 1975), a cognitive control task (Simon task), and answered a few self-report questionnaires to assess measures of emotional distress (see below the tools section). All participants received a score higher than 24 on the MMSE. Eleven participants began the MBIS-2*4 course, and one left after three sessions (9% dropout rate). Eight participants began the MBIS-1*8 course, and three left after two sessions (38% dropout rate). Sixteen participants were administered to the control group. Reasons for dropout were: Difficulty following instructions due to hearing issues, decline in health, and the illness of a partner and a resulting difficulty in commitment. Four participants did not complete the courses (see below the design section). Hence, data from 31 participants were available for the pre-post analysis.

Tools

Mindfulness-Based Intervention for Seniors (MBIS) course: A course based on the MBCT and MBSR courses was established. The course program was created according to the principles of model of Hölzel et al. (2011). The course included eight sessions of 30 min each. Each session included an exercise (10–20 min), psycho-education (5–10 min), and/or experience sharing (3–10 min). In addition, the course participants were requested to practice 10–20 min a day, in accordance with what they exercised in the session. Aside from the formal exercise, the course participants were also encouraged to integrate mindfulness tasks into their day-to-day lives. According to model of Hölzel et al. (2011), the course began with Attention Regulation and Body

Awareness exercises. With time, the exercises that activate Emotion Regulation and Change in Perspective on the Self processes were added. The psycho-education and sharing emphasized the relevance and significance of life for the participants.

Mindfulness Skills were measured *via* the Five Facets Mindfulness Questionnaire (FFMQ; Baer et al., 2006; In Hebrew: Tarrasch and Berger, 2022). This questionnaire is a 36-item self-report questionnaire, with five sub-scales: Observing; Describing; Acting with awareness; Non-judging of inner experience; and Non-reactivity to inner experience. Responses are reported on a five-point Likert scale, ranging from "Never or with very little probability" to "Almost always or usually correct," the latter reflecting a high level of mindfulness. This questionnaire has also been shown to have high reliability and validity.

Emotional distress was measured via Hebrew self-report questionnaires for depression (BDI-II) and mood (PHQ-9), validated by the Israeli ministry of health. The BDI-II is an updated version of Beck's depression questionnaire (Beck et al., 1996). It is a 21-item multiple-choice questionnaire and is validated and reliable for self-reporting. Each item has four answer options, each receiving 0–3 points. The higher the total score, the higher the depression level. The PHQ-9 is a sub-questionnaire of the PHQ-SADS questionnaire (Patient Health Questionnaire—Somatization, Anxiety, and Depression; Kroenke et al., 2010), which is used as a quick assessment of depression and mood.

Cognitive control was examined *via* the Simon task. The Simon task is particularly appropriate for senior participants as it has simple instructions and does not require language fluency. Stimulus presentation and data collection are done with laptops. Circles presented at a diameter of five degrees (a viewing distance of 60 cm from the screen) and colored blue, red, yellow, and green were used as the stimuli and were presented at one of four locations: left, right, above, or below the center of the screen.

Choosing four colors, instead of two, was intended to negate the possibility of repetition priming (Maylor et al., 2011). Each trial included a white screen that appeared for 500 ms, after which a white screen with a black cross at the center was presented for 500 ms. Then, a stimulus appeared on the left, right, above, or below the center of the screen for 400 ms. After the stimulus disappeared, the white screen was presented for 600 ms (see Figure 1). The participants were requested to identify the colored circles that appeared on the screen and to press the appropriate button on the left or right side of the keyboard. They were requested to answer as quickly and as accurately as possible. First, the participants practiced 20 trials. Then, they performed the two parts of the experiment, each of which included 91 trials. The participants were permitted to take a break between the two parts of the experiment. For some of the participants, the "D" key represented red and green and the "L" key represented blue and yellow. For the other half of the participants, the key-color combination was reversed.

Results

Demographic parameters

A one-way ANOVA was performed to compare age, level of education, and MMSE score between groups, and a χ^2 test was performed to compare gender (see Table 1). There were no differences between the groups in MMSE score and gender. *Post hoc* analyses using the Scheffé *post hoc* criterion for significance revealed age and level of education effects: the control group was

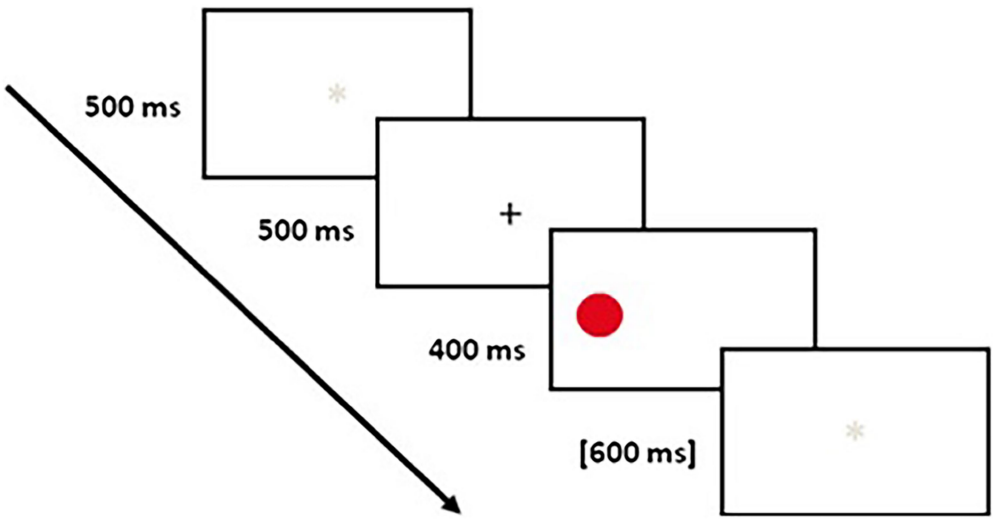

FIGURE 1
The four stages at each trial of the Simon task.

TABLE 1 Averages (SDs) and differences and effects between the groups in the demographic and self-report variables.

	MBIS-1*8 (*N* =5)	MBIS-2*4 (*N* =10)	Control (*N*=16)	All participants (*N* =31)	Statistic parameter	*p*<	η^2_p
No. of women	4	10	12	26	$\chi 2 = 2.9$	ns	
Age (yrs)	80.6 (2.7)	83.1 (4.4)$^{(+)}$	79.1 (2.5)$^{(-)}$	80.6 (3.7)	$F(1,28) = 4.7$	0.05	
Education (yrs)	17.2 (3.1)$^{(+)}$	12 (2.5)$^{(-)}$	12.1 (2.8)$^{(-)}$	12.9 (3.3)	$F(1,28) = -3.52$	0.01	
MMSE	29.2 (1.9)	27.8 (2.9)	29 (1.0)	28.6 (2.0)	$F(1,28) = 1.43$	ns	
MMSE Before	29.2 (1.8)	27.8 (2.9)	29 (1.0)	28.6 (2.0)	All *Fs* (1,28) <1	ns	
MMSE After	29.0 (1.4)	28.5 (2.4)	28.8 (1.6)	28.7 (2.1)			
PHQ-9 Before	5.6 (2.7)	9.5 (5.3)	7.13 (3.3)	8.2 (4.8)	$F(1,28) = 6.17$	0.05	0.31
					For MBIS groups:		
PHQ-9 After	3.2 (0.8)	7.2 (5)	7.31 (2.4)	5.9 (4.5)	$F = 11.73$	0.01	0.29
BDI-II (MBIS-groups) Before	8.6 (3.8)	9.7 (6.9)	–	9.3 (5.9)[1]	$F(1,13) = 3.3$	0.09	0.2
BDI-II (MBIS-groups) After	6.8 (4.6)	7.8 (4.8)	–	7.5 (4.6)[1]			

(+/−) represents post-hoc significant differences between the groups; [1]$N = 15$.

significantly younger than the MBIS-2*4 group and the level of education of the MBIS-1*8 group was significantly higher than that of the other two groups.

Mindfulness measures (FFMQ)

In an attempt to examine if there were differences in mindfulness measures between the groups prior to the intervention, we conducted an independent samples *t*-test. There were no significant differences between the groups in any of the measures. A mixed model ANOVA test with within- and between-participant variables was conducted to examine the mindfulness measures as time-dependent (before and after the intervention), with course type (MBIS-2*4/MBIS-1*8) as a between-participant variable. The hypothesis that the different interventions will encourage an increase in mindfulness measures was only supported for the sub-scale, nonreactivity to inner experience. A significant main effect for time was found for this measure [$F(1,12) = 5.29$, $p < 0.05$, $\eta^2 = 0.31$], such that its' level after the intervention was higher ($M = 3.41$, $SD = 0.81$) than its level prior to the intervention ($M = 2.67$, $SD = 0.64$). In contrast, a significant main effect for time was found for the two sub-scales, acting with awareness and nonjudging of inner experience, though in the opposite direction from that which was hypothesized [$F(1,12) = 6.29$, $p < 0.05$, $\eta^2 = 0.35$; $F(1,12) = 5.23$, $p < 0.05$, $\eta^2 = 0.30$, respectively]; a decline in acting with awareness and a decline in nonjudging of inner experience after the intervention. No significant changes were apparent in the other mindfulness measures when their levels before and after the intervention were compared (see Figure 2 and Supplementary Table S1 in the Appendix).

Emotional distress measures (PHQ-9, BDI-II)

A mixed model ANOVA test with within- and between-participant variables was conducted to examine the emotional distress measures as time-dependent, with group type (MBIS-2*4/MBIS-1*8/control) as a between-participant variable. In accordance with the research hypothesis, a significant interaction effect of time-group was found in the PHQ-9 (mood) measure, such that this measure decreased as a result of the intervention (see Table 1). In other words, participants from both MBIS groups reported a more positive mood after the intervention (see Figure 3). Further, looking at the BDI-II measure of depression, tested for the MBIS groups but not the control group, a marginally significant main effect of time was found with an effect size of 0.2 (partial eta squared) and *F* greater than 3 (see Table 1), such that the reported level of depression after the intervention was lower than the reported level of depression prior to it. In contrast to our research hypothesis, there was no interaction between time and course type in any of the emotional distress measures (i.e., all $Fs < 1$).

Cognitive functioning (MMSE, Simon task)

We conducted a mixed model ANOVA with within and between participant variables test to measure general cognitive functioning (MMSE) as dependent on time (before and after the intervention), with group type as a between participants (MBIS-2*4/MBIS-1*8/control) variable. Since we had a small sample size, a Shapiro–Wilk test was performed and did not show evidence of non-normality

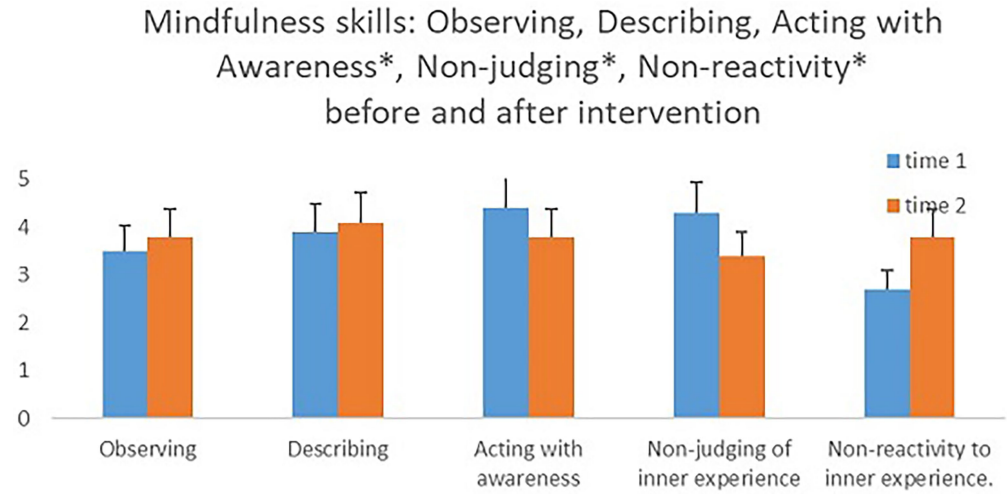

FIGURE 2
Mindfulness skills before and after the intervention.

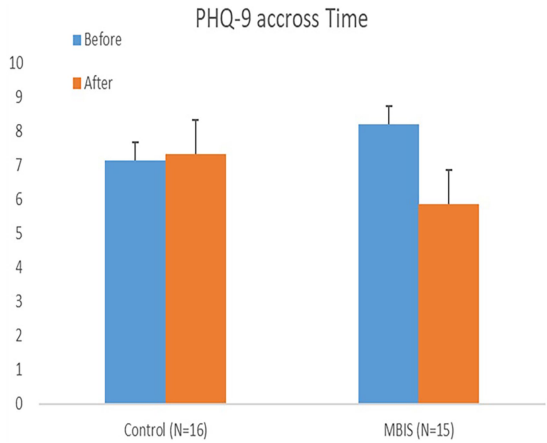

FIGURE 3
Depression level and mood before and after the intervention.

($W = 0.92$, value of $p = 0.49$). Based on this outcome, and since the within-facility assignment was random, we decided to use a parametric test. Assumptions of the repeated measures ANOVAs were met with no violations [*Mauchly's Test*- $\chi^2(2) = 2.042$, $p = 0.36$]. No main effect of time or group was found, and no time-group interaction was found either (see Table 1).

The average response time (RT) on the Simon task for each participant in each condition was calculated as the average of correct responses only. RTs that deviated more than 2.5 SDs from the average or that were lower than 150 ms were removed from the analysis. Further, one of the MBIS-2*4 participant's data was removed from the final analysis due to a technical issue (see Table 2).

A mixed model ANOVA test with within- and between-participant variables was conducted to measure accuracy percentage for each group (MBIS-2*4/MBIS-1*8/control), time (before/after the intervention), and congruency (Congruent/Incongruent/neutral condition). The general accuracy percentage was high: 89% before the intervention; and 93% after the intervention. A main effect for congruency was found [$F(2,52) = 11.701$, $p < 0.00006$, $\eta^2 = 0.31$], showing low accuracy rates for incongruent trials compared to congruent and neutral trials [$F(1,26) = 6.88$, $p < 0.014$, $\eta^2 = 0.21$]. No other effects for accuracy were found (see Table 3).

For RT, the neutral condition was excluded for simplification purposes. Mean RTs and SDs are reported in Supplementary Table S2 in the Supplementary material. A main effect for time was found [$F(1,26) = 8.3$, $p < 0.008$, $\eta^2 = 0.24$], such that the RTs in Time 2 were faster than the RTs in Time 1; a significant main effect was found for congruency [$F(1,26) = 25.3$, $p < 0.00003$, $\eta^2 = 0.49$], such that RTs in the congruent trials were faster than the RTs in the incongruent trials-Simon effect; a significant interaction was found between group and congruency [$F(2,26) = 4.78$, $p < 0.017$, $\eta^2 = 0.27$], such that the Simon effect appeared in the MBIS-2*4 and the control group beyond Time but not in the MBIS-1*8 group [$F(1,26) = 7.19$, $p < 0.05$, $\eta^2 = 0.22$]; a significant interaction effect was found between time and congruency [$F(1,26) = 4.63$ $p < 0.04$, $\eta^2 = 0.15$] such that the congruent trials were significantly reduced from Time 1 to Time 2 [$F(1,26) = 15.16$ $p < 0.0006$, $\eta^2 = 0.36$] while incongruent trials showed only marginally significant reduction [$F(1,26) = 3.04$ $p < 0.09$, $\eta^2 = 0.10$; see Table 3 and Supplementary Table S2].

Sequential analyses were also carried out. In an attempt to examine if the performance of the previous trial influences the performance of a following (current) trial, we conducted an ANOVA, which included a previous trial variable (previous congruent/previous incongruent). A significant main effect was found for the previous trial variable [$F(1,26) = 27.06$ $p < 0.00002$, $\eta^2 = 0.51$] such that the RTs after congruent trials were shorter

Table 2 Averages (SDs) of accuracy percentages in the Simon task and main effect for congruency.

	Before (Time 1)				After (Time 2)				df	F	p<	η^2_p
	MBIS-1*8 (N=5)	MBIS-2*4 (N=10)	Control (N=16)	All participants (N=31)	MBIS-1*8 (N=5)	MBIS-2*4 (N=10)	Control (N=16)	All participants (N=31)				
Congruent	93% (7%)	80% (0.35%)	94% (5%)	89% (17%)	96% (4%)	86% (6%)	95% (5%)	93% (8%)	2,52	11.70	0.000	0.31
Incongruent	89% (14%)	78% (36%)	92% (5%)	86% (15%)	95% (2%)	79% (23%)	91% (7%)	88% (11%)				
Neutral	96% (4%)	79% (6%)	94% (2%)	90% (19%)	98% (5%)	83% (2%)	97% (19%)	93% (10%)				

than the RTs after incongruent trials. Additionally, a significant interaction was found between congruency and previous trial congruency [$F(1,26) = 9.66$ $p < 0.004$, $\eta^2 = 0.27$], such that a Gratton effect was found (see Table 3 and Supplementary Table S2). Namely, the Simon effect was smaller after incongruent trials than after congruent trials. This result contrasts previous findings regarding the Gratton effect in older adults, and indeed, does not reflect specific patterns of each group, as shown below.

The four-way interaction between time, group, congruency, and previous trial congruency did not reach significance but yet had a medium effect size [$F(2,26) = 2.36$, $p < ns$, $\eta^2 = 0.15$]. Following our hypothesis, we analyzed a four-way interaction looking only at the two MBIS groups. This four-way interaction was significant [$F(1,26) = 4.69, p < 0.04, \eta^2 = 0.15$]. Further analysis showed that the Gratton effect appeared for the MBIS-1*8 group after the intervention [$F(1,11) = 6.62$, $p < 0.025$, $\eta^2 = 0.38$], such that the Simon effect was significant after congruent trials but not after incongruent trials. Both the Control group and MBIS 4*2 groups showed the maladaptive, old adults' typical pattern of sequential effects in time 2 (see Figure 4).

Discussion

The aim of this study was to examine the influence of a brief mindfulness-based intervention appropriated for senior participants, on measures of emotional distress and cognitive control in healthy seniors. Another aim was to examine the influence of session frequency and intervention length on the amount of improvement in the aforementioned measures.

The main findings of this study were: The intervention, in both frequency forms, created a difference in reported levels of mindfulness, improved reported levels of depression and mood, and influenced cognitive functioning, compared to the control group, as will be detailed below.

Mindfulness measures

In accordance with the research hypothesis, we found an improvement in the Non-reactivity to inner experience measure, whose score was the lowest prior to the intervention. This finding will be explained with the emotional and cognitive findings. In addition, the Non-judging of inner experience and Acting with awareness measures showed a decline after the intervention, while their scores prior to the intervention were the highest. This finding is surprising and would need to repeat itself in future research to be appropriately substantiated. In the context of this study, we can hypothesize that this decline is a result of the increase in attention that participants paid to their daily activities, as a result of the course. In other words, it is possible that the participants were "naïve" and thought of themselves (and reported accordingly) as being very aware prior to the intervention. Their enhanced

TABLE 3 RT effects (RT in ms) in the Simon task.

Effects	Meaning	*df*	*F*	*p*<	η^2_p
Time	Trials on time1 faster than trials ontime2	1,26	8.3	0.007	0.24
Congruency	Congruent faster than Incongruent	1,26	25.3	0	0.49
Time × Congruency	Simon effect ontime2 larger Simon effect ontime1	1,26	4.6	0.05	0.15
Group × Congruency		2,26	4.78	0.017	0.27
Planned Comparisons	Simon effect for MBIS -1*8 is the smallest	1,26	7.19	0.012	0.22
Prev-Congruency	Trials after congruent shorter thantrials after incongruent	1,26	27	0	0.51
Congruency × Prev-Congruency	Smaller Simon effect after Incongruent than after Congruent	1,26	9.66	0.005	0.27
Time × Group × Congruency × Prev-Congruency[1]		1,26	4.69	0.03	0.15
Planned comparisons –	Sequential Gratton appeared only following MBIS-1*8 (time2)	1,11	6.62	0.025	0.38

[1]only at the MBIS groups. All other effects and interactions were not significant [i.e., (all Fs < 1)]. Supplementary material: See separate file.

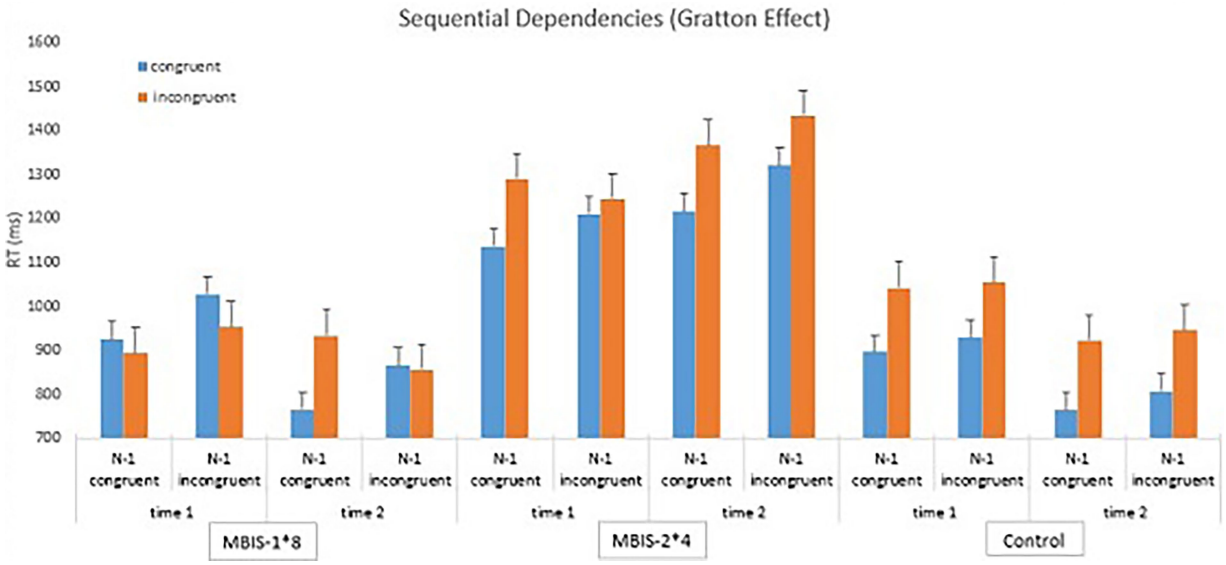

FIGURE 4
Averages and standard deviations in the sequential analyses for both groups before and after the intervention.

awareness resulting from the intervention may have encouraged a more realistic reporting on acting with awareness and, subsequently, engendered a lower score in this measure. Along with enhanced awareness, Judging also increased toward "not aware enough behavior." In other words, it is possible that the increase in Judging and the decrease in Acting with awareness actually reflect an improved and more accurate perception of personal experience among the senior participants.

No improvement was found for the measures Observation and Description; whose scores were the highest prior to the intervention. As in previous research (Morone et al., 2009), the base level of mindfulness skills was found to be higher in senior participants than it was in young participants. This makes it difficult to see improvement as a result of the intervention (i.e., ceiling effect).

Emotional distress measures

The improvement in depression and mood measures in this preliminary pilot study points to the raw potential of brief mindfulness-based interventions for seniors in the community.

This is even more impressive considering two elements: (1) Even though the base level of depression was not considered clinical, and the participant scores were low prior to the intervention, there was still an improvement in their state and their scores significantly declined; (2) This study examined a group of very older adults senior participants (the average age of the participants in this study was 82, higher than the average age of most MBI studies conducted on seniors), and the intervention still appeared appropriate for them and improved very important measures of the psychological wellbeing of this age group.

It is important to note that all the emotional measures changed in the same manner in both groups, irrelevant of session frequency and course length. This supports findings of Carmody and Baer (2009), which showed no correlation between course length and course results. However, it is possible that course length and session concentration had an "offsetting effect" on the results. On one hand, a lengthy intervention (MBIS-1*8) allowed for a more significant adaptation because of the amount of time the participants were involved in the course. On the other hand, it is possible that the 1-week intervals between sessions were too long of a break and interrupted the learning of a new skill, the opposite of which being an advantage of the second intervention (MBIS-2*4), in which two sessions a week were provided.

Cognitive control

A difference was found between the groups' performance of the Simon task, above and beyond time, such that the MBIS-2*4 group, which was characterized by fewer years of education and fewer social ties, had a greater Simon effect than the MBIS-1*8 group. Education and social ties act as resilience factors that decrease cognitive damage in old age (Stern, 2002), and it appears that they contributed to this gap in performance between the two groups.

Similar to previous research, the Simon effect in the senior participants of this study was greater than the Simon effect that was reported in the research literature on young participants. This finding suggests a difficulty in the inhibition response system in seniors (Aisenberg et al., 2014). In other words, senior participants display a weakened capacity to avoid information coming from a task-irrelevant dimension. In the task used in this study, the irrelevant dimension was the spatial location, and senior participants posed more difficulty avoiding this information than young participants.

Post the intervention, the Gratton effect appeared for the MBIS-1*8 group. This finding is difficult to explain considering the lack of a Simon effect prior to the intervention. However, its appearance suggests successful functioning, which is not common among seniors (Aisenberg et al., 2014), and appeared in this study only after the intervention. The difference between the groups in the Gratton effect can be due to the fact that the MBIS-1*8 group more significantly made use of what they learned in the course, due to their higher level of education and their improvement in the Nonreactivity to internal events measure. However, it is possible that the improvement in performance and the appearance of the Gratton effect are also due to the fact that this group participated in a lengthier course. In contrast to emotional changes that can be situational, cognitive processes mature over a longer period of time and are, therefore, expected to appear after a longer period of time (Chiesa et al., 2011). This can also explain the improvement in the emotional measures (i.e., depression and mood) and the lack of improvement in the main measure of cognitive control (Simon effect) in this study. It is important to note that the improvement in reaction time in the Simon task is expected due to repeated performance and, therefore, we will not assume that this achievement is a result of the interventions.

This study has several important limitations. First, most of our participants were older adults women, and generalization to older adults men needs further evidence. Second, the number of participants in this study is small and influenced the statistical power of the analyses, and the validity of the effectiveness conclusions. Many efforts were taken to encourage participation and to avoid attrition, such as personal reminders, make-up sessions, etc. Future research should maintain a small group of participants (as in this study) but attempt at increasing the statistical power *via* a larger number of groups. Third, due to the advanced age of the participants, it was difficult for some of the participants to follow instructions due to hearing loss, to concentrate during the meditation, and to read the written instructions for the home exercises. These are common difficulties in the senior population, and clearly affect the validity of this study, though as an ecological study it is part of the disadvantages. Another issue that limits the strengths of our results is related to differences between groups: First, because the participants were drafted from assisted living facilities, we distributed them into the different experimental conditions in a semi-randomized allocation (randomized between experimental and control but not for the type of experimental-frequency group). As a result, there were pre-intervention differences between the experimental groups in education and social ties, which possibly affected the results. Second, the frequency of sessions and length of course, which we wanted to examine, changed the number of practice days at home between the sessions. The groups had an equal amount of total-class time, but the MBIS-1*8 course required its participants to practice 7 consecutive days at home each week, while the MBIS-2*4 course required its participants to practice 2–4 days at home each week. As aforementioned, this likely influenced the learning process and the amount of dedication to the course. A third difference between the groups is the level of skillfulness of the course mentor. The two courses ended at the same time but began at different times. As a result, most of the MBIS-2*4 course sessions were offered after the MBIS-1*8 course sessions ended and, although the efforts to make the sessions identical across groups, the confidence and skillfulness of the mentor were definitely higher and the number of errors was fewer for the MBIS-2*4 group than they were for the MBIS-1*8 group. This was not reflected in the research findings, aside from *via* the amount of attrition in the MBIS-2*4 group, which was smaller. In addition, we compared experimental groups to a control group, which met weekly but with no structural program across sessions. Due to technical restrictions, not all questionnaires were

administered in the control group, which further limits our comparison. Difficulties in measurement: First, due to time and location constraints, the Simon task was provided on different laptops, under different lighting conditions, and on different table heights, which damaged the reliability of the RT measurement in the cognitive task. These are expected constraints in the senior population, but still have an undeniable influence on the results. Second, the abbreviation of the intervention required choosing appropriate exercises that would reflect all the elements that contribute to the mindfulness intervention. However, it seems that for the senior population, repeated practice and high frequency are of great value. Thus, it makes sense to examine an appropriated course for seniors, which will combine advantages and will include bi-weekly sessions for a period of 8 weeks, and a total of 16 sessions.

Despite these limitations, the study's strengths rely on its ecological nature. Older adults (aged 72–91) took part in this study, while maintaining their routine and sometimes unexpected life circumstances. Aging involves cognitive decline and emotional distress, and social interventions bear incredible preventative potential. Here, the social effect of the groups may have contributed to our emotional effects but was compared to a control group, who did not enjoy the same benefits.

We encourage future research to include a longitudinal measure after 6 months. This would enable us to understand how deep the aforementioned changes are. We also assume that the differences between groups will strengthen as a result of longitudinal influences. Likewise, it would be interesting to examine the association between participant traits and their experienced change as a result of the intervention. Various nursing home workers can be trained to conduct multiple courses of MBIS within the institutions.

In conclusion, a brief mindfulness-based intervention succeeded at engendering change in mindfulness measures, similar to the results reported from full MBSR interventions. Most importantly, the intervention succeeded in improving measures of psychological distress and cognitive capacity among senior participants. This was only a pilot study with a small sample size; hence caution should be made about generalizability to the larger population. Yet, it has great potential implications for the improvement of quality of life and psychological well-being of aging and aged individuals. In times of need, interventions that can be offered in a group setting, at a low price, and at different community centers or isolated nursing homes (as in a time of pandemic such as COVID-19 pandemic) are necessary. We provide an initial offer for a treatment-maintenance solution for seniors, with a ready-to-use protocol to administer immediately.

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.

Ethics statement

The studies involving human participants were reviewed and approved by the ethic committee of the school of Social and Community Sciences at Ruppin Academic Center, R2017. The patients/participants provided their written informed consent to participate in this study.

Author contributions

All authors agree to be accountable for the content of the work. MH performed the study as part of her MA thesis, wrote the protocol, ran the MBIS groups in nursing homes, analyzed the data, and wrote parts of the manuscript. DA-S supervised MHs' work, in writing the protocol, analyzing the data, and writing the manuscript. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2022.994336/full#supplementary-material

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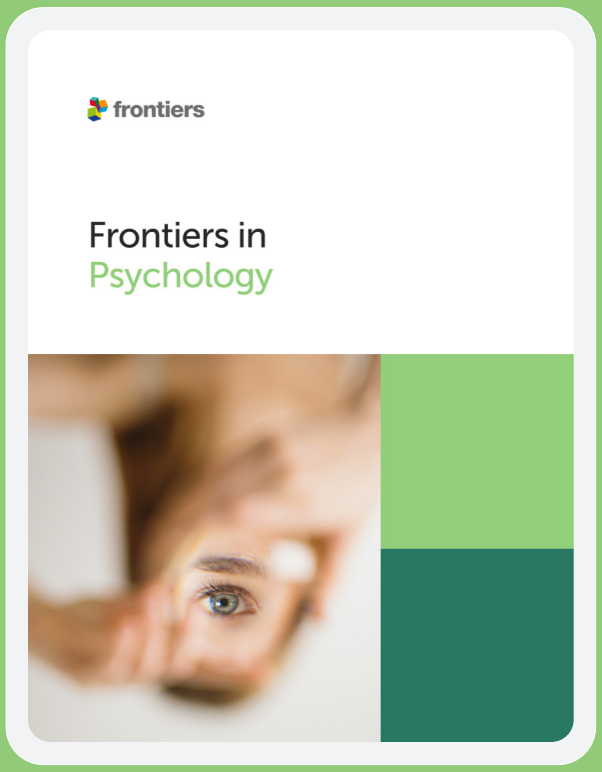

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