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Consequences of population aging for public health in different areas of life, 2nd Edition

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The risk of falls among the aging population: A systematic review and meta-analysis

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Aim: This study aims to clarify the risk factors for falls to prevent severe consequences in older adults.

Methods: We searched the PubMed, Web of Science, Embase, and Google Scholar databases using the terms "risk factors" OR "predicting factors" OR "predictor" AND "fall" OR "drop" to identify all relevant studies and compare their results. The study participants were divided into two groups, the "fall group" and the "control group", and differences in demographic characteristics, lifestyles, and comorbidities were compared.

Results: We included 34 articles in the analysis and analyzed 22 factors. Older age, lower education level, polypharmacy, malnutrition, living alone, living in an urban area, smoking, and alcohol consumption increased the risk of falls in the aging population. Additionally, comorbidities such as cardiac disease, hypertension, diabetes, stroke, frailty, previous history of falls, depression, Parkinson's disease, and pain increased the risk of falls.

Conclusion: Demographic characteristics, comorbidities, and lifestyle factors can influence the risk of falls and should be taken into consideration.

KEYWORDS

age, malnutrition, fall, meta-analysis, rural

Introduction

By 2050, people older than 65 years are estimated to account for 16% of the population (1). Falls are a major public health problem, as approximately 28–35% of individuals aged ≥ 65 years experience falls each year. As the aging population increases, more individuals will be at risk of falling (2).Among older people, physical falls are events that adversely affect health and lead to disability and mortality (3, 4). Moreover, fall-associated economic burdens are substantial and continue to increase worldwide (4, 5). Even non-injury falls are associated with negative impacts, such as anxiety, depression, and decreased mobility, which greatly affect the quality of life (QOL) and aging trajectory. The most harmful consequences of injurious falls are hip fracture and brain damage (4). Research on the risk of falling has become increasingly important to maintain the health of older individuals (2).Early screening for the risk of fall that takes risk factors into account is needed. Many retrospective, cross-sectional, and longitudinal studies have examined fall prevalence, fall-related consequences, and risk factors for falls in older individuals. However, even though some reviews have

addressed these topics (6, 7), a high-quality systematic review has yet to be conducted. Therefore, in this study, we aimed to investigate the association between lifestyle factors and fall risk in aging adults to promote the development of effective fall prevention strategies.

Methods

Guidelines and ethical review

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines in this systematic review. As this study was a review, no ethical approval was necessary.

Search strategy and data extraction

We hypothesized that demographic characteristics, lifestyle factors, and comorbidities would influence the risk of falls in the aging population. We chose these risk factors on the basis of records in the literature. After searching and carefully reading the literature, we found that the above factors had the most related studies and received the most attention. Therefore, we compared these factors between fall and non-fall groups. We searched for potentially relevant articles published in English before January 2022 during the initial search process. The terms searched in the PubMed, Web of Science, Embase, and Google Scholar databases were as follows: "risk factors" OR "predicting factors" OR "predictor" AND "fall" OR "drop". Since Boolean operators do not work on Google Scholar, we used search terms like "risk factors for fall" and "predicting factors for fall" on Google Scholar. Two authors independently screened all the abstracts and citations of all studies identified with the search strategy to determine eligible studies. Data were independently extracted by two of the authors using a standardized Excel file. Studies were considered eligible if they included two groups and aging individuals (≥65 years old) with or without falls, and presented data on the baseline lifestyle characteristics and comorbidities of the participants. The exclusion criteria were as follows: duplicate publications, reviews, studies on unrelated topics, studies with different variables, and studies with different group criteria. The search process consisted of 2 steps, the initial search with short keywords and then detailed search with detailed search strategy (present in Supplementary File 1). The description of the detailed search strategy for each part of the PICO research question is provided in Supplementary File 1, which is amended for other databases using database-specific subject headings, where available, and keywords in both titles and abstracts. The extracted data included baseline characteristics, lifestyle habits,

TABLE 1 Details of included papers.

Author	Year	Included number	Research type
Carvalho	2020	131	Retrospect study
Díaz et al. (8)	2020	2,849	Retrospect study
Dixe et al. (9)	2021	204	Prospective cohort study
Djurovic et al. (10)	2021	561	Retrospect study
Fukui et al. (11)	2021	185	Prospective cohort study
Griffin et al. (12)	2020	353	Observational study of RCT
Lackoff et al. (13)	2020	2,114	Prospective cohort study
Ilhan et al. (14)	2019	1,441	Retrospect study
Naharci et al. (15)	2020	520	Prospective cohort study
Immonen et al. (16)	2020	872	Retrospect study
Inacio et al. (17)	2021	32,316	Retrospect study
Ishida et al. (18)	2020	6,081	Retrospect study
Kim et al. (19)	2013	294	Retrospect study
Kitayuguchi et al. (20)	2021	965	Prospective cohort study
Pradeep Kumar et al. (21)	2021	63	Cross-sectional study
Pradeep Kumar et al. (21)	2021	150	Retrospect study
Ie et al. (22)	2021	343	Retrospect study
Lee et al. (23)	2021	232	Prospective cohort study
Magnuszewski et al. (24)	2020	358	Cross-sectional study
Makino et al. (25)	2021	2,520	Prospective cohort study
Mat et al. (26)	2021	605	Prospective cohort study
Nugraha et al. (27)	2021	154	Prospective cohort study
Pelicioni et al. (28)	2021	95	Randomized controlled trial
Pereira et al. (29)	2021	508	Cross-sectional study
Ravindran et al. (30)	2016	501	Prospective cohort study
Rivan et al. (31)	2021	815	Prospective cohort study
Sagawa et al. (32)	2018	1,817	Prospective cohort study
Schultz et al. (33)	2015	278	Retrospect study
Severo et al. (34)	2018	358	Prospective cohort study
Teoh et al. (35)	2020	1,415	Cross-sectional study
Tsai et al. (36)	2021	6,153	Retrospect study
Wang et al. (37)	2020	2,049	Prospective cohort study
Yu et al. (38)	2021	237	Prospective cohort study
Yu et al. (38)	2021	1,164	Retrospect study
Zhang et al. (39)	2021	7,307	Retrospect study

RCT, Randomized controlled trial.

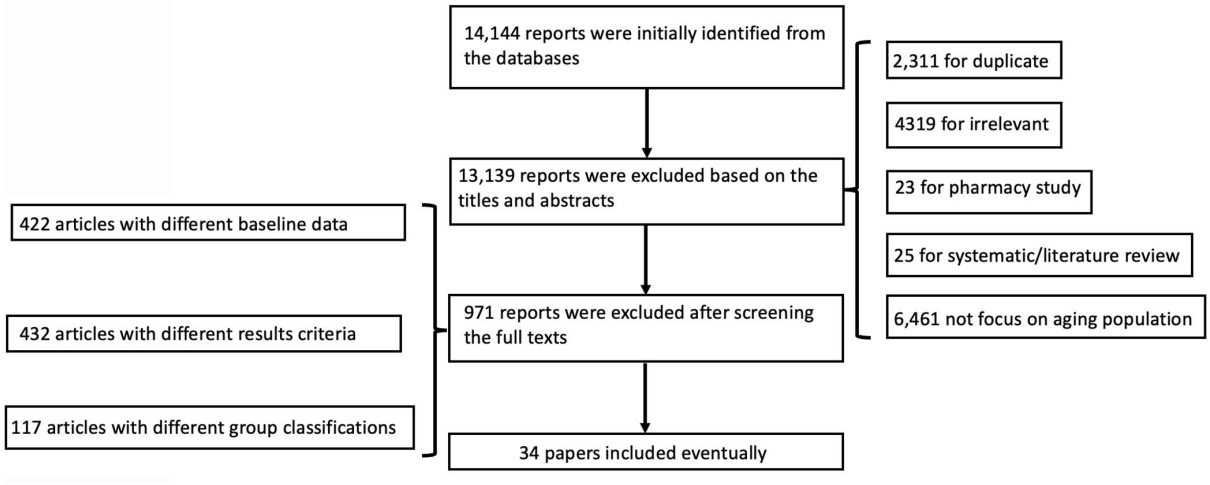

FIGURE 1
Flowchart of the literature review process and exclusion criteria.

comorbidities, and occurrence of falls. All the included data were subsequently entered in RevMan 5.1.4.

Comparisons

In our meta-analysis, we compared 22 factors between the two groups (the fall group and the control [no falls] group). The factors included age, body mass index (BMI), education level, polypharmacy, sex, relationship status (living alone), residential location (rural), (mal)nutrition, smoking status, alcohol consumption, and comorbidities including cardiac disease, hypertension, diabetes, stroke, depression, Parkinson's disease, pain, vision impairment, frailty, previous history of falls, and cognitive impairment.

Quality assessment

The quality of the included studies was assessed by two authors according to the Cochrane Collaboration Reviewer's Handbook and the Quality of Reporting of Meta-analysis guidelines (40, 41).

Data analysis

The data were analyzed using RevMan 5.1.4. Continuous outcomes are presented as weighted mean differences (MDs) with 95% confidence intervals (CIs). Dichotomous data are presented as relative risks (RRs) with 95% CIs. A meta-analysis was performed using fixed-effect or random-effects models as appropriate. Specifically, the fixed-effects models were used when no significant heterogeneity was present, and the random-effects models were used when heterogeneity was present. Statistical heterogeneity among the trials was evaluated by the I^2 test, with significance set at $P < 0.05$.

Results

Description of the included studies

A total of 14,144 reports were initially identified from the databases. After screening for duplicate publications, reviews, and irrelevant records based on the titles and abstracts, 13,139 reports were excluded from the study. After screening the full texts, 422 articles with different baseline data, 432 articles with different results criteria, and 117 articles with different group classifications were excluded. Thus, we eventually included 34 articles in the final analysis (8–32, 34–39, 42–44). The conditions of these studies and the clinical details of the participants are presented in Table 1. A flow chart of the literature search is shown in Figure 1.

Characteristics and lifestyles of people with/without falls

First, we compared aging adults in terms of age, BMI, education level, polypharmacy, malnutrition, sex (female), living alone, living in a rural area, smoking status, and alcohol consumption (Figures 2A–L). Older age (MD 1.87; 95% CI 1.14–2.6; $p < 0.00001$, Figure 2A), number of drugs used (MD.36; 95% CI.19–0.52; $p < 0.0001$, Figure 2E), and polypharmacy (RR

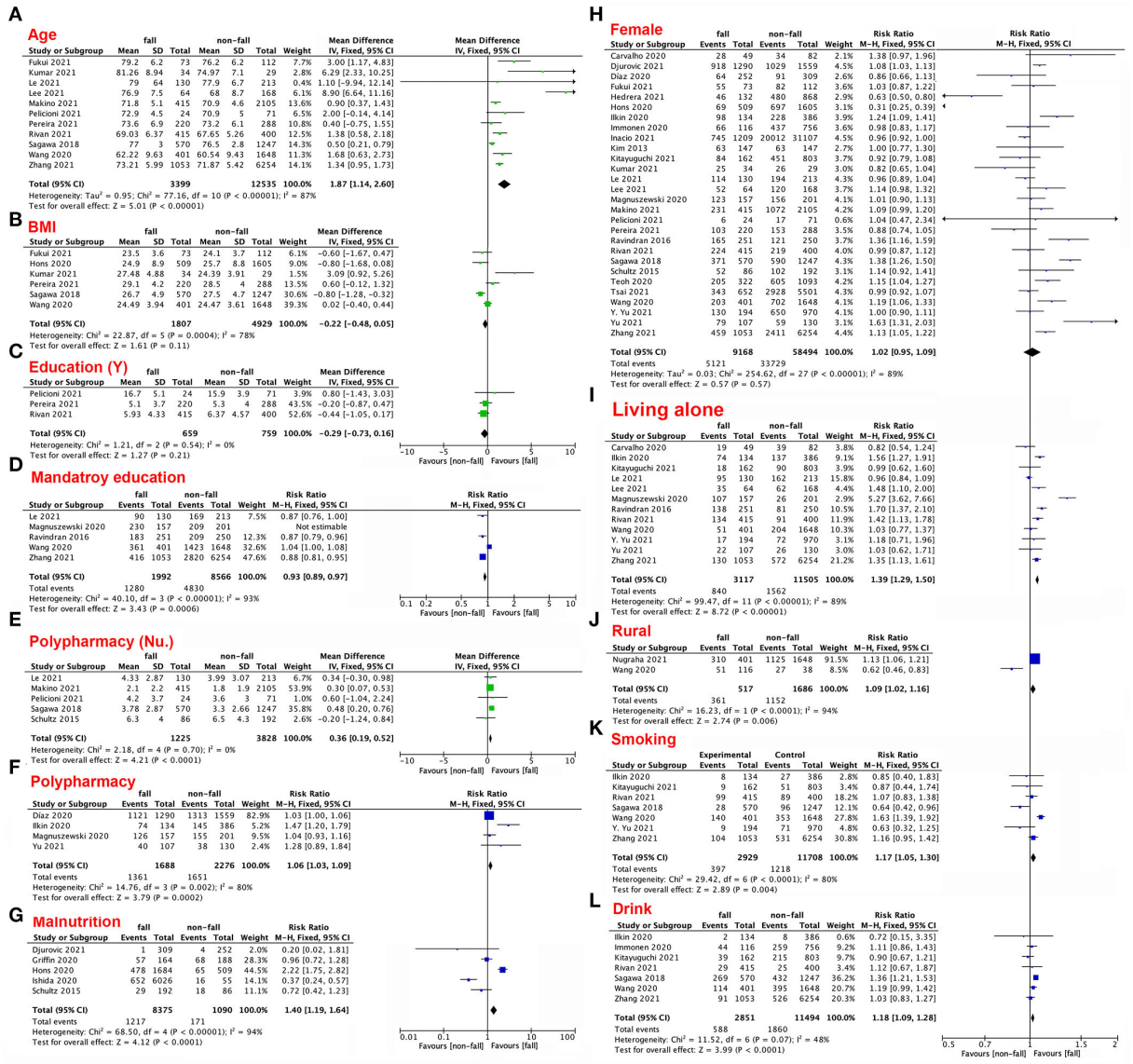

FIGURE 2
(A–L) Forest plots of the impacts of patient characteristics and lifestyle factors on the risk of falls.

1.06; 95% CI 1.03–1.09; $p = 0.0002$, Figure 2F) were associated with increased incidence of falls. Malnutrition (RR 1.4; 95% CI 1.19–1.64; $p < 0.0001$, Figure 2G), living alone (RR 1.39; 95% CI 1.29–1.5; $p < 0.00001$, Figure 2I), living in a rural area (RR 1.09; 95% CI 1.02–1.16; $p = 0.006$, Figure 2J), smoking (RR 1.17; 95% CI 1.05–1.3; $p = 0.004$, Figure 2K), and alcohol consumption (RR 1.18; 95% CI 1.09–1.28; $p < 0.001$, Figure 2L) were risk factors for falls. Education level (MD −0.29; 95% CI −0.73–0.16; $p = 0.21$, Figure 2C) had no impact on risk of falls, but completion of the mandatory level of education (RR 0.93; 95% CI 0.89–0.97; $p = 0.006$, Figure 2D) decreased the risk of falls. BMI (MD −0.22; 95% CI −0.48–0.05; $p = 0.11$, Figure 2B) and sex (RR 1.02; 95% CI 1–1.04; $p = 0.13$, Figure 2H) did not affect risk of falls.

Comorbidities in people with or without falls

Eleven comorbidities were compared between people with and without falls: cardiac disease, hypertension, diabetes, stroke, vision dysfunction, frailty, fall history, cognitive impairment, depression, Parkinson's disease, and pain (Figures 3A–L). Even

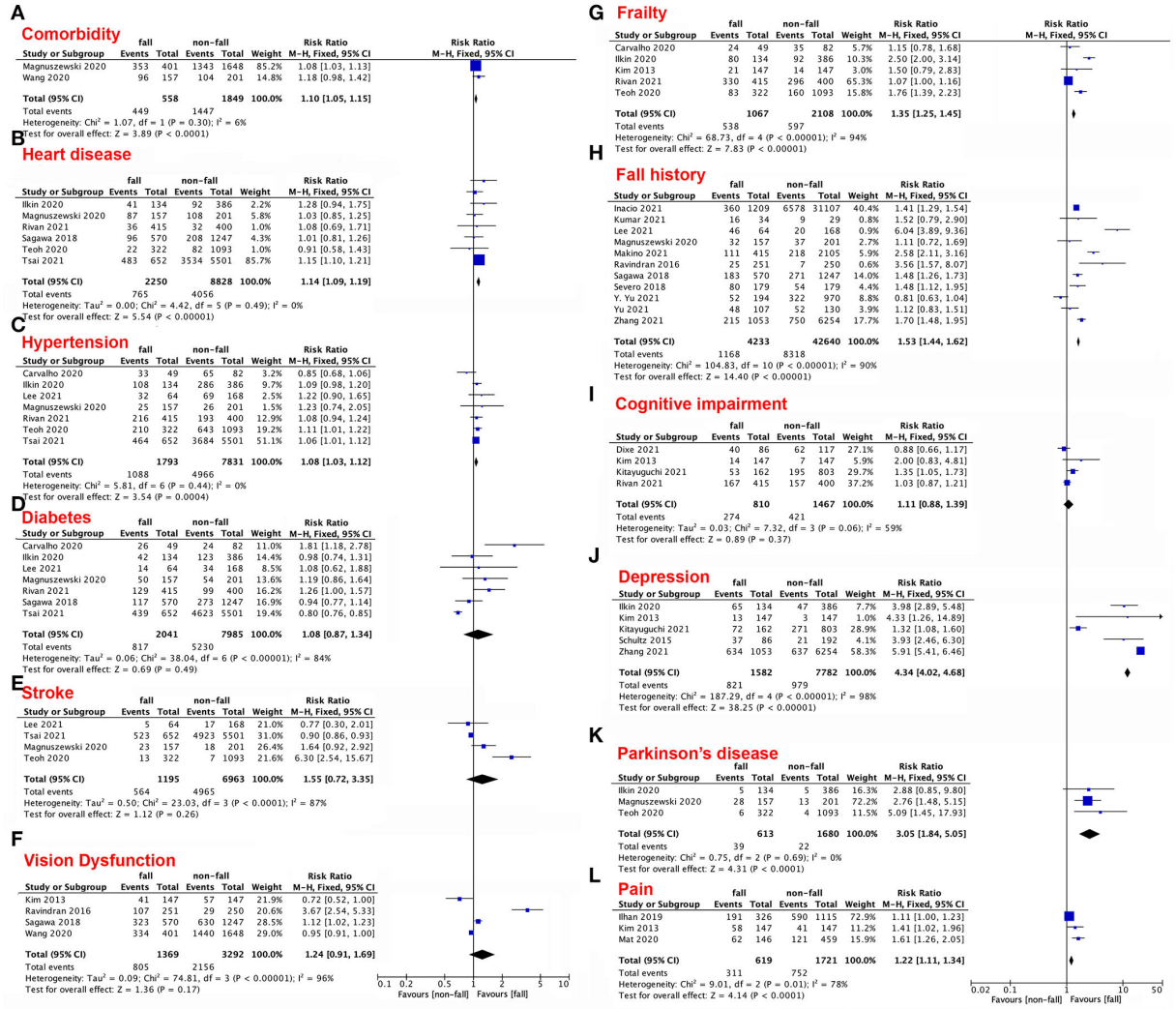

FIGURE 3
(A–L) Forest plots of the impacts of comorbidities on the risk of falls.

though these comorbidities may alter the rate of frailty among elderly individuals (RR 1.1; 95% CI 1.05–1.15; $p < 0.0001$, Figure 3A), not all of the comorbidities mentioned above necessarily influence falls. For instance, diabetes (RR 1.08; 95% CI 0.87–1.34; $p = 0.49$, Figure 3D), stroke (RR 1.55; 95% CI 0.72–3.35; $p = 0.26$, Figure 3E), vision dysfunction (RR 1.24; 95% CI 0.91–1.69; $p = 0.17$, Figure 3F), and cognitive impairment (RR 1.11; 95% CI 0.88–1.39; $p = 0.37$, Figure 3I) did not significantly differ between the two groups. In contrast, heart disease (RR 1.14; 95% CI 1.09–1.19; $p < 0.00001$, Figure 3B), hypertension (RR 1.08; 95% CI 1.03–1.12; $p = 0.0004$, Figure 3C, frailty (RR 1.35; 95% CI 1.25–1.45; $p < 0.00001$, Figure 3G), fall history (RR 1.53; 95% CI 1.44–1.62; $p < 0.00001$, Figure 3H), depression (RR 4.34; 95% CI 4.02–4.68; $p < 0.00001$, Figure 3K), Parkinson's disease (RR 3.05; 95% CI 1.84–5.05; $p < 0.0001$, Figure 3K), and pain (RR 1.22; 95% CI 1.11–1.34; $p < 0.0001$, Figure 3L) were associated with increased risk of falls among the aging population.

Discussion

In older adults, falls impose major health, economic, and societal burdens (16). Falls are the leading cause of injury in the elderly population (36). A serious fall could result in decreased independence and reduced QOL (36). Hip fracture, in particular, is a serious and devastating consequence of falling in older individuals (36). Moreover, Makino et al. reported that fall history is the most influential predictor of future falls (25).

According to recent research, fall history increases the current risk of falls. Some research has also proposed that fear of falling is significantly associated with falls. Usually, fear of falling arises from a fall history (45). Patil R et al. suggested that fear of falling may increase even after a non-injurious fall. Subsequently, older adults may enter into a negative cycle in which they reduce their activity, leading to reduction in functionality (45). To avoid this negative cycle, we recommend early prevention of falls in elderly adults. Fear of falling was also independently associated with presence of knee pain, with a significant relationship observed between fear of falling and moderate to severe knee pain but not mild knee pain (14). Pain is a frequently mentioned factor, but only a few studies have prospectively collected data on fall occurrence in relation to knee pain or the lack of association between knee pain and fall occurrence during long-term follow-up. Furthermore, fear of falling may exacerbate depression. Our present results demonstrated that depression can also impact the risk of falls. As most falls result from loss of balance while walking and poor balance is the leading risk factor for falls, people tend to focus on the importance of mobility in the risk of falls (46). This explains the lack of sufficient predictive factors in older adults at risk of one or more falls. Additionally, social factors can increase the psychological burden on elderly individuals and reduce self-care capability, a factor with strong influences (47) on the risk of falls as well as the incidence rates of many diseases. Thus, the identification of risk factors for falls will provide important guidance for the care of elderly individuals.

Older age, polypharmacy, malnutrition, frailty, smoking, and alcohol consumption significantly increased the risk of falls; these factors also reflect decline in physical condition. Moreover, chronic illnesses are very common in older adults, and cardiac disease, hypertension, diabetes, stroke, and Parkinson's disease are associated with falls. Older adults residing in urban areas had a higher risk of falling than those residing in rural areas (27). This difference may be explained by traffic, which can impede medical treatment. Residency in suburban areas has certain advantages; for instance, it is easier to engage in physical exercises, such as walking, in suburban and rural areas than in urban areas. Physical exercise helps to reduce the risk of falls in adults and improves lower limb strength in older people (27, 47). Moreover, living in a rural area is associated with less pollution exposure; this factor is particularly important in developing countries because pollution may cause comorbidities. However, only a few articles have focused on this topic. We plan to explore this topic further in the future once a larger number of relevant reports have been published. Sex has been identified as a risk factor for falls among older adults (37), but in our study, women did not have a higher risk of falling than men. While women experience a higher rate of frailty than men (37), men are more likely to exhibit harmful lifestyle habits, such as smoking and consuming alcohol; therefore, sex differences in the risk of falling merit further study. Another risk factor in our study is living alone, which increases the risk of depressive symptoms and the impacts of falls.

A major strength of this study is that we analyzed data from several large-scale, well-characterized cohorts and systematically summarized the risk factors for falls in the elderly population. These findings can inform healthcare in the elderly population. Biswas et al. explored the risk factors for falls among older adults in India (6); however, their study focused on only the Indian population and thus exhibited geographic and ethnic limitations. Xie et al. examined risk factors for the development of fear of falling, but fear of falling was only one of the risk factors for falls; we suggest that it is more meaningful to identify the risk factors for falls. Our meta-analysis also has some limitations. For example, we did not categorize the participants according to whether they lived in the community or in nursing homes, which is a major factor associated with the risk of falls.

Conclusion

We demonstrated that (1) older age, polypharmacy, malnutrition, single status, living in a rural area, smoking, and alcohol consumption significantly increased the risk of falls in elderly adults. In contrast, higher education level was protective against falls. Additionally, we found that (2) individuals with cardiac disease, hypertension, frailty, previous history of falls, depression, Parkinson's disease, and pain had a higher risk of falls than individuals without such comorbidities.

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 authors.

Author contributions

Data acquisition and drafting of the manuscript: QX, XO, and JL. Conception and design of the study: JL. Analysis and/or interpretation of data: QX and XO. 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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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2022.902599/full#supplementary-material

References

1. United Nations, Desa, Population Division, World Population Prospects 2019: Highlights. Available online at: http://www.population.un.org/wpp/Publications/Files/wpp2019_highlights.pdf (accessed April 7, 2020).

2. Organization WH. WHO Global Report on Falls Prevention in Older Age. Available online at: https://www.who.int/publications-detail-redirect/9789241563536 (accessed September 26, 2021).

3. Blain H, Dargent-Molina P, Martin FC, Rosendahl E, van der Velde N, Bousquet J, et al. European Society for Clinical and Economic Aspects of Osteoporosis and Osteoarthritis (ESCEO), Osteoporosis Research and Information Group (GRIO), and International osteoporosis Foundation (IOF), A comprehensive fracture prevention strategy in older adults: The European Union Geriatric Medicine Society (EUGMS) Statement. *J Nutr Health Aging.* (2016) (6):647–52. doi: 10.1007/s12603-016-0741-y

4. Gill TM, Murphy TE, Gahbauer EA, Allore HG. Association of injurious falls with disability outcomes and nursing home admissions in community-living older persons. *Am J Epidemiol.* (2013) 178:418–25. doi: 10.1093/aje/kws554

5. Spaniolas K, Cheng JD, Gestring ML, Sangosanya A, Stassen NA, Bankey PE. Ground level falls are associated with significant mortality in elderly patients. *J Trauma.* (2010) 69:821–5. doi: 10.1097/TA.0b013e3181efc6c6

6. Biswas I, Adebusoye B, Chattopadhyay K. Risk factors for falls among older adults in India: A systematic review and meta-analysis. *Health Sci Rep.* (2022) 5:e637. doi: 10.1002/hsr2.637

7. Xie Q, Pei J, Gou L, Zhang Y, Zhong J, Su Y, et al. Risk factors for fear of falling in stroke patients: a systematic review and meta-analysis. *BMJ Open.* (2022) 12:e056340. doi: 10.1136/bmjopen-2021-056340

8. Díaz LB, Casuso-Holgado MJ, Labajos-Manzanares MT, Barón-López FJ, Pinero-Pinto E, Romero-Galisteo RP, et al. Analysis of fall risk factors in an aging population living in long-term care institutions in SPAIN: A retrospective cohort study. *Int J Environ Res Public Health.* (2020) 17:7234. doi: 10.3390/ijerph17197234

9. Dixe MDA, Madeira C, Alves S, Henriques MA, Baixinho CL. Gait Ability and Muscle Strength in Institutionalized Older Persons with and without Cognitive Decline and Association with Falls. *Int J Environ Res Public Health.* (2021) 18:11543. doi: 10.3390/ijerph182111543

10. Djurovic O, Mihaljevic O, Radovanovic S, Kostic S, Vukicevic M, Brkic BG, et al. Risk factors related to falling in patients after stroke. *Iran J Public Health.* (2021) 50:1832–41. doi: 10.18502/ijph.v50i9.7056

11. Fukui K, Maeda N, Komiya M, Sasadai J, Tashiro T, Yoshimi M, et al. The relationship between modified short physical performance battery and falls: A cross-sectional study of older outpatients. *Geriatrics (Basel).* (2021) 6:106. doi: 10.3390/geriatrics6040106

12. Griffin A, O'Neill A, O'Connor M, Ryan D, Tierney A, Galvin R. The prevalence of malnutrition and impact on patient outcomes among older adults presenting at an Irish emergency department: a secondary analysis of the OPTI-MEND trial. *BMC Geriatr.* (2020) 20:455. doi: 10.1186/s12877-020-01852-w

13. Lackoff AS, Hickling D, Collins PF, Stevenson KJ, Nowicki TA, Bell JJ. The association of malnutrition with falls and harm from falls in hospital inpatients: Findings from a 5-year observational study. *J Clin Nurs.* (2020) 29:429–36. doi: 10.1111/jocn.15098

14. Ilhan B, Bahat G, Erdogan T, Kiliç C, Karan MA. Chronic pain: prevalent and independently associated with frailty and female gender in geriatric outpatients. *Eur Geriatr Med.* (2019) 10:931–7. doi: 10.1007/s41999-019-00235-8

15. Naharci MI, Tasci I. Frailty status and increased risk for falls: The role of anticholinergic burden. *Arch Gerontol Geriatr.* (2020) 90:104136. doi: 10.1016/j.archger.2020.104136

16. Immonen M, Haapea M, Similä H, Enwald H, Keränen N, Kangas M, et al. Association between chronic diseases and falls among a sample of older people in Finland. *BMC Geriatr.* (2020) 20:225. doi: 10.1186/s12877-020-01621-9

17. Inacio MC, Moldovan M, Whitehead C, Sluggett JK, Crotty M, Corlis M, et al. The risk of fall-related hospitalisations at entry into permanent residential aged care. *BMC Geriatr.* (2021) 21:686. doi: 10.1186/s12877-021-02640-w

18. Ishida Y, Maeda K, Nonogaki T, Shimizu A, Yamanaka Y, Matsuyama R, et al. Malnutrition at admission predicts in-hospital falls in hospitalized older adults. *Nutrients.* (2020) 12:541. doi: 10.3390/nu12020541

19. Kim YS, Smi CK. Fall risk factors and fall risk assessment of inpatients. *Korean J Adult Nurs.* (2013) 25:74–82. doi: 10.7475/kjan.2013.25.1.74

20. Kitayuguchi J, Abe T, Okuyama K, Gomi T, Okada S, Shiwaku K, et al. Association between a hilly neighborhood environment and falls among rural older adults: a crosssectional study. *J Rural Med.* (2021) 16:214–21. doi: 10.2185/jrm.2021-028

21. Pradeep Kumar D, Wendel C, Mohler J, Laksari K, Toosizadeh N. Between-day repeatability of sensor-based in-home gait assessment among older adults: assessing the effect of frailty. *Aging Clin Exp Res.* (2021) 33:1529–37. doi: 10.1007/s40520-020-01686-x

22. Ie K, Chou E, Boyce RD, Albert SM. Fall risk-increasing drugs, polypharmacy, and falls among low-income community-dwelling older adults. *Innov Aging.* (2021) 5:igab001. doi: 10.1093/geroni/igab001

23. Lee YY, Chen CL, Lee IC, Lee IC, Chen NC. History of falls, dementia, lower education levels, mobility limitations, and aging are risk factors for falls among the community-dwelling elderly: a cohort study. *Int J Environ Res Public Health.* (2021) 18:9356. doi: 10.3390/ijerph18179356

24. Magnuszewski L, Swietek M, Kasiukiewicz A, Kuprjanowicz B, Baczek J, Beata Wojszel Z. Health, functional and nutritional determinants of falls experienced in the previous year-a cross-sectional study in a geriatric ward. *Int J Environ Res Public Health.* (2020) 17:4768. doi: 10.3390/ijerph17134768

25. Makino K, Lee S, Bae S, Chiba I, Harada K, Katayama O, et al. Simplified decision-tree algorithm to predict falls for community-dwelling older adults. *J Clin Med.* (2021) 10:5184. doi: 10.3390/jcm10215184

26. Mat S, Kamaruzzaman SB, Chin AV, Tan MP. Impact of knee pain on fear of falling, changes in instrumental activities of daily living, and falls among malaysians age 55 years and above. *Front Public Health.* (2020) 8:571196. doi: 10.3389/fpubh.2020.571196

27. Nugraha S, Prasetyo S, Susilowati IH, Rahardjo TBW. Urban-rural dimension of falls and associated risk factors among community-dwelling older adults in west java, Indonesia. *J Aging Res.* (2021) 2021:8638170. doi: 10.21203/rs.3.rs-542482/v1

28. Pelicioni PHS, Lord SR, Sturnieks DL, Halmy B, Menant JC. Cognitive and motor cortical activity during cognitively demanding stepping tasks in older people at low and high risk of falling. *Front Med.* (2021) 8:554231. doi: 10.3389/fmed.2021.554231

29. Pereira C, Bravo J, Reis G, Mendes F. Aging safely in Alentejo - understanding for action - preventing falls and violence against older people: study rationale, aims, design, and preliminary results. *BMC Public Health.* (2021) 21:861. doi: 10.1186/s12889-021-10807-8

30. Ravindran RM, Kutty VR. Risk factors for fall-related injuries leading to hospitalization among community-dwelling older persons: a hospital-based case-control study in Thiruvananthapuram, Kerala, India. *Asia Pac J Public Health.* (2016) 28:70S—6S. doi: 10.1177/1010539515611229

31. Rivan NFM, Singh DKA, Shahar S, Wen GJ, Rajab NF, Din NC, et al. Cognitive frailty is a robust predictor of falls, injuries, and disability among community-dwelling older adults. *BMC Geriatr.* (2021) 21:593. doi: 10.1186/s12877-021-02525-y

32. Sagawa N, Marcum ZA, Boudreau RM, Hanlon JT, Albert SM, O'Hare C, et al. Low blood pressure levels for fall injuries in older adults: the health, aging and body composition study. *Eur J Ageing.* (2018) 15:321–30. doi: 10.1007/s10433-017-0449-9

33. Schultz M, Rosted E, Sanders S. Frailty is associated with a history with more falls in elderly hospitalised patients. *Dan Med J.* (2015) 62:A5058.

34. Severo IM, Kuchenbecker RS, Vieira DFVB, Lucena AF, Almeida MA. Risk factors for fall occurrence in hospitalized adult patients: a case-control study. *Rev Lat Am Enfermagem.* (2018) 26:e3016. doi: 10.1590/1518-8345.2460.3016

35. Teoh RJJ, Mat S, Khor HM, Kamaruzzaman SB, Tan MP. Falls, frailty, and metabolic syndrome in urban dwellers aged 55 years and over in the Malaysian elders longitudinal research (MELoR) study - a cross-sectional Study. *Postgrad Med.* (2021) 133:351–6. doi: 10.1080/00325481.2020.1842026

36. Tsai CY, Lin ES Li YT, Tung TH, Chen WC. The relationship between storey of buildings and fall risk. *Front Public Health.* (2021) 9:665985. doi: 10.3389/fpubh.2021.665985

37. Wang X, Chen Z, Li Z, Chen B, Qi Y, Li G, et al. Association between frailty and risk of fall among diabetic patients. *Endocr Connect.* (2020) 9:1057–64. doi: 10.1530/EC-20-0405

38. Yu WY, Hwang HF, Chen CY, Lin MR. Situational risk factors for fall-related vertebral fractures in older men and women. *Osteoporos Int.* (2021) 32:1061–70. doi: 10.1007/s00198-020-05799-x

39. Zhang XM, Yuan L, Guo N, Bo HX, Jiao J, Wu XJ, et al. Cognitive frailty and falls in a national cohort of older chinese inpatients. *J Nutr Health Aging.* (2021) 25:993–8. doi: 10.1007/s12603-021-1670-y

40. Julian PT. Higgins and Sally Green, Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.4 The Cochrane Collaboration. Available online at: https://www.cochranehandbook.org/ (2011).

41. Moher D, Liberati A, Tetzlaff J, Altman DG Prisma Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Int J Surg.* (2010) 8:658. doi: 10.1016/j.ijsu.2010.02.007

42. Carvalho TC, Dini AP. Risk of falls in people with chronic kidney disease and related factors. *Rev Lat Am Enfermagem.* (2020) 28:e3289. doi: 10.1590/1518-8345.3911.3289

43. Friedman DS, West SK, Gitlin LN, Ramulu PY. Longitudinal changes in daily patterns of objectively measured physical activity after falls in older adults with varying degrees of glaucoma. *EClinicalMedicine.* (2021) 40:101097. doi: 10.1016/j.eclinm.2021.101097

44. García-Hedrera FJ, Noguera-Quijada C, Sanz-Márquez S, Pérez-Fernández E, Acevedo-García M, Domínguez-Rincón R, et al. Incidence and characteristics of falls in hospitalized patients: A cohort study. *Enferm Clin (Engl Ed).* (2021) 31:381–9. doi: 10.1016/j.enfcle.2021.04.003

45. Patil R, Uusi-Rasi K, Kannus P, Karinkanta S, Sievänen H. Concern about falling in older women with a history of falls: associations with health, functional ability, physical activity and quality of life. *Gerontology.* (2014) 60:22–30. doi: 10.1159/000354335

46. Avin KG, Hanke TA, Kirk-Sanchez N, McDonough CM, Shubert TE, Hardage J, et al. Academy of geriatric physical therapy of the American physical therapy association. Management of falls in community-dwelling older adults: clinical guidance statement from the academy of geriatric physical therapy of the American physical therapy association. *Phys Ther.* (2015) 95:815–34. doi: 10.2522/ptj.20140415

47. Caristia S, Campani D, Cannici C, Frontera E, Giarda G, Pisterzi S, et al. Physical exercise and fall prevention: A systematic review and meta-analysis of experimental studies included in Cochrane reviews. *Geriatr Nurs.* (2021) 42:1275–86. doi: 10.1016/j.gerinurse.2021.06.001

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Predicting Chinese older adults' intention to live in nursing homes using an integrated model of the basic psychological needs theory and the theory of planned behavior

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The growing number of aging populations has become a major problem worldwide. Nursing homes play an essential role in the later life of older adults. Previous research indicated potential associations between external factors and older adults' intention to live in nursing homes. However, intrinsic motivation has yet to be fully understood. This article addresses an academic void that integrated the Basic Psychological Needs Theory (BPNT) and the Theory of Planned Behavior (TPB) to explore older adults' intentions to live in nursing homes. More specifically, it tested the effects of autonomy, competence, and relatedness needs satisfaction as defined in the BPNT on attitudes, subjective norms, perceived behavioral control, and live-in intentions toward nursing homes in the TPB. An online survey provided quantitative data from 425 aging people. The results indicated that the higher the satisfaction of the basic psychological needs (i.e., autonomy needs, competence needs, and relatedness needs) of the older adults, the lower their intention to live in nursing homes. Furthermore, social pressure partially mediates this relationship. That is, the higher the satisfaction of the basic psychological needs of older adults, the lower the pressure from society. Thus, they should be admitted to the nursing home, and the lower their intention to live in nursing homes. The results contribute to a better understanding of the deep psychological motivation of the older adults' intention to live in nursing homes and support further development of the BPNT-TPB model in older adults' health research.

KEYWORDS

Chinese older adults, nursing home, basic psychological needs satisfaction, the theory of planned behavior, intention

Introduction

Addressing an aging population has long become a question of great interest in various fields. China is one of the countries with the fastest aging population (1). While many older adults live separately from their adult children, leading to more and more "empty nest" families (2), older adults' frailty raises the need for nursing homes. In the last few decades, there has been a surge of interest in older adults' intention to live in nursing homes (3). Previous studies on the intention to live in nursing homes have typically concentrated on demographic factors (4–7) and children's financial and emotional support (4, 8, 9). Nevertheless, the rapid changes in China's demographic, social and economic conditions weaken the traditional home care system (3).

It is observed that the integration model of self-determination theory (SDT) and planned behavior theory have yielded promising results in different studies (10–13). Nevertheless, no study has investigated the self-determination theory's role in the older adults' intention to live in nursing homes, not to mention the use of the integration model. The basic psychological needs theory is one of the six mini theories of self-determination theory (14). Given the above, this paper has two aims. First, it investigates the effect of three psychological needs satisfaction on the older adults' intention to live in nursing homes. Second, test the Chinese older adults' intention to live in the nursing home using the integration model.

Literature review and hypothesis development

Nursing homes

Sanford et al. (15) have reached an international consensus on the definition of the "nursing home" and what type of services the "nursing home" provides. Therefore, the nursing home in this context refers to a facility with a domestic design that provides 24-h functional support and care to older adults who need help with their daily activities, who often have complex health needs and increased vulnerability. The older adults in nursing homes are self-care, semi-self-care, and non-self-care elders. Most nursing homes mainly accept residents who need long-term care. Most of the employees in nursing homes are trained nurses.

Basic psychological needs theory

According to Ryan et al. (16), everyone must meet three needs to protect their mental health and the best human functions. The three most basic needs are "autonomy," "competence" and "relatedness." Autonomy needs satisfaction refers to the feeling that the individual is free to initiate, maintain, and terminate the target behavior (17). Competence needs satisfaction refers to the perception that one can influence the environment in an ideal way and complete a task within the scope of his ability (17); relatedness needs satisfaction refers to an individual's feeling that they can maintain a good relationship with significant others: care for each other and support each other (18). These needs are cross-personal and cross-cultural and apply to every aspect of life (19). Meeting these needs is essential; they guide people's behavior and are a potential behavioral incentive (17, 20).

Theory of planned behavior

Ajzen (21) proposed that attitude, subjective norm, and perceived behavioral control together form behavioral intentions. In TPB theory, the intention is defined as an "indication of how hard people are willing to try, of how much effort they are planning to exert, performing the behavior" (21). Attitude refers to an individual's positive or negative evaluation of a specific intention and behavior. Perceived behavioral control is used to describe whether the behavior is complex and whether it is under their control (21). Subjective norms can be defined as the social pressure perceived by significant others or reference groups (22).

BPNT-TPB framework

A common criticism of predicting human behavior using TPB or basic psychological needs theory basic psychological needs theory (BPNT) alone concerns a lack of motivation. The theory of planned behavior is believed to overlook the origin of social cognitive beliefs; self-determination theory fails to explain the contingency of situations nor the process of transforming motivational orientation into behavioral intentions and behaviors (23, 24).

Some scholars tend to integrate self-determination theory with the theory of planned behavior to address these shortcomings. Drawing on 45 tests of SDT-TPB structures, Hagger and Chatzisarantis (12) used meta-analysis to examine the motivation sequence. The results indicated that the proximal predictors of TPB partially mediated the significant effect of SDT on intention. The basic psychological needs theory is the most widely used SDT's six mini-theories (14). Consequently, this study assumed that the BPNT-TPB model is appropriate for studying older adults' intentions to live in nursing homes. This study classifies essential psychological needs satisfaction into three dimensions: autonomy needs satisfaction, competence needs satisfaction and relatedness satisfaction (16), and explores the more complicated relationship between BPNT and TPB variables. The framework model is as shown in Figure 1.

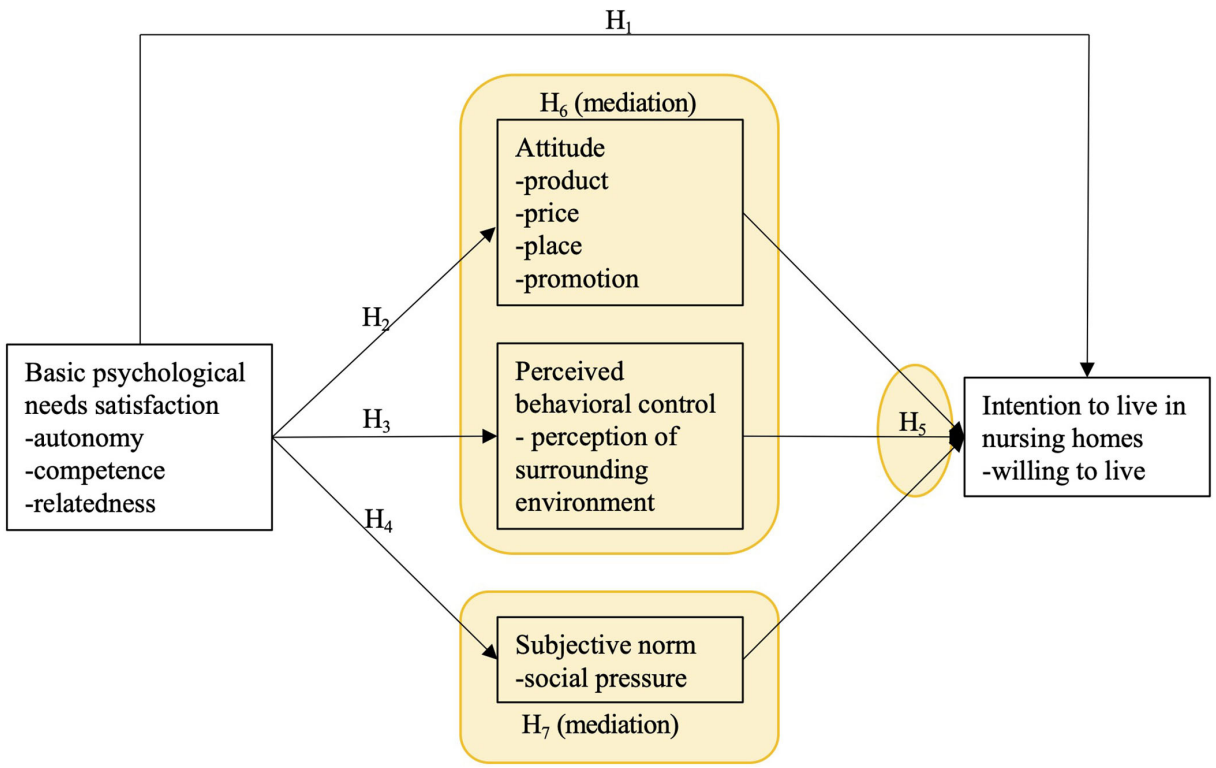

FIGURE 1
Framework model.

Development of hypotheses

Relationship between basic psychological needs satisfaction and intention

Al-Jubari (25) suggested that autonomic motivation occurs when an individual's behavior satisfies basic psychological needs, namely autonomy, competence, and relatedness. Hagger (26) pinpointed those essential psychological needs satisfaction, directly and indirectly, affected intention. Besides, according to Harris et al. (27), the SDT suggested that people who have been adequately satisfied with psychological needs were more likely to engage in actions to sustain their sense of autonomy, competence, and relatedness needs. Therefore, older adults who meet basic psychological needs in their daily lives may continue their original lifestyle to meet their needs of autonomy, competence, and relatedness. They are expected to be less willing to live in nursing homes. So, this research proposes hypothesis 1:

H1: Basic psychological needs satisfaction negatively influences the intention to live in nursing homes.

Relationship between basic psychological needs satisfaction and TPB variables

Individuals align their cognitions and emotions with overall motivation, resulting in self-motivated behaviors to meet the basic psychological needs of autonomy, competence, and relatedness (28). Deci et al. (29) pointed out that the satisfaction of people's needs for autonomy, competence, and relatedness facilitates internalizing their values and supervision processes, which was verified in another study (30). González-Cutre (31) concluded that TPB lacks the origin of the belief, and an individual's pursuit of basic psychological need satisfaction provides the reasons for attitude, intention and behavioral engagement. These research results agreed that the basic psychological need satisfaction predicts proximal factors of TPB: attitudes, subjective norms and perceived behavioral control.

Previous research has concluded that the satisfaction of three basic psychological needs positively affects individual exercise participation in sports (32). According to Baard et al. (33), people with higher satisfaction with their needs usually have a positive attitude toward the target behavior and find it easier to exhibit positive behavior. Similarly, Baard et al. (33) suggested that the higher people's satisfaction with the three needs, the higher their self-esteem and welfare. Al-Jubari (25) researched college students' entrepreneurial intentions and found that satisfaction with basic psychological needs positively affected entrepreneurial attitude, perceived behavioral control, and the subjective norm.

Therefore, this study speculate that for the Chinese older adults, the higher the basic psychological needs satisfaction, the

more positive their attitude toward continuing their original life, but the more negative their attitude toward nursing homes. At the same time, there will be less pressure on significant others around them to put them in nursing homes, and the subjective norm will be lower. On the contrary, the higher basic psychological needs satisfaction of the older adults are associated with a higher the perceived behavioral control. This research proposes hypotheses 2–4:

H2: Basic psychological needs satisfaction negatively influences attitude.

H3: Basic psychological needs satisfaction negatively influences subjective norms.

H4: Basic psychological needs satisfaction positively influences perceived behavioral control.

Relationship among TPB variables

In a seminal paper, Ajzen (21) provides the earliest description of TPB that behavioral intention is a function of attitude, subjective norm, and perceived behavioral control. In a recent nursing home study, Huang's (34) research show that attitude and perceived behavioral control directly affect the intention to move into a nursing home. Subjective norms have the most negligible effect on intention but strongly affect intention through attitude. The mediation effect shows that their opinions and social perceptions will affect attitudes and thus affect behavioral intentions of moving into a nursing home. At the same time, perceived behavioral control also strongly influences the intention of older adults to move into nursing homes. No matter how positive their attitude toward moving into senior housing is nor how significant others support their decision, their intention to move in will decrease as long as there are potential restrictions. Therefore, this study proposes hypotheses 5–7:

H5: Attitude, subjective norms, and perceived behavioral control positively influence the intention to live in nursing homes.

Mediation effect on TPB variables

Many scholars have integrated SDT and TPB to explain the processes behind the behavior. Hagger's (26) motivational sequence research found that basic psychological needs satisfaction affects intentions *via* attitudes and perceived behavioral control. At the same time, the subjective norm's effect is insignificant. This view is supported by Barkoukis (35), who found that the proximal predictors of TPB: attitude, subjective norm, and perceived behavioral control mediate the effect of basic psychological need satisfaction on the intention to exercise leisure time. Similarly, Al-Jubari (25) underlines that attitude and perceived behavioral control completely mediate the effect of satisfying the basic psychological needs of college students' entrepreneurial intention. Therefore, we hypothesized that the basic psychological needs satisfaction indirectly impacts intention *via* attitude, subjective norms and perceived behavioral control. Therefore, this research proposes hypotheses 8–10:

H6: Attitude and perceived behavioral control mediate the effect of basic psychological needs satisfaction on the intention to live in nursing homes.

H7: Subjective norms play a mediating role in the effect of basic psychological needs satisfaction on the intention to live in nursing homes.

Methods

Population and sampling technique

This study employed a cross-sectional survey method and distributed electronic questionnaires from January to February 2022. The target population was "the older adults over 60 years old, living in Henan, China, sober-minded, able to use a smartphone." According to the sampling formula (36), a minimum of 387 samples should be drawn to ensure accuracy. Our study collected a total of 425 valid questionnaires.

Respondents characteristics

A total of 425 respondents completed the questionnaire, 117 were male and 248 were female. 64.5% of respondents were aged 60–70 years old. 30.4% of respondents had income between 3,001 and 4,000 yuan. 28.0% of respondents were educated in high school. 46.4% of respondents had only one child, and 48.7% of respondents' physical condition was completely healthy. Table 1 provides an overview of the respondent's gender, age, income, education, number of children, and physical condition.

Research instrument and statistical analysis

This study used a 6-point scale to let respondents choose (37). The research instrument was scaled that has been validated. Basic psychological needs satisfaction was measured using the psychological satisfaction portion of Chen et al.'s (38) scale, attitude referenced by Purnomo et al.'s (39) scale (attitude to 4Ps: product, price, place, and promotion), subjective norm and perceived behavioral control used Nsoh's (40) scale, intention adopts Xie et al.'s (41) scale. The software used are SPSS and AMOS. The key statistical analysis used is descriptive, reliability, validity, correlation, regression, mediating effect analysis and structural equation modeling.

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TABLE 1 Descriptive statistics of respondents.

Attribute	Category	Number	Percentage
Gender	Male	177	41.6
	Female	248	58.4
Age	60–70	274	64.5
	71–80	125	29.4
	81–90	20	4.7
	91 and above	6	1.4
Income	0–1000 yuan	52	12.2
	1001–2000 yuan	33	7.8
	2001–3000 yuan	72	16.9
	3001–4000 yuan	129	30.4
	4001–5000 yuan	108	25.4
	5001 and above	31	7.3
Education	uneducated	33	7.8
	primary school	61	14.4
	junior high school	90	21.2
	high school	119	28.0
	college	94	22.1
	Undergraduate	20	4.7
	Master degree and above	8	1.9
Number of children	0	7	1.6
	1	197	46.4
	2	149	35.1
	3	56	13.2
	4 and above	16	3.8
Physical condition	completely healthy	207	48.7
	chronically ill but able to take care of themselves	197	46.4
	chronically ill and unable to take care of themselves	21	4.9
	Bedridden and unable to take care of them self	0	0

Results

Reliability analysis

Reliability analysis uses Cronbach's alpha reliability coefficient to check the consistency of questionnaire research variables on each measurement item. It can be seen from Table 2 that Cronbach's alpha coefficient of each variable is greater than the standard of 0.7 (0.862–0.921), indicating that the variable has good internal consistency reliability. The "Corrected item-total Correlation" number is greater than the standard of 0.5 (0.645–0.832), indicating that the measurement items meet the research requirements. "Cronbach's Alpha if Item Deleted" shows that deleting any item will not cause Cronbach's alpha value to increase, indicating that the variable has good reliability (42).

TABLE 2 Reliability analysis.

Variable	Item	Corrected item-total correlation	Cronbach's Alpha if item deleted	Cronbach's Alpha
BPNS-AU	AU1	0.770	0.798	0.862
	AU2	0.745	0.809	
	AU3	0.664	0.842	
	AU4	0.662	0.843	
BPNS-CO	CO1	0.775	0.880	0.904
	CO2	0.792	0.874	
	CO3	0.811	0.867	
	CO4	0.764	0.885	
BPNS-RE	RE1	0.789	0.848	0.891
	RE2	0.764	0.858	
	RE3	0.757	0.861	
	RE4	0.729	0.871	
AT-PD	AT1	0.723	0.899	0.911
	AT2	0.721	0.899	
	AT3	0.703	0.901	
	AT4	0.712	0.900	
	AT5	0.746	0.896	
	AT6	0.775	0.893	
	AT7	0.737	0.897	
AT-PR	AT8	0.749	0.870	0.895
	AT9	0.763	0.867	
	AT10	0.742	0.872	
	AT11	0.750	0.870	
	AT12	0.705	0.880	
AT-PL	AT13	0.645	0.881	0.887
	AT14	0.732	0.862	
	AT15	0.750	0.858	
	AT16	0.776	0.852	
	AT17	0.743	0.861	
AT-PM	AT18	0.692	0.914	0.921
	AT19	0.703	0.913	
	AT20	0.724	0.912	
	AT21	0.729	0.912	
	AT22	0.680	0.914	
	AT23	0.700	0.913	
	AT24	0.700	0.913	
	AT25	0.686	0.914	
	AT26	0.699	0.913	
	AT27	0.707	0.913	
SN	SN1	0.816	0.882	0.910
	SN2	0.760	0.893	
	SN3	0.776	0.890	
	SN4	0.741	0.898	
	SN5	0.775	0.890	
PBC	PBC1	0.801	0.820	0.887
	PBC2	0.773	0.846	
	PBC3	0.767	0.852	
IN	IN1	0.822	0.874	0.910
	IN2	0.816	0.876	
	IN3	0.832	0.864	

BPNS-AU, Basic psychological needs satisfaction-autonomy satisfaction; BPNS-CO, Basic psychological needs satisfaction-competence satisfaction; BPNS-RE, Basic psychological needs satisfaction-relatedness satisfaction; AT-PD, attitude to product; AT-PR, attitude to price; AT-PL, attitude to place; AT-PM, attitude to promotion; SN, subjective norm; PBC, perceived behavioral control; IN, intention to live in nursing homes.

TABLE 3 Convergent validity analysis of scales.

Variables	Items	Factor loading	CR	AVE
BPNS	AU	0.830	0.879	0.671
	CO	0.773		
	RE	0.713		
BPNS-AU	AU1	0.871	0.863	0.613
	AU2	0.822		
	AU3	0.715		
	AU4	0.712		
BPNS-CO	CO1	0.828	0.905	0.705
	CO2	0.842		
	CO3	0.868		
	CO4	0.819		
BPNS-RE	RE1	0.857	0.891	0.672
	RE2	0.822		
	RE3	0.817		
	RE4	0.782		
AT	ATPD	0.692	0.853	0.592
	ATPR	0.792		
	ATPL	0.813		
	ATPM	0.775		
AT-PD	AT1	0.756	0.911	0.595
	AT2	0.763		
	AT3	0.738		
	AT4	0.745		
	AT5	0.792		
	AT6	0.825		
	AT7	0.777		
AT-PR	AT8	0.799	0.895	0.630
	AT9	0.833		
	AT10	0.801		
	AT11	0.794		
	AT12	0.738		
AT-PL	AT13	0.687	0.889	0.617
	AT14	0.776		
	AT15	0.807		
	AT16	0.831		
	AT17	0.817		
AT-PM	AT18	0.731	0.921	0.540
	AT19	0.734		
	AT20	0.754		
	AT21	0.765		
	AT22	0.707		
	AT23	0.732		
	AT24	0.733		
	AT25	0.717		
	AT26	0.734		
	AT27	0.738		
PBC	PBC1	0.885	0.888	0.726
	PBC2	0.840		
	PBC3	0.830		
IN	In1	0.879	0.912	0.776
	In2	0.869		
	In3	0.894		

BPNS, basic psychological needs satisfaction; BPNS-AU, Basic psychological needs satisfaction-autonomy satisfaction, BPNS-CO, Basic psychological needs satisfaction-competence satisfaction; BPNS-RE, Basic psychological needs satisfaction-relatedness satisfaction; AT, attitude to 4P; AT-PD, attitude to product; AT-PR, attitude to price; AT-PL, attitude to place; AT-PM, attitude to promotion; SN, subjective norm; PBC, perceived behavioral control; IN, intention to live in nursing homes.

TABLE 4 Discrimination validity: Pearson correlation and AVE square root.

	BPNS	ATP	SN	PBC	IN
BPNS	**0.819**				
AT	−0.144**	**0.769**			
SN	−0.223**	0.230**	**0.820**		
PBC	−0.107*	0.197**	0.211**	**0.852**	
IN	−0.431**	0.521**	0.653**	0.466**	**0.881**

Bolded values are AVE root values; BPNS, basic psychological needs satisfaction; AT, attitude to 4P; SN, subjective norm; PBC, perceived behavioral control; IN, intention to live in nursing homes.
*$P < 0.05$, **$P < 0.01$.

Convergent and discriminant validity

Table 3 shows that the standardized factor loadings of each item are greater than 0.6 (0.687–0.894), the combined reliability (CR) is more significant than 0.7 (0.853–0.921) and the average variation extraction (AVE) is more significant than 0.5 (0.540–0.776), indicating that each variable has good convergent validity (43).

CFA can also be used to analyse the discriminant validity of the scale. Table 4 presents the results of the discriminant validity analysis of the scale. The diagonal line in the table is the AVE square root value, and the rest are the correlation coefficients. The AVE root of each factor is greater than the standardized correlation coefficient outside the diagonal, so the scale has good discriminant validity. Therefore, based on the above analysis, the scales of this study have good validity (43).

Hypothesis testing, model fit and path analysis

This study used a structural equation model, as shown in Figure 2, where the hypotheses were tested concerning the model fit, path coefficient, and mediation test.

The results of the model fit analysis are presented in Table 5. Table 5 showed that CMIN/DF = 1.249, GFI = 0.887, AGFI = 0.873, NFI = 0.903, IFI = 0.979, TLI = 0.978, CFI = 0.979, and RMSEA = 0.024, which indicated that the fitness of the measurement model was acceptable.

Table 6 summarizes the results obtained from the preliminary analysis. Basic psychological needs satisfaction significantly negatively affects intention ($\beta = -0.167$, $p < 0.001$), so H1 is supported. Basic psychological needs satisfaction has no significant effect on attitude ($\beta = -0.071$, $p > 0.05$), so H2 is not supported. Basic psychological needs satisfaction significantly negatively affects subjective norm ($\beta = -0.186$, $p < 0.01$), so H3 is supported. Basic psychological needs satisfaction has no significant effect on perceived

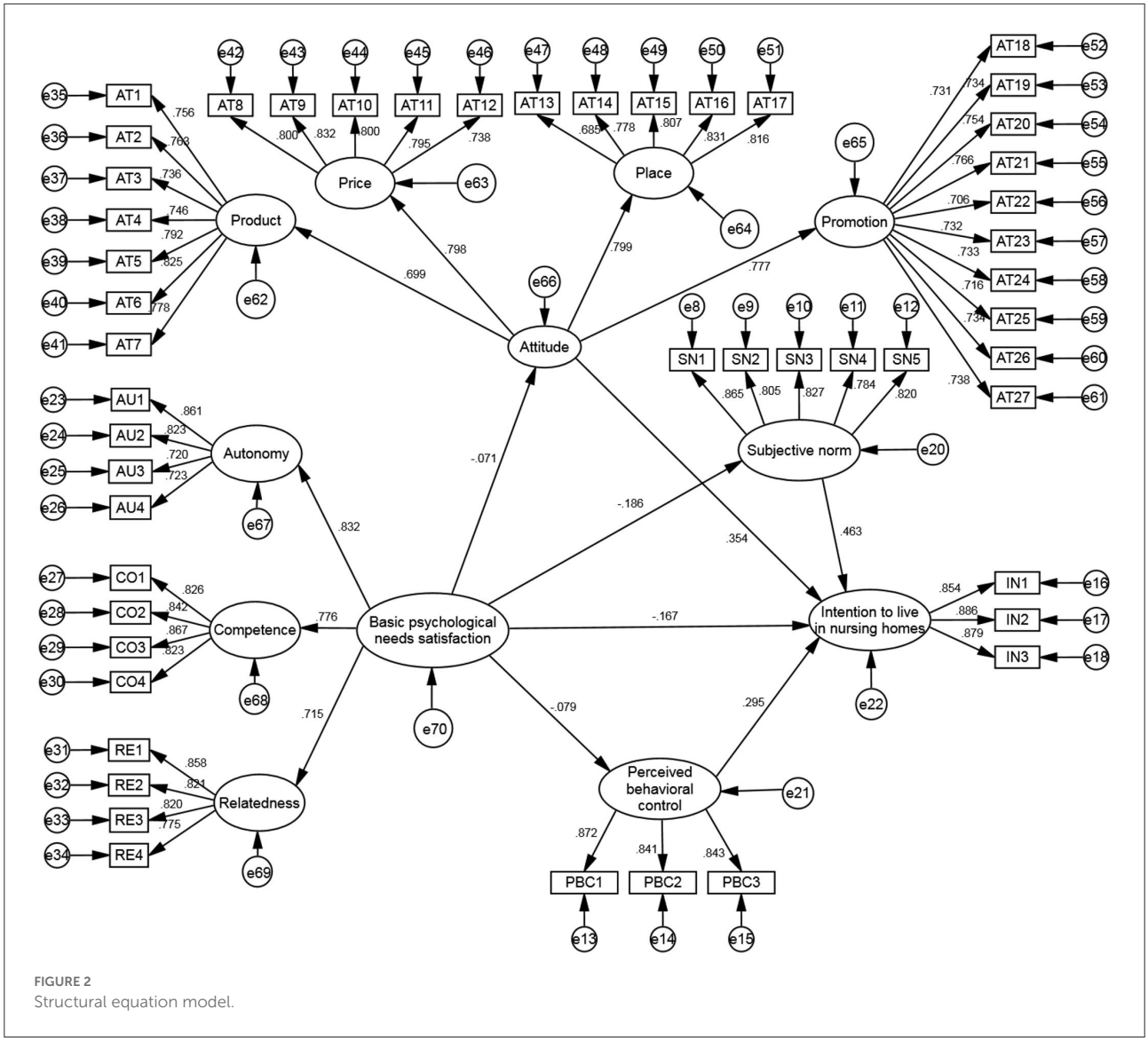

FIGURE 2
Structural equation model.

behavioral control ($\beta = -0.079$, $p > 0.05$), so H4 is not supported.

Attitude has a significant positive effect on intention ($\beta = 0.354$, $p < 0.001$), the subjective norm has a significant positive effect on intention ($\beta = 0.463$, $p < 0.001$), and perceived behavioral control has a significant positive effect on intention ($\beta = 0.295$, $p < 0.001$), so H5 is supported.

Mediating effect analysis

The mediating effect is not supported if the path from the independent variable to the mediating variable is insignificant. The results obtained from 4.3, H2 and H4 are not supported. So, the mediating effects of attitude and perceived behavioral control are not supported. H6 is not supported.

The bootstrap method is one of the most suitable methods for verifying the mediation effect (44, 45). Therefore, the bootstrapping method was used to verify the mediating effect. When the 95% confidence interval excludes 0, the effect is significant. Conversely, when the 95% confidence interval for the direct effect includes 0, the effect is insignificant. Under the premise that the total effect is significant, if both the indirect effect and the direct effect are significant, then the variable has a partial mediating effect; if the direct effect is not significant and the indirect effect is significant, then the variable has a full mediating effect (45).

Table 7 shows that the indirect effect value of BPNS_SN_IN is −0.086. The 95% confidence interval is (−0.156, −0.011) and (−0.159, −0.012), excluding 0, indicating that the indirect effect is significant, so H7 is supported. The direct effect of BPNS_IN is −0.171. After adding the subjective norm, the total effect of BPNAU_IN is −0.318, so the Subjective norm has a partial mediating effect.

TABLE 5 Model fit index.

Fit index	Standard	Value	Fitting situation
CMIN	—	1441.366	—
DF	—	1157	—
CMIN/DF	<3	1.249	Good
RMR	<0.08	0.058	Good
GFI	>0.9	0.887	Acceptable
AGFI	>0.9	0.873	Acceptable
NFI	>0.9	0.903	Good
IFI	>0.9	0.979	Good
TLI	>0.9	0.978	Good
CFI	>0.9	0.979	Good
RMSEA	<0.08	0.024	Good

Discussions and conclusion

It is worth mentioning that our research found that basic psychological needs satisfaction harms the Chinese older adults' intention to live in nursing homes. This finding is consistent with the hypothesis of this study. Meeting people's basic psychological needs can promote their physical and psychological wellbeing (17). In the whole life cycle of older adults, "living in a nursing home" manifests regression and weakening of personal ability. Therefore, the higher the basic psychological needs satisfaction of the older adults, the less willing they are to live in nursing homes.

The surprising correlation is basic psychological needs satisfaction did not affect the older adults' attitude to nursing homes. These results differ from previous studies (12, 13). They may somewhat limit these findings. It could be argued that the positive results were due to the attitude scale using the attitude's 4Ps scale (attitude to nursing homes' product, price, place and promotion). The scale includes 27 items with four dimensions: prices, product, place and promotion. Compared with the attitude scale in TPB (21, 46), this scale has a different focus (on the marketing 4Ps) and is more detailed. These differences mean that study findings need to be interpreted cautiously. Therefore, this result may be explained by the fact that when people's attitude toward a thing is measured from the perspective of marketing 4Ps, people's attitudes may not be

TABLE 6 Path coefficient of the research model.

Hypothesis	Path hypothesis			Path coefficient	Path hypothesis	S.E.	C.R.	*P*-value	Test results
H1	IN	←	BPNS	−0.167	−0.201	0.038	−5.805	***	Supported
H2	AT	←	BPNS	−0.071	−0.054	0.044	−1.287	0.301	Not Supported
H3	SN	←	BPNS	−0.186	−0.216	0.065	−3.471	0.008	Supported
H4	PBC	←	BPNS	−0.079	−0.097	0.070	−1.397	0.210	Not Supported
H5	IN	←	AT	0.354	0.609	0.068	9.087	***	Supported

***$P < 0.001$. BPNS, basic psychological needs satisfaction; AT, attitude to 4P; SN, subjective norm; PBC, perceived behavioral control; IN, intention to live in nursing homes.

TABLE 7 Bootstrap results of mediating effect.

Path	Standardized effect value	Bias-Corrected 95%CI		Percentile 95%CI	
		Lower bounds	Upper bounds	Lower bounds	Upper bounds
Total Effect					
BPNS_IN	−0.318	−0.472	−0.139	−0.481	−0.143
Indirect Effect					
BPNS_AT_IN	−0.027	−0.091	0.031	−0.093	0.033
BPNS_SN_IN	−0.086	−0.156	−0.011	−0.159	−0.012
BPNS_PBC_IN	−0.024	−0.070	0.023	−0.073	0.024
Direct Effect					
BPNS_IN	−0.171	−0.273	−0.063	−0.275	−0.064

BPNS, basic psychological needs satisfaction; AT, attitude to 4P; SN, subjective norm; PBC, perceived behavioral control; IN, intention to live in nursing homes.

related to the degree of satisfaction of basic psychological needs but only related to the 4Ps of the thing itself.

In addition, basic psychological needs satisfaction does not affect perceived behavioral control, which does not support previous studies (25, 47). Reviewing the definition of perceived behavioral control, it stands for perceptions of whether the behavior is "difficult" and under its own control (21). They are combined with the requirements of staying in a Chinese nursing home. There may be several aspects of the perceived behavioral control of older adults over admission to nursing homes. First, whether their pension is sufficient to cover the cost of living in suitable nursing homes and daily living. An ethnographic study of China's older adults' care institutions addressed older adults' perceptions of their financial and caregiving choices. Older adults expressed that soaring medical costs determine their caregiving choices, "if I use my pension to pay for a nursing home, I cannot afford medicine" (48).

Similarly, if older adults have insufficient or no pensions, their perceived behavioral control may be the extent to which their family members (i.e., adult children) are willing to pay for nursing home expenses. A study of institutional care for older adults from rural China showed that the cost of entering a nursing home for rural older adults is mostly paid by their adult children (49). Second, the extent to which older adults' family members are willing to care for them at home is also one factor that influences the perceived behavioral control of Chinese older adults. In the Confucian culture, older Chinese adults are typically cared for by family members (50). But because of the "one-child policy" and the rise of "female professionals," family members have a heavier burden of caring for the older adults at home than before (51). Studies have shown that when the caregivers are adult children rather than spouses or "other related" there is a small risk of placement in a nursing home (52). Third, whether there are any restrictions on admission to nursing homes may also be related to the perceived behavioral control of older adults. For example, care needs levels, and funding review. Research from rural China shows that most nursing homes refuse to admit frail and demented older adults because of a lack of skilled nursing staff (53). Nevertheless, not all nursing homes do not admit frail and demented older adults. There is no universal set of standards for admission to nursing homes, and each nursing home has different admission standards and corresponding charging standards. There is no charge for admission to public nursing homes in China, so the older adults need to meet the requirements of being over 60 years old and having no infectious diseases, mental illnesses, etc., and the older adults need to apply for admission in advance. Private nursing homes need to be charged, and admission generally requires the issuance of a medical examination report from the hospital and the payment of a deposit. Private nursing homes in some cities need to apply in advance and wait due to scarcity and good service. Fourth, the perceived behavioral control of older adults was also related to how long the waiting list for admission to a nursing home is. Some private nursing homes have long waiting lists, and the final list may be skewed toward the more successful (54).

An explanation for the uncorrelated relationship between basic psychological needs satisfaction and perceived behavioral control is that older adults may simply have no idea whether admission to a nursing home is "difficult" for them. A Chinese study shows that placing an older adults in a nursing home is often a deliberate decision made by adult children (55). Therefore, we found that the perceived behavioral control of older adults' nursing home admission contains many factors.

Subjective norm mediates basic psychological needs satisfaction and intention to live in nursing homes in our topic. That is, the higher the satisfaction of the basic psychological needs of the older adults, the less pressure they perceive "you should live in a nursing home" from significant others around them, and the lower their intention to live in a nursing home. Conversely, the lower the satisfaction of the basic psychological needs of the older adults, the higher the pressure they perceive "you should be admitted to a nursing home" from significant others around them, and the higher their intention to live in nursing homes. This is an unexpected outcome: the subjective norm is more potent than we thought. The Chinese collectivist culture may explain this result that the subjective normative effect of collectivism is stronger than individualism (56).

Research implications

Theoretical implications

The findings from this study make several contributions to the current literature. First, there is no research integrating motivation sequences to explore the older adults' intention to live in nursing homes. This research fills this gap and enriches the BPNT-TPB model's usage context. Second, our research found that there may be no correlation between basic psychological needs satisfaction and attitudes. Although this may be related to our choice of the marketing four Ps scale for attitudes rather than the traditional attitude scales in TPB, it is still an unexpected finding that gives us theoretical implications. Last, our findings also highlight the importance of subjective norms in research in the context of China's culture, where collectivism is stronger than individualism. These findings will provide theoretical suggestions for future related research in China.

Practical implications

This research should be precious to the specific government departments and entrepreneurs who wish to attract residents. On the one hand, the lower level of the basic psychological needs satisfaction of the older adults, the higher intention they admit to nursing homes. So, entrepreneurs need to find ways to attract older adults who do not meet their basic psychological needs by building an environment that satisfies autonomy, relatedness, and competence in nursing homes. Marketers should try to segment older adult populations and develop appropriate marketing plans for older adults who do not meet basic psychological needs in their daily lives.

On the other hand, because of the only mediating effect of subjective norm, our study suggests that the opinions of significant others are also crucial for older adults' occupancy. So, entrepreneurs and marketers should identify significant others around older adults, their adult children, spouses, and siblings. Moreover, develop service plans and marketing programs that meet the needs of significant others to increase occupancy. For example, the perception that "sending parents to nursing homes is unfilial" still exists in Chinese society (57). So, if marketers ramped up the promotion that sending older adults to nursing homes for more professional services is more filial, it could increase occupancy rates for the whole industry. Besides, some adult children will experience a series of psychological torture after sending older adults to nursing homes, and grief and guilt are common manifestations (58). Furthermore, research shows that older adults experience a series of psychological reactions when they move to a nursing home, "fear, struggle, compromise, acceptance, and contribution" (59). These bad experiences are pain points that need to be addressed urgently. If entrepreneurs install a remote video system in nursing homes, significant others can video chat with older adults to ease the sense of loss of sudden separation. Significant others can also continue to express their concern for the older adults by video chatting. This can help significant others, and older adults go through the difficult relocation period smoothly. Besides, this may increase the satisfaction of the significant others and the older adults in the nursing home. Thereby enhancing the individual competitiveness of nursing homes.

Study limitations and future research

Three limitations are worth highlighting. First, this study uses a cross-sectional survey to test the hypotheses. The researcher needs to be aware of possible time-sensitive relationships between the variables. Second, the sample of this study is the older adults in Henan Province, China. There may be regional bias in the findings. If more general findings are needed, other regions need to be studied. Previous studies suggested that culture affects people's perceptions, thoughts and behaviors (60, 61). This can provide a theoretical basis for studying the different behaviors due to different cultures and norms that affect the older adults' needs and perceptions of nursing homes. Third, the research instruments used in this study may have limitations. The attitude's 4Ps scale was used to measure the attitude of the older adults toward nursing homes, and the results showed that the attitude of the older adults toward nursing home marketing 4Ps was not affected by the degree of satisfaction of basic psychological needs. However, this result does not equate to the fact that the older adults' attitude toward nursing homes is not affected by the degree of satisfaction with basic psychological needs. Future studies can change the attitude scale for research if more objective results are needed. If future research requires more objective results, the attitude scale can be changed for research.

In addition, this study also found the only partial mediating role of subjective norms (i.e., opinions and pressures from significant others) in the relationship between basic psychological needs satisfaction and intentions to live in nursing homes. This result suggests that significant others are important for older adults to have specific intentions. Consequently, future research can further investigate the factors that predict the attitudes of the older adults' "significant others." Besides, some predictors that we did not include in the study may also be helpful for research in this direction. Distance from nursing homes to their own homes may be a good predictor of essential psychological needs satisfaction. Future research can consider integrating distance into the basic psychological needs model. Finally, future studies could translate live intentions into behaviors through longitudinal study designs.

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 Rajamangala University of Technology Rattanakosin. The patients/participants provided their written informed consent to participate in this study.

Author contributions

ML conceived the research, collected the data, performed the data analysis and interpretation, wrote, and revised the manuscript. JD guided the research ideas, helped revise the manuscript, and intensively edited the language of the manuscript. RL helped revise the manuscript and guided

the journal selection. NW contributed to the development of research ideas. 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

References

1. Sun C, Yu Y, Li X, Cai Y, Ding Y, Zhu S, et al. The factors of adaptation to nursing homes in mainland China: a cross-sectional study. *BMC Geriatr.* (2020) 20:517. doi: 10.1186/s12877-020-01916-x

2. Liu C, Feng Z, Mor V. Case-mix and quality indicators in Chinese elder care homes: are there differences between government-owned and private-sector facilities? *J Ame Geriatrics Soc.* (2014) 62:371–7. doi: 10.1111/jgs.12647

3. Feng Z, Zhan HJ, Feng X, Liu C, Sun M, Mor V, et al. An industry in the making: the emergence of institutional elder care in urban China. *J Am Geriatrics Soc.* (2011) 59:738–44. doi: 10.1111/j.1532-5415.2011.03330.x

4. Chen L, Ye M. The role of children's support in elders' decisions to live in a yanglaoyuan (residential long-term care). *J Cross-Cultural Gerontol.* (2013) 28:75–87. doi: 10.1007/s10823-012-9185-y

5. Grundy E, Jitlal M. Socio-demographic variations in moves to institutional care 1991–2001: a record linkage study from England and Wales. *Age Ageing.* (2007) 36:424–30. doi: 10.1093/ageing/afm067

6. Gaugler JE, Duval S, Anderson KA, Kane RL. Predicting nursing home admission in the US: a meta-analysis. *BMC Geriatr.* (2007) 7:1–14. doi: 10.1186/1471-2318-7-13

7. Nihtilä E, Martikainen P. Why older people living with a spouse are less likely to be institutionalized: the role of socioeconomic factors and health characteristics. *Scand J Pub Health.* (2008) 36:35–43. doi: 10.1177/1403494807086421

8. Gibler KM, Lumpkin JR, Moschis GP. Making the decision to move to retirement housing. *J Consum Market.* (1998) 15:44–54. doi: 10.1108/07363769810202673

9. Gilbert FW, Tudor RK, Paolillo JG. The decision making unit in the choice of a long-term health care facility. *J App Bus Res.* (1994) 10:63–73. doi: 10.19030/jabr.v10i2.5939

10. Chan DKC, Fung YK, Xing S, Hagger MS. Myopia prevention, near work, and visual acuity of college students: integrating the theory of planned behavior and self-determination theory. *J Behav Med.* (2014) 37:369–80. doi: 10.1007/s10865-013-9494-9

11. Hagger MS, Chatzisarantis NL, Culverhouse T, Biddle SJ. The processes by which perceived autonomy support in physical education promotes leisure-time physical activity intentions and behavior: a trans-contextual model. *J Educ Psychol.* (2003) 95:784–95. doi: 10.1037/0022-0663.95.4.784

12. Hagger MS, Chatzisarantis NL. Integrating the theory of planned behaviour and self-determination theory in health behaviour: a meta-analysis. *Br J Health Psychol.* (2009) 14:275–302. doi: 10.1348/135910708X373959

13. Al-Jubari I, Hassan A, Liñán F. Entrepreneurial intention among University students in Malaysia: integrating self-determination theory and the theory of planned behavior. *Int Ent Manage J.* (2019) 15:1323–42. doi: 10.1007/s11365-018-0529-0

14. Gilal FG, Zhang J, Paul J, Gilal NG. The role of self-determination theory in marketing science: an integrative review and agenda for research. *Eur Manage J.* (2019) 37:29–44. doi: 10.1016/j.emj.2018.10.004

15. Sanford AM, Orrell M, Tolson D, Abbatecola AM, Arai H, Bauer JM, et al. An international definition for "nursing home". *J Am Med Dir Assoc.* (2015) 16:181–4. doi: 10.1016/j.jamda.2014.12.013

16. Ryan RM, Deci EL. *Overview of Self-Determination Theory: An Organismic Dialectical Perspective. Handbook of Self-Determination Research.* Rochester, NY: University Rochester Press (2002), p. 3–33.

17. Deci EL, Ryan RM. The "what" and "why" of goal pursuits: human needs and the self-determination of behavior. *Psychol Inq.* (2000) 11:227–68. doi: 10.1207/S15327965PLI1104_01

18. Ryan RM, Deci EL. *Self-Determination Theory: Basic Psychological Needs in Motivation, Development, and Wellness.* New York, NY: Guilford Publications (2017).

19. Milyavskaya M, Koestner R. Psychological needs, motivation, and well-being: a test of self-determination theory across multiple domains. *Pers Ind Diff.* (2011) 50:387–91. doi: 10.1016/j.paid.2010.10.029

20. Van den Broeck A, Vansteenkiste M, De Witte H, Soenens B, Lens W. Capturing autonomy, competence, and relatedness at work: construction and initial validation of the Work-related Basic Need Satisfaction scale. *J Occup Org Psychol.* (2010) 83:981–1002. doi: 10.1348/096317909X481382

21. Ajzen I. The theory of planned behavior. *Org Behav Hum Dec Processes.* (1991) 50:179–211. doi: 10.1016/0749-5978(91)90020-T

22. De Pelsmacker P, Janssens W. The effect of norms, attitudes and habits on speeding behavior: scale development and model building and estimation. *Accident Anal Prev.* (2007) 39:6–15. doi: 10.1016/j.aap.2006.05.011

23. Cho H, Hussain RSB, Kang HK. The role of social support and its influence on exercise participation: the perspective of self-determination theory and the theory of planned behavior. *Soc Sci J.* (2020) 58:1–15. doi: 10.1080/03623319.2020.1756176

24. Chatzisarantis NL, Hagger MS, Smith B. Influences of perceived autonomy support on physical activity within the theory of planned behavior. *Eur J Soc Psychol.* (2007) 37:934–54. doi: 10.1002/ejsp.407

25. Al-Jubari I. College students' entrepreneurial intention: testing an integrated model of SDT and TPB. *Sage Open.* (2019) 9:1–15. doi: 10.1177/2158244019853467

26. Hagger MS, Chatzisarantis NL, Harris J. From psychological need satisfaction to intentional behavior: testing a motivational sequence in two behavioral contexts. *Pers Soc Psychol Bullet.* (2006) 32:131–48. doi: 10.1177/0146167205279905

27. Harris J, Hagger MS. Do basic psychological needs moderate relationships within the theory of planned behavior? *J App Biobehav Res.* (2007) 12:43–64. doi: 10.1111/j.1751-9861.2007.00013.x

28. Deci E, Ryan R. *Intrinsic Motivation and Self-Determination in Human Behaviour.* New York, NY: Plenum (1985).

29. Deci EL, Ryan RM. The general causality orientations scale: self-determination in personality. *J Res Pers.* (1985) 19:109–34. doi: 10.1016/0092-6566(85)90023-6

30. Boezeman EJ, Ellemers N. Intrinsic need satisfaction and the job attitudes of volunteers versus employees working in a charitable volunteer organization. *J Occup Org Psychol.* (2009) 82:897–914. doi: 10.1348/096317908X383742

31. González-Cutre D, Sicilia A, Beas-Jiménez M, Hagger M. Broadening the trans-contextual model of motivation: a study with S panish adolescents. *Scand J Med Sci Sports.* (2014) 24, 306–19. doi: 10.1111/sms.12142

32. Chatzisarantis NL, Hagger MS, Biddle SJ, Karageorghis C. The cognitive processes by which perceived locus of causality predicts participation in physical activity. *J Health Psychol.* (2002) 7:685–99. doi: 10.1177/1359105302007006872

33. Baard PP, Deci EL, Ryan RM. Intrinsic need satisfaction: a motivational basis of performance and weil-being in two work settings 1. *J Applied Soc Psychol.* (2004) 34:2045–68. doi: 10.1111/j.1559-1816.2004.tb02690.x

34. Huang H. Factors influencing intention to move into senior housing. *J App Gerontol.* (2012) 31:488–509. doi: 10.1177/0733464810392225

35. Barkoukis V, Hagger MS, Lambropoulos G, Tsorbatzoudis H. Extending the trans-contextual model in physical education and leisure-time contexts: examining the role of basic psychological need satisfaction. *Br J Educ Psychol.* (2010) 80:647–70. doi: 10.1348/000709910X487023

36. Krejcie RV, Morgan DW. Determining sample size for research activities. *Educ Psychol Measure.* (1970) 30:607–10. doi: 10.1177/001316447003000308

37. Chang LA. psychometric evaluation of 4-point and 6-point Likert-type scales in relation to reliability and validity. *App Psychol Measure.* (1994) 18:205–15. doi: 10.1177/014662169401800302

38. Chen B, Vansteenkiste M, Beyers W, Boone L, Deci EL, Van der Kaap-Deeder J, et al. Basic psychological need satisfaction, need frustration, and need strength across four cultures. *Motiv Emot.* (2015) 39:216–36. doi: 10.1007/s11031-014-9450-1

39. Purnomo SH, Lee YH. Why is understanding customer attitude toward 4Ps marketing mix important? The case of the livestock input industry in Indonesia. *J Dev Agri Econ.* (2010) 2:107–14. doi: 10.5897/JDAE.9000141

40. Nsoh MW. *Information Security Systems Policy Violation: An Analysis of Management Employee Interpersonal Relationship and the Impact on Deterrence [dissertation]*. Colorado Springs, CO: Colorado Technical University (2015).

41. Xie Q, Song W, Peng X, Shabbir M. Predictors for e-government adoption: integrating TAM, TPB, trust and perceived risk. *Elect Lib.* (2017) 35:2–20. doi: 10.1108/EL-08-2015-0141

42. DeVellis RF. S*cale Development: Theory and Applications*. Newbury Park, CA: Sage (1991).

43. Fornell C, Larcker DF. Structural equation models with unobservable variables and measurement error: algebra and statistics. *J Market Res.* (1981) 18:382–8. doi: 10.1177/002224378101800313

44. Preacher KJ, Hayes AF. SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behav Res Methods Inst Comput.* (2004) 36:717–31. doi: 10.3758/BF03206553

45. Hayes AF, Scharkow M. The relative trustworthiness of inferential tests of the indirect effect in statistical mediation analysis: does method really matter? *Psychol Sci.* (2013) 24:1918–27. doi: 10.1177/0956797613480187

46. Ajzen I, Sheikh S. Action versus inaction: anticipated affect in the theory of planned behavior. *J App Soc Psychol.* (2013) 43:155–62. doi: 10.1111/j.1559-1816.2012.00989.x

47. Sørebø Ø, Halvari H, Gulli VF, Kristiansen R. The role of self-determination theory in explaining teachers' motivation to continue to use e-learning technology. *Comput Educ*. (2009) 53:1177–87. doi: 10.1016/j.compedu.2009.06.001

48. Keimig R. Engaging experts: expanding participation and enhancing research in Chinese eldercare institutions. *J Aging Soc Policy.* (2017) 29:461–74. doi: 10.1080/08959420.2017.1364082

49. Wu B, Mao Z, Xu Q. Institutional care for elders in rural China. *J Aging Soc Policy.* (2008) 20:218–39. doi: 10.1080/08959420801977632

50. Chen S, Cui Y, Ding Y, Sun C, Xing Y, Zhou R, et al. Prevalence and risk factors of dysphagia among nursing home residents in eastern China: a cross-sectional study. *BMC Geriatr.* (2020) 20:1–10. doi: 10.1186/s12877-020-01752-z

51. Wang Y, Wang J, Maitland E, Zhao Y, Nicholas S, Lu M, et al. Growing old before growing rich: inequality in health service utilization among the mid-aged and elderly in Gansu and Zhejiang Provinces, China. *BMC Health Serv Res.* (2012) 12:1–11. doi: 10.1186/1472-6963-12-302

52. Andrén S, Elmståhl S. Effective psychosocial intervention for family caregivers lengthens time elapsed before nursing home placement of individuals with dementia: a five-year follow-up study. *Int Psycho.* (2008) 20:1177–92. doi: 10.1017/S1041610208007503

53. Wu B, Mao ZF, Zhong R. Long-term care arrangements in rural China: review of recent developments. *J Am Med Dir Assoc.* (2009) 10:472–7. doi: 10.1016/j.jamda.2009.07.008

54. Wong L, Tang J. Dilemmas confronting social entrepreneurs: care homes for elderly people in Chinese cities. *Pac Aff.* (2006) 79:623–40. doi: 10.5509/2006794623

55. Chang YP, Schneider JK. Decision-making process of nursing home placement among chinese family caregivers. *Pers Psych Care.* (2010) 46:108–18. doi: 10.1111/j.1744-6163.2010.00246.x

56. Cho H, Lee JS. The influence of self-efficacy, subjective norms, and risk perception on behavioral intentions related to the H1N1 flu pandemic: a comparison between K orea and the US. *Asian J Soc Psychol.* (2015) 18:311–24. doi: 10.1111/ajsp.12104

57. Zhang H. Sending parents to nursing homes is unfilial? An exploratory study on institutional elder care in China. *Int Soc Work.* (2019) 62:351–62. doi: 10.1177/0020872817725137

58. Riquelme-Marín A, Martín-Carbonell M, Ortigosa-Quiles JM, Méndez I. Development and exploration of psychometric properties of the family adjustment questionnaire for admitting an older adult to a nursing home (CAFIAR). *Int J Environ Res Pub Health.* (2020) 17:7597. doi: 10.3390/ijerph17207597

59. Lan X, Xiao H, Chen Y. Psychosocial reactions to relocation to a nursing home among Chinese older adults. *Arch Gerontol Geriatrics.* (2020) 91:10423. doi: 10.1016/j.archger.2020.104230

60. Song L, Li RYM, Yao Q. An informal institution comparative study of occupational safety knowledge sharing via French and English Tweets: languaculture, weak-strong ties and AI sentiment perspectives. *Safety Sci.* (2022) 147:105602. doi: 10.1016/j.ssci.2021.105602

61. Sun S, Li T, Ma H, Li RYM, Gouliamos K, Zheng J, et al. Does employee quality affect corporate social responsibility? Evidence from China. *Sustainability.* (2020) 12:2692. doi: 10.3390/su12072692

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Prevalence and associated factors of cross-sectional and incident self-reported arthritis or rheumatism among a national community sample of middle-aged and older adults in Thailand

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Background: The study aimed to assess the prevalence and associated factors of cross-sectional and incident arthritis or rheumatism among a national community sample of middle-aged and older adults in Thailand.

Methods: We analyzed cross-sectional and longitudinal data from two consecutive waves (2015 and 2017) of the Health, Aging, and Retirement in Thailand (HART) study. Arthritis or rheumatism (SRA) was assessed by self-reported health care provider diagnosis.

Results: The cross-sectional (baseline) sample included 5,616 participants (≥45 years, median age 66 years, interquartile range 57 to 76 years) and the incident (follow-up) sample included 3,545 participants. The prevalence of SRA in the cross-sectional sample (baseline) was 4.0% and in the incident (follow-up) sample 5.3%. In the cross-sectional multivariable model, obesity class I (aOR: 1.78, 95% CI: 1.19 to 2.67), obesity class II (aOR: 1.82, 95% CI: 1.02 to 3.25), hypertension (aOR: 1.90, 95% CI: 1.35 to 2.66), brain disease and/or psychiatric problems (aOR: 4.79, 95% CI: 2.27 to 10.62), sleep problem (aOR: 1.45, 95% CI: 1.01 to 2.07) and prescription drug use (aOR: 1.63, 95% CI: 1.14 to 2.33) were positively associated, and not in the labor force (aOR: 0.53, 95% CI: 0.34 to 0.84), and employed (aOR: 0.63, 95% CI: 0.41 to 0.99) were negatively associated with SRA. In the incident multivariable model, obesity class I (aOR: 1.78, 95% CI: 1.17 to 3.61), obesity class II (aOR: 2.01, 95% CI: 1.12 to 3.61), poor mental health (aOR: 1.69, 95% CI: 1.19 to 2.41), and functional disability (aOR: 2.04, 95% CI: 1.01 to 4.13) were positively associated, and current alcohol use (aOR: 0.50, 95% CI: 0.25 to 0.99) was negatively associated with SRA.

Conclusion: The middle and older Thai adults had a low prevalence and incidence of SRA, and several physical and mental risk factors for cross-sectional and/or incident SRA were identified.

KEYWORDS

arthritis (MeSH), aging, rheumatoid arthritis, survey, Thailand

Introduction

A significant global burden of disability can be attributed to arthritis (1, 2). Worldwide, in the adult population, the prevalence of knee osteoarthritis was 3.8% (16.0% in persons ≥40 years), hip osteoarthritis 0.85% and rheumatoid arthritis was 0.24% (1–3). Among predominantly older adults in six low-and middle-income countries, the prevalence of self-reported arthritis (SRA) was 19.9% among women and 14.1% among men (4). Among older adults (≥50 years) in South Africa, 24.7% had SRA (5), in India (≥50 years) 14.7% (6), and in China (≥45 years) 31.4% had SRA (7). We were unable to identify national data on the prevalence, incidence, and correlates of SRA among the aging population in Thailand, which led to the study.

According to previous studies (7–22), factors associated with arthritis include sociodemographic factors, health risk behaviors, poor mental health, and chronic conditions. Sociodemographic factors associated with arthritis include older age (7–11), female sex (7–11), higher economic status (9) and lower education (10, 12). Specific health risk behaviors, such as smoking (13), low physical activity or sedentary behavior (12, 14–16), non-alcohol use (17) and obesity (5, 8, 14, 18) have shown to increase the risk of arthritis. Moreover, poor mental health (5, 19, 20), including sleep problems (19) and depressive symptoms (10, 18, 21), increased the odds of arthritis. Certain chronic conditions, such as hypertension (7, 10), cardiovascular disease (7, 22), kidney and chronic lung disease (7), and functional disability (10, 11, 19) were also found to be associated with arthritis. Factors associated with incident arthritis include increasing age (7, 23), female sex (7, 23), physical activity (7), physical inactivity (23) cardiovascular disease (7), obesity (24, 25), lower well-being (26), sleep problems (27) and depression (23, 28).

The study aimed to assess for the first time the prevalence, incidence, and factors associated with SRA among middle-aged and older adults in a national community-based sample in Thailand in 2015 and 2017.

Methods

Sample and procedure

We analyzed cross-sectional and longitudinal data from two consecutive waves in 2015 and 2017 of the Health, Aging, and Retirement in Thailand (HART) study. From the total population and household data from the Department of Provincial Administration (DOPA), Ministry of Interior, in Thailand, a three-stage stratified random sampling was used. In stage 1, in each of 6 regions (Bangkok & Vicinity, East, North, Northeast, and South) in Thailand, one small province (<250,000 people ≥45 years) and one large province (>250,000 people ≥45 years) was selected, except for the East where only one province was selected. In stage 2, each province is classified into urban areas (number of blocks) and rural areas (number of villages). In stage 3, 5,600 households were selected from the sampled blocks and villages. In each household, one person (≥45 years) was randomly selected, which was the inclusion criterium. Proxy interviews were conducted for frail participants (29). The 2015 survey (from February to July) (N = 5,616), and the 2017 survey (from January to June 2017) included 3,708 members of the 2015 HART cohort (192 died during follow-up or 4.3% of the baseline respondents who were in the study area; 1,554 moved away from the study area; 270 declined participation and the response rate: 72.33% and the retention rate: 66.03%). Attrition analysis found that those who were not followed-up were more likely more educated, Buddhist and male, while there were no significant differences in terms of other sociodemographic and all health variables. Participants were interviewed at their homes by trained field workers after written informed consent was obtained. The study was approved by the "Ethics Committee in Human Research, National Institute of Development Administration – ECNIDA (ECNIDA 2020/00012)."

Measures

Arthritis or rheumatism was assessed with self-reported health care provider diagnosis. Self-report is a reliable method of identifying arthritis or rheumatism in large population-based surveys (7).

Other chronic conditions were evaluated by self-reported health care provider diagnosed conditions, including hypertension, diabetes, lung diseases, emphysema, cardiovascular diseases, heart disease, heart failure, kidney diseases, liver diseases, emotional/nervous or psychiatric disease, brain diseases and Alzheimer's disease.

Sociodemographic information included age, sex, educational level, religion, and annual income quartile (30).

Employment status. First, participants were asked if they had a job (working for an employed, self-employed, or working for family or relative's business) now (Yes/No). Participants who had no job currently were asked if they worked before but retired, worked before and intended to work in the future but were currently not looking for a job, or never had a job. Retired individuals were defined as having no job at the moment and not intending to work in the future, those without a job and intending to work in the future as unemployed, and those who never had a job as 'not in the workforce' (31).

Tobacco smoking was sourced from the item, "Have you ever smoked cigarettes?" (response options: "1 = yes, and still smoke now, 2 = yes, but quit smoking, and 3 = never").

Alcohol use was sourced from the item, "Have you ever drunk alcoholic beverages such as liquor, beer or wine?" (response options: 1 = yes, and still drinking now, 2 = yes, but do not drink now, and 3 = never).

Physical activity in the past week was classified as "none = inactivity, 1–149 min/week = low activity, and ≥150 min/week = high activity" (32).

Body Mass Index (BMI) was assessed by self-reported body weight and height, and classified into "underweight (< 18.5 kg/m^2), normal weight (18.5–22.9 kg/m^2), overweight (23–24.9 kg/m^2), obesity class I (25–29.9 kg/m^2), and obesity class II (30 kg/m^2)" (33).

Prescription drug use was assessed with the question, "In the last 2 years, did you use any prescription drug?" (Yes/No).

Functional disability was defined as any of four activity of daily living (ADL) limitations (34), previously found a valid measure in older adults in Thailand (35) (Cronbach's α = 0.94 at wave 1).

Probable depression (≥10 scores) was assessed using the Center for Epidemiologic Studies Depression (CES-D-10) scale (36), previously found a valid measure in Thailand (37, 38).

Factors associated with incident arthritis include increasing age [7/23], female sex (7, 23), physical activity (7), physical inactivity (23) cardiovascular disease (7), obesity (24, 25), lower well-being (26),

TABLE 1 Cross-sectional and incident arthritis or rheumatism.

Variables	Subcategory	Cross-sectional arthritis or rheumatism		*p*-value	Incident arthritis or rheumatism		*p*-value
		No	Yes		No	Yes	
All		5,392 (96.0)	224 (4.0)		3,356 (94.7)	189 (5.3)	
Age (in years)	45–54	1,078 (97.6)	27 (2.4)	0.003	635 (96.2)	25 (3.8)	0.018
	55–64	1,449 (96.6)	51 (3.4)		927 (95.8)	41 (4.2)	
	65–74	1,305 (95.3)	65 (4.7)		848 (93.8)	56 (6.2)	
	75 or more	1,560 (95.1)	81 (4.9)		946 (93.4)	67 (6.6)	
Sex	Female	2,809 (95.9)	121 (4.1)	0.573	1782 (94.2)	109 (5.8)	0.220
	Male	2,583 (96.2)	103 (3.8)		1,574 (95.2)	80 (4.8)	
Education	≤Elementary	4,389 (95.8)	191 (4.2)	0.175	2,810 (94.5)	165 (5.5)	0.217
	>Elementary	983 (96.8)	33 (3.2)		538 (95.7)	24 (4.3)	
Religion	Muslim or other	337 (94.0)	24 (6.0)	0.035	267 (93.0)	20 (7.0)	0.199
	Buddhist	5,008 (96.2)	200 (3.8)		3,087 (94.8)	169 (5.2)	
Employment status	Retired	1314 (94.1)	83 (5.9)	<0.001	821 (93.5)	57 (6.5)	0.002
	Unemployed	324 (95.3)	16 (4.7)		214 (90.7)	22 (9.3)	
	Not in labor force	1,089 (96.3)	42 (3.7)		679 (95.0)	36 (5.0)	
	Employed	2,554 (97.0)	78 (3.0)		1,598 (95.9)	69 (4.1)	
Income quartile	Low	1,336 (95.2)	67 (4.8)	0.174	813 (94.8)	45 (5.2)	0.254
	Lower middle	1,320 (95.7)	59 (4.3)		834 (94.1)	52 (5.9)	
	Upper middle	1,367 (96.3)	52 (3.7)		869 (93.9)	56 (6.1)	
	High	1,369 (96.7)	46 (3.3)		840 (95.9)	36 (4.1)	
Alcohol use	Never	4,350 (96.0)	180 (4.0)	0.069	2,699 (94.2)	167 (5.8)	0.010
	Past	368 (94.1)	23 (5.9)		237 (95.2)	12 (4.8)	
	Current	674 (97.0)	21 (3.0)		420 (97.7)	10 (2.3)	
Smoking tobacco	Never	4,310 (96.1)	173 (3.9)	0.013	2,678 (94.4)	160 (5.6)	0.266
	Past	398 (93.4)	28 (6.6)		262 (96.0)	11 (4.0)	
	Current	684 (96.7)	23 (3.3)		416 (95.9)	18 (4.1)	
Physical activity	None	3,251 (96.3)	125 (3.7)	0.180	1,953 (94.1)	123 (5.9)	0.137
	1–149 minutes/week	1,297 (95.2)	66 (4.8)		849 (95.2)	43 (4.8)	
	≥150 minutes/week	844 (96.2)	33 (3.8)		554 (96.0)	23 (4.0)	
Body mass index	Normal	1,845 (96.5)	67 (3.5)	0.028	1l151 (95.8)	51 (4.2)	0.011
	Under	542 (97.0)	17 (3.0)		325 (93.9)	21 (6.1)	
	Overweight	968 (96.1)	39 (3.9)		603 (95.4)	29 (4.6)	
	Obesity I	1l164 (94.9)	63 (5.1)		714 (92.8)	55 (7.2)	
	Obesity II	330 (94.0)	21 (6.0)		200 (91.7)	18 (8.3)	
Probable depression	No	4,367 (96.4)	161 (3.6)	0.018	,2727 (95.0)	144 (5.0)	0.029
	Yes	605 (94.5)	35 (5.5)		362 (92.3)	30 (7.7)	
Mental health	Good (80–100)	3,705 (96.5)	135 (3.5)	0.004	2,367 (95.6)	108 (4.4)	<0.001
	Poor (<80)	1,562 (94.8)	85 (5.2)		917 (92.4)	75 (7.6)	
Sleep problem	Rarely/sometimes	4,470 (96.5)	164 (3.5)	<0.001	2,809 (95.2)	141 (4.8)	0.007
	Often/Mostly	859 (93.8)	57 (6.2)		516 (92.5)	42 (7.5)	
Hypertension	No	3,565 (97.3)	100 (2.7)	<0.001	2,210 (95.5)	105 (4.5)	0.004
	Yes	1,827 (93.6)	124 (6.4)		1,146 (93.2)	84 (6.8)	
Diabetes	No	4,591 (96.3)	176 (3.7)	0.007	2,866 (94.9)	153 (5.1)	0.094
	Yes	801 (94.3)	48 (5.7)		490 (93.2)	36 (6.8)	

(Continued)

TABLE 1 (Continued)

Variables	Subcategory	Cross-sectional arthritis or rheumatism		*p*-value	Incident arthritis or rheumatism		*p*-value
		No	Yes		No	Yes	
Cardiovascular disease	No	5,136 (96.2)	203 (3.8)	0.002	3,192 (94.9)	172 (5.1)	0.013
	Yes	256 (92.4)	21 (7.6)		164 (90.6)	17 (9.4)	
Kidney diseases	No	5,301 (96.2)	210 (3.8)	<0.001	33,00 (94.8)	182 (5.2)	0.039
	Yes	91 (86.7)	14 (13.3)		56 (88.9)	7 (11.1)	
Brain diseases/ psychiatric problems	No	5,340 (96.2)	211 (3.8)	<0.001	3,325 (94.7)	185 (5.3)	0.107
	Yes	52 (80.0)	13 (20.0)		31 (88.6)	4 (11.4)	
Lung diseases	No	5,347 (96.0)	220 (4.0)	0.134	3,325 (94.7)	186 (5.3)	0.362
	Yes	45 (91.8)	4 (8.2)		31 (91.2)	3 (8.8)	
Prescription drug	No	4,484 (96.5)	162 (3.5)	<0.001	2,785 (95.5)	144 (4.9)	0.016
	Yes	908 (93.6)	62 (6.4)		571 (92.7)	45 (7.3)	
Functional disability	No	5,110 (96.2)	203 (3.8)	0.058	3,212 (95.0)	169 (5.0)	<0.001
	Yes	188 (93.5)	13 (6.5)		516 (92.5)	13 (11.9)	

sleep problems (27) and depression (23, 28). The CES-D10 had a reliability coefficient of 0.78.

Mental health status was assessed with the question: "In general, how would you rate your mental health status?" Responses ranged from 0 = very poor to 100 excellent, and poor mental health was defined as 0 to <80 and good mental health as 80–100.

Sleep problem was defined as almost always or often (vs. sometimes or very rarely or never) having trouble falling asleep/insomnia in the past week.

Data analysis

The proportion of older adults with cross-sectional and incident SRA are presented with frequencies and percent. Pearson Chi-square tests are used to compare characteristics among groups. The first logistic regression model estimated odds ratios (OR) and confidence intervals (CI) for cross-sectional SRA, and the second model compared baseline without SRA with incident SRA. Variables significant in univariable analysis were included in the multivariable models. $p \leq 0.05$ was considered statistically significant. All statistical analyzes were performed with StataSE 15.0 (College Station, TX, USA).

Results

Sample characteristics

The cross-sectional (baseline) sample in 2015 included 5,616 participants (≥45 years, median age 66 years, interquartile range 57 to 76 years) and the incident (follow-up) sample in 2017 included 3,545 participants. The prevalence of SRA in the cross-sectional sample (baseline) was 4.0% and in the incident (follow-up) sample 5.3%. The binary analysis in the cross-sectional sample found that age, religion, employment status, smoking status, body mass index, probable depression, mental health, sleep problem, hypertension, diabetes, cardiovascular disease, kidney disease, brain disease or psychiatric problems, and prescription drug use differed significantly between people with SRA and without SRA. Binary analysis in the incident sample found that age, employment status, alcohol use, body mass index, probable depression, mental health status, sleep problem, hypertension, cardiovascular disease, kidney disease, prescription drug use and functional disability differed significantly between people with SRA and without SRA (see Table 1).

Cross-sectional associations with SRA

In the multivariable model, brain disease and/or psychiatric problems (aOR: 4.79, 95% CI: 2.27 to 10.62), hypertension (aOR: 1.90, 95% CI: 1.35 to 2.66), obesity class II (aOR: 1.82, 95% CI: 1.02 to 3.25), obesity class I (aOR: 1.78, 95% CI: 1.19 to 2.67), prescription drug use (aOR: 1.63, 95% CI: 1.14 to 2.33), and sleep problem (aOR: 1.45, 95% CI: 1.01 to 2.07) were positively associated, and not in the labor force (aOR: 0.53, 95% CI: 0.34 to 0.84), and employed (aOR: 0.63, 95% CI: 0.41 to 0.99) were negatively associated with SRA (see Table 2).

Associations with incident SRA

In the multivariable model, functional disability (aOR: 2.04, 95% CI: 1.01 to 4.13), obesity class II (aOR: 2.01, 95% CI: 1.12 to 3.61), obesity class I (aOR: 1.78, 95% CI: 1.17 to 3.61), and poor mental health (aOR: 1.69, 95% CI: 1.19 to 2.41), were positively associated, and current alcohol use (aOR: 0.50, 95% CI: 0.25 to 0.99) was negatively associated with SRA (see Table 3).

TABLE 2 Cross-sectional associations with arthritis, Health, Aging, and Retirement in Thailand (HART).

Variables	Subcategory	COR (95% CI)		AOR (95% CI)	
Age (in years)	Scale	1 (Reference)	<0.001	1 (Reference)	0.090
		1.02 (1.01 to 1.03)		1.01 (1.00 to 1.03)	
Sex	Female	1 (Reference)	0.573	—	
	Male	0.93 (0.71 to 1.21)			
Education	≤Elementary	1 (Reference)	0.176	—	
	>Elementary	0.77 (0.53 to 1.12)			
Religion	Muslim or other	1 (Reference)	0.036	1 (Reference)	0.082
	Buddhist	0.63 (0.41 to 0.97)		0.63 (0.37 to 1.06)	
Employment status	Retired	1 (Reference)	0.379	1 (Reference)	0.685
	Unemployed	0.78 (0.45 to 1.35)	0.010	0.85 (0.46 to 1.60)	0.007
	Not in labor force	0.61 (0.41 to 0.89)	<0.001	0.53 (0.34 to 0.84)	0.044
	Employed	0.48 (0.35 to 0.66)		0.63 (0.41 to 0.99)	
Income quartile	Low	1 (Reference)	0.509	1 (Reference)	0.597
	Lower middle	0.89 (0.62 to 1.28)	0.143	0.89 (0.59 to 1.36)	0.575
	Upper middle	0.76 (0.52 to 1.10)	0.040	0.87 (0.55 to 1.40)	0.720
	High	0.67 (0.46 to 0.98)		0.91 (0.54 to 1.54)	
Alcohol use	Never	1 (Reference)	0.070	—	
	Past	1.51 (0.97 to 2.36)	0.226		
	Current	0.75 (0.48 to 1.19)			
Smoking tobacco	Never	1 (Reference)	0.008	1 (Reference)	0.071
	Past	1.75 (1.16 to 2.65)	0.433	1.57 (0.96 to 2.55)	0.713
	Current	0.84 (0.54 to 1.30)		1.10 (0.66 to 1.86)	
Physical activity	None	1 (Reference)	0.072	—	
	1–149 min/week	1.32 (0.98 to 1.80)	0.933		
	≥150 min/week	1.02 (0.69 to 1.50)			
Body mass index	Normal	1 (Reference)	0.864	1 (Reference)	0.713
	Under	0.86 (0.50 to 1.48)	0.613	0.92 (0.51 to 1.65)	0.183
	Overweight	1.11 (0.74 to 1.66)	0.026	1.32 (0.84 to 2.05)	0.003
	Obesity I	1.49 (1.05 to 2.12)	0.029	1.78 (1.19 to 2.67)	0.041
	Obesity II	1.75 (1.06 to 2.90)		1.82 (1.02 to 3.25)	
Probable depression	No	1 (Reference)	0.019	1 (Reference)	0.117
	Yes	1.57 (1.08 to 2.28)		1.42 (0.92 to 2.20)	
Mental health	Good (80-100)	1 (Reference)	0.005	1 (Reference)	0.069
	Poor (<80)	1.49 (1.13 to 1.97)		1.39 (0.98 to 1.90)	
Sleep problem	Rarely/sometimes	1 (Reference)	2.47	1 (Reference)	0.044
	Often/Mostly	1.81 (1.33 to 2.47)		1.45 (1.01 to 2.07)	
Hypertension	No	1 (Reference)	<0.001	1 (Reference)	<0.001
	Yes	2.40 (1.85 to 3.17)		1.90 (1.35 to 2.66)	
Diabetes	No	1 (Reference)	0.008	1 (Reference)	0.397
	Yes	1.56 (1.13 to 2.17)		0.84 (0.56 to 1.26)	
Cardiovascular disease	No	1 (Reference)	0.002	1 (Reference)	0.265
	Yes	2.08 (1.30 to 3.31)		1.37 (0.79 to 2.39)	

(Continued)

TABLE 2 (Continued)

Variables	Subcategory	COR (95% CI)		AOR (95% CI)	
Kidney diseases	No	1 (Reference)	<0.001	1 (Reference)	0.148
	Yes	3.88 (2.18 to 6.93)		1.78 (0.81 to 3.90)	
Brain diseases and psychiatric problems	No	1 (Reference)	<0.001	1 (Reference)	<0.001
	Yes	6.33 (3.39 to 11.80)		4.79 (2.17 to 10.62)	
Lung diseases	No	1 (Reference)	0.143	—	
	Yes	2.16 (0.77 to 6.06)			
Prescription drug	No	1 (Reference)	<0.001	1 (Reference)	0.008
	Yes	1.89 (1.40 to 2.55)		1.63 (1.14 to 2.33)	
Functional disability	No	1 (Reference)	0.061	—	
	Yes	1.74 (0.98 to 3.11)			

COR, Crude Odds Ratio; AOR, Adjusted Odds Ratio; CI, Confidence Interval.

Discussion

The study found that the cross-sectional prevalence of SRA (4.0%) was lower than in previous studies among middle-aged and older adults in India (14.7%) (6), in six lower resourced countries (19.9% among women and 14.1% among men) (4), in China (31.4%) (7), in South Africa (24.7%) (5), and in Mexico (18). The lower prevalence of SRA in Thailand may be attributed to a lower rate of some risk factors, such as obesity, compared to other middle-income countries (7). Some other explanation for these country differences could be differences in the measurement of SRA, however, in all the studies cited here in India (6), China (7), Mexico (18), South Africa (5), and the six-country study (4) used exactly the same SRA, as in this study. However, the relatively low rate of SRA in Thailand appears to be confirmed in a community study in rural Thailand (≥15 years) with a prevalence of 11.3% osteoarthritis (based on radiographic and serological examinations) (39), and the global observation age-standardized incidence rates were the lowest in Southeast Asia (6.2), and the highest in high-income North America (22.5), South Asia (20.7), and Western Europe (20.4) (40).

We found that among women and those of older age, the prevalence of SRA was higher than among men and younger participants; however, this was not significant, unlike some previous research (7–11, 23). Some research studies found an association between lower education (10, 12) and SRA, but we did not find a significant association. The employment and higher economic status were in the unadjusted analysis protective against SRA, while in a study among older adults in Ghana the higher wealth status was associated with arthritis (9). In unadjusted analysis, being a Muslim or other increased the odds of SRA, which is contrary to a finding from a study in Thailand that found that the prevalence of radiographic knee osteoarthritis was significantly higher in Buddhists than in Muslims (41). The authors (41) attribute these differences to religious practices ("Muslims pray since childhood by forcing the knees into deep flexion, stretching the soft tissue surrounding the knee and decrease stiffness and contact pressure of the articular cartilage").

In line with previous findings (5, 8, 14, 18, 24, 25), this study found a cross-sectional and incident association between obesity and SRA. Obesity may 'exhibit a chronic subclinical inflammatory state' increasing the risk of rheumatoid arthritis (42). Some studies found an association between physical inactivity and arthritis (12, 14, 15, 23, 43), while this study did not find this association. The non-significant association between physical inactivity and SRA in this study may be related to how physical activity was measured, it only included exercise and no other physical activity. In analyzing incident SRA, we found that current alcohol use was protective against arthritis, which is consistent with a review (17). The protective effect of alcohol use against arthritis may be explained "*via* attenuation of the innate inflammatory response" (17).

Furthermore, the study found associations between poor mental health (neurological or psychiatric problems, sleep symptoms, poor mental health and in unadjusted analysis probable depression) and SRA, which is consistent with previous results (5, 10, 18–21, 26–28). The association between sleep problems and arthritis may be related to pain at night (19). Prothero et al. (19) showed that "psychological interventions resulted in small to moderate improvement in biopsychosocial outcomes for patients with rheumatoid arthritis in addition to those achieved by standard care." Furthermore, the relationship between poor mental health, such as depression, and SRA may also be bidirectional (44).

Consistent with some previous research (7, 10, 11, 19, 22), this study found a positive association between functional disability, hypertension, and in unadjusted analysis diabetes, cardiovascular disease, kidney disease and arthritis. It is possible that in these various physical conditions there is an underlying connection through pain and associated inflammatory dysfunction (10). Some determinants, such as sleep problems, or hypertension (7, 10), may also be consequences. For example, in this study, hypertension and sleep problems were positively associated with SRA in cross-sectional analysis but not in incident analysis. Furthermore, we found that the prevalence of SRA was higher among those who used prescription drugs, which is consistent with a study in the USA (43).

TABLE 3 Longitudinal associations with incident arthritis, HART 2015–2017.

Variables	Subcategory	COR (95% CI)		AOR (95% CI)	
Age (in years)	Scale	1 (Reference)	0.653	1 (Reference)	0.573
		1.12 (0.68 to 1.87)	0.036	1.01 (0.99 to 1.02)	
		1.60 (1.04 to 2.72)	0.015		
		1.80 (1.12 to 2.88)			
Sex	Female	1 (Reference)	0.219	—	
	Male	0.83 (0.62 to 1.12)			
Education	≤Elementary	1 (Reference)	0.219	—	
	>Elementary	0.76 (0.49 to 1.18)			
Religion	Muslim or other	1 (Reference)	0.206	—	
	Buddhist	0.73 (0.45 to 1.19)			
Employment status	Retired	1 (Reference)	0.134	1 (Reference)	0.106
	Unemployed	1.48 (0.89 to 2.48)	0.221	1.62 (0.98 to 1.02)	0.252
	Not in labor force	0.77 (0.50 to 1.18)	0.010	0.75 (0.47 to 1.22)	0.342
	Employed	0.62 (0.43 to 0.89)		0.80 (0.51 to 1.27)	
Income quartile	Low	1 (Reference)	0.566	—	
	Lower middle	1.13 (0.75 to 1.70)	0.457		
	Upper middle	1.17 (0.78 to 1.75)	0.266		
	High	0.78 (0.50 to 1.21)			
Alcohol use	Never	1 (Reference)	0.514	1 (Reference)	0.896
	Past	0.82 (0.45 to 1.49)	0.004	0.96 (0.50 to 1.83)	0.049
	Current	0.39 (0.20 to 0.74)		0.50 (0.25 to 0.99)	
Smoking tobacco	Never	1 (Reference)	0.268	—	
	Past	0.70 (0.38 to 1.31)	0.205		
	Current	0.72 (0.44 to 1.19)			
Physical activity	None	1 (Reference)	0.232	—	
	1–149 min/week ≥150 min/week	0.81 (0.56 to 1.15) 0.66 (0.42 to 1.04)	0.073		
Body mass index	Normal	1 (Reference)	0.156	1 (Reference)	0.584
	Under	1.46 (0.87 to 2.46)	0.728	1.17 (0.66 to 2.08)	0.946
	Overweight	1.09 (0.68 to 1.73)	0.006	1.02 (0.62 to 1.68)	0.007
	Obesity I	1.74 (1.18 to 2.58)	0.013	1.78 (1.17 to 3.61)	0.020
	Obesity II	2.03 (1.16 to 3.51)		2.01(1.12 to 3.61)	
Probable depression	No	1 (Reference)	0.032	1 (Reference)	0.726
	Yes	1.57 (1.04 to 2.35)		1.09 (0.67 to 1.78)	
Mental health	Good (80-100)	1 (Reference)	<0.001	1 (Reference)	0.004
	Poor (<80)	1.79 (1.32 to 2.43)		1.69 (1.19 to 2.41)	
Sleep problem	Rarely/sometimes	1 (Reference)	0.008	1 (Reference)	0.245
	Often/Mostly	1.62 (1.14 to 2.32)		1.29 (0.84 to 2.00)	
Hypertension	No	1 (Reference)	0.004	1 (Reference)	0.097
	Yes	1.54 (1.15 to 2.07)		1.34 (0.95 to 1.88)	
Diabetes	No	1 (Reference)	0.098	—	
	Yes	1.37 (0.94 to 2.00)			

(Continued)

TABLE 3 (Continued)

Variables	Subcategory	COR (95% CI)		AOR (95% CI)	
Cardiovascular disease	No	1 (Reference)	0.014	1 (Reference)	0.722
	Yes	1.92 (1.14 to 3.25)		1.12 (0.59 to 2.13)	
Kidney diseases	No	1 (Reference)	0.045	1 (Reference)	0.129
	Yes	2.27 (1.02 to 5.05)		1.92 (0.83 to 4.47)	
Brain diseases and psychiatric problems	No	1 (Reference)	0.117	—	
	Yes	2.32 (0.81 to 6.64)			
Lung diseases	No	1 (Reference)	0.368	—	
	Yes	1.73 (0.52 to 5.71)			
Prescription drug	No	1 (Reference)	0.017	1 (Reference)	0.144
	Yes	1.53 (1.08 to 2.16)		1.33 (0.91 to 1.95)	
Functional disability	No	1 (Reference)	0.002	1 (Reference)	0.047
	Yes	2.55 (1.40 to 4.64)		2.04 (1.01 to 4.13)	

COR, Crude Odds Ratio; AOR, Adjusted Odds Ratio; CI, Confidence Interval.

Study limitations include self-report evaluation, including diagnosed arthritis or rheumatism by a health care provider. The self-reported outcome may be limited due to common-method variance bias, recall or social desirability bias. Since only SRA was assessed, we cannot distinguish between different types of arthritis. The high attrition rate is a limitation for the longitudinal data. The study cannot establish causality due to confounding and reverse causality. Some variables that may affect arthritis, such as diet, were not included in this study but hopefully in the future. Future research should include multiple waves of HART to establish trajectories of SRA.

Conclusion

One in twenty middle-aged and older Thai adults had SRA. Factors associated with cross-sectional and/or incident SRA included obesity, mental problems, sleep problems, prescription drug use, and functional disability. This information may be taken into account in the prevention and management of arthritis in Thailand and provide hints for future research.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found here: Gateway to Global Aging Data, Health, Aging, and Retirement in Thailand: https://g2aging.org/?section=study&studyid$=$44.

Ethics statement

The studies involving human participants were reviewed and approved by Ethics Committee in Human Research, National Institute of Development Administration dmECNIDA (ECNIDA 2020/00012). The patients/participants provided their written informed consent to participate in this study.

Author contributions

SP and KP conceived and designed the research, performed statistical analysis, drafted the manuscript, and made critical revision of the manuscript for key intellectual content. All authors fulfill the criteria for authorship, read and approved the final version of the manuscript, have agreed to authorship, and order of authorship for this 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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References

1. Cross M, Smith E, Hoy D, Nolte S, Ackerman I, Fransen M, et al. The global burden of hip and knee osteoarthritis: estimates from the global burden of disease 2010 study. *Ann Rheum Dis.* (2014) 73:1323–30. doi: 10.1136/annrheumdis-2013-204763

2. Cross M, Smith E, Hoy D, Carmona L, Wolfe F, Vos T, et al. The global burden of rheumatoid arthritis: estimates from the global burden of disease 2010 study. *Ann Rheum Dis.* (2014) 73:1316–22. doi: 10.1136/annrheumdis-2013-204627

3. Cui A, Li H, Wang D, Zhong J, Chen Y, Lu H. Global, regional prevalence, incidence, and risk factors of knee osteoarthritis in population-based studies. *EClinicalMedicine.* (2020) 3:29–30. doi: 10.1016/j.eclinm.2020.100587

4. Brennan-Olsen SL, Cook S, Leech MT, Bowe SJ, Kowal P, Naidoo N, et al. Prevalence of arthritis according to age, sex and socioeconomic status in six low and middle income countries: analysis of data from the World Health Organization study on global ageing and adult health (SAGE) Wave 1. *BMC Musculoskelet Disord.* (2017) 18:271. doi: 10.1186/s12891-017-1624-z

5. Peltzer K, Phaswana-Mafuya N. Arthritis and associated factors in older adults in South Africa. *Turk J Geriatr.* (2013) 16:389–94.

6. Peltzer K, Pengpid S. Prevalence and correlates of arthritis among a nationally representative population-based sample of older adults in India. *Int J Disabil Hum Dev.* (2022) 21:81–8.

7. Li C, Liu T, Sun W, Wu L, Zou ZY. Prevalence and risk factors of arthritis in a middle-aged and older Chinese population: the China health and retirement longitudinal study. *Rheumatology.* (2015) 54:697–706. doi: 10.1093/rheumatology/keu391

8. Silverwood V, Blagojevic-Bucknall M, Jinks C, Jordan JL, Protheroe J, Jordan KP. Current evidence on risk factors for knee osteoarthritis in older adults: a systematic review and meta-analysis. *Osteoarth Cartil.* (2015) 23:507–15. doi: 10.1016/j.joca.2014.11.019

9. Nakua EK, Otupiri E, Dzomeku VM, Owusu-Dabo E, Agyei-Baffour P, Yawson AE, et al. Gender disparities of chronic musculoskeletal disorder burden in the elderly Ghanaian population: study on global ageing and adult health (SAGE WAVE 1). *BMC Musculoskelet Disord.* (2015) 16:204. doi: 10.1186/s12891-015-0666-3

10. Blay SL, Fillenbaum GG, Andreoli SB, Gastal FL. Prevalence and concomitants of arthritis in the elderly in Rio Grande do Sul, Brazil. *PLoS ONE.* (2012) 7:e45418. doi: 10.1371/journal.pone.0045418

11. French HP, Galvin R, Horgan NF, Kenny RA. Prevalence and burden of osteoarthritis amongst older people in Ireland: findings from The Irish longitudinal study on ageing (TILDA). *Eur J Public Health.* (2016) 26:192–8. doi: 10.1093/eurpub/ckv109

12. Arokiasamy P, Uttamacharya, Kowal P, Capistrant BD, Gildner TE, Thiele E, et al. Chronic noncommunicable diseases in 6 low- and middle-income countries: findings from wave 1 of the world health organization's study on global ageing and adult health (SAGE). *Am J Epidemiol.* (2017) 185:414e–28. doi: 10.1093/aje/kww125

13. Sugiyama D, Nishimura K, Tamaki K, Tsuji G, Nakazawa T, Morinobu A, et al. Impact of smoking as a risk factor for developing rheumatoid arthritis: a meta-analysis of observational studies. *Ann Rheum Dis.* (2010) 69:70–81. doi: 10.1136/ard.2008.096487

14. Patel S, Ram F, Patel SK, Kumar K. Association of behavioral risk factors with self-reported and symptom or measured chronic diseases among adult population (18–69 years) in India: evidence from SAGE study. *BMC Public Health.* (2019) 19:560. doi: 10.1186/s12889-019-6953-4

15. Tierney M, Fraser A, Kennedy N. Physical activity in rheumatoid arthritis: a systematic review. *J Phys Act Health.* (2012) 9:1036–48. doi: 10.1123/jpah.9.7.1036

16. Fenton SAM. Veldhuijzen van Zanten JJCS, Duda JL, Metsios GS, Kitas GD. Sedentary behaviour in rheumatoid arthritis: definition, measurement and implications for health. *Rheumatology.* (2018) 57:213–26. doi: 10.1093/rheumatology/kex053

17. Scott IC, Tan R, Stahl D, Steer S, Lewis CM, Cope AP. The protective effect of alcohol on developing rheumatoid arthritis: a systematic review and meta-analysis. *Rheumatology.* (2013) 52:856–67. doi: 10.1093/rheumatology/kes376

18. Pengpid S, Peltzer K. Prevalence and correlates of arthritis among a nationally representative population-based sample of older adults in Mexico. *Int J Disabil Hum Dev.* (2020) 19:603–10.

19. Machado GM, Barreto SM, Passos VM, Lima-Costa MF. Health status indicators among community-dwelling elders with arthritis: the Bambuí health and aging study. *J Rheumatol.* (2006) 33:342–7.

20. Prothero L, Barley E, Galloway J, Georgopoulou S, Sturt J. The evidence base for psychological interventions for rheumatoid arthritis: a systematic review of reviews. *Int J Nurs Stud.* (2018) 82:20–9. doi: 10.1016/j.ijnurstu.2018.03.008

21. Vennu V, Misra H, Misra A. Depressive symptoms and the risk of arthritis: a survival analysis using data from the osteoarthritis initiative. *Indian J Psychiatry.* (2019) 61:444–50. doi: 10.4103/psychiatry.IndianJPsychiatry_241_18

22. Hossain MB, Kopec JA, Atiquzzaman M, Karim ME. The association between rheumatoid arthritis and cardiovascular disease among adults in the United States during 1999-2018, and age-related effect modification in relative and absolute scales. *Ann Epidemiol.* (2022) 71:23–30. doi: 10.1016/j.annepidem.2022.03.005

23. Seavey WG, Kurata JH, Cohen RD. Risk factors for incident self-reported arthritis in a 20 year followup of the Alameda county study cohort. *J Rheumatol.* (2003) 30:2103–11.

24. Berry KM, Neogi T, Baker JF, Collins JM, Waggoner JR, Hsiao CW, et al. Obesity progression between young adulthood and midlife and incident arthritis: a retrospective cohort study of US adults. *Arthritis Care Res.* (2021) 73:318–27. doi: 10.1002/acr.24252

25. Okely JA, Cooper C, Gale CR. Wellbeing and arthritis incidence: the survey of health, ageing and retirement in Europe. *Ann Behav Med.* (2016) 50:419–26. doi: 10.1007/s12160-015-9764-6

26. Wilkins K. Incident arthritis in relation to excess weight. *Health Rep.* (2004) 15:39–49.

27. Poole L, Jackowska M. The association between depressive and sleep symptoms for predicting incident disease onset after 6-year follow-up: findings from the English longitudinal study of ageing. *Psychol Med.* (2019) 49:607–16. doi: 10.1017/S0033291718001290

28. Ke C, Qiao Y, Liu S, Rui Y, Wu Y. Longitudinal research on the bidirectional association between depression and arthritis. *Soc Psychiatry Psychiatr Epidemiol.* (2021) 56:1241–7. doi: 10.1007/s00127-020-01994-7

29. Anantanasuwong D, Theerawanviwat D, Siripanich P. Panel survey and study on health and aging, and retirement in Thailand. In: Gu D and Dupre M (Eds) *Encyclopedia of Gerontology and Population Aging.* Cham: Springer (2019).

30. Anantanasuwong D, Pengpid S, Peltzer K. Prevalence and associated factors of successful ageing among people 50 years and older in a national community sample in Thailand. *Int J Environ Res Public Health.* (2022 7) 19:10705. doi: 10.3390/ijerph191710705

31. Jang SN, Cho SI, Chang J, Boo K, Shin HG, Lee H, et al. Employment status and depressive symptoms in Koreans: results from a baseline survey of the Korean longitudinal study of aging. *J Gerontol B Psychol Sci Soc Sci.* (2009) 64:677–83. doi: 10.1093/geronb/gbp014

32. WHO. World Health Organization (WHO) guidelines on physical activity and sedentary behavior. Licence: CC BY-NC- SA3.0 IGO. (2020). Available online at: https://file:///C:/Users/user/Downloads/9789240015128-eng%20(2).pdf (accessed June 20, 2022).

33. Wen CP, David Cheng TY, Tsai SP. Are Asians at greater mortality risks for being overweight than Caucasians? Redefining obesity for Asians. Public Health Nutr. (2009) 12:497–506. doi: 10.1017/S1368980008002802

34. Katz S, Ford AB, Heiple KG, Newill VA. Studies of illness in the aged: recovery after fracture of the hip. *J Gerontol.* (1964) 19:285–93. doi: 10.1093/geronj/19.3.285

35. Senanarong V, Harnphadungkit K, Prayoonwiwat N, Poungvarin N, Sivasariyanonds N, Printarakul T, et al. new measurement of activities of daily living for Thai elderly with dementia. *Int Psychogeriatr.* (2003) 15:135–48. doi: 10.1017/s1041610203008822

36. Andresen EM, Malmgren JA, Carter WB, Patrick DL. Screening for depression in well older adults: evaluation of a short form of the CES-D (center for epidemiologic studies depression scale). *Am J Prev Med.* (1994) 10:77–84.

37. Nilmanut S, Kuptniratsaikul V, Pekuman P, Tosayanonda O. The Study of The Center for Epidemiologic Studies-Depression Scale (CES-D) in Thai People Siriraj Hospital. *ASEAN J Rehabil Med.* (1997) 6:3.

38. Mackinnon A, McCallum J, Andrews G, Anderson I. The center for epidemiological studies depression scale in older community samples in Indonesia, North Korea, Myanmar, Sri Lanka, and Thailand. *J Gerontol B Psychol Sci Soc Sci.* (1998) 53:P343–52. doi: 10.1093/geronb/53b.6.p343

39. Chaiamnuay P, Darmawan J, Muirden KD, Assawatanabodee P. Epidemiology of rheumatic disease in rural Thailand: a WHO-ILAR COPCORD study. community oriented programme for the control of rheumatic disease. *J Rheumatol.* (1998) 25:1382–7.

40. Safiri S, Kolahi AA, Hoy D, Smith E, Bettampadi D, Mansournia MA, et al. Global, regional and national burden of rheumatoid arthritis 1990-2017: a systematic analysis of the global burden of disease study 2017. *Ann Rheum Dis.* (2019) 78:1463–71. doi: 10.1136/annrheumdis-2019-215920

41. Chokkhanchitchai S, Tangarunsanti T, Jaovisidha S, Nantiruj K, Janwityanujit S. The effect of religious practice on the prevalence of knee osteoarthritis. *Clin Rheumatol.* (2010) 29:39–44. doi: 10.1007/s10067-009-1295-8

42. George MD, Baker JF. The obesity epidemic and consequences for rheumatoid arthritis care. *Curr Rheumatol Rep.* (2016) 18:6. doi: 10.1007/s11926-015-0550-z

43. Lane NE, Ivanova J, Emir B, Mobasheri A, Jensen MG. Characterization of individuals with osteoarthritis in the United States and their use of prescription and over-the-counter supplements. *Maturitas.* (2021) 145:24–30. doi: 10.1016/j.maturitas.2020.12.001

44. Ng CYH, Tay SH, McIntyre RS, Ho R, Tam WWS, Ho CSH. Elucidating a bidirectional association between rheumatoid arthritis and depression: a systematic review and meta-analysis. *J Affect Disord.* (2022) 311:407–15. doi: 10.1016/j.jad.2022.05.108

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Informal caregivers in Germany – who are they and which risks and resources do they have?

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Background: The aim of this study is to describe the social characteristics, the health and living situation and the prevalence of behavioral risk factors of adult informal caregivers compared to non-caregivers in Germany.

Methods: We used data from the German Health Update (GEDA 2019/2020-EHIS survey) which is a cross-sectional population-based health interview survey conducted between 04/2019 and 09/2020. The sample comprised 22,646 adults living in private households. Three mutually exclusive groups of providing informal care or assistance were differentiated: intense caregivers (informal care ≥10 h/week), less-intense caregivers (informal care <10 h/week) and non-caregivers. For the three groups weighted prevalences of social characteristics, health status (self-perceived health, health-related activity limitations, chronic diseases, low back disorder or other chronic back defect, depressive symptoms), behavioral risk factors (at-risk drinking, current smoking, insufficient physical activity, non-daily fruit and vegetable consumption, obesity) and social risk factors (single household, low social support) were calculated and stratified by gender. Separate regression analyses adjusted for age-group were conducted to identify significant differences between intense and less-intense caregivers vs. non-caregivers, respectively.

Results: Overall, 6.5% were intense caregivers, 15.2% less-intense caregivers and 78.3% non-caregivers. Women provided care more often (23.9%) than men (19.3%). Informal care was most frequently provided in the age group of 45 to 64 years. Intense caregivers reported worse health status, were more often current smokers, physical inactive, obese and lived less often alone than non-caregivers. However, in age-group adjusted regression analyses only few significant differences were seen: Female and male intense caregivers had more often a low back disorder and lived less often alone compared to non-caregivers. In addition, male intense care-givers reported more often worse self-perceived health, health-related activity limitation, and the presence of chronic diseases. In contrast, less-intense caregivers and non-caregivers differed in favor of the less-intense caregivers.

Discussion: A substantial proportion of the adult German population provides informal care regularly, especially women. Intense caregivers are a vulnerable group for negative health outcomes, especially men. In particular measures to prevent low back disorder should be provided. As the necessity of providing informal care will probably increase in the future, this will be important for the society and public health.

KEYWORDS

informal care, population-based study, Health Monitoring, Germany, health status, behavioral risk factors, social risk factors

1. Introduction

The progression of the demographic change and the increase in life expectancy are leading to a steady increase in the share of older people with physical and cognitive impairments frequently in need of long-term care.

A large part of this long-term care is provided by informal caregivers, usually family members. Since the introduction of the statutory long-term care insurance in Germany in 1995, the provision of informal care services can be supported by cash benefits or in-kind benefits if the Medical Service of the Health Insurance Funds certified a need of care. Currently, around 4.1 million people in Germany claim benefits from long-term care insurance every month. Most of the recipients receive outpatient care (about 3.3 million), 2.1 million are cared for at home by informal caregivers (mostly relatives), and around 818,000 people receive inpatient care.

In Germany, the criteria for needing long-term care and entitlement to long-term care benefits from the long-term care insurance are regulated by law. If an entitlement exists, people in need of care can decide how and by whom they will be cared for, with various forms or facilities available (outpatient care, nursing home, alternative forms of living). The choice depends on the severity of the need for care, but also on the circumstances of the care dependent people and their families. For care at home, long-term care insurance provides financial support if those affected choose to be cared for by relatives, friends or volunteers instead of an outpatient care service (1). People who are not entitled to benefits from long-term care insurance but are dependent on help and care must organize this through informal caregivers and/or through self-financed professional services. Informal care thus includes both the provision of care services supported by long-term care insurance and care and/or support in everyday life without the involvement of long-term care insurance. The long-term care situation might have positive or negative impact on the health situation of caregivers. Other studies found that caregivers are exposed to greater strains in their daily lives, which may affect physical and mental health and can be associated with increased stress and social isolation (2–5).

The aim of this study is to describe the social characteristics, the health and living situation and the prevalence of behavioral risk factors of adult informal caregivers compared to non-caregivers in Germany.

2. Materials and methods

2.1. Study design and sampling

The Robert Koch Institute regularly carries out surveys to monitor the health of the population in Germany. We used data from the GEDA 2019/2020-EHIS survey, which is a cross-sectional population-based health interview survey that was conducted between April 2019 and September 2020 using computer-assisted, fully-structured telephone interviews. The study population comprised people aged 15 or above living in private households, whose usual residence at the time of data collection was Germany. This includes both one- and multi-person households that operate independently and provide for their own needs. As such, collective households such as hospitals, care and residential homes, prisons, military barracks, religious institutions, boarding houses or hostels are not included in the survey. The survey used a telephone sample, which was provided by the Arbeitskreis Deutscher Markt- und Sozialforschungsinstitute e. V. (ADM). It is based on the so-called dual-frame method, in which two selection populations are used: one consisting of mobile phone numbers, and another consisting of landline phone numbers. This sampling method provides (almost) complete coverage of the population in Germany. A method developed by Leslie Kish for the random selection of respondents in multi-person households (the Kish Selection Grid,) was used to randomly select prospective respondents. Here, all potential interview partners are given the same selection probability and one person is randomly selected by the computer. This person is identified on the basis of the recorded age and gender. A total of 23,001 individuals with complete interviews participated in GEDA 2019/2020-EHIS (12,101 women, 10,838 men, 62 reported another gender identity or did not provide information). The response rate according to the standards of the American Association for Public Opinion Research was 21.6% (6). A detailed description of the methodology as well as of the classification of the response rate of GEDA 2019/2020-EHIS is available elsewhere (7). For our analyses we used data from all respondents with a female or male gender identity aged 18 years an older ($n = 22{,}646$).

2.2. Data protection and ethics

GEDA 2019/2020-EHIS is subject to strict compliance with the data protection provisions set out in the EU General Data Protection Regulation (GDPR) and the Federal Data Protection Act (BDSG). The Ethics Committee of the Charité – Universitätsmedizin Berlin assessed the ethics of the study and approved the implementation of the study (application number EA2/070/19). Participation in the study was voluntary. The participants were informed about the aims and contents of the study and about data protection. Informed consent was obtained verbally.

2.3. Measures

Internationally established instruments of the European Health Interview Survey (EHIS) were used to assess self-reported information on the provision of informal care or assistance, health status, behavioral risk factors, social support and sociodemographic characteristics (8).

2.3.1. Provision of informal care

Respondents were asked, if they provide care or assistance to one or more persons suffering from some age problem, chronic health condition or infirmity, at least once a week. If they provided care, one further question assessed, for how many hours per week these respondents usually provide care or assistance (<10 h per week; at least 10 but <20 h per week; 20 h per week or more). We differentiated between providing no informal care (i.e., non-caregivers), informal care <10 h/week (less-intense caregivers) and informal care at least 10 h/week (intense caregivers).

2.3.2. Health status

The three questions of the Minimum European Health Module (MEHM) (9) include the *self-perceived health* by a single question 'How is your health in general?' (very good, good, fair, bad, very bad), the presence of *chronic diseases* or a long-standing health problem lasting for 6 months or more (yes, no), and the *health-related activity limitations*. The latter was assessed using the Global Activity Limitation Indicator (GALI) *via* the question 'Are you limited because of a health problem in activities people usually do?' (severely limited, limited, but not severely, not limited at all). Participants with limitations were additionally asked 'Have you been limited for at least the past 6 months?' (yes, no). Participants who had been limited for more than 6 months were defined as having longer-term health limitations. All other participants were considered to have no long-term limitations. The prevalence of a *low back disorder or other chronic back defect* in the past 12 months were assessed by a single question (yes, no). *Depressive symptoms* within the last 2 weeks were defined according to the German version of the 8-item Patient Health Questionnaire (PHQ-8; cut-off $\geq$10/24) (10).

2.3.3. Behavioral risk factors

Individuals with alcohol consumption within the past 12 months were asked by a quantity-frequency measure separately for the amount of standard drinks consumed on weekdays (Mondays to Thursdays) and during weekends (Fridays to Sundays). The responses were used to calculate grams of pure alcohol consumed per day. *At-risk drinking* according to national guidelines (11, 12) was considered when >10/20 g pure alcohol per day was reported by women/men. Lower amounts were considered as low-risk alcohol consumption (including abstainers past 12 months or lifetime). Smoking status was assessed by a single question "Do you smoke tobacco products, including heated tobacco products?" *Current smoking* was defined for answers "yes, daily" or "yes, occasionally". All other answer options (i.e., no, not any more, I have never smoked) were defined as current non-smoking. Work-related, transport-related and leisure-time physical activity in a typical week was assessed by the German version of the European Health Interview Survey – Physical Activity Questionnaire (EHIS-PAQ) (13). Respondents were asked about the duration of the physical activity they undertake during a typical week, in the form of both moderate-intensity aerobic physical activity conducted during leisure time and cycling used for transportation, as well as the number of days a week during which they undertake muscle-strengthening activities. *Insufficient physical activity* was defined as not meeting the recommendations of the World Health Organization on 2.5 hours of aerobic activity a week, as well as muscle-strengthening activities twice a week. Information on *non-daily fruit and vegetable consumption* was combined from two frequency questions regarding fruit and vegetable/salad consumption. A non-daily fruit and vegetables consumption was considered for those reporting a non-daily consumption of fruits or vegetables. *Obesity* (yes, no) was defined as a body mass index of $\geq$30 kg/m² based on self-report of body weight and height according to the classification of the World Health Organization (14).

2.3.4. Social characteristics

Social support was assessed using the OSLO-3 Scale (15) and categorized as low, moderate and high. Household size was dichotomized as living in a *single household* (yes, no). Participants were asked to indicate which *gender* they felt they belonged to (female, male, other gender identity) (16). Due to the small number of cases, participants who indicated a different gender identity or no gender identity were not included in the analyses. *Age* in years was categorized into two different groupings: (a) 18–44, 45–64 and $\geq$65 years and (b) 18–29, 30–44, 45–64, 65–79 and $\geq$80 years. *Educational levels* were assigned to low, medium, and high education groups according to the Comparative Analyses of Social Mobility in Industrial Nations (CASMIN) classification using school and vocational educational attainment (17, 18). *Municipality size* was categorized as rural (population < 5,000), small town (population 5,000 to <20,000), medium town (population 20,000 to <100,000), and city (population 100,000 and more) (reference date: 31 December 2018). *Current employment status* was differentiated into full-time and part-time employment, retirement and other (e.g., unemployed, being a student/pupil, fulfilling domestic asks, military or civilian service).

2.4. Data analysis

Weighted prevalences are presented overall or separately for women and men stratified by the provision of informal care or assistance with 95% confidence intervals (95% CI). Separate multinomial regression analyses were applied to determine group differences for caregivers and non-caregivers on health status, behavioral risk factors and social risk factors. In detail, intense and less-intense caregivers were compared with non-caregivers as the reference group. Regression analyses were calculated and adjusted for age group. Odds ratios are presented and significant *p*-values indicated.

The analyses were performed applying a weighting factor in order to correct for deviations of the sample from the population structure. As part of the data weighting, a design weighting was first performed for the different selection probabilities (mobile and landline network). Subsequently, an adjustment was made to the official population figures related to age, sex, federal state and type of district (reference date: 31 December 2019). In addition, the sample was adjusted to the education distribution in the 2017 Microcensus according to the International Standard Classification of Education (ISCED classification) (19).

All analyses were conducted using Stata 17.0 (Stata Corp., College Station, TX, USA, 2017). In order to take the weighting appropriately into account when calculating confidence intervals and *p*-values, all analyses were calculated using the survey procedures of Stata 17.0. A difference between groups was assumed to be statistically significant if the corresponding $p < 0.05$.

3. Results

3.1. Sample characteristics

In total, 51.1% were female, 38.8% were 18–44 years old, 52.4% had a medium education level, 33.8% lived in a city, 40.2% worked full-time (Table 1).

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TABLE 1 Sample characteristics (total sample: $n = 22,646$).

	N (% unweighted)	% weighted	95% CI
Gender			
Female	11,959 (52.8)	51.1	50.1–52.1
Male	10,687 (47.2)	48.9	47.9–49.9
Age groups in years			
18–44	5,847 (25.8)	38.8	37.8–39.9
45–64	8,963 (39.6)	35.1	34.2–36.0
≥ 65	7,836 (34.6)	26.0	25.2–26.9
Education level			
Low	4,261 (18.8)	29.5	28.6–30.5
Medium	9,947 (43.9)	52.4	51.4–53.4
High	8,378 (37.0)	18.0	17.5–18.6
Missing	60 (0.3)		
Municipality size			
Rural	1,766 (7.8)	10.7	10.0–11.3
Small town	5,031 (22.2)	25.3	24.4–26.2
Medium town	5,805 (25.6)	30.2	29.3–31.2
City	8,503 (37.5)	33.8	32.9–34.7
Missing	1,541 (6.8)		
Current employment status			
Full–time employment	8,601 (38.0)	40.2	39.2–41.2
Part–time employment	3,564 (15.7)	15.6	14.9–16.3
Retirement	7,967 (35.2)	27.5	26.7–28.4
Other[a]	2,467 (10.9)	16.7	15.9–17.5
Missing	47 (0.2)		
Informal Care			
Intense caregivers (≥10 h/week)	1,573 (6.9)	6.5	77.5–79.1
Less-intense caregivers (<10 h/week)	3,843 (17.0)	15.2	14.5–15.9
Non-caregivers	17,183 (75.9)	78.3	6.0–7.0
Missing	47 (0.2)		

[a]Unemployed, being a student/pupil, fulfilling domestic tasks, military or civilian service; 95% CI = 95% confidence interval; Percentages may not total 100 due to rounding.

3.2. Provision of informal care

Overall, 21.7% ($n = 5,416$) of the participants provided informal care or support for one or more persons suffering from age-related complaints, chronic illnesses or frailty at least once a week (Table 1). A total of 6.5% provided informal care at least 10 h per week (intense caregivers); 15.2% <10 h per week (less-intense caregivers).

Women provided informal care more often (23.9%) than men (19.3%) (Table 2). Informal caregiving is most frequently provided in the age group of 45 to 64 years, among both women and men: 32.7% of women and 24.6% of men of that age stated that they supported or cared for others (Figure 1).

3.3. Health status and the provision of informal care

The analyses reveal that female intense caregivers were significantly more likely to have a low back disorder or other chronic back defects than female non-caregivers (43.0 vs. 32.4%). There were no significant differences between these two groups and all other variables concerning health status (Table 3).

Male intense caregivers reported also significantly more often a low back disorder or other chronic back defect (41.8 vs. 28.7%) compared to male non-caregivers. In addition, they indicated more often fair/bad/very bad self-perceived health (44.0 vs. 28.0%), health-related activity limitations (47.7 vs. 30.0%), and the presence of chronic diseases (58.8 vs. 45.5%) than male non-caregivers. No significant differences were found concerning depressive symptoms (Table 3).

Female and male less-intense caregivers showed significantly less often a fair/bad/very bad self-perceived health compared to female and male non-caregivers (females: 28.6 vs. 31.4%; males: 25.3 vs. 28.0%). Among women, it was also found that less-intense caregivers had significantly fewer health-related activity limitations than non-caregivers (33.0 vs. 35.6%). No significant differences were found for the other variables concerning health status (Table 3).

3.4. Behavioral risk factors and the provision of informal care

There were no significant differences between female and male intense caregivers compared to female and male non-caregivers concerning behavioral risk factors (Table 4).

Less-intense caregivers showed a more favorable health behavior than non-caregivers. They were significantly less often physically inactive (females: 72.1 vs. 77.2%; males: 64.5 vs. 71.3%) and their fruit and vegetable consumption was significantly less likely to be non-daily (females: 52.0 vs. 55.9%; males: 73.1 vs. 76.6%). There were no significant differences concerning at-risk drinking, current smoking, and obesity (Table 4).

3.5. Social risk factors and the provision of informal care

Both female and male caregivers (regardless of the extent of care provided) lived significantly less often alone compared to non-caregivers (females: intense caregivers 23.6%, less-intense caregivers 32.5%, non-caregivers 40.7%; males: intense caregivers 33.3%, less-intense caregivers 37.8% non-caregivers 43.2%) (Table 5).

Low social support was significantly less common among female and male less-intense caregivers compared to non-caregivers (females: 10.2 vs. 15.3%, males: 11.8 vs. 16.7%). No significant differences were found between intense caregivers and non-caregivers concerning social support (Table 5).

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TABLE 2 Social characteristics by provision of informal care (weighted analyses).

		Intense caregivers		Less–intense caregivers		Non–caregivers	
		%	95% CI	%	95% CI	%	95% CI
Female	**Total**	7.7	7.1–8.5	16.2	15.3–17.2	76	74.9–77.1
	Age groups in years						
	18–44	25.5	20.9–30.7	30.6	27.4–34.0	39.4	37.8–41.1
	45–64	49	44.3–53.8	46	42.9–49.1	30.5	29.1–31.9
	≥ 65	25.5	21.8–29.5	23.4	21.1–25.9	30.1	28.7–31.5
	Education level						
	Low	34.2	29.5–39.2	20.8	18.2–23.8	29.4	27.8–31.0
	Medium	55.9	51.0–60.6	63.7	60.7–66.6	53.9	52.3–55.5
	High	10	8.4–11.7	15.4	13.9–17.1	16.7	15.9–17.6
	Municipality size						
	Rural	14.3	11.1–18.2	11.5	9.6–13.9	9.9	8.9–10.9
	Small town	28.4	24.0–33.2	25.8	23.1–28.7	25	23.6–26.5
	Medium town	29.1	24.9–33.6	33.2	30.1–36.4	30.3	28.8–31.9
	City	28.3	24.1–32.9	29.5	26.7–32.5	34.8	33.3–36.3
	Current employment status						
	Full–time job	23.4	19.7–27.7	31.6	28.7–34.7	27.1	25.7–28.6
	Part–time job	28.8	24.6–33.4	29.6	26.8–32.5	23.1	21.9–24.4
	Retirement	26.9	23.1–31.1	23.9	21.6–26.5	31.5	30.1–33.0
	Other[a]	20.8	17.0–25.3	14.9	12.5–17.6	18.2	16.9–19.6
Male	**Total**	5.2	4.6–5.9	14.1	13.1–15.1	80.7	79.6–81.8
	Age groups in years						
	18–44	22.9	17.8–28.8	33.2	29.4–37.2	43.3	41.7–45.0
	45–64	43.8	37.6–50.1	46.7	42.9–50.5	33.5	32.0–35.1
	≥ 65	33.4	27.8–39.5	20.2	17.6–23.0	23.1	21.9–24.4
	Education level						
	Low	41.1	34.7–47.7	29.6	25.9–33.6	30.2	28.6–31.9
	Medium	45.6	39.4–52.0	51	47.2–54.8	49	47.3–50.6
	High	13.3	10.9–16.1	19.4	17.5–21.6	20.8	19.9–21.8
	Municipality size						
	Rural	7.5	4.9–11.3	12	9.6–14.9	10.9	9.8–12.0
	Small town	36.8	30.4–43.7	24.9	21.7–28.3	24.5	23.1–26.0
	Medium town	27.8	22.5–33.8	31	27.4–34.8	29.6	28.1–31.2
	City	27.9	22.6–33.9	32.2	28.7–35.9	34.9	33.4–36.5
	Current employment status						
	Full–time employment	40.4	34.4–46.8	56.6	52.9–60.4	53.8	52.2–55.4
	Part–time employment	6.3	3.9–10.0	7.9	5.9–10.5	5.9	5.2–6.7
	Retirement	38.6	32.6–44.9	23	20.3–25.9	24.4	23.1–25.7
	Other[a]	14.7	10.6–20.1	12.5	9.8–15.7	15.9	14.6–17.3

[a]Unemployed, being a student/pupil, fulfilling domestic tasks, military or civilian service; 95% CI = 95% confidence interval; Percentages may not total 100 due to rounding.

4. Discussion

About one fifth of the respondents provide informal care, mainly at least 10 h per week. Women provide informal care more often than men. Caregivers most often belong to the age group 45 to 64 years. Intense caregivers more often suffer from back pain than those who provide less or no care. Men who provide intense care are more likely to report fair/bad/very bad self-perceived health status, health related

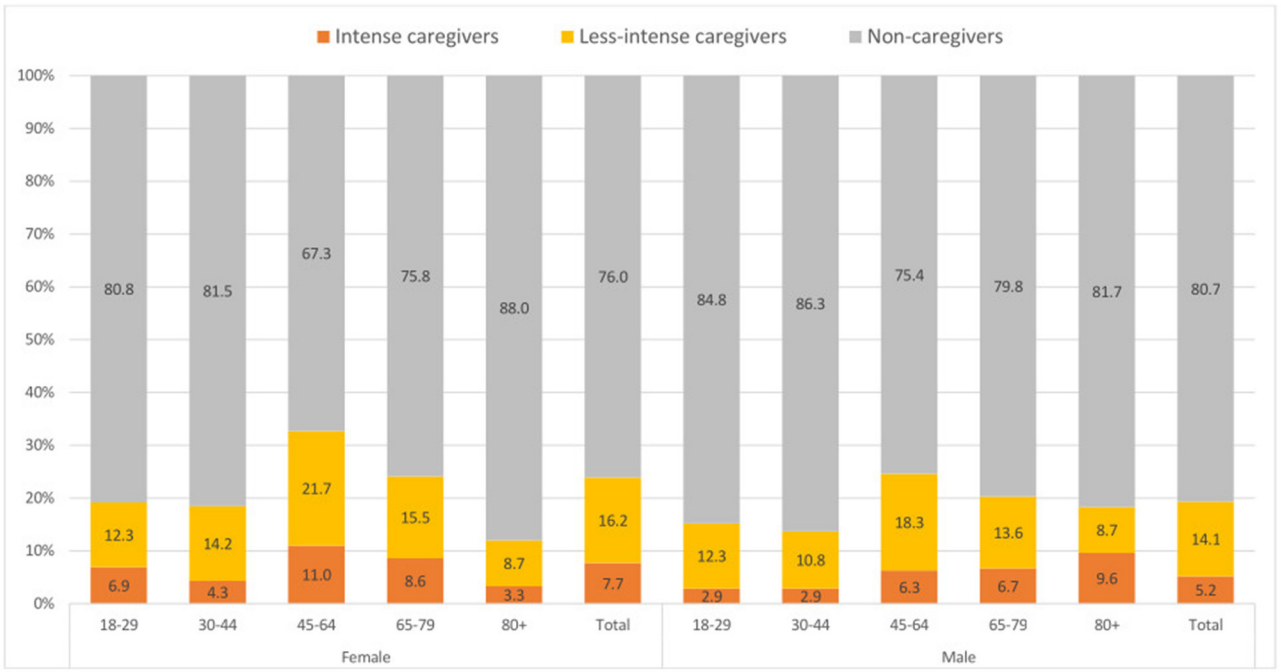

FIGURE 1
Percentage of informal care-giving activities by gender and age group in years (weighted analyses). Percentages may not total 100 due to rounding.

limitations in daily living and chronic diseases than non-caregivers. Female and male less-intense caregivers were less often physically inactive and non-daily fruits and vegetables consumption was less likely compared to non-caregivers. The majority of caregivers do not live alone. Low social support is not as common among less-intense caregivers as among non-caregivers.

It must be considered that there is no international consensus on how the indicator of informal long-term care should be implemented in survey studies. A comparison of the studies EHIS, The Survey of Health, Aging and Retirement in Europe (SHARE) and the European Quality of Life Survey (EQLS) shows a very inconsistent picture. Based on different question wordings there are remarkable differences in the level of informal long-term care provision in the population and the differences between countries hardly follow a clear pattern (20). The EHIS definition used here is very broad and includes not only long-term care activities in the narrower sense but also other, not further defined support services in daily life. In the present analyses, it was assumed that frequent provision of support ($\geq$10 h per week) suggests a regular activity with daily or almost daily caregiving and therefore comes closer to the construct of informal care. Nevertheless, it must be stated that a clear definition of informal long-term care is still missing especially on the European level (21). The present study allows to describe the group of informal caregivers in more detail with regard to the extent of care provided and their social characteristics, health status, and possible risk and protective factors, and to compare them with the group of non-caregivers.

There are only a few cross-sectional studies on the social characteristics, health and living situation and the prevalence of behavioral risk factors of adult informal caregivers in Germany. The proportion of informal caregivers that was identified in these studies (22, 23) is similar to the present results. Consistent with our findings, the existing studies also show that women provide informal care more often than men and that the proportion of caregiving increases with age (22–24). This finding is also confirmed by international study results (25).

A current systematic review suggests that informal caregiving may be associated with adverse health related outcomes like several mental and physical disorders, including pain (26). This is line with our results for men: With the exception of depressive symptoms, intense caregivers are more likely to report worse health outcomes than non-caregivers. For women, we found significant differences in health status only for back pain, which is consistent with the research findings (27). The fact that we did not find more adverse health outcomes for caregiving women compared to non-caregivers should be further investigated. Apparently, female caregivers and female non-caregivers differ less in different health status characteristics than male caregivers and male non-caregivers do. Focusing future research on differences within gender groups could provide new insights into this. In summary, it should be emphasized that the main burden of care work is to be found in middle age and that possible health-promoting and relieving measures should not least focus on this group. Furthermore, noticeable gender differences should be considered and investigated further. In the present study, the negative effects of care work on the health of caring men are striking. Thus, future research should also clarify the extent to which gender-related approaches to health promotion and prevention could be promising for informal carers.

Regarding behavioral risk factors, our results show hardly any differences between intensive caregivers respectively less-intense caregivers, and non-caregivers. The exceptions are insufficient physical activity and non-daily fruit and vegetable consumption where differences are found between less intensive caregivers and non-caregivers in favor of the less-intense caregivers. That caregiving is associated with health-promoting behaviors is supported by previous findings (28). However, in contrast to our results, these findings indicate increased risk behaviors among caregivers, e.g.

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TABLE 3 Health status of caregivers and non–caregivers by gender (weighted analyses).

		Intense caregivers		Less-intense caregivers		Non-caregivers		Intense care vs. no care (Ref.)	Less intense care vs. no care (Ref.)
		%	95% CI	%	95% CI	%	95% CI	OR[a]	OR[a]
Female	**Self–perceived health**								
	Very good/good	63.1	58.2–67.6	71.4	68.3–74.2	68.6	67.1–70.1	Ref.	Ref.
	Fair/bad/very bad	36.9	32.4–41.8	28.6	25.8–31.7	31.4	29.9–32.9	1.19	0.84*
	Health-related activity limitations								
	No	59.6	54.8–64.1	67	64.0–70.0	64.4	62.8–65.9	Ref.	Ref.
	Yes	40.4	35.9–45.2	33	30.0–36.0	35.6	34.1–37.2	1.12	0.84*
	Chronic disease								
	No	42.9	38.2–47.7	47.4	44.2–50.6	48.6	47.1–50.2	Ref.	Ref.
	Yes	57.1	52.3–61.8	52.6	49.4–55.8	51.4	49.8–52.9	1.14	0.99
	Low back disorder or other chronic back defect								
	No	57	52.1–61.7	63.4	60.2–66.4	67.6	66.1–69.0	Ref.	Ref.
	Yes	43	38.3–47.9	36.6	33.6–39.8	32.4	31.0–33.9	1.47**	1.16
	Depressive symptoms								
	No	89.2	85.6–92.0	91.3	88.8–93.3	91.4	90.3–92.3	Ref.	Ref.
	Yes	10.8	8.0–14.4	8.7	6.7–11.2	8.6	7.7–9.7	1.25	0.98
Male	**Self–perceived health**								
	Very good/good	56	49.5–62.3	74.7	71.2–77.9	72	70.4–73.5	Ref.	Ref.
	Fair/bad/very bad	44	37.7–50.5	25.3	22.1–28.8	28	26.5–29.6	1.61**	0.79*
	Health-related activity limitations								
	No	52.3	45.9–58.6	69.1	65.5–72.6	70	68.4–71.5	Ref.	Ref.
	Yes	47.7	41.4–54.1	30.9	27.4–34.5	30	28.5–31.6	1.71***	0.94
	Chronic disease								
	No	41.2	35.2–47.6	53.5	49.7–57.2	54.5	52.8–56.1	Ref.	Ref.
	Yes	58.8	52.4–64.8	46.5	42.8–50.3	45.5	43.9–47.2	1.39*	0.96
	Low back disorder or other chronic back defect								
	No	58.2	51.9–64.4	66.9	63.2–70.4	71.3	69.8–72.8	Ref.	Ref.
	Yes	41.8	35.6–48.1	33.1	29.6–36.8	28.7	27.2–30.2	1.57**	1.16
	Depressive symptoms								
	No	91.6	86.7–94.9	91.8	88.8–94.1	92.6	91.5–93.6	Ref.	Ref.
	Yes	8.4	5.1–13.3	8.2	5.9–11.2	7.4	6.4–8.5	1.15	1.06

[a]Separate multinomial logistic regression analyses adjusted for age group; 95% CI = 95% confidence interval; Ref., reference group; OR, odds ratios; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

related to obesity and smoking. Our findings that non-daily consumption of fruits and vegetables and insufficient physical activity are less common among less-intensive caregivers compared with intensive caregivers or non-caregivers are also confirmed by others (29). A recent systematic review (30) aimed at better understanding of physical activity of caregivers. The authors conclude that the current body of research is insufficient to assess whether informal caregivers are at higher risk for physical inactivity than non-caregivers. They recommend further research with validated measures for the different domains of physical activity (leisure time, daily physical activity, caregiving duties). And it should be noted that we only consider healthy diet on the basis of one indicator, which does not adequately reflect the complexity of nutrition.

Overall, with the exception of back pain the results do not suggest consistent major negative effects of caregiving on health status for women and men. Similarly, intense caregivers did not report having worse health-related lifestyles than non-caregivers. Less-intense caregivers report even better health than non-caregivers. One explanation to understanding these associations is that healthier people are more likely to take on caregiving tasks, while those with

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TABLE 4 Health behavioral risk factors of caregivers and non–caregivers by gender (weighted analyses).

		Intense caregivers		Less-intense caregivers		Non-caregivers		Intense care vs. no care (Ref.)	Less intense care vs. no care (Ref.)
		%	95% CI	%	95% CI	%	95% CI	OR[a]	OR[a]
Female	**At-risk drinking**								
	No	89.6	86.3–92.2	89	87.2–90.6	88.8	87.8–89.7	Ref.	Ref.
	Yes	10.4	7.8–13.7	11	9.4–12.8	11.2	10.3–12.2	0.89	0.95
	Current smoking								
	No	72.2	67.4–76.5	75	71.9–78.0	76.5	75.1–78.0	Ref.	Ref.
	Yes	27.8	23.5–32.6	25	22.0–28.1	23.5	22.0–24.9	1.23	1.03
	Insufficient physical activity								
	No	19.4	16.1–23.2	27.9	25.1–30.8	22.8	21.5–24.1	Ref.	Ref.
	Yes	80.6	76.8–83.9	72.1	69.2–74.9	77.2	75.9–78.5	1.22	0.77**
	Non-daily fruit and vegetable consumption								
	No	48.1	43.4–52.9	48	44.9–51.2	44.1	42.5–45.7	Ref.	Ref.
	Yes	51.9	47.1–56.6	52	48.8–55.1	55.9	54.3–57.5	0.84	0.84*
	Obesity								
	No	76.3	71.8–80.3	81.5	78.9–83.9	81.4	80.0–82.6	Ref.	Ref.
	Yes	23.7	19.7–28.2	18.5	16.1–21.1	18.6	17.4–20.0	1.24	0.93
Male	**At-risk drinking**								
	No	86.8	81.8–90.5	83.9	80.9–86.5	83.7	82.4–84.9	Ref.	Ref.
	Yes	13.2	9.5–18.2	16.1	13.5–19.1	16.3	15.1–17.6	0.74	0.96
	Current smoking								
	No	64.8	58.3–70.8	65.9	61.9–69.6	66.2	64.6–67.9	Ref.	Ref.
	Yes	35.2	29.2–41.7	34.1	30.4–38.1	33.8	32.1–35.4	1.28	1.02
	Insufficient physical activity								
	No	23.3	18.7–28.5	35.5	31.9–39.4	28.7	27.2–30.1	Ref.	Ref.
	Yes	76.7	71.5–81.3	64.5	60.6–68.1	71.3	69.9–72.8	1.1	0.65***
	Non-daily fruit and vegetable consumption								
	No	26.6	21.5–32.4	26.8	23.7–30.2	23.4	22.1–24.7	Ref.	Ref.
	Yes	73.4	67.6–78.5	73.2	69.8–76.3	76.6	75.3–77.9	0.86	0.82*
	Obesity								
	No	75.8	69.8–81.0	79.2	75.8–82.3	81.5	80.2–82.8	Ref.	Ref.
	Yes	24.2	19.0–30.2	20.8	17.7–24.2	18.5	17.2–19.8	1.29	1.08

[a]Separate multinomial logistic regression analyses adjusted for age group; 95% CI = 95% confidence interval; Ref., reference group; OR, odds ratios; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

poorer health are less likely to do so (healthy caregiver effect) (31, 32). Further, received social support could also help avoid a burden (33). Otherwise, it cannot be excluded that the definition of informal care that was implemented in EHIS may not be sufficiently specific to clearly distinguish caregivers with a high care burden from those caregivers that frequently spend time with their relatives while being supported in care activities by professional services and thus have a much lower care burden. This could weaken the association between informal caregiving and health. Finally, caregivers who experience high levels of burden are probably less likely to participate in a health survey due to time constrains as an analysis of reasons for non-participation among individuals 65 years and older suggest (34). We therefore assume that the proportion of caregivers with health problems could be underestimated.

In addition, due to the demographic change and population aging we are expecting higher numbers of people in need of care (35). Researches from the European Joint Research Center estimate that the number of people aged 50 years and older with long-term care needs will increase by approximately 24% by 2050 and 36% by 2070 (36). The major part of care will continue to be provided by informal caregivers. A structured review showed that despite the important role of informal care, few studies have included this aspect of care into their demand models (37). Therefore, their health status and burden should be regularly

TABLE 5 Social risk factors of caregivers and non–caregivers by gender (weighted analyses).

		Intense caregivers		Less-intense caregivers		Non-caregivers		Intense care vs. no care (Ref.)	Less intense care vs. no care (Ref.)
		%	95% CI	%	95% CI	%	95% CI	OR[a]	OR[a]
Female	**Single household**								
	No	76.4	71.6–80.6	67.5	64.3–70.6	59.3	57.7–60.9	Ref.	Ref.
	Yes	23.6	19.4–28.4	32.5	29.4–35.7	40.7	39.1–42.3	0.42***	0.72***
	Social support								
	Moderate/high	88.1	84.6–90.8	89.8	87.2–92.0	84.7	83.3–85.9	Ref.	Ref.
	Low	11.9	9.2–15.4	10.2	8.0–12.8	15.3	14.1–16.7	0.75	0.63**
Male	**Single household**								
	No	66.7	59.7–73.1	62.2	58.1–66.2	56.8	55.1–58.5	Ref.	Ref.
	Yes	33.3	26.9–40.3	37.8	33.8–41.9	43.2	41.5–44.9	0.80*	0.65**
	Social support								
	Medium/high	79.2	71.9–85.0	88.2	84.9–90.8	83.3	81.8.—84.6	Ref.	Ref.
	Low	20.8	15.0–28.1	11.8	9.2–15.1	16.7	15.4–18.2	1.23	0.65**

[a]Separate multinomial logistic regression analyses adjusted for age group; 95% CI = 95% confidence interval; Ref., reference group; OR, odds ratios; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

monitored in order to develop prevention strategies to avoid negative health effects.

4.1. Strengths and limitations

The results refer to a large nation-wide population-based sample of 22,646 respondents aged 18 years and older. Possible factors associated with selection bias have been considered by weighting according to age, sex and education (7). Nevertheless, the following limitations have to be considered. The first wave of the 2020 COVID-19 pandemic was coincident within the survey period of this study. It cannot be completely ruled out that a change in willingness to participate during the pandemic has had an impact on certain health indicators. The present analyses were done under the assumption that the sample does not show systematic bias due to the containment measures. Moreover, initial analyses do not show a systematic selection between the subsamples of the comparison periods 2019 and 2020. We therefore suggest that the data collection during the pandemic did not represent an exceptional period with significant impact on the level of care-relevant indicators (38).

However, it must be considered that GEDA 2019/2020-EHIS was not primarily aimed at informal carers. For example, we lack detailed information on whom and why somebody is cared for and also former caregiving activities. Therefore, we cannot give more insight in (a) the reported gender differences of intense caregivers regarding their relationship with the person cared for; i.e., support of partners vs. non-partners or (b) the care needs and strains of care. Furthermore, healthy people may be more likely to provide informal care and that they may stop doing so when their health deteriorates.

Another related limitation of the study is that we cannot distinguish between respondents with friends or family members in need of care who actively provide care and those who don't but delegate this to third parties like professional care services. The willingness to provide informal care can vary due to many factors such as degree of kinship, career orientation, time constraints, distance between one's own residence and that of the person to be cared for. This alone may entail a selection between informal caregivers and non-caregivers, which should be taken more into account in future studies.

4.2. Conclusion

Our study results show that in Germany a significant proportion of people provide informal care. Even though the present study did not show any serious health effects on those providing informal care, it can be assumed that they experience burden, especially when care is provided over a longer period of time. Preventive measures are important and should be supported in any way in order to maintain physical and mental health of informal care-givers. With the expected increase in the number of people needing care, protecting those who provide care is an important part of meeting future challenges.

Data availability statement

The dataset presented in this article is not readily available because the authors confirm that some access restrictions apply to the data underlying the findings. The data set cannot be made publicly available because informed consent from study participants did not cover public deposition of data. However, the minimal data set underlying the findings is archived in the "Health Monitoring" Research Data Centre at the Robert Koch Institute (RKI) can be accessed by researchers on reasonable request. On-site access to the data set is possible at the Secure Data Center of the RKI's "Health Monitoring" Research Data Centre. Requests should be submitted

to the "Health Monitoring" Research Data Centre, Robert Koch Institute, Berlin, Germany (e-mail: fdz@rki.de).

Ethics statement

The study involving human participants was reviewed and approved by the Ethics Committee of the Charité – Universitätsmedizin Berlin (application number EA2/070/19). Informed consent was obtained verbally. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

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

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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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References

1. Nadash P, Doty P, von Schwanenflügel M. The german long-term care insurance program: evolution and recent developments. *Gerontologist.* (2018) 58:588–97. doi: 10.1093/geront/gnx018

2. Bauer JM, Sousa-Poza A. Impacts of informal caregiving on caregiver employment, health, and family. *J Popul Ageing.* (2015) 8:113–45. doi: 10.1007/s12062-015-9116-0

3. Hajek A, Kretzler B, König HH. Informal caregiving, loneliness and social isolation: a systematic review. *Int J Environ Res Pub Health.* (2021) 18:22. doi: 10.3390/ijerph182212101

4. Kaschowitz J, Brandt M. Health effects of informal caregiving across Europe: a longitudinal approach. *Social Sci Med.* (2016) 173:72–80. doi: 10.1016/j.socscimed.2016.11.036

5. Zwar L, König HH, Hajek A. Consequences of different types of informal caregiving for mental, self-rated, and physical health: longitudinal findings from the German Ageing Survey. *Qual Life Res.* (2018) 27:2667–79. doi: 10.1007/s11136-018-1926-0

6. American Association for Public Opinion Research (AAPOR). *Standard Definitions - Final Disposition Codes of Case Codes and Outcome Rates for Surveys.* Deerfield: AAPOR (2016).

7. Allen J, Born S, Damerow S, Kuhnert R, Lemcke J, Müller A, et al. German health update (GEDA 2019/2020-EHIS) – background and methodology. *J Health Monit.* (2021) 6:66–79. doi: 10.25646/8559

8. Eurostat. *European Health Interview Survey (EHIS wave 3) — Methodological Manual.* Luxembourg: Publications Office of the European Union (2018).

9. Cox B, van Oyen H, Cambois E, Jagger C. le Roy S, Robine JM, et al. The reliability of the minimum european health module. *Int J Public Health.* (2009) 54:55–60. doi: 10.1007/s00038-009-7104-y

10. Kroenke K, Strine TW, Spitzer RL, Williams JB, Berry JT, Mokdad AH. The PHQ-8 as a measure of current depression in the general population. *J Affect Disord.* (2009) 114:163–73. doi: 10.1016/j.jad.2008.06.026

11. Burger M, Bronstrup A, Pietrzik K. Derivation of tolerable upper alcohol intake levels in Germany: a systematic review of risks and benefits of moderate alcohol consumption. *Preventive medicine.* (2004) 39:111–27. doi: 10.1016/j.ypmed.2003.11.011

12. Seitz HK, Bühringer GKM. *Grenzwerte für den Konsum alkoholischer Getränke Jahrbuch Sucht.* Geesthacht: Neuland Verlagsgesellschaft (2008). p. 205–9.

13. Finger JD, Tafforeau J, Gisle L, Oja L, Ziese T, Thelen J, et al. Development of the european health interview survey - physical activity questionnaire (EHIS-PAQ) to monitor physical activity in the European Union. *Arch Public Health.* (2015) 73:59. doi: 10.1186/s13690-015-0110-z

14. World Health Organization. *Obesity: Preventing and Managing the Global Epidemic.* Geneva: WHO (2000).

15. Dalgard OS. Community health profile as tool for psychiatric prevention. *In:* Trent DR, Reed C, editors *Promotion of Mental Health.* Avebury: Aldershot. (1996).

16. Pöge K, Rommel A, Starker A, Prütz F, Tolksdorf K, Öztürk I, et al. Survey of sex/gender diversity in the GEDA 2019/2020-EHIS study - objectives, procedure and experiences. *J Health Monit.* (2022) 7:48–65. doi: 10.25646/9958

17. Lechert Y, Schroedter J, Lüttinger P. *Die Umsetzung Der Bildungsklassifikation CASMIN Für Die Volkszählung 1970, die Mikrozensus- Zusatzerhebung 1971 Und Die Mikrozensen.* (2022). Available online at: https://www.ssoar.info/ssoar/handle/document/26235 (accessed July 22, 2022).

18. Brauns H, Steinmann S. Educational Reform in France, West-Germany and the United Kingdom: updating the CASMIN Educational Classification. *ZUMA-Nachrichten.* (1999) 23:7–44.

19. Forschungsdatenzentren der Statistischen Ämter des Bundes und der Länder. Metadaten: Mikrozensus (2017). On-Site-Zugang. doi: 10.21242/12211.2017.00.00.1.1.1

20. Tur-Sinai A, Teti A, Rommel A, Hlebec V, Lamura G. How many older informal caregivers are there in Europe? comparison of estimates of their prevalence from three european surveys. *Int J Environ Res Pub Health.* (2020) 17:24. doi: 10.3390/ijerph17249531

21. Tur-Sinai A, Teti A, Rommel A, Hlebec V, Yghemonos S, Lamura G. Cross-national data on informal caregivers of older people with long-term care needs in the European population: time for a more coordinated and comparable approach. *J Biosoc Sci.* (2022) 6:1–5. doi: 10.1017/S0021932021000742

22. Wetzstein M, Rommel A, Lange C. *Informal Caregivers - Germany's Largest Nursing Service.* Berlin: Robert Koch-Institut. (2016).

23. Backhaus N, Rose U. *Beschäftigte mit Pflegeaufgaben im privaten Umfeld: Verbreitung und psychische Gesundheit.* Dortmund: Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (2022).

24. Rothgang H, Müller R. Gesundheit pflegender Angehöriger. In: Barmer GEK, editor. *Pflegereport 2018 Schriftenreihe zur Gesundheitsanalyse Band 12.* Berlin: Barmer (2018). p. 100–91.

25. Verbakel E, Tamlagsronning S, Winstone L, Fjaer EL, Eikemo TA. Informal care in europe: findings from the european social survey (2014) special module on the social determinants of health. *Eur J Public Health.* (2017) 27:90–5. doi: 10.1093/eurpub/ckw229

26. Janson P, Willeke K, Zaibert L, Budnick A, Berghofer A, Kittel-Schneider S, et al. Mortality, morbidity and health-related outcomes in informal caregivers

compared to non-caregivers: a systematic review. *Int J Environ Res Pub Health*. (2022) 19:864. doi: 10.3390/ijerph19105864

27. Suzuki K, Tamakoshi K, Sakakibara H. Caregiving activities closely associated with the development of low-back pain among female family caregivers. *J Clin Nurs.* (2016) 25:2156–67. doi: 10.1111/jocn.13167

28. Gottschalk S, König HH, Brettschneider C. The association between informal caregiving and behavioral risk factors: a cross-sectional study. *Int J Public Health.* (2020) 65:911–21. doi: 10.1007/s00038-020-01402-6

29. García-Mayor J, Moreno-Llamas A, De la Cruz-Sánchez E. Health-related lifestyle of Spanish informal caregivers: results from two national health surveys. *Family Relations.* (2022) 1–15. doi: 10.1111/fare.12689

30. Lindsay RK, Vseteckova J, Horne J, Smith L, Trott M, De Lappe J, et al. The prevalence of physical activity among informal carers: a systematic review of international literature. *Sport Sci Health.* (2022). doi: 10.1007/s11332-021-00893-x

31. McGuire LC, Bouldin EL, Andresen EM, Anderson LA. Examining modifiable health behaviors, body weight, and use of preventive health services among caregivers and non-caregivers aged 65 years and older in Hawaii, Kansas, and Washington using 2007 BRFSS. *J Nutr Health Aging.* (2010) 14:373–9. doi: 10.1007/s12603-010-0083-0

32. Pinquart M, Sörensen S. Correlates of physical health of informal caregivers: a meta-analysis. *J Gerontol Series B.* (2007) 62:P126–P37. doi: 10.1093/geronb/62.2.P126

33. Shiba K, Kondo N, Kondo K. Informal and formal social support and caregiver burden: the AGES caregiver survey. *J Epidemiol.* (2016) 26:622–8. doi: 10.2188/jea.JE20150263

34. Gaertner B, Seitz I, Fuchs J, Busch MA, Holzhausen M, Martus P, et al. Baseline participation in a health examination survey of the population 65 years and older: who is missed and why? *BMC Geriatr.* (2016) 16:21. doi: 10.1186/s12877-016-0185-6

35. Quashie NT, Wagner M, Verbakel E, Deindl C. Socioeconomic differences in informal caregiving in Europe. *Eur J Ageing.* (2022) 19:621–32. doi: 10.1007/s10433-021-00666-y

36. European Commission. *Long-Term Care (LTC): Projections.* (2022) Available online at: https://migration-demography-tools.jrc.ec.europa.eu/atlas-demography/stories/AoD/2/S3.8 (accessed September 29, 2022).

37. Worrall P, Chaussalet TJ, A. structured review of long-term care demand modelling. *Health Care Manag Sci.* (2015) 18:173–94. doi: 10.1007/s10729-014-9299-6

38. Damerow S, Rommel A, Prütz F, Beyer AK, Hapke U, Schienkiewitz A. Developments in the health situation in Germany during the initial stage of the COVID-19 pandemic for selected indicators of GEDA 2019/2020-EHIS. *J Health Monit.* (2020) 5:3–20. doi: 10.25646/7172

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Physical function, ADL, and depressive symptoms in Chinese elderly: Evidence from the CHARLS

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Background: Depressive symptoms are a serious public health problem that affects the mental health of older adults. However, current knowledge of the association between ADL disability and physical dysfunction and depressive symptoms in Chinese adults is insufficient. We intend to analyze the association between physical function, ADL, and depressive symptoms in older Chinese adults.

Methods: The data obtained from the China Health and Retirement Longitudinal Survey (2015 and 2018) (CHARLS). This includes 3,431 in 2015 and 3,258 in 2018 over the age of 60. Comparing 2015 and 2018 data, multivariate logistic regression models were used to explore the relationship between physical function, ADL, and depressive symptoms in urban and rural older adults, adjusting for sociodemographic factors associated with depression in older adults.

Results: The prevalence of depressive symptoms among older adults in China was 33.8 percent in 2015 and 50.6 percent in 2018. In baseline data from 2015 and 2018, residence, gender, marital status, drinking, physical function, ADL, and self-rated health were all found to be significantly associated with depressive symptoms in older adults. The differences in physical function, ADL and depressive symptoms among older adults in 2015 and 2018 were further analyzed based on urban and rural stratification. Both physical dysfunction and ADL disability were significantly associated with depressive symptoms in rural older adults in 2015 and 2018. And in urban areas, ADL was found to be significantly associated with depressive symptoms in urban older adults. Multivariate logistic regression analysis demonstrated that ADL disability was significantly associated with depressive symptoms among older adults in both urban and rural areas. Physical dysfunction was only significant in rural areas with depressive symptoms. The alpha level was instead set to 0.05 for all statistical tests.

Conclusion: Rural, female, 60–70 years of age, primary school or below, married, non-smoking, non-drinking, physical dysfunction, ADL disability and self-rated poor health make-up a higher proportion of depressed older adults. ADL disability and physical dysfunction were more likely to be associated with depressive symptoms in rural Chinese older adults. Therefore, the physical and mental health of rural elderly should be of concern. The rural older adults should receive additional support from the government and society.

KEYWORDS

ADL disability, physical dysfunction, depressive symptoms, urban and rural elderly, CHARLS

1. Introduction

As the number of older adults continues to increase, increasing attention was paid to the health problems of older adults (1). Depressive symptoms are common in older adults (1). There is evidence that depressive symptoms could be difficult to treat later in life (2). Besides, it might lead to reduced physical activities, lower the quality of life, and generate self-grief and even suicide (3). Studies showed that prevalence of depressive symptoms in Asian elderly was 7.8–46% (4). The overall prevalence of depressive symptoms was higher in Brazilian older adults (30.2%) than Chilean older adults (26.3%) (5). Furthermore, studies on older adults in China revealed that the prevalence differed between 13 and 41% (6). The disease burden of depressive symptoms in China had been on the rise and would continue to increase in the coming decades (7).

Researchers identified some as risk factors of depressive symptoms including female gender, somatic illness, cognitive impairment, functional disability, and history of depressive symptoms (8). Studies showed that reduced physical function in older adults was the main risk factor for developing depressive symptoms (9). A longitudinal community-based study reported that physical function independently predicts depressive morbidity in late-life (10). A study showed physical symptoms and poorer physical function reported increased depressive symptoms (11). At the same time, a decline in physical function leads to a loss of independence and consequent depressive symptoms. These studies demonstrated that those with the lowest levels of physical function carry the largest risk of onset of both depressive symptoms and anxiety over time (12). There was evidence that ADL disability may be a risk factor for depressive symptoms in previous studies (13, 14). ADL disability was associated with depressive symptoms and expanded psychological burden in older adults (15). An article on the level of depressive symptoms among elderly Turkish people, the findings indicated that ADL anticipated depressive symptoms among older adults (16). A study in South Korea reported that restriction of ADL, which means restriction of physical function, was also associated with early depressive symptoms. Lack of physical function leads to diminished social relations and depressive symptoms (17). In addition, economic, political, cultural, and other factors affect depressive symptoms differently. Depressive symptoms a financial burden on older adults and families. Studies demonstrated the medical expenses on depressive symptoms were 1.86 times that of non-depressed patients (18).

Currently, there was limited knowledge about the relationship between ADL disability and physical dysfunction and depressive symptoms in the Chinese older adults. In a prospective study of 2,713 Chinese older adults who completed interviews with the Chicago Chinese Aged Population Study, a significant relationship was discovered between depressive symptoms and the occurrence of functional disability (19). ADL disability was found to be a high-risk group for depressive symptoms in older adults in a study on changes in depressive symptoms levels in older Chinese (20). In a community-based study in Beijing, it was indicated that older adults with disabilities were more likely to experience depressive symptoms (21). Similarly, community-based research has linked ADL disability with increased risk of depressive symptoms in middle-aged and older Chinese adults (22). Data from one study showed that physical dysfunction in older silicosis patients was significantly associated with the prevalence of depressive symptoms (23). In addition, an analysis of factors influencing mental health in older Chinese adults showed that physical function and ADL were strongly associated with depressive symptoms in older adults (24).

In previous studies, depressive symptoms in older adults have mainly been studied in terms of ADL disability in a particular region or community. Our study was based on the China Health and Retirement Longitudinal Study (CHARLS), which was collected from respondents across the country. The sample of over-60 s used for the study was broader and more representative. Correspondingly, based on the above data, we mainly explore the relationship between physical function, ADL, and depressive symptoms. The purposes were the following: (1) To compare depressive symptoms prevalence in 2015 and 2018; (2) To study the influencing factors of depressive symptoms in older adults; (3) To evaluate the association between physical function, ADL, and depressive symptoms among urban and rural older Chinese adults.

2. Research methods

2.1. Data

The China Health and Retirement Longitudinal Study (CHARLS) is a large-scale interdisciplinary survey project hosted by the National Development Institute of Peking University and carried out by the China Social Science Survey Center of Peking University. It is high-quality microdata representing the households and individuals of middle-aged and older Chinese adults over the age of 45. CHARLS conducted surveys and interviews in 150 counties and 450 communities (villages) of 28 provinces (autonomous regions and municipalities) in 2011, 2013, 2015, and 2018, respectively. The CHARLS National Baseline Survey was launched in 2011 and followed for two years, with 23,000 respondents in 12,400 households. Data from 2015 and 2018 are used in this study. Seniors aged 60 and over were selected for the study. A total of 3,431 subjects were screened in 2015 and 3258 in 2018.

Ethical approval for data collection in CHARLS is obtained from the Biomedical Ethics Review Committee of Peking University. Peking University Public Data Management Agency agreed to our use of the data.

2.2. Depression

The Center for Epidemiological Studies Depression Scale (CES-D-10) was used to measure depressive symptoms in the CHARLS questionnaire. CES-D-10 was highly reliable and effective in successfully measuring depressive symptoms in middle-aged and older adults (25). Previous studies demonstrated that a score of 10 on the CES-D had reasonable levels of sensitivity (0.85) and specificity (0.80) in Chinese adults (26). The simplified scale consists of 10 questions with options as "rarely or none of the time (<1 day), some or few times (1–2 days), occasionally or a moderate

number of times (3–4 days), most of the time (5–7 days), the assignment value range was 0–3 points, total score was calculated. A higher score indicates greater symptoms of depression. A score of 10 and below was "no depressive symptoms" and assigned a value of 0; the score above 10 was "depressive symptoms" and assigned a value of 1 (24).

2.3. State of health

In CHARLS, self-rated health (SRH) was obtained by asking participants, "How do you feel about your health status?" SRH was transformed into two categories of variables, respectively, self-rated good health and self-rated poor health.

2.4. Physical function

The CHARLS questionnaire sets some physical function related questions, including: running or jogging 1 km, wandering 1 km, walking 100 meters, sitting in a chair for a long time and then standing up, ascending several floors continuously, bending over, bending knees or squat, stretch arms up along your shoulders, walk 100 meters to run or jog 1 km, pick up a tiny coin from the table, each answer for questions was divided into four responses as follows: (1) No difficulty; (2) Difficulty but still can be completed; (3) Difficulty and need help; (4) Unable to complete. If a subject reported difficulty with any of the 9 items, they were defined as having a physical dysfunction (24).

2.5. ADL

In CHARLS, the ADL scale was used to determine the disability of older adults. The ADL scale had good reliability and validity and was generally used in China and abroad (27). The ADL scale consists of 12 items: dressing, bathing, eating, getting into or out of bed, using the bathroom, controlling urination and defecation, doing household chores, cooking, shopping, making phone calls, taking medication, managing money. Each answer for questions was divided into 4 reactions as follows: (1) No, I do not have any difficulty; (2) I have difficulty but still can do it; (3) Yes, I have difficulty and need help; (4) I cannot do it (15). If a subject report having difficulty with any of the 12 items, then they were defined as having an ADL disability (24).

2.6. General demographic information

Covariates included gender, age, education level, marital status, address, smoking, drinking, physical exercise, and social activity. Gender included both males and females. Age was divided into 60–70, 71–80, 80 and above. Education levels were divided into primary school or below, middle school, high school or secondary school, and college or above. Marital status was classified as married or unmarried. Smoking, drinking, physical exercise, and social activity were divided into two groups: yes and no.

2.7. Statistical method

Excel 2019 was used to store and filter the data. IBM SPSS (version 22.0) was used for statistical analysis. Descriptive statistics were assigned to describe the demographic information of the participants. Continuous variables were presented as means and standard deviations. The categorical variables were presented as frequencies and percentages. The chi-squared test was used to compare categorical variables. Logistic regression was used when multiple variables were considered simultaneously. Multivariate logistic regression models were performed to compute the relationship between physical function, ADL, and depressive symptoms based on urban and rural stratification. Multivariate logistic regression analysis adjusted for sociodemographic confounding factors associated with depression in older adults. The statistical significance level was set at 0.05. Results were presented as odds ratios (ORs) and 95% confidence intervals (CIs).

3. Results

3.1. Study population

In 2015 and 2018, 3,431 and 3,258 older adults were included, respectively. The mean age of older adults was 66 [Standard Deviation (SD) = 7.041], and 63.1% of the participants were female, 27.7% resident in urban areas in 2015. The mean age of older adults was 68 [Standard Deviation (SD) = 6.563] years, and 68.4% of the participants were female, 31.2% resident in urban areas in 2018. The baseline characteristics were presented in Table 1.

3.2. Depressive symptoms in older adults

In 2015, 33.8% of older adults had depressive symptoms, which increased to 50.6% in 2018. In 2015, the proportion of older people with depressive symptoms in urban and rural areas was 27.5 and 36.2%, respectively, and will increase to 44.2 and 53.6% in 2018. Those who were unmarried, residence in rural, younger, lower education level, physical dysfunction, ADL disability, self-rated poor health was more likely to suffer from depressive symptoms in 2015 and in 2018 (Table 1).

3.3. Depressive symptoms in urban and rural

The prevalence of depressive symptoms in older adults was assessed in 2015 and 2018 respectively, and stratified by urban and rural areas at baseline. Based on 2015 data, physical dysfunction and ADL disability were all substantially related to depressive symptoms in rural older adults (Table 2). Based on data in 2018, physical dysfunction and ADL disability were all significantly related to depressive symptoms in urban and rural older adults (Table 3).

In 2015, the older adults with depressive symptoms had higher ADL disability (51.5%) than those without depressive symptoms (40.9%) in urban areas (Table 2). In 2018, the proportion of ADL

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TABLE 1 Demographic characteristics and depressive symptoms in elderly [*N* (%)].

Variables	Total	2015 ($n = 3,431$)			Total	2018 ($n = 3,258$)		
		No depressive symptoms ($n = 2,271$)	Depressive symptoms ($n = 1,160$)	*P*		No depressive symptom ($n = 1,608$)	Depressive symptoms ($n = 1,650$)	*P*
Residence								
Urban	945 (27.7)	685 (30.2)	260 (22.4)	<0.001	1,016 (31.2)	567 (35.3)	449 (27.2)	<0.001
Rural	2,486 (72.5)	1,586 (69.8)	900 (77.6)		2,242 (68.8)	1,041 (64.7)	1,201 (72.8)	
Gender								
Female	2,166 (63.1)	1,308 (57.6)	858 (74.0)	<0.001	2,230 (68.4)	929 (59.6)	1,271 (77.0)	<0.001
Male	1,265 (36.9)	963 (42.4)	302 (26.0)		1,028 (31.6)	649 (40.4)	379 (23.0)	
Age (year)								
60–70	2,249 (65.5)	1,450 (63.8)	799 (68.9)	0.001	1,817 (55.8)	884 (55.0)	933 (56.5)	0.440
71–80	923 (26.9)	624 (27.5)	299 (25.8)		1,162 (35.7)	577 (35.9)	585 (35.5)	
>80	259 (7.5)	197 (8.7)	62 (5.3)		279 (8.6)	147 (9.1)	132 (8.0)	
Education level								
Primary school or below	3,077 (89.7)	2,034 (89.6)	1,043 (89.9)	0.315	2,541 (78.0)	1,180 (73.4)	1,361 (82.5)	<0.001
Middle school	253 (7.4)	163 (7.2)	90 (7.8)		420 (12.9)	250 (15.5)	170 (10.3)	
High school	79 (2.3)	56 (2.5)	23 (2.0)		231 (7.1)	134 (8.3)	97 (5.9)	
College or above	22 (0.6)	18 (0.8)	4 (0.3)		66 (2.0)	44 (2.7)	22 (1.3)	
Marital status								
Unmarried	795 (23.2)	491 (21.6)	304 (26.2)	<0.001	776 (23.8)	332 (20.6)	444 (26.9)	<0.001
Married	2,636 (76.8)	1,780 (78.4)	856 (73.8)		2,482 (76.2)	1,276 (79.4)	1,206 (73.1)	
Smoking								
No	2,485 (72.4)	1,554 (68.4)	931 (80.3)	<0.001	2,949 (90.5)	1,450 (90.2)	1,499 (90.8)	0.511
Yes	946 (27.6)	717 (31.6)	229 (19.7)		309 (9.5)	158 (9.8)	151 (9.2)	
Drinking								
No	2,468 (71.9)	1,578 (69.5)	890 (76.7)	<0.001	2,522 (77.4)	1,203 (74.8)	1,319 (79.9)	<0.001
Yes	963 (28.1)	693 (30.5)	270 (23.3)		736 (22.6)	405 (25.2)	331 (20.1)	
Physical exercise								
No	360 (10.5)	226 (10.0)	134 (11.6)	0.148	272 (8.3)	112 (7.0)	160 (9.7)	0.005
Yes	3,071 (89.5)	2,045 (90.0)	1,026 (88.4)		2,986 (91.7)	1,496 (93.0)	1,490 (90.3)	
Social activity								
No	1,841 (53.7)	1,204 (53.0)	637 (54.9)	0.292	1,646 (50.5)	815 (50.7)	831 (50.4)	0.855
Yes	1,590 (46.3)	1,067 (47.0)	523 (45.1)		1,612 (49.5)	793 (49.3)	819 (49.6)	
Physical function								
Normal	526 (15.0)	381 (16.8)	135 (11.6)	<0.001	1,016 (31.2)	646 (40.2)	370 (22.4)	<0.001
Dysfunction	2,915 (85.0)	1,890 (83.2)	1,025 (88.4)		2,242 (68.8)	962 (59.8)	1,280 (77.6)	
ADL								
Normal	1,563 (45.6)	1,157 (50.9)	406 (35.0)	<0.001	1,607 (49.3)	891 (55.4)	716 (43.4)	<0.001
Disability	1,868 (54.4)	1,114 (49.1)	754 (65.0)		16,51 (50.7)	717 (44.6)	934 (56.6)	
Self-rated health								
Poor	1,956 (57.0)	1,172 (51.6)	784 (67.6)	<0.001	2,677 (82.2)	1,220 (75.9)	1,457 (88.3)	<0.001
Good	1,726 (45.4)	1,099 (48.4)	376 (32.4)		581 (17.8)	388 (24.1)	193 (11.7)	

TABLE 2 Depressive symptoms based on urban and rural stratification of physical function and ADL in 2015 [N (%)].

Variables	Urban ($n = 945$)			Rural ($n = 2,486$)		
	No depressive symptoms	Depressive symptoms	*P*	No depressive symptoms	Depressive symptoms	*P*
Total	685 (72.5)	260 (27.5)		1,586 (63.8)	900 (36.2)	
Physical function			0.978			<0.001
Normal	127 (18.5)	48 (18.5)		254 (16.0)	87 (9.7)	
Dysfunction	558 (81.5)	212 (81.5)		1,332 (84.0)	813 (90.3)	
ADL			0.003			<0.001
Normal	405 (59.1)	126 (48.2)		752 (47.4)	280 (31.1)	
Disability	280 (40.9)	134 (51.5)		834 (52.6)	620 (68.9)	

TABLE 3 Depressive symptoms based on urban and rural stratification of physical function and ADL in 2018 [N (%)].

Variables	Urban ($n = 1,016$)			Rural ($n = 2,242$)		
	No depressive symptoms	Depressive symptoms	*P*	No depressive symptoms	Depressive symptoms	*P*
Total	567 (55.8)	449 (44.2)		1,041 (46.4)	1,201 (53.6)	
Physical function			0.002			<0.001
Normal	226 (39.9)	137 (30.5)		420 (40.3)	233 (19.4)	
Dysfunction	341 (60.1)	312 (69.5)		621 (59.7)	968 (80.6)	
ADL			<0.001			<0.001
Normal	364 (64.2)	219 (48.8)		527 (50.6)	497 (41.4)	
Disability	203 (35.8)	230 (51.2)		514 (49.4)	704 (58.6)	

disability with depressive symptoms (51.2) was higher than for older adults without depressive symptoms (35.8%) (Table 3). The percentage of older adults with physical dysfunction who were depressed was 69.5% in 2018 compared to 81.5% in 2015.

In rural areas, older adults who had trouble taking care of themselves were more likely to be depressed. In 2015, 90.3% of rural older adults with physical dysfunction had elevated depressive symptoms, and in 2018, 80.6% had elevated depressive symptoms. The percentage of depressed older adults with ADL disability was 68.9% in 2015 compared to 58.6% in 2018. In both 2015 and 2018, older adults with ADL disability had higher rates of depressive symptoms than those without depressive symptoms (Tables 2, 3).

3.4. Association between physical function, ADL, and depressive symptoms

Table 4 depicts the relationship between physical function and ADL and depressive symptoms in urban and rural older adults in 2015. Table 5 describes the relationship between physical function and ADL and depressive symptoms in 2018 urban and rural populations of older adults. In 2015 and 2018, we found that ADL disability was significantly associated with depressive symptoms among older adults in both urban and rural areas.

In urban areas, ADL disability was associated with a higher risk of depressive symptoms in 2015 (OR = 1.50) and in 2018 (OR = 1.79). In rural areas, ADL disability (OR = 1.69) and physical dysfunction (OR = 1.51) were associated with a higher risk of depressive symptoms in 2015. Similarly, in 2018, ADL disability (OR = 1.34) and physical dysfunction (OR = 1.61) were significant (Tables 4, 5).

In summary, both ADL disability and physical dysfunction were more likely to be associated with depressive symptoms in rural older adults.

4. Discussion

Based on data from the China Longitudinal Survey of Health and Retirement (CHARLS) in 2015 and 2018, we compared the characteristic differences among populations of depressive symptoms in older adults. In addition, multivariate logistic regression models were designed to identify urban-rural differences in physical function, ADL, and depressive symptoms in the Chinese adults, and to adjust for confounding factors. Key findings of the present study were (1) the prevalence of depressive symptoms among older adults in China was higher in 2015 than in 2018, and (2) residence, gender, marital status, drinking, physical function, ADL, and self-rated health were linked to depressive symptoms, and (3) among rural older adults with ADL disability and physical dysfunction, the likelihood of depressive symptoms was higher.

In the current report, the prevalence of depressive symptoms among older adults in China varied from 33.8% in 2015 to 50.6% in 2018, indicating a high level of depressive symptoms. The results

TABLE 4 OR with 95% CI of depressive symptoms according to the physical function and ADL stratified by urban and rural in 2015.

Variables		Urban		Rural	
		Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)[a]
Physical function	Normal	Ref		Ref	
	Dysfunction	0.93 (0.64–1.35)	0.95 (0.65–1.39)	1.48 (1.14–1.93)**	1.51 (1.15–1.98)**
ADL	Normal	Ref		Ref	
	Disability	1.55 (1.16–2.07)**	1.50 (1.11–2.03)**	1.89 (1.59–2.26)***	1.69 (1.40–2.03)***

[a] Adjusted for gender, age, marital status, smoking, drinking, and self-rated health.
*P < 0.05, **P < 0.01, and ***P < 0.001.

TABLE 5 OR with 95% CI of depressive symptoms according to the physical function and ADL stratified by urban and rural in 2018.

Variables		Urban		Rural	
		Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)[a]
Physical function	Normal	Ref		Ref	
	Dysfunction	1.52 (1.17–1.98)	1.22 (0.78–1.89)	2.75 (2.28–3.33)***	1.61 (1.20–2.17)**
ADL	Normal	Ref		Ref	
	Disability	1.89 (1.47–2.44)***	1.79 (1.38–2.32)***	1.38(1.16–1.98)***	1.34 (1.13–1.60)**

[a] Adjusted for gender, education level, marital status, drinking, physical exercise, and self-rated health.
*P < 0.05, **P < 0.01, and ***P < 0.001.

were like previous research, depressive symptoms burden had been and would be progressively enhancing in China (7, 27). One study demonstrated that depressive symptoms were over 41% among older adults in China (28). A study in Bangladesh surveyed 168 healthy retired residents aged 60-80 years and found a 36.9% rate of depressive symptoms in older adults (29). While in a cross-sectional study abroad, the rate of depressive symptoms was 66.9% in 229 older adults in Hanoi, Vietnam (30).

Depressive symptoms were higher among rural older adults in our survey than among urban older adults. With rapid social and economic development, the gap between urban and rural areas has become more pronounced. Young and middle-aged workers work in municipalities, while older people and children live in rural areas. More attention should be paid to the mental health of older adults (31). A previous study identified that older adults who live alone in rural areas have a higher risk of depressive symptoms (31). "Empty nesters" tendency might be to account for the increased prevalence of depressive symptoms among older adults in rural China (32). The value of family was very important to the Chinese adults. Children of older adults in rural areas went out to work and were separated from their parents, reducing contact with the elderly, and increasing loneliness (33). At the same time, the responsibility for caring for infants among older adults in rural areas has expanded. As a result, older adults in rural China need additional social assistance. The health of older adults was considerably affected by the social environment. Urban older adults had higher quality medical resources and financial assistance than rural older adults (34). Older adults in urban areas can enjoy social activities and find spiritual comfort in their spare time. These findings denote that the government and society should pay more attention to the psychological problems of older adults in rural areas, allocate resources more effectively, expand public service provision, and reduce the gap between urban and rural areas (35).

In addition, the results demonstrated that residence, gender, marital status, drinking, physical function, ADL, and self-rated health were linked to depressive symptoms. Females were more likely to experience depressive symptoms. According to a Chinese study on the relationship between fat and depressive symptoms, 19.9% of males and 33.2% of females had depressive symptoms. Females were more likely to be depressed as a result of hormonal variations (36). According to a longitudinal study of aging in Ireland, females had a greater fear of tumbling and activity restrictions. This fear could affect the psychology of older adults. Our findings agreed with previous studies. In our study, older adults who were married had lower rates of depressive symptoms. Previous research on older adults has revealed that marital status was a strong predictor of depressive symptoms, with unmarried older adults being more likely to be depressed (6, 37). Single or split older adults had higher levels of depressive symptoms (37). Older adults could be psychologically affected by these events. Alcohol use and self-rated health were shown to be strongly linked with depressive symptoms in older adults in a poll of community-dwelling older adults (38). According to the survey results, self-rated health was highly correlated with depressive symptoms in older adults, which was consistent with earlier studies. A prospective study conducted in Spanish uncovered that moderate alcohol use protects older adults from developing depressive symptoms (39). Furthermore, Dao A et al. indicated that elderly people who drank alcohol had 3.4 times fewer depressive symptoms than no-drinkers (30). The second most important factor in determining depressive symptoms was self-rated health. Evidence was mounting that the older adults who self-rate their health as poor had higher levels of depressive symptoms (6). In the 2015 findings, older adults aged 60-70 and non-smokers were more likely to be depressed. While not significant in the 2018 study results. The two-year sample size varied, as did the study's findings. Further

investigation was needed in the future to reveal the relationship between smoking and age and depressive symptoms.

Ultimately, this study focused on the relationship between physical function, ADL, and depressive symptoms in older Chinese adults in urban and rural areas. Physical function declines with age and numerous daily activities are difficult to perform independently. Physical decline was a key challenge to self-care ability of older adults (40). Limitations in daily activities and physical function cause older adults to lose their independence, leading to depressive symptoms and grief. These conditions could lead to psychosocial and financial difficulties. Substantial evidence suggested that ADL disability were at a higher risk of depressive symptoms (6), physical dysfunction associated with depressive symptoms in Chinese adults aged 55 and older (41). Older adults with elevated levels of functional restriction might have depressive symptoms (40), ADL disability might promote the development of depressive symptoms (22). This study demonstrates previous research by analyzing the association between physical function, ADL, and depressive symptoms. Depressed older adults were more likely to have physical dysfunction and ADL disability. Other studies have identified a strong association between ADL disability and physical dysfunction and risk of depressive symptoms in rural older adults. Therefore, the Chinese government and society must pay attention to the physical health of the elderly, especially those in rural areas. The government and society should give additional help to older adults with ADL disability and physical dysfunction. For individuals, sedentary lifestyle led to a decline in the capacity to conduct ADL (42). Older adults would require frequent physical activity to enhance their functional capacity and mental health (43).

Several limitations of the present study should be mentioned. First, the cross-sectional study was unable to draw causal inferences. Second, the CES-D-10 might exhibit recall bias and could only be used to screen for depressive symptoms, not to diagnose depressive symptoms (22). Third, the older adults included in this paper were screened from a database containing 23,000 respondents and may differ from the original data. Finally, self-aggregated data might overestimate the association between variables and depressive symptoms.

5. Conclusion

In summary, this study provides evidence of an association between physical function, ADL, and depressive symptoms in older Chinese adults. It showed that rural, female, 60–70 years old, primary school or below, married, non-smoking, non-drinking, physical dysfunction, ADL disability and self-rated poor health make-up a higher proportion of depressed older adults. Multivariate logistic regression models suggest that ADL disability and physical dysfunction were more likely to be associated with depressive symptoms in rural Chinese older adults. Older adults should be encouraged to participate in moderate physical and social activities to prevent physical dysfunction. The government and society should pay attention to the mental health of older adults in rural areas.

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.

Author contributions

YY and YD: design of the study and interpretation of data. XL: data processing. WP: data processing, article design, and revision. YC: article modification. 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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References

1. Li N, Pang L, Chen G, Song X, Zhang J, Zheng X. Risk factors for depression in older adults in Beijing. *Can J Psychiatry.* (2011) 56:466–73. doi: 10.1177/070674371105600804

2. Schaakxs R, Comijs HC, Lamers F, Kok RM, Beekman ATF, Penninx BWJH. Associations between age and the course of major depressive disorder: a 2-year longitudinal cohort study.

Lancet Psychiatry. (2018) 5:581–90. doi: 10.1016/S2215-0366(18)30166-4

3. Kaneko Y, Motohashi Y, Sasaki H, Yamaji M. Prevalence of depressive symptoms and related risk factors for depressive symptoms among elderly persons living in a rural Japanese community: a cross-sectional study. *Community Ment Health J.* (2007) 43:583–90. doi: 10.1007/s10597-007-9096-5

4. Tengku Mohd TAM, Yunus RM, Hairi F, Hairi NN, Choo WY. Social support and depression among community dwelling older adults in Asia: a systematic review. *BMJ Open.* (2019) 9:e026667. doi: 10.1136/bmjopen-2018-026667

5. Campos AC, Albala C, Lera L, Sánchez H, Vargas AM. Ferreira e Ferreira E. Gender differences in predictors of self-rated health among older adults in Brazil and Chile. *BMC Public Health.* (2015) 15:365. doi: 10.1186/s12889-015-1666-9

6. Fan X, Guo X, Ren Z, Li X, He M, Shi H, et al. The prevalence of depressive symptoms and associated factors in middle-aged and elderly Chinese people. *J Affect Disord.* (2021) 293:222–8. doi: 10.1016/j.jad.2021.06.044

7. Charlson FJ, Baxter AJ, Cheng HG, Shidhaye R, Whiteford HA. The burden of mental, neurological, and substance use disorders in China and India: a systematic analysis of community representative epidemiological studies. *Lancet.* (2016) 388:376–89. doi: 10.1016/S0140-6736(16)30590-6

8. Djernes JK. Prevalence and predictors of depression in populations of elderly: a review. *Acta Psychiatr Scand.* (2006) 113:372–87. doi: 10.1111/j.1600-0447.2006.00770.x

9. Kvæl LAH, Bergland A, Telenius EW. Associations between physical function and depression in nursing home residents with mild and moderate dementia: a cross-sectional study. *BMJ Open.* (2017) 7:e016875. doi: 10.1136/bmjopen-2017-016875

10. Turvey CL, Schultz SK, Beglinger L, Klein DM, A. longitudinal community-based study of chronic illness, cognitive and physical function, and depression. *Am J Geriatr Psychiatry.* (2009) 17:632–41. doi: 10.1097/JGP.0b013e31819c498c

11. Friedman MM, Griffin JA. Relationship of physical symptoms and physical functioning to depression in patients with heart failure. *Heart Lung.* (2001) 30:98–104. doi: 10.1067/mhl.2001.114180

12. Stegenga BT, Nazareth I, Torres-González F, Xavier M, Svab I, Geerlings MI, et al. Depression, anxiety and physical function: exploring the strength of causality. *J Epidemiol Community Health.* (2012) 66:e25. doi: 10.1136/jech.2010.128371

13. Zhao D, Hu C, Chen J, Dong B, Ren Q, Yu D, et al. Risk factors of geriatric depression in rural China based on a generalized estimating equation. *Int Psychogeriatr.* (2018) 30:1489–97. doi: 10.1017/S1041610218000030

14. Bowen ME, Ruch A. Depressive symptoms and disability risk among older white and latino adults by nativity status. *J Aging Health.* (2015) 27:1286–305. doi: 10.1177/0898264315580121

15. Yaka E, Keskinoglu P, Ucku R, Yener GG, Tunca Z. Prevalence and risk factors of depression among community dwelling elderly. *Arch Gerontol Geriatr.* (2014) 59:150–4. doi: 10.1016/j.archger.2014.03.014

16. Bozo O, Toksabay NE, Kürüm O. Activities of daily living, depression, and social support among elderly Turkish people. *J Psychol.* (2009) 143:193–205. doi: 10.3200/JRLP.143.2.193-206

17. Byeon H. Development of a depression in Parkinson's disease prediction model using machine learning. *World J Psychiatry.* (2020) 10:234–44. doi: 10.5498/wjp.v10.i10.234

18. Bock JO, Brettschneider C, Weyerer S, Werle J, Wagner M, Maier W, et al. Excess health care costs of late-life depression–results of the AgeMooDe study. *J Affect Disord.* (2016) 199:139–47. doi: 10.1016/j.jad.2016.04.008

19. Kong D, Solomon P, Dong X. Depressive symptoms and onset of functional disability over 2 years: a prospective cohort study. *J Am Geriatr Soc.* (2019) 67:S538–S544. doi: 10.1111/jgs.15801

20. Ni Y, Tein JY, Zhang M, Yang Y, Wu G. Changes in depression among older adults in China: A latent transition analysis. *J Affect Disord.* (2017) 209:3–9. doi: 10.1016/j.jad.2016.11.004

21. Jiang J, Tang Z, Futatsuka M. The impact of ADL disability on depression symptoms in a community of Beijing elderly, China. *Environ Health Prev Med.* (2002) 7:199–204. doi: 10.1007/BF02898005

22. He M, Ma J, Ren Z, Zhou G, Gong P, Liu M. et al. Association between activities of daily living disability and depression symptoms of middle-aged and older Chinese adults and their spouses: a community based study. *J Affect Disord.* (2019) 242:135–42. doi: 10.1016/j.jad.2018.08.060

23. Wang C, Yang LS, Shi XH, Yang YF, Liu K, Liu RY. Depressive symptoms in aged Chinese patients with silicosis. *Aging Ment Health.* (2008) 12:343–8. doi: 10.1080/13607860802120938

24. Mengqi L. *Influencing Factors and Policy Suggestions of Mental Health of Chinese Elderly–Based on the 2015 China Health and Retirement Longitudinal Study*. Hangzhou, China: Zhejiang University. (2018)

25. Chen H, Mui AC. Factorial validity of the center for epidemiologic studies depression scale short form in older population in China. *Int Psychogeriatr.* (2014) 26:49–57. doi: 10.1017/S1041610213001701

26. Boey KW. Cross-validation of a short form of the CES-D in Chinese elderly. *Int J Geriatr Psychiatry.* (1999) 14:608–17.

27. Yang G, Wang Y, Zeng Y, Gao GF, Liang X, Zhou M, et al. Rapid health transition in China, 1990-2010: findings from the Global Burden of Disease Study 2010. *Lancet.* (2013) 381:1987–2015. doi: 10.1016/S0140-6736(13)61097-1

28. Xie T, Liu D, Guo J, Zhang B. The longitudinal effect of sensory loss on depression among Chinese older adults. *J Affect Disord.* (2021) 283:216–22. doi: 10.1016/j.jad.2021.01.081

29. Disu TR, Anne NJ. Griffiths MD, Mamun MA. Risk factors of geriatric depression among elderly Bangladeshi people: a pilot interview study. *Asian J Psychiatr.* (2019) 44:163–9. doi: 10.1016/j.ajp.2019.07.050

30. Dao ATM, Nguyen VT, Nguyen HV, Nguyen LTK. Factors associated with depression among the elderly living in urban Vietnam. *Biomed Res Int.* (2018) 2018:2370284. doi: 10.1155/2018/2370284

31. Gong F, Zhao D, Zhao Y, Lu S, Qian Z, Sun Y. The factors associated with geriatric depression in rural China: stratified by household structure. *Psychol Health Med.* (2018) 23:593–603. doi: 10.1080/13548506.2017.1400671

32. Purtle J, Nelson KL, Yang Y, Langellier B, Stankov I, Diez Roux AV. Urban-rural differences in older adult depression: a systematic review and meta-analysis of comparative studies. *Am J Prev Med.* (2019) 56:603–13. doi: 10.1016/j.amepre.2018.11.008

33. Huang LJ MM. RN, Du WT MM, RN, Liu YC MM, RN, et al. Loneliness, stress, and depressive symptoms among the chinese rural empty nest elderly: a moderated mediation analysis. *Issues Ment Health Nurs.* (2019) 40:73–8. doi: 10.1080/01612840.2018.1437856

34. Selvaratnam DP, Tin PB. Lifestyle of the elderly in rural and urban Malaysia. *Ann N Y Acad Sci.* (2007) 1114:317–25. doi: 10.1196/annals.1396.025

35. Liu D, Xi J, Hall BJ, Fu M, Zhang B, Guo J, et al. Attitudes toward aging, social support and depression among older adults: difference by urban and rural areas in China. *J Affect Disord.* (2020) 274:85–92. doi: 10.1016/j.jad.2020.05.052

36. Qian J, Li N, Ren X. Obesity and depressive symptoms among Chinese people aged 45 and over. *Sci Rep.* (2017) 7:45637. doi: 10.1038/srep45637

37. Fatima M, Sehar A, Ali M, Iqbal A, Shaukat F. Incidence of depression among community dwelling healthy elderly and the predisposing socio-environmental factors. *Cureus.* (2019) 11:e4292. doi: 10.7759/cureus.4292

38. Han KM, Han C, Shin C, Jee HJ, An H, Yoon HK, et al. Social capital, socioeconomic status, and depression in community-living elderly. *J Psychiatr Res.* (2018) 98:133–40. doi: 10.1016/j.jpsychires.2018.01.002

39. García-Esquinas E, Ortolá R, Galán I, Soler-Vila H, Laclaustra M, Rodríguez-Artalejo F. Moderate alcohol drinking is not associated with risk of depression in older adults. *Sci Rep.* (2018) 8:11512. doi: 10.1038/s41598-018-29985-4

40. Muramatsu N, Yin H, Hedeker D. Functional declines, social support, and mental health in the elderly: does living in a state supportive of home and community-based services make a difference? *Soc Sci Med.* (2010) 70:1050–8. doi: 10.1016/j.socscimed.2009.12.005

41. Deng Y, Paul DR. The relationships between depressive symptoms, functional health status, physical activity, and the availability of recreational facilities: a rural-urban comparison in middle-aged and older Chinese adults. *Int J Behav Med.* (2018) 25:322–30. doi: 10.1007/s12529-018-9714-3

42. Penha JC, Piçarro Ida C, de Barros Neto TL. Evolução da aptidão física e capacidade funcional de mulheres ativas acima de 50 anos de idade de acordo com a idade cronológica, na cidade de Santos. *Cien Saude Colet.* (2012) 17:245–53. doi: 10.1590/S1413-81232012000100027

43. Zaleski AL, Taylor BA, Panza GA, Wu Y, Pescatello LS, Thompson PD. et al. Coming of age: considerations in the prescription of exercise for older adults. *Methodist Debakey Cardiovasc J.* (2016) 12:98–104. doi: 10.14797/mdcj-12-2-98

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Prevalence and factors of discordance attitudes toward advance care planning between older patients and their family members in the primary medical and healthcare institution

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Background: This study aimed at investigating the prevalence and factors of the discordant attitudes toward advance care planning (ACP) among older patients and their family members toward patients' engagement in ACP in the primary medical and healthcare institution.

Methods: In a cross-sectional study, a total of 117 older patients and 117 family members from Jinhua Fifth Hospital in China were enrolled. The questionnaire included sociodemographic characteristics, functional capacity assessment, and attitudes toward patients' engagement in ACP. Functional capacity assessment scales included the Modified Barthel Index (MBI), the Short-Form Mini-Nutritional Assessment (MNA-SF), the 15-item Geriatric Depression Scale (GDS-15), the Mini-Mental State Examination (MMSE), the Clinical Frailty Scale (CFS), and the SARC-F questionnaire.

Results: The discordance attitudes toward patients' engagement in ACP between patients and family members accounted for 41(35.0%). In the multivariate logistic analysis, factors associated with higher odds of discordance attitudes toward patients' engagement in ACP included greater age differences between patients and family members ($OR = 1.043$, 95% CI: 1.007–1.081), lower educational level for family members ($OR = 3.373$, 95% CI: 1.239–9.181), the patient's higher GDS-15 score ($OR = 1.437$, 95% CI: 1.185–1.742), and patient's higher MNA-SF score ($OR = 1.754$, 95% CI: 1.316–2.338).

Conclusion: Older patients and their family members had little ACP knowledge, and factors that influence discordance attitudes toward patients' engagement in ACP included the age gaps between patients and family members, family members' educational level, patients' depressive symptoms, and patients' nutritional status.

KEYWORDS

advance care planning, attitudes, older adults, geriatric assessment, advance directives

1. Introduction

The acceleration of population aging in China has brought more challenges to elderly care services, medical and social resources. And end-of-life care issues such as living wills and place of death have become a problem that cannot be ignored. In order to promote death with dignity, it is an urgent task to build a healthy China under the current aging situation. Therefore, the Healthy China 2030 Plan and other far-reaching reforms released by the Chinese Government have pointed out the necessity of palliative care and hospice care including the implementation of advance care planning (ACP). ACP refers to a process wherein individuals with clearly aware decision-making capacity reflect upon personal life experience and values to make their future care goals and treatment preferences in advance (1, 2). As an important concept of ACP, advance directives (ADs) are usually in a legal formal written document that nominates a substitute decision proxy and/or determined life-sustaining treatment through a living will (3). The implementation of ACP is associated with realizing medical autonomy (3), relieving stress, anxiety, and depression in family members (4), reducing over-utilization of aggressive measures during the end of life (5–7), cutting down Medicare costs (8), and decreasing in-hospital mortality (9, 10).

Research on ACP for older adults in China is still in the early stage, and only one city on the mainland currently has such relevant local legal regulations. Of cognitively normal Chinese older adults from 140 nursing homes in Hong Kong, 88% of older residents preferred having ADs regarding their future medical treatments (11). A multicenter cross-sectional study from 25 hospitals throughout mainland China included 91.1% of older patients aged over 60 years, and the results reported that 38.3% of patients had heard about ACP, and 50.6% were willing to carry out ACP when being informed about relevant knowledge of ACP (12). The study clarified attitudes and preferences toward ACP in a relatively Chinese large sample mostly in tertiary hospitals but did not involve the elderly population in the primary medical and health care institution and the influence of functional status on ACP attitudes. Prior research has compared attitudes toward ACP between patients and family members, which has focused on specific diseases such as cancer and heart failure (13, 14). Different from the other specialized wards with a certain specific disease, older patients in the geriatric wards in the primary medical and health care institution, may have advanced age, complex multimorbidity, multiple functional loss, and a higher proportion at the final stage of the disease. It may be more common to hide the true condition of the patients and make medical decisions on behalf of their family members. Prior studies have suggested that despite their family members understanding the patient's wishes regarding end-of-life care, frequent disagreement between them about treatment preferences and goals of care often arises (15). However, medical decisions that are in concordance with seriously ill patients' values and goals are regarded as high-quality care (16, 17). Discordance with the patient's values, goals, and medical treatments has been shown to increase medical costs and prolong end-of-life difficulties (17–19). Additionally, other factors including health status, family support, physical functioning, and experiences of family or relatives rescuing may affect their perceptions of ACP and end-of-life care.

Thus, this study aimed at investigating the attitudes and preferences of older patients and their family members toward patients' engagement in ACP in a primary medical and healthcare institution. Moreover, this study integrated factors such as the functional capacity to explore the associated factors on discordance attitudes toward ACP between patients and their family members.

2. Methods

2.1. Study design and setting

A cross-sectional study was carried out in the Department of Geriatrics in Jinhua Fifth Hospital between October 2020 and August 2021. Jinhua Fifth Hospital, the first filed public hospital for old-age care in Jinhua City, Zhejiang Province, mainly serves the elderly with disability and multiple comorbidities. The medical and old-age care integration model in the primary medical and health care institution refers to integrating medical care, rehabilitation, nursing, and life care, and is an effective means to improve the quality of old-age care.

2.2. Participants

One hundred seventeen patients and 117 family members from Jinhua Fifth Hospital were enrolled by convenience sampling. Patients' inclusion criteria: (a) Age $\geq$ 60 years; (b) Patients with clear consciousness who have no communication barriers; (c) Patients who can sign informed consent voluntarily and cooperate in completing the investigation. Patients' exclusion criteria: unable to cooperate to complete the ACP questionnaire because of consciousness disorder, severe cognitive impairment, and other critical conditions. Family members' inclusion criteria: family members of hospitalized patients who voluntarily participated and were able to cooperate in completing the study.

This study was approved by the Medical Ethics Committee of Jinhua Fifth Hospital (number: 2021-04), and written informed consent was obtained from the patients and their family members prior to the data collection.

2.3. Measurements

Both patients and family members completed the questionnaires about sociodemographic and ACP attitudes, and functional capacity assessment by comprehensive geriatric assessment (CGA) was only investigated by the patients. Patients and family members separately expressed their own perspectives on ACP through face-to-face interviews.

Sociodemographic data including age, sex, marital status (categorized by married, divorced, widow, or single), educational level (classified as high school or below), medical insurance, religion, the relationship between patients and caregivers, self-reported family support (coded as poor, fair, and good), self-reported health status (coded as poor, fair, and good), concurrent diseases (including coronary artery disease, hypertension,

TABLE 1 Characteristics of older patients and their family members.

Variables	Patients ($n = 117$)	Family members ($n = 117$)	Z or X^2	P-value
Age, median (IQR), scores[#]	80.0 (69.5, 87.0)	60.0 (52.0, 65.0)	−10.032	<0.001
Male, *n* (%)	66 (56.4)	52 (44.4)	3.351	0.067
Married, *n* (%)	87 (74.4)	110 (94.0)	16.983	<0.001
High school or above, *n* (%)	30 (25.6)	70 (59.8)	27.940	<0.001
Self-reported health status, *n* (%)			86.576	<0.001
Poor/fair	98 (83.8)	27 (23.1)		
Good	19 (16.2)	90 (76.9)		
Comorbidities, *n* (%)				
Coronary artery disease	30 (25.6)	3 (2.6)	25.718	<0.001
Hypertension	57 (48.7)	7 (6.0)	53.768	<0.001
Diabetes	26 (22.2)	1 (0.9)	26.167	<0.001
Cerebrovascular disease	15 (12.8)	0 (0)	16.027	<0.001
Respiratory disease	26 (22.2)	1 (0.9)	26.167	<0.001
Osteoarticular diseases	18 (15.4)	1 (0.9)	16.555	<0.001
Caregiver relationship, *n* (%)				
Spouses	NA	29 (24.8)		
Children	NA	81 (69.2)		
Sibling/relatives	NA	7 (6.0)		
Self-reported family support, *n* (%)				
Poor/fair	41 (35.0)	NA		
Good	76 (65.0)	NA		
MMSE, median (IQR), scores[#]	19.0 (15.0, 25.0)	NA		
GDS-15, median (IQR), scores[#]	7.0 (5.0, 8.0)	NA		
MBI, median (IQR), scores[#]	90.0 (75.0, 97.5)	NA		
MNA-SF, median (IQR), scores[#]	12.0 (9.0, 12.0)	NA		
CFS, median (IQR), scores[#]	5.0 (3.0, 6.0)	NA		
SARC-F, median (IQR), scores[#]	3.0 (0, 4.0)	NA		

IQR, interquartile range; MMSE, the Mini-Mental State Examination; GDS-15, the 15 item Geriatric Depression Scale; MBI, the Modified Barthel Index; MNA-SF, the Short-Form Mini-Nutritional Assessment; CFS, the Clinical Frailty Scale.
[#]The Mann-Whitney U tests.

diabetes, cerebrovascular disease, respiratory disease, and osteoarticular diseases), and prescription medications were recorded.

The functional capacity assessment was conducted by CGA based on the Chinese expert consensus recommendation (20). In this study, the activity of daily living was assessed by the Modified Barthel Index (MBI), and the higher the MBI score indicated the better the activity of daily living (21). The Short-Form Mini-Nutritional Assessment (MNA-SF) was used to ascertain the degree of malnutrition risk (22). Depressive symptoms were evaluated using the 15-item Geriatric Depression Scale (GDS-15), with higher scores indicating more depressive symptoms (23). Cognitive function was assessed using the Mini-Mental State Examination (MMSE) (24). Higher MMSE score indicated better cognitive function. Frailty was detected by the Clinical Frailty Scale (CFS) which was scored from 1 (very fit) to 9 (severely frail) (25). Based on the clinical judgment, a higher CFS score was considered a higher degree of frailty. The SARC-F questionnaire was used to screen sarcopenia, with higher values indicating a greater likelihood of sarcopenia (26).

A structured questionnaire about ACP attitudes was completed independently by patients and their family members. The questionnaire included prior experience with relatives and friends being rescued (coded as yes or no), attitudes toward death (categorized by fear, avoid discussing, and accept discussing),

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TABLE 2 Comparison of attitudes of older patients and their family members toward ACP and end-of-life treatments for the patients.

Variables	Patients ($n = 117$)	Family members ($n = 117$)	X^2	P-value
Surrogate, *n* (%)		NA		
Self	10 (8.5)			
Spouses	8 (6.8)			
Children	98 (83.8)			
Sibling/relatives	1 (0.9)			
Prior experience relatives and friends being rescued, *n* (%)	63 (53.8)	57 (48.7)	0.616	0.433
Attitude toward death, *n* (%)			7.672	0.022
Fear	14 (12.0)	6 (5.1)		
Avoid discussing	24 (20.5)	14 (12.0)		
Accept discussing	79 (67.5)	97 (82.9)		
Value statement about end-of-life care, *n* (%)			55.658	<0.001
Active treatment	31 (26.5)	88 (75.2)		
Relieve uncomfortable symptoms	67 (57.3)	23 (19.7)		
Maintenance daily function and quality of life	8 (6.8)	3 (2.6)		
Unknown	11 (9.4)	3 (2.6)		
Preferences for end-of-life treatments				
Cardiopulmonary resuscitation, *n* (%)			25.435	<0.001
Yes	53 (45.3)	88 (75.2)		
No	21 (17.9)	16 (13.7)		
Unknown	43 (36.8)	13 (11.1)		
Invasive mechanical ventilation support, *n* (%)			19.549	<0.001
Yes	27 (23.1)	36 (30.8)		
No	47 (40.2)	67 (57.3)		
Unknown	43 (36.8)	14 (12.0)		
Non-invasive ventilation support, *n* (%)			26.684	<0.001
Yes	52 (44.4)	89 (76.1)		
No	23 (19.7)	15 (12.8)		
Unknown	42 (35.9)	13 (11.1)		
Renal replacement therapy, *n* (%)			27.492	<0.001
Yes	42 (35.9)	78 (66.7)		
No	32 (27.4)	26 (22.2)		
Unknown	43 (36.8)	13 (11.1)		
Gastrointestinal colostomy, *n* (%)			23.793	<0.001
Yes	43 (36.8)	77 (65.8)		
No	31 (26.5)	25 (21.4)		
Unknown	43 (36.8)	15 (12.8)		
Nasal tube, *n* (%)			29.222	<0.001
Yes	48 (41.0)	87 (74.4)		
No	26 (22.2)	17 (14.5)		
Unknown	43 (36.8)	13 (11.1)		

(Continued)

TABLE 2 (Continued)

Variables	Patients ($n = 117$)	Family members ($n = 117$)	X^2	P-value
Deep vein catheterization, *n* (%)			27.352	<0.001
Yes	49 (41.9)	86 (73.5)		
No	25 (21.4)	18 (15.4)		
Unknown	43 (36.8)	13 (11.1)		
Urinary catheter, *n* (%)			28.289	<0.001
Yes	51 (43.6)	89 (76.1)		
No	23 (19.7)	15 (12.8)		
Unknown	42 (35.9)	13 (11.1)		
Transfusion, *n* (%)			28.328	<0.001
Yes	50 (42.7)	89 (76.1)		
No	24 (20.5)	14 (12.0)		
Unknown	43 (36.8)	14 (12.0)		
Preferred place of death, *n* (%)			5.364	0.068
Home	20 (17.1)	13 (11.1)		
Medical or elderly care institutions	6 (5.1)	15 (12.8)		
General hospital	91 (77.8)	89 (76.1)		

ACP knowledge, determination surrogate, value statement about end-of-life (coded as active treatment, relieving uncomfortable symptoms, maintenance of daily function, and quality of life or unknown), preferences for end-of-life treatments (including cardiopulmonary resuscitation, invasive mechanical ventilation support, non-invasive ventilation support, renal replacement therapy, gastrointestinal colostomy, nasal tube, deep vein catheterization, urinary catheter, and transfusion), and desired place of death. Discordance attitudes were defined based on patients' and family members' responses to the question about whether to consider ACP engagement of patients if patients cannot make decisions due to a medical condition (such as coma).

2.4. Data collection process

Patients and their family members were informed of the aim and the detailed process of the study when they visited the Department of Geriatrics. After obtaining their informed consent, they were interviewed by a trained researcher and the data were analyzed by another researcher.

2.5. Sample size calculation

A sample size of 111 patients was calculated to detect a discordance rate (p) of 32% according to a previous study (27), assuming a type I error (α) of 0.05, a desired precision (d) was 0.05, and a two-sided test. N represents the estimated annual cases of 165 new elderly patients admitted to the geriatrics department of the primary medical and healthcare institution. A non-response rate was set as 5%, and 117 pairs of patients and family members were required. The formula is as follows:

$$n = \frac{\left(\frac{Z_\alpha}{\delta}\right)^2 * p * (1-p)}{1 + [\left(\frac{Z_\alpha}{\delta}\right)^2 * p * (1-p)]/N} \quad (1)$$

2.6. Statistical analysis

Data were analyzed using SPSS 18.0 software (SPSS, Chicago, IL, USA). The frequency and distribution tested by the normality test for all variables were evaluated. The continuous variables included patients' age, family members' age, the age gap between patients and family members, and functional capacities. These variables were presented as median (interquartile range, IQR) because they were not normally distributed, and the Mann-Whitney U tests were used to compare the differences between groups. Theχ^2 tests were used to estimate differences in other variables between groups, and dichotomous variables are expressed as numbers (percentages). Furthermore, a multivariate logistic regression model to estimate odds ratios (*ORs*) and 95% confidence intervals (*CIs*) was conducted to identify associated influencing variables with discordance attitudes toward ACP between older patients and their family members. The variables with $P < 0.2$ in bivariate analysis were selected in the multivariate logistic regression analysis. A *P*-value of <0.05 was considered statistical significance.

TABLE 3 The patient and family member factors associated with discordance attitudes toward ACP by bivariate analysis.

Variables	Accordance ($n = 76$)	Discordance ($n = 41$)	Z or X^2	P-value
Patient				
Age, median (IQR), years[#]	80.0 (70.0, 87.0)	79.0 (65.5, 86.5)	−0.223	0.824
Age difference between patient and caregiver, median (IQR), scores[#]	23.0 (3.0, 28.8)	26.0 (7.5, 32.0)	−1.872	0.061
Male, *n* (%)	45 (59.2)	21 (51.2)	0.692	0.406
Married, *n* (%)	53 (69.7)	34 (82.9)	2.430	0.119
High school or above, *n* (%)	20 (26.3)	10 (24.4)	0.052	0.820
Self-reported health status, *n* (%)			0.451	0.502
Poor/fair	55 (72.4)	32 (78.0)		
Good	21 (27.6)	9 (22.0)		
Self-reported family support, *n* (%)			6.688	0.010
Poor/Fair	33 (43.4)	8 (19.5)		
Good	42 (56.6)	33 (80.5)		
Comorbidities, *n* (%)				
Coronary artery disease	18 (23.7)	12 (29.3)	0.436	0.509
Hypertension	35 (46.1)	22 (53.7)	0.617	0.432
Diabetes	18 (23.7)	8 (19.5)	0.268	0.605
Cerebrovascular disease	11 (14.5)	4 (9.8)	0.530	0.466
Respiratory disease	20 (26.3)	6 (14.6)	2.103	0.147
Osteoarticular diseases	11 (14.5)	7 (15.4)	0.138	0.710
Prior experience relatives and friends rescued, *n* (%)	34 (44.7)	29 (70.7)	7.241	0.007
MMSE, median (IQR), scores[#]	21.0 (16.0, 25.0)	16.5 (14.0, 25.8)	−0.852	0.394
GDS-15, median (IQR), scores[#]	6.0 (3.0, 8.0)	7.5 (7.0, 8.0)	−3.596	<0.001
MBI, median (IQR), scores[#]	90.0 (70.0, 95.0)	90.0 (80.0, 100.0)	−1.125	0.261
MNA-SF, median (IQR), scores[#]	12.0 (8.0, 12.0)	12.0 (11.5, 12.0)	−2.621	0.009
CFS, median (IQR), scores[#]	5.0 (3.3, 6.0)	5.0 (3.0, 5.0)	−1.780	0.075
SARC-F, median (IQR), scores[#]	2.5 (0, 4.0)	3.0 (0, 4.0)	−0.268	0.789
Family member				
Age, median (IQR), scores[#]	60.0 (53.3, 65.0)	57.0 (49.5, 62.5)	−1.896	0.058
Male, *n* (%)	30 (39.5)	22 (53.7)	2.170	0.141
Married, *n* (%)	74 (97.4)	36 (87.8)		0.050
High school or above, *n* (%)	49 (64.5)	21 (51.2)	1.947	0.163
Self-reported health status, *n* (%)			1.282	0.258
Poor/fair	20 (26.3)	34 (82.9)		
Good	56 (73.7)	7 (17.1)		
Prior experience relatives and friends being rescued, *n* (%)	43 (56.6)	14 (34.1)	5.364	0.021

IQR, interquartile range; MMSE, the Mini-Mental State Examination; GDS-15, the 15 item Geriatric Depression Scale; MBI, the Modified Barthel Index; MNA-SF, the Short-Form Mini-Nutritional Assessment; CFS, the Clinical Frailty Scale.
[#]The Mann-Whitney U tests.

3. Results

Table 1 presents the characteristics of 117 eligible pairs of patients and family members. Among patients, 66 (56.4%) were male, with a median age of 80 years. Among family members, 52 (44.4%) were males, with a median age of 60 years. Significant differences were found in age, marital status, educational level, self-reported health status, and comorbid

TABLE 4 The patient and family member factors associated with discordance attitudes toward ACP by multivariate logistic analysis.

	OR (95% *CI*)	*P*-value
Patient		
Age differences between patients and family members	1.043 (1.007, 1.081)	0.019
GDS-15 score	1.437 (1.185, 1.742)	<0.001
MNA-SF score	1.754 (1.316, 2.338)	<0.001
Family member		
High school or above	Ref	
Junior high and below	3.373 (1.239, 9.181)	0.017

MMSE, the Mini-Mental State Examination; GDS-15, the 15 item Geriatric Depression Scale; MBI, the Modified Barthel Index; MNA-SF, the Short-Form Mini-Nutritional Assessment; CFS, the Clinical Frailty Scale.
The model adjusted for age difference between patient and family member, patient covariates (marriage status, family support, health status, prior experience relatives and friends rescued, GDS-15 score, MNA-SF score, CFS score), and family member covariates (sex, marriage status, education level, prior experience relatives and friends rescued).

diseases between patients and family members (all $P < 0.05$).

Table 2 displays the attitudes of older patients and their family members toward ACP and end-of-life treatments for the patients. About 84% of patients chose their children as their medical decision-making surrogates. Family members were more willing to actively discuss death with patients in order to cope with the subsequent irreversible final stage of life, but, in fact, family members preferred to choose active treatment for patients. In regards to the preferred place of death, there was no significance between patients and family members.

Only 4 patients (3.4%) and 14 family members (12.0%) heard of ACP. When the ACP was fully informed, the percentages of instituting ACP in the irreversible final stage of life increased to 51.3 and 78.6%, respectively. However, the discordant attitudes toward ACP between patients and family members accounted for 41 (35.0%). In the bivariate analysis, several patients' and family members' factors were associated with discordant attitudes toward ACP (Table 3). In the multivariate logistic analysis, factors associated with higher odds of discordance attitudes toward ACP included greater age differences between patients and family members (*OR* = 1.043, 95% *CI*: 1.007–1.081), higher GDS-15 score (*OR* = 1.437, 95% *CI*: 1.185–1.742), higher MNA-SF score (*OR* = 1.754, 95% *CI*: 1.316–2.338), and lower educational level for family members (*OR* = 3.373, 95% *CI*: 1.239–9.181) (Table 4).

4. Discussion

This study included older patients and their family members in the primary medical and healthcare institution, and identified that discordance attitudes toward patients' engagement in ACP between them were common, with the discordance rate accounting for ∼35%. More specifically, most patients and their family members viewed general hospitals as the preferred location of death, but family members would choose more aggressive life-sustaining treatments for patients at the end of life than patients themselves. Indeed, multiple previous studies demonstrated poor patient-surrogate agreement about patients' end-of-life treatment preferences (15, 27, 28). One study showed that agreement between older persons and their surrogates regarding living will completion were 81%, while agreement about the other aspects of ACP including healthcare surrogates, attitudes toward life-sustaining treatments, and the quality and quantity of life was 62–68% (27). The low compliance of patients' end-of-life preferences may be attributed to the lack of ACP knowledge. The dissemination and implementation of ACP need to take into account cultural and ethical considerations (29, 30). It is well known that people in a Western culture attach great importance to patient autonomy and quality of life, partly because they have received death education since childhood, as well as the legislative power of patient autonomy and informed consent (31, 32). However, adult children in Chinese traditional culture often act on the patient's preferred surrogates for future medical decisions, they are endowed with important family responsibilities to make every effort to prolong their older patients' lives. And the collectivism of family and society is considered as having a higher value than patient autonomy in end-of-care decision-making, which prevents ACP discussion by families who are reluctant to inform patients of their true condition and discuss death (33). In addition, ethical conflicts about what is a reasonable decision for a patient end of life care often occur during ACP communication and the decision-making process (34, 35).

In addition to cultural and ethical considerations, our study found that discordance attitudes varied greatly with respect to age gaps between patients and family members, family members' educational level, patients' depressive symptoms, and patients' nutritional status. The smaller the age gap between the patient and his family member is, that is, they are both in advanced age, the easier the family members understand the patient's preference. On the contrary, the greater the age gap between the two, the younger family members may make decisions against the patient's will due to traditional culture, ethics, and other factors. There are no relevant studies to explore the association between the age gap and disagreement attitudes toward ACP activities between patients and their family members. Thus, the result of this study needs to be further warranted in a large sample study. Moreover, the awareness rates of ACP knowledge in both older patients and their family members in this study were obviously lower than the previously reported rates in tertiary general hospitals (12), and it may be supportive of the importance of promoting ACP education in the primary institutions. Except for ACP education, original educational level is known to influence individuals' attitudes toward ACP, and our study revealed that poorly educated family members were more prone to make decisions that were against the patients' end-of-life preferences than those with highly educated. In accordance with a recent study investigating factors influencing older married couples possessing an AD, the result clarified that older couples in which one or both spouses went to college were more prone to report AD concordance (36). Compared with poorly educated

family members, highly educated family members may have more access to increase their knowledge and understanding of patients' wishes, and are more likely to joint communicate end-of-life treatment and care preferences with their elders, thus reducing the burden of making difficult end-of-life decisions on behalf of patients.

Functional capacity parameters, especially depressive symptoms and the nutritional status of patients were identified as important associated modifiable factors. Evidence showed that depression was associated with enhancing discussions about end-of-life care and declining cardiopulmonary resuscitation (37, 38), and a decrease in depressive symptoms, in turn, increased the likelihood of patients changing preferences from declining to desiring cardiopulmonary resuscitation (39). ACP discussion and intervention could facilitate alleviating anxiety and depressive symptoms of terminally ill patients and their surviving relatives, but neither improves the quality of life nor the end-of-life care decision-making process (4, 40). Fluctuations in patients' depressive symptoms and lack of communication may increase the possibility of inconsistent attitudes toward ACP. Furthermore, the patient's poor nutritional status was associated with an accordance attitude toward ACP. The observed association can be explained by the fact that older patients with malnutrition were accompanied by multiple comorbidities, reduced physical functioning, and dependence on activities of daily living (41). Poor physical condition and dependence synergistically make older patients a more self-perceived burden to their families (42). Older adults often have a perception that they do not want to burden others, including their families (43, 44). Moreover, prior studies of the perspective of the elderly on ACP have shown that ACP would ease the family burden (45). Hence, increasing family burdens seems to be an important factor in end-of-life decision-making for older adults. The discordant attitudes toward ACP between older patients and their family members were seen in older patients with good nutritional status in this context.

Studies have shown ACP focused more on improved concordance of care, particularly at the end of life, rather than improved clinical outcomes (46). Another study described the ACP process as part of chronic disease management (47). Based on these findings, the integration of ACP for older patients in the primary medical and health care institution into routine care may facilitate informed and shared decision-making in regard to complicated therapeutic options and palliative care that is in line with personal values and preferences. This study identified several modifiable and non-modifiable factors toward ACP discordance attitudes, which were important for good communication between older patients and their family members. It is suggested that clinicians need to pay close attention to the potentially vulnerable groups with discordant attitudes, and patient-family-clinician shared decision-making about end-of-life preferences should be adopted to achieve the goal of honoring patients' values, preferences, and wishes. In addition to ACP education, the ACP-related laws and regulations, and the robust healthcare system need to be supported at the national level in order to implement ACP smoothly.

However, this study also has some limitations. Firstly, this study recorded older patients and their family members' perceived attitudes toward future ACP engagement of patients, rather than actual discordance in medical care and treatments received. Attitudes toward end-of-life preferences would change during hospitalization for some patients and their family members, due to various reasons. Secondly, this study did not explore physician preferences for the patient's care goals and treatments. Thirdly, this study was conducted in a single institution with a relatively small sample, and the data were collected at one point in time. Thus, the findings were of limited generality, and no causality could be assumed. Fourth, the lack of collection of response rates and characteristics of non-responders may result in biased prevalence estimates and selection bias, and the results should be interpreted with caution.

5. Conclusion

This study indicated that older patients and their family members had little ACP knowledge, and factors that influence discordance attitudes toward patients' engagement in ACP included age gaps between patients and family members, family members' educational level, patients' depressive symptoms, and patients' nutritional status. Early ACP education for older patients and their family members may promote ACP communications, and thus facilitate patient-family-clinician shared decision-making in the primary medical and healthcare institution, which eventually achieves the goal of honoring patients' values, preferences, and wishes.

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 authors.

Ethics statement

The studies involving human participants were reviewed and approved by the Medical Ethics Committee of Jinhua Fifth Hospital. The patients/participants provided their written informed consent to participate in this study.

Author contributions

SS and SQ contributed to the conceptualization and methodology. LY and SS analyzed the data and wrote the original draft. LY, GJ, MC, and XX contributed to data collection. All authors contributed to implementing and revising 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.

Publisher's note

References

1. Brinkman-Stoppelenburg A, Rietjens JA, van der Heide A. The effects of advance care planning on end-of-life care: a systematic review. *Palliat Med.* (2014) 28:1000–25. doi: 10.1177/0269216314526272

2. Rietjens JAC, Sudore RL, Connolly M, van Delden JJ, Drickamer MA, Droger M, et al. Definition and recommendations for advance care planning: an international consensus supported by the European Association for Palliative Care. *Lancet Oncol.* (2017) 18:e543–e51. doi: 10.1016/S1470-2045(17)30582-X

3. Silveira MJ, Kim SY, Langa KM. Advance directives and outcomes of surrogate decision making before death. *N Engl J Med.* (2010) 362:1211–8. doi: 10.1056/NEJMsa0907901

4. Detering KM, Hancock AD, Reade MC, Silvester W. The impact of advance care planning on end of life care in elderly patients: randomised controlled trial. *BMJ.* (2010) 340:c1345. doi: 10.1136/bmj.c1345

5. Sudore RL, Fried TR. Redefining the "planning" in advance care planning: preparing for end-of-life decision making. *Ann Intern Med.* (2010) 153:256–61. doi: 10.7326/0003-4819-153-4-201008170-00008

6. Becker C, Lecheler L, Hochstrasser S, Metzger KA, Widmer M, Thommen EB, et al. Association of communication interventions to discuss code status with patient decisions for do-not-resuscitate orders: a systematic review and meta-analysis. *JAMA Netw Open.* (2019) 2:e195033. doi: 10.1001/jamanetworkopen.2019.5033

7. Guidelines for the appropriate use of do-not-resuscitate orders. Council on Ethical and Judicial Affairs, American Medical Association. *JAMA.* (1991) 265:1868–71. doi: 10.1001/jama.265.14.1868

8. Nicholas LH, Langa KM, Iwashyna TJ, Weir DR. Regional variation in the association between advance directives and end-of-life Medicare expenditures. *JAMA.* (2011) 306:1447–53. doi: 10.1001/jama.2011.1410

9. Lum HD, Sudore RL, Bekelman DB. Advance care planning in the elderly. *Med Clin North Am.* (2015) 99:391–403. doi: 10.1016/j.mcna.2014.11.010

10. Bischoff KE, Sudore R, Miao Y, Boscardin WJ, Smith AK. Advance care planning and the quality of end-of-life care in older adults. *J Am Geriatr Soc.* (2013) 61:209–14. doi: 10.1111/jgs.12105

11. Chu LW, Luk JK, Hui E, Chiu PK, Chan CS, Kwan F, et al. Advance directive and end-of-life care preferences among Chinese nursing home residents in Hong Kong. *J Am Med Dir Assoc.* (2011) 12:143–52. doi: 10.1016/j.jamda.2010.08.015

12. Kang L, Liu XH, Zhang J, Shan PY, Wang JP, Zhong P, et al. Attitudes toward advance directives among patients and their family members in China. *J Am Med Dir Assoc.* (2017) 18:808.e7–e11. doi: 10.1016/j.jamda.2017.05.014

13. Feng C, Wu J, Li J, Deng HY, Liu J, Zhao S. Advance directives of lung cancer patients and caregivers in China: a cross sectional survey. *Thorac Cancer.* (2020) 11:253–63. doi: 10.1111/1759-7714.13237

14. Kim J, Shin MS, Park YM, Lee HN, Heo S, Ounpraseuth S. Associations of advance directive knowledge, attitudes, and barriers/benefits with preferences for advance treatment directives among patients with heart failure and their caregivers. *J Card Fail.* (2020) 26:61–9. doi: 10.1016/j.cardfail.2019.07.011

15. Shalowitz DI, Garrett-Mayer E, Wendler D. The accuracy of surrogate decision makers: a systematic review. *Arch Intern Med.* (2006) 166:493–7. doi: 10.1001/archinte.166.5.493

16. Figueroa JF, Schnipper JL, McNally K, Stade D, Lipsitz SR, Dalal AK. How often are hospitalized patients and providers on the same page with regard to the patient's primary recovery goal for hospitalization? *J Hosp Med.* (2016) 11:615–9. doi: 10.1002/jhm.2569

17. Steinhauser KE, Christakis NA, Clipp EC, McNeilly M, McIntyre L, Tulsky JA. Factors considered important at the end of life by patients, family, physicians, and other care providers. *JAMA.* (2000) 284:2476–82. doi: 10.1001/jama.284.19.2476

18. Oo NM, Scott IA, Maggacis R, Rajakaruna N. Assessing concordance between patient preferences in advance care plans and in-hospital care. *Aust Health Rev.* (2019) 43:425–31. doi: 10.1071/AH18011

19. Unroe KT, Hickman SE, Torke AM, Group ARCW. Care consistency with documented care preferences: methodologic considerations for implementing the "measuring what matters" quality indicator. *J Pain Symptom Manage.* (2016) 52:453–8. doi: 10.1016/j.jpainsymman.2016.04.015

20. Chen X, Yan J, Wang J, Yu P, Geriatric GBoCMA. Chinese expert consensus on the application of comprehensive geriatric assessment for the elderly. *Aging Med.* (2018) 1:100–5. doi: 10.1002/agm2.12019

21. Mahoney FI, Barthel DW. Functional evaluation: the Barthel index. *Md State Med J.* (1965) 14:61–5. doi: 10.1037/t02366-000

22. Kaiser MJ, Bauer JM, Ramsch C, Uter W, Guigoz Y, Cederholm T, et al. Validation of the mini nutritional assessment short-form (MNA-SF): a practical tool for identification of nutritional status. *J Nutr Health Aging.* (2009) 13:782–8. doi: 10.1007/s12603-009-0214-7

23. Dennis M, Kadri A, Coffey J. Depression in older people in the general hospital: a systematic review of screening instruments. *Age Ageing.* (2012) 41:148–54. doi: 10.1093/ageing/afr169

24. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res.* (1975) 12:189–98. doi: 10.1016/0022-3956(75)90026-6

25. Rockwood K, Song X, MacKnight C, Bergman H, Hogan DB, McDowell I, et al. A global clinical measure of fitness and frailty in elderly people. *CMAJ.* (2005) 173:489–95. doi: 10.1503/cmaj.050051

26. Malmstrom TK, Miller DK, Simonsick EM, Ferrucci L, Morley JE. SARC-F: a symptom score to predict persons with sarcopenia at risk for poor functional outcomes. *J Cachexia Sarcopenia Muscle.* (2016) 7:28–36. doi: 10.1002/jcsm.12048

27. Fried TR, Redding CA, Robbins ML, O'Leary JR, Iannone L. Agreement between older persons and their surrogate decision-makers regarding participation in advance care planning. *J Am Geriatr Soc.* (2011) 59:1105–9. doi: 10.1111/j.1532-5415.2011.03412.x

28. Pruchno RA, Lemay EP Jr, Feild L, Levinsky NG. Predictors of patient treatment preferences and spouse substituted judgments: the case of dialysis continuation. *Med Decis Making.* (2006) 26:112–21. doi: 10.1177/0272989X06286482

29. Master JF, Wu B, Ni P, Mao J. The compliance of end-of-life care preferences among older adults and its facilitators and barriers: a scoping review. *J Am Med Dir Assoc.* (2021) 22:2273–80.e2. doi: 10.1016/j.jamda.2021.05.007

30. Deng RL, Duan JZ, Zhang JH, Miao JR, Chen LL, Lee DT. Advance care planning for frail older people in China: a discussion paper. *Nurs Ethics.* (2019) 26:1696–706. doi: 10.1177/0969733018779177

31. Tanaka M, Kodama S, Lee I, Huxtable R, Chung Y. Forgoing life-sustaining treatment - a comparative analysis of regulations in Japan, Korea, Taiwan, and England. *BMC Med Ethics.* (2020) 21:99. doi: 10.1186/s12910-020-00535-w

32. Wiesing U, Jox RJ, Hessler HJ, Borasio GD. A new law on advance directives in Germany. *J Med Ethics.* (2010) 36:779–83. doi: 10.1136/jme.2010.036376

33. Ip M, Gilligan T, Koenig B, Raffin TA. Ethical decision-making in critical care in Hong Kong. *Crit Care Med.* (1998) 26:447–51. doi: 10.1097/00003246-199803000-00013

34. Poveda-Moral S, Rodriguez-Martin D, Codern-Bove N, Jose-Maria P, Sanchez-Valero P, Pomares-Quintana N, et al. Managing ethical aspects of advance directives in emergency care services. *Nurs Ethics.* (2021) 28:91–105. doi: 10.1177/0969733020952112

35. Mueller PS, Hook CC, Fleming KC. Ethical issues in geriatrics: a guide for clinicians. *Mayo Clin Proc.* (2004) 79:554–62. doi: 10.4065/79.4.554

36. Koss CS, Jensen D. Going it alone: advance directive discordance in older married couples. *J Appl Gerontol.* (2020) 39:1274–83. doi: 10.1177/0733464819884439

37. Fakhri S, Engelberg RA, Downey L, Nielsen EL, Paul S, Lahdya AZ, et al. Factors affecting patients' preferences for and actual discussions about end-of-life care. *J Pain Symptom Manage.* (2016) 52:386–94. doi: 10.1016/j.jpainsymman.2016.03.012

38. Stapleton RD, Nielsen EL, Engelberg RA, Patrick DL, Curtis JR. Association of depression and life-sustaining treatment preferences in patients with COPD. *Chest.* (2005) 127:328–34. doi: 10.1378/chest.127.1.328

39. Rosenfeld KE, Wenger NS, Phillips RS, Connors AF, Dawson NV, Layde P, et al. Factors associated with change in resuscitation preference of seriously ill patients. The SUPPORT Investigators. Study to understand prognoses and preferences for outcomes and risks of treatments. *Arch Intern Med.* (1996) 156:1558–64. doi: 10.1001/archinte.1996.00440130104011

40. Tang ST, Chen JS, Wen FH, Chou WC, Chang JW, Hsieh CH, et al. Advance care planning improves psychological symptoms but not quality of life and preferred end-of-life care of patients with cancer. *J Natl Compr Canc Netw.* (2019) 17:311–20. doi: 10.6004/jnccn.2018.7106

41. Cereda E, Pedrolli C, Klersy C, Bonardi C, Quarleri L, Cappello S, et al. Nutritional status in older persons according to healthcare setting: a systematic review and meta-analysis of prevalence data using MNA((R)). *Clin Nutr.* (2016) 35:1282–90. doi: 10.1016/j.clnu.2016.03.008

42. Akazawa T, Akechi T, Morita T, Miyashita M, Sato K, Tsuneto S, et al. Self-perceived burden in terminally ill cancer patients: a categorization of care strategies based on bereaved family members' perspectives. *J Pain Symptom Manage.* (2010) 40:224–34. doi: 10.1016/j.jpainsymman.2009.12.015

43. Rehmann-Sutter C. Self-perceived burden to others as a moral emotion in wishes to die. A conceptual analysis. *Bioethics.* (2019) 33:439–47. doi: 10.1111/bioe.12603

44. Gudat H, Ohnsorge K, Streeck N, Rehmann-Sutter C. How palliative care patients' feelings of being a burden to others can motivate a wish to die. Moral challenges in clinics and families. *Bioethics.* (2019) 33:421–30. doi: 10.1111/bioe.12590

45. McPherson CJ, Wilson KG, Murray MA. Feeling like a burden to others: a systematic review focusing on the end of life. *Palliat Med.* (2007) 21:115–28. doi: 10.1177/0269216307076345

46. Jimenez G, Tan WS, Virk AK, Low CK, Car J, Ho AHY. Overview of systematic reviews of advance care planning: summary of evidence and global lessons. *J Pain Symptom Manage.* (2018) 56:436–59.e25. doi: 10.1016/j.jpainsymman.2018.05.016

47. Mechler K, Liantonio J. Palliative care approach to chronic diseases: end stages of heart failure, chronic obstructive pulmonary disease, liver failure, and renal failure. *Prim Care.* (2019) 46:415–32. doi: 10.1016/j.pop.2019.05.008

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Association between advance care planning and depressive symptoms among community-dwelling people with dementia: An observational cross-sectional study during the COVID-19 pandemic in Japan

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Objectives: Advance care planning (ACP) is an increasing priority for people with dementia during the COVID-19 pandemic. This study evaluated the association between ACP initiation and depressive symptoms among home-dwelling people living with dementia.

Methods: An internet-based questionnaire survey was conducted with Japanese family caregivers of home-dwelling persons with dementia in June 2021. Family caregivers evaluated the level of depressive symptoms in persons with dementia using the Neuropsychiatric Inventory (NPI). Caregivers also rated the quality of life of persons with dementia using the EQ-5D-5L.

Results: A total of 379 family caregivers participated in the survey. Depressive symptoms were reported in 143 persons with dementia (37.7%). A total of 155 persons with dementia (40.9%) had initiated ACP, of which 88 (56.8%) had care professionals involved in ACP conversation. After adjusting for the characteristics of persons with dementia and caregivers, persons with professional involvement showed significantly more severe depressive symptoms compared to those who did not initiate ACP. There was no significant difference in the quality of life of persons with dementia according to ACP initiation.

Conclusions: Many home-dwelling persons with dementia experienced depressive symptoms during the COVID-19 pandemic, especially in cases where

care professionals were involved in ACP conversations. Optimal and proactive ACP approaches need to be developed to prevent depressive symptoms in newly diagnosed persons.

KEYWORDS

advance care planning, community, dementia, depression, family caregiver

1. Introduction

Living well with dementia becomes a global public health priority as the number of people with dementia continues to increase (1). Dementia is currently irreversible and people with dementia face a progressive decline in functional and mental capacity, with a median survival of 3–10 years following clinical diagnosis (2, 3). Although promotion of early diagnosis is often included in several national dementia plans (4), dementia diagnosis is associated with an elevated risk of depression and suicide (5–7). Suicidal ideation may be caused by dementia-related anxiety (8). Post-diagnostic support should be embedded in dementia plans to support people with dementia in re-establishing and maintaining a positive identity in the face of the condition (9).

Timely advance care planning (ACP) could comprise post-diagnostic support for people with dementia. ACP is defined as an ongoing communication process about future care among the person affected by dementia, family member/s, and the healthcare team (10). Initiation of ACP following dementia diagnosis provides an opportunity for people with dementia to express their values in life. Such communication and expression might prevent the development of depressive symptoms and reduce the risk of suicide. However, ACP for people with dementia is typically reported in care home settings (11, 12), for those with moderate to severe cognitive impairment who may lack decisional capacity (13). This results in their family members having to engage in decision making processes for them (13). The active involvement of community-dwelling people with dementia in ACP has not been sufficiently researched. Furthermore, outcomes of ACP are typically focused on end-of-life care measures (14). Little is known about the impact of ACP on depressive symptoms in persons with dementia.

ACP is an urgent priority for people with dementia during the COVID-19 pandemic. COVID-19 has caused a global health crisis alongside enforced isolation measures, which have a disproportional impact on people with dementia (15). Being unable to access social support services due to COVID-19 has contributed to worse quality of life in people with dementia (16). Furthermore, these individuals are particularly vulnerable to COVID-19 because of their age, multimorbidity, and difficulties in maintaining physical distancing (17). Thus, ACP is recommended to discuss the stage at which hospital admission for COVID-19 might not add much value (18). This may affect the practice of ACP among persons with dementia and their family caregivers. Moreover, understanding the association between depression and ACP during the COVID-19 pandemic can provide implications for imparting dementia care in adapted formats, considering the long-term public health restrictions.

This study therefore investigated the association between ACP initiation and depressive symptoms among people with dementia during the COVID-19 pandemic. We hypothesized that individuals having initiated ACP would show lower levels of depressive symptoms compared to those who have not yet initiated ACP.

2. Materials and methods

2.1. Design

This research was a cross-sectional observational study that was conducted using an online survey hosted by an Internet survey company (Macromill Inc.), which provides a global online research system. This web-based survey was conducted with Japanese residents. For more detailed information, please refer to Nakanishi et al. (19) study.

2.2. Setting

On June 25, 2021, a self-administered questionnaire was distributed to eligible individuals who were registered members of the survey company. Participants aged 40 years or older were randomly sampled from the company's member pool and were asked to complete the questionnaire by 27 June 2021. A continuous rise in the daily number of COVID-19 cases was observed during the study period, following the relief of the emergency declaration on 20 June. By 24 June, 21.3% of older adults in Japan had received the second dose of COVID-19 vaccine (20).

The members' continued participation was considered indicative of their consent to the questionnaire instructions provided on the website. The instructions assured the participants that their personal information would be protected and that their data would be anonymized. Any identifying information (participants' names and other identifiers that could lead to the identification of a participant) was removed when we received the data from the Internet survey company, and no images/videos were obtained from the participants.

2.3. Participants

Potential participants fulfilled the following criteria: (a) aged 40 years or older, (b) having been a primary non-professional caregiver

for a home-dwelling person with dementia, and (c) having no conflicts of interest with advertising or marketing research entities. We excluded caregivers under the age of 40 because they comprise only 2% of all caregivers in Japan, making it difficult to consider such young caregivers providing care (21). Dementia in this survey was defined as having formal diagnosis of Alzheimer's disease, vascular, Lewy body, or other types of dementias, and having regular visits to healthcare institutions for the treatment. Based on these criteria, the Internet survey company randomly recruited members from their potential pool of participants by sending e-mails and posting notifications on their website. It was estimated that there were 1,913 persons in the pool who had a family member with a dementia diagnosis in the same household requiring regular visits to healthcare organizations for treatment.

Eligible persons who agreed to the terms and conditions of the online survey could access the self-report questionnaire. Since the Internet survey company ceased recruitment once the target number of respondents had been reached, the response rate could not be determined.

2.4. Measurements

All variables were measured using an online self-report questionnaire developed by the authors. The recruited participants were instructed to log in to the portal and complete the online questionnaire.

The primary outcome measure was the depressive symptoms of a person with dementia. Depressive symptoms were evaluated using an item of depression from the Neuropsychiatric Inventory – Nursing Home version (NPI-NH). The original NPI-NH comprises 12 items to rate the frequency and severity of neuropsychiatric symptoms in persons with dementia (22–25). Scores for depression range from 0 to 12, with higher scores indicating more severe symptoms. The Japanese version of the NPI-NH has good validity and reliability (26).

The secondary outcome measures included the quality of life of people with dementia. Quality of life was evaluated using the EuroQol 5 Dimension 5 Levels (EQ-5D-5L). The original EQ-5D-5L consists of five items: "mobility," "self-care," "usual activities," "pain/discomfort," and "anxiety/depression" (27, 28). The EQ-5D-5L score ranges from 0 to 1, with higher scores indicating greater quality of life. The Japanese version of the EQ-5D-5L has been validated (29, 30).

ACP initiation was the primary independent variable. In the questionnaire, family caregivers were asked whether the person with dementia had initiated ACP. ACP was defined as "thinking about one's own future, and talking to the person's family and others about what is important to the person". The definition was created by the research team based on materials from dementia-related associations (31, 32) and suggestions from family caregivers and staff working at four dementia-related organizations in Japan. When a person with dementia did initiate any form of ACP, family caregivers were also asked to respond to the timing of initiation (e.g., diagnosis, hospital admission), types of care professionals involved in the conversation, and the topics discussed. Categories of timing of initiation were developed by the research group based on the recommendations of ACP in dementia (33). Types of professionals were defined with reference to dementia care pathways in Japan (34). Categories of topics discussed were also developed by the research group based on intervention programs to encourage ACP among community residents (35, 36). As half of the participants with ACP initiation did not involve any care professionals in the conversation, participants were divided into three groups: never initiated ($N = 224$), no professionals other than relatives involved ($N = 67$), and care professionals involved in the conversation ($N = 88$).

We measured the characteristics of persons with dementia, including age, sex, type of dementia, duration of illness from clinical diagnosis, level of cognitive impairment, activities of daily living (ADL), presence of physical complications, and delusions. Physical complications were categorized as heart disease, cancer, or circulatory disease. The level of cognitive impairment was evaluated using the Japanese version of the Cognitive Performance Scale (CPS) provided by the interRAI Assessment System (37). The is a validated measure that uses five variables to classify older adults into cognition categories ranging from intact (a score of 0) to very severely impaired (a score of 6) (37). The Japanese version of the CPS has demonstrated fair reliability and validity (38). ADL were measured using the Japanese version of the Activities of Daily Living Self-performance Hierarchy Scale (ADL-H) provided by the interRAI Assessment System (39). The ADL-H is a 10-item scale that measures basic aspects of activities related to self-care and mobility (38). Total scores range from 0 to 6, with higher scores indicating greater physical dependency. The Japanese version of the ADL-H has demonstrated good validity (40). Delusional symptoms were assessed using the NPI as they were associated with suicidal ideation (41). Duration of illness was categorized into "within 24 months", "25–60 months", or "61 months or longer", based on quartiles (25, 51, 92.5) and the literature (5–7).

We also assessed characteristics of family caregivers, including age, sex, educational attainment, and relationship with the person with dementia. As the majority of family caregivers were the children (74.9%) of the person with dementia, the relationship with the person was categorized into "children" or "other relatives" in the analysis.

2.5. Study size

The required sample size for conducting an analysis of variance for depressive symptoms was calculated using the G*Power 3.1.9.7 software (42, 43). Based on recent reports on the prevalence of ACP in Belgium (11.8%) (44) and Australia (16.0%) (45), we assumed the prevalence of ACP initiation to be 16% in this study. Assuming a significance level of 0.05 and 95% power, a medium effect size (Cohen's $d = 0.5$), and using a two-tailed test, the desired sample size was determined to be 390.

After data collection, we discovered that out of 40.9% of the participants who had initiated ACP, 43.2% had no professionals involved in ACP; we divided the participants into three groups according to ACP initiation and professional involvement. *Post-hoc* power analysis showed a small effect size (Cohen's $f = 0.2$).

2.6. Ethical considerations

The study protocol was approved by the Ethics Committee Tohoku University Graduate School of Medicine (number 2021-5-154) and the Tokyo Metropolitan Institute of Medical Science (number 20–55). The research was conducted in accordance with the principles of the Declaration of Helsinki (version November 2013). It is in agreement with the law regarding medical-scientific research in humans.

2.7. Statistical analysis

The characteristics of persons with dementia and caregivers were compared among the three groups according to ACP initiation. ANOVAs were used for continuous variables with Bonferroni correction, and χ^2 tests were used for categorical variables.

Depressive symptoms and quality of life of the person were compared among the three groups according to ACP initiation, using ANOVAs with Bonferroni correction.

Multiple linear regression analysis was conducted using the three groups according to ACP initiation as independent variables and the total score of each outcome measure as dependent variables. All the persons' and family caregivers' characteristics were included as covariates.

Statistical significance was set to $\alpha = 0.05$. All statistical analyses were conducted using STATA version 17.0 (StataCorp LLC, College Station, TX, USA).

3. Results

3.1. Participant characteristics

A total of 412 family caregivers who were registered with the Internet survey company completed the survey. Of the 412 respondents, 33 were excluded because they reported that their loved ones had been admitted to long-term care facilities or hospitals by the time of the survey. Therefore, the remaining 379 family caregivers of home-dwelling individuals with dementia were included in the final sample.

At the time of enrolment, the mean age of the family caregivers was 58.2 years [standard deviation (SD) = 8.9]; 52.8% were men, 44.1% had graduated from university or graduate school, and the majority (74.9%) were children of the loved ones. Most (97.4%) of the respondents lived with their loved ones. One-fifth of the loved ones were men (19.0%; Table 1). An average of 65.3 months had passed since diagnosis (range = 2–313 months; SD = 55.8 months).

3.2. Initiation of ACP

One hundred and fifty-five (40.9%) of the respondents reported that their loved ones had initiated ACP. Of these, approximately half (49.7%) reported that the initiation was triggered by a dementia diagnosis. One-fifth (20.0%) reported that the initiation was triggered by new accreditation for a long-term care insurance benefit. Other types of triggers included increased difficulty

TABLE 1 Characteristics of 379 family caregivers and persons with dementia.

Variable	*N* (%) or mean [Standard Deviation (SD)]
Family caregiver	
Age, year, range 40–83, mean (SD)	58.2 (8.9)
Sex, man, *n* (%)	200 (52.8)
Educational attainment, *n* (%)	
Junior high school or high school	138 (36.4)
Vocational school or college	74 (19.5)
University or graduate school	167 (44.1)
Relationship with the person with dementia, *n* (%)	
Child	284 (74.9)
Spouse	61 (16.1)
Spouse of child	29 (7.7)
Other relative	5 (1.3)
Person with dementia	
Living situation, *n* (%)	
Living with respondent caregiver	369 (97.4)
Living with other caregiver	3 (0.8)
Living alone	7 (1.8)
Demographic	
Age, year, range 41-99, mean (SD)	82.7 (8.7)
Sex, man, *n* (%)	72 (19.0)
Duration of illness from diagnosis, *n* (%)	
Within 24 months	92 (24.3)
25–60 months	120 (31.7)
61 months or longer	167 (44.1)
Type of dementia, *n* (%)	
Alzheimer's disease	254 (67.0)
Vascular	55 (14.5)
Lewy body	51 (13.5)
Frontotemporal	9 (2.4)
Mixed	13 (3.4)
Other, including unspecified	24 (6.3)
Functioning	
ADL dependence, range 0–6, mean (SD)	2.9 (2.0)
Cognitive impairment, range 0–6, mean (SD)	3.1 (1.2)
Delusional symptoms, range 0–12, mean (SD)	1.5 (2.9)
Physical complication, *n* (%)	
Cardiovascular disease	76 (20.1)
Neurological disease other than Alzheimer's disease	54 (14.2)
Respiratory disease	25 (6.6)
Malignant neoplasm	19 (5.0)
Kidney disease	16 (4.2)

Activities of daily living (ADL) were evaluated using the Japanese version of the Activities of Daily Living Self-Performance Hierarchy Scale. Cognitive impairment was evaluated using the Japanese version of the Cognitive Performance Scale. Delusional symptoms were evaluated using the Japanese version of the Neuropsychiatric Inventory (NPI).

managing own property or daily life (8.4%) and admittance to an acute hospital for treatment of a physical illness (4.5%).

Two-fifths (43.2%) reported that no one other than relatives were involved in the ACP conversations. Regarding the cases in which health-care professionals were involved in such conversations, the most commonly reported type of professional was care managers of in-home care services (34.2%). Other types of professionals included staff of a day-care center (27.7%), care manager of a residential care service (25.2%), and Community General Support Center (17.4%) which provides comprehensive support for older community residents. The doctor who provided the dementia diagnosis was present in 16.8% of the cases. Initial-phase intensive support team for dementia that, conducts home visits and assessments, and provides information and advice to persons with early signs of dementia, was present in only 5.2% of the cases.

The most frequently discussed ACP-related topic was the point at which the loved ones would need to enter residential care (67.7%). Other topics included important roles in the community and values (41.9%), the loved one's habits and preferences (38.7%), social activities the loved one would like to continue (29.0%), social relationships the loved one would like to maintain (25.2%), tube feeding (25.2%), and application of cardiopulmonary resuscitation or transfer to an emergency department when breathing or heart stops (21.9%).

The 88 persons whose care professionals were involved in the conversation had significantly older caregivers, male caregivers, caregivers with higher educational attainment, more severe ADL dependence, more severe delusional symptoms, and a higher prevalence of respiratory disease or malignant neoplasm (Supplementary Table 1).

3.3. Depressive symptoms of persons with dementia

The mean score of depressive symptoms measured by NPI was 1.34 (SD = 2.46). A total of 143 persons (37.7%) presented with depressive symptoms. The 88 persons with professional involvement showed significantly more severe depressive symptoms compared to 224 persons without ACP initiation. There was no significant difference in depressive symptoms between the 67 persons with no professional involvement and 224 persons without initiation (Table 2).

Multiple linear regression analysis showed a significant association with more severe depressive symptoms in persons with professional involvement (Table 3). There were also significant associations with more severe depressive symptoms in more severe delusional symptoms and presence of neurological diseases other than Alzheimer's disease (Supplementary Table 2).

3.4. Quality of life of persons with dementia

The mean score of quality of life measured by the EQ-5D-5L was 0.62 (SD = 0.22). The 88 persons with professional involvement showed significantly lower quality of life compared to 224 persons without ACP initiation. There was no significant difference in quality of life between the 67 persons with no professional involvement and 224 persons without initiation (Table 2).

The multiple linear regression analysis did not show significant association between quality of life and ACP initiation (Table 3). Quality of life was significantly greater for younger persons with dementia, women, those who had a shorter duration of illness from diagnosis, less dependence on ADL, less cognitive impairment, less severe delusional symptoms, and absence of neurological disease, malignant neoplasm, or kidney disease (Supplementary Table 2).

4. Discussion

Contrary to our hypothesis, ACP initiation was associated with more severe depressive symptoms in home-dwelling persons with dementia. ACP initiation was not significantly associated with the quality of life of persons with dementia. Initiation was triggered by dementia diagnosis or accreditation of long-term care insurance benefits. Among those with initiation, 43% did not have any care professionals involved in the conversation process. Furthermore, professional involvement was significantly associated with worse depressive symptoms in persons with dementia.

There is little evidence regarding person-centered outcomes of ACP in terms of depressive symptoms or quality of life, rather than end-of-life measures (14, 46). One randomized-controlled study reported greater improvement in depressive symptoms and quality of life among 10 persons with dementia who received the intervention (35). The association between depressive symptoms and ACP initiation in this study was inconsistent with the previous study (35). There are long-term concerns among professionals regarding ACP causing stress and anxiety in people with dementia and family caregivers (14). This is because the conversation process requires imagining a situation in which the person will lose decisional capacity. However, trusting and open relationships would help overcome such difficult emotions (47). Our findings showed that the participants had a mean duration of 65 months following the clinical diagnosis of dementia, and 39% had depressive symptoms. Although the risk of suicide is most likely after initial diagnosis and decreases over time (5–7), depression and anxiety are highly prevalent across dementia stages (48). Many persons in our study experienced depressive symptoms even some years after receiving the dementia diagnosis. Thus, the ACP initiation and involvement of professionals could reflect their coping strategies in response to dementia-related anxiety. Anxiety and depression were associated with greater ACP engagement among older adults (49). Our results suggest that care professionals may intervene only when the person has worsened symptoms. Further examination is needed to verify whether optimal, timely, and proactive ACP approaches in newly diagnosed persons can prevent dementia-related anxiety and depressive symptoms.

Care professionals were involved in conversations with 57% of the 155 persons with dementia who had initiated ACP. The most frequent types of care professionals involved in ACP included care managers of in-home care services (34%), staff of day-care centers (28%), and care managers of residential care services (25%). Only 17% of the participants had conversations involving doctors

TABLE 2 Comparison of outcome measures according to the initiation of advance care planning (ACP).

	ACP initiation				
Mean (standard deviation)	Never initiated ($N = 224$)	No professionals involved ($N = 67$)	Professionals involved ($N = 88$)	F (2)	*P*-value
Depressive symptoms	0.99 (2.02)[a]	1.33 (2.40)	2.24 (3.21)[a]	8.52	<0.001
Quality of life	0.64 (0.21)[a]	0.64 (0.25)	0.56 (0.22)[a]	4.63	0.010

[a]Significant difference with $P < 0.017$, Bonferroni correction. Depressive symptoms were evaluated using the Japanese version of the Neuropsychiatric Inventory (NPI) (range 0–12). Quality of life was evaluated using the Japanese version of the EuroQol 5 dimensions 5-level (EQ-5D-5L) (range 0–1).

TABLE 3 Multiple linear regression analyses of outcome measures.

	Depressive symptoms		Quality of life	
	Coefficient	95%CI	Coefficient	95%CI
ACP initiation, reference = never initiated				
Professionals involved	0.69	0.11, 1.26	0.003	−0.04, 0.04
No professionals involved	0.001	−0.60, 0.60	−0.01	−0.05, 0.03

CI, confidence interval. Depressive symptoms were evaluated using the Japanese version of the Neuropsychiatric Inventory (NPI) (range 0–12). Quality of life was evaluated using the Japanese version of the EuroQol 5 dimensions 5-level (EQ-5D-5L) (range 0–1). The model included following covariates: family caregiver's age, sex, educational attainment; the person with dementia's age, sex, duration of illness from diagnosis, type of dementia, ADL dependence, cognitive impairment, delusional symptoms, and physical complication.

who provided the dementia diagnosis. In Japan, where there is no registration system for general practitioners, initiation of ACP is promoted in the Initial-phase Intensive Support Teams, which are expected to provide post-diagnostic support to people with dementia and family caregivers (34). However, in our study, there were only 5% of participants whose ACP involved Initial-phase Intensive Support Teams. This may reflect the fact that most people with dementia do not access initial-phase intensive support teams due to less availability compared to general health and social care services.

Our findings also showed that 40.9% of the participants had initiated ACP. The involvement of the person with dementia appeared to be greater than that reported by family physicians among nursing home residents in Belgium (11.8%) (44). Since, 2018 the Ministry of Health, Labor, and Welfare in Japan has announced November 30 as the national ACP (Jinsei-Kaigi) day. This national campaign may have increased awareness of ACP among community-dwelling older adults (50). Uncertainty and instability in healthcare due to the COVID-19 pandemic could also add to the awareness of persons with dementia and family caregivers about planning for the future. Nonetheless, the topics discussed were focused on institutionalization rather than living well with dementia, such as important roles in the community and values of the person. In Australia, more than a half of individuals with dementia knew about ACP, whereas only one-quarter had written down their values and preferences for future care (51). Most persons with dementia in Canada preferred focusing on the present rather than planning for the future (52). Therefore, raising awareness strategies may be imperative to encourage people with dementia to express their values and future hope during ACP conversations. There is currently limited evidence on effective ways of engaging persons with dementia in ACP (53). The COVID-19 guidance on ACP has largely focused on a plan recording an individual's treatment process rather than enabling conversations that constitute the planning process (54). Further strategies are warranted to implement ACP in a more ethical, coordinated and person-centered practice during the COVID-19 pandemic (55).

4.1. Strengths and limitations

The strengths of this study lie in the inclusion of home-dwelling persons and person-centered outcome measures of ACP rather than measures specific to end-of-life care. However, our study has some limitations. A cross-sectional design could not determine the causality between ACP initiation and depressive symptoms. Our data collection was based on the responses of family caregivers. This may have led to a bias regarding outcome measures for persons with dementia and the initiation of ACP. Family caregivers tended to rate worse quality of life for the person with dementia than their self-reported evaluation (56). Family caregivers also had a low to moderate agreement with persons with dementia on care preferences (57). This might have affected their perception of the ACP initiation and types of professionals involved in conversation. Although sex and mean age of our participants were similar with those reported in previous studies using online surveys in Japan (58, 59), our participants included more sons than female partners and daughters of people with dementia, which were more often reported in clinical settings (60) and national questionnaire surveys (61). This study's definition of ACP was developed based on suggestions from Japanese dementia-related associations with a focus on conversation. This definition may not be applicable to ACP in other countries that typically involve documentation of preferences and decisions.

5. Conclusion

Persons with dementia exhibited more severe depressive symptoms when they had care professionals involved in ACP. This study is an important step toward improving post-diagnostic

support for community-dwelling persons having dementia and their family caregivers, requiring the implementation of a more person-centered approach to ACP. Educational and clinical strategies should be examined to encourage care professionals to engage in proactive and effective ACP for people with dementia in the early stages of the disease course.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by the Ethics Committee Tohoku University Graduate School of Medicine, Tokyo Metropolitan Institute of Medical Science. The patients/participants provided their informed consent to participate in this study.

Author contributions

MN, TN, YM, and SY devised the project, conceptualized the ideas, participated in the study design, and evaluation of the questionnaire. MS, HY, and AN were involved in the literature review. MN and TN assisted in data collection and data entry. MN and SY performed data analysis and drafting of the manuscript. TN, YM, MS, HY, SY, and AN contributed substantially to manuscript revision. All authors have read, agreed to the published version of the manuscript, 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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Supplementary material

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References

1. Prince M, Wimo A, Gherchet M, Ali G, Wu Y, Prina M. *World Alzheimer Report 2015: The Global Impact of Dementia. An Analysis of Prevalence, Incidence, Cost and Trends 2015*. (2015). Available online at: https://www.alzint.org/u/WorldAlzheimerReport2015.pdf (accessed March 26, 2022).

2. Brodaty H, Seeher K, Gibson L. Dementia time to death: a systematic literature review on survival time and years of life lost in people with dementia. *Int Psychogeriatr.* (2012) 24:1034–45. doi: 10.1017/S1041610211002924

3. Todd S, Barr S, Roberts M, Passmore AP. Survival in dementia and predictors of mortality: a review. *Int J Geriatr Psychiatry.* (2013) 28:1109–24. doi: 10.1002/gps.3946

4. Nakanishi M, Nakashima T, Shindo Y, Miyamoto Y, Gove D, Radbruch L, et al. An evaluation of palliative care contents in national dementia strategies in reference to the European association for palliative care white paper. *Int Psychogeriatr.* (2015) 27:1551–61. doi: 10.1017/S1041610215000150

5. Erlangsen A, Zarit SH, Conwell Y. Hospital-diagnosed dementia and suicide: a longitudinal study using prospective, nationwide register data. *Am J Geriatr Psychiatry.* (2008) 16:220–28. doi: 10.1097/01.JGP.0000302930.75387.7e

6. Haw C, Harwood D, Hawton K. Dementia and suicidal behavior: a review of the literature. *Int Psychogeriatr.* (2009) 21:440–53. doi: 10.1017/S1041610209009065

7. Draper B, Peisah C, Snowdon J, Brodaty H. Early dementia diagnosis and the risk of suicide and euthanasia. *Alzheimers Dement.* (2010) 6:75–82. doi: 10.1016/j.jalz.2009.04.1229

8. Cui R, Maxfield M, Fiske A. Dementia-related anxiety and coping styles associated with suicidal ideation. *Aging Ment Health.* (2020) 24:1912–15. doi: 10.1080/13607863.2019.1636205

9. Stamou V, La Fontaine J, O'Malley M, Jones B. The nature of positive post-diagnostic support as experienced by people with young onset dementia. *Aging Ment Health.* (2021) 25:1125–33. doi: 10.1080/13607863.2020.1727854

10. van der Steen JT, Radbruch L, Hertogh CM, Gage H, Parkes J, Carter J, et al. White paper defining optimal palliative care in older people with dementia: a Delphi study and recommendations from the European Association for Palliative Care. *Palliat Med.* (2014) 28:197–209. doi: 10.1177/0269216313493685

11. Robinson L, Dickinson C, Rousseau N, Beyer F, Clark A, Hughes J, et al. A systematic review of the effectiveness of advance care planning interventions for people with cognitive impairment and dementia. *Age Ageing.* (2012) 41:263–69. doi: 10.1093/ageing/afr148

12. Dixon J, Karagiannidou M, Knapp M. The effectiveness of advance care planning in improving end-of-life outcomes for people with dementia and their carers: a systematic review and critical discussion. *J Pain Symptom Manage.* (2018) 55:132–50. doi: 10.1016/j.jpainsymman.2017.04.009

13. van der Steen JT, van Soest-Poortvliet MC, Hallie-Heierman M, Onwuteaka-Philipsen BD, Deliens L, de Boer ME, et al. Factors associated with initiation of advance care planning in dementia: a systematic review. *J Alzheimers Dis.* (2014) 40:743–57. doi: 10.3233/JAD-131967

14. Wendrich-van Dael A, Bunn F, Lynch J, Pivodic L, Van den Block L, Goodman C. Advance care planning for people living with dementia: an umbrella review of effectiveness and experiences. *Int J Nurs Stud.* (2020) 107:103576. doi: 10.1016/j.ijnurstu.2020.103576

15. Numbers K, Brodaty H. The effects of the COVID-19 pandemic on people with dementia. *Nat Rev Neurol.* (2021) 17:69–70. doi: 10.1038/s41582-020-00450-z

16. Giebel C, Lord K, Cooper C, Shenton J, Cannon J, Pulford D, et al. A UK survey of COVID-19 related social support closures and their effects on older people, people with dementia, and carers. *Int J Geriatr Psychiatry.* (2021) 36:393–402. doi: 10.1002/gps.5434

17. Livingston G, Huntley J, Sommerlad A, Ames D, Ballard C, Banerjee S, et al. Dementia prevention, intervention, and care: 2020 report of the lancet commission. *Lancet.* (2020) 396:413–46. doi: 10.1016/S0140-6736(20)30367-6

18. Bolt SR, van der Steen JT, Khemai C, Schols JMGA, Zwakhalen SMG, Meijers JM. The perspectives of people with dementia on their future, end of life and on being cared for by others: a qualitative study. *J Clin Nurs.* (2022) 31:1738–52. doi: 10.1111/jocn.15644

19. Nakanishi M, Nakashima T, Miyamoto Y, Yamasaki S, Nishida A. Family caregivers' concerns about advance care planning for home-dwelling people with dementia: a cross-sectional observational study in Japan. *BMC Palliat Care.* (2022) 21:114. doi: 10.1186/s12904-022-01008-0

20. Prime Minister's Office of Japan. *Novel Coronavirus Vaccines*. (2022). Available online at: https://www.kantei.go.jp/jp/content/KOREI-vaccination_data3.xlsx. (accessed March 26, 2022).

21. Ministry of Health, Labour and Welfare. *Comprehensive Survey of Living Conditions 2016*. Tokyo: Health, Labour and Welfare Statistics Association (2018).

22. Cummings JL, Mega M, Gray K, Rosenberg-Thompson S, Carusi DA, Gornbein J. The Neuropsychiatric Inventory: comprehensive assessment of psychopathology in dementia. *Neurology.* (1994) 44:2308. doi: 10.1212/WNL.44.12.2308

23. Cummings JL. The Neuropsychiatric Inventory: assessing psychopathology in dementia patients. *Neurology.* (1997) 48:10S–6S. doi: 10.1212/WNL.48.5_Suppl_6.10S

24. Kaufer DI, Cumming JL, Christine D, Bray T, Castellon S, Masterman D, et al. Assessing the impact of neuropsychiatric symptoms in Alzheimer's disease: the neuropsychiatric inventory caregiver distress scale. *J Am Geriatr Soc.* (1998) 46:210–15. doi: 10.1111/j.1532-5415.1998.tb02542.x

25. Wood S, Cummings JL, Hsu MA, Barclay T, Wheatley MV, Yarema KT, et al. The use of the Neuropsychiatric Inventory in nursing home residents. Characterization and measurement. *Am J Geriatr Psychiatry.* (2008) 8:75–83. doi: 10.1097/00019442-200002000-00010

26. Shigenobu K, Hirono N, Tabushi K, Ikeda M. Validity and reliability of the japanese version of the neuropsychiatric inventory-nursing home version (NPI-NH). *Brain Nerve.* (2008) 60:1463–69. doi: 10.11477/mf.1416100399

27. Herdman M, Gudex C, Lloyd A, Janssen MF, Kind P, Parkin D, et al. Development and preliminary testing of the new five-level version of EQ-5D (EQ-5D-5L). *Qual Life Res.* (2011) 20:1727–36. doi: 10.1007/s11136-011-9903-x

28. Van Hout B, Janssen MF, Feng YS, Kohlmann T, Busschbach J, Golicki D, et al. Interim scoring for the EQ-5D-5L: mapping the EQ-5D-5L to EQ-5D-3L value sets. *Value Health.* (2012) 15:708–15. doi: 10.1016/j.jval.2012.02.008

29. Ikeda S, Shiroiwa T, Igarashi A, Noto S, Fukuda T, Saito S, et al. Developing a Japanese version of the EQ-5D-5L value set. *J Natl Inst Public Health.* (2015) 64:47–55.

30. Kawano Y, Asada T, Kinoshita T, Yasuda A, Hachimori A, Inaba Y, et al. A study of the reliability and validity of the Japanese version of EuroQol EQ-5D and VAS in patients with Alzheimer's disease. *Jpn J Geriatr Psychiatr.* (2009) 20:1149–59.

31. Dementia Australia. *Information and Worksheets to Guide Your Thinking and Discussion in Planning Ahead*. (2022). Available online at: https://www.dementia.org.au/files/start2talk/Information-and-worksheets-to-guide-your-thinking-and-discussion-in-planning-ahead.pdf (accessed March 26, 2022).

32. Denning KH, Castle E, Scates C, Vries KD. Advance care plans in dementia: user-centred design. *BMJ Support Palliat Care.* (2020) 10:e38. doi: 10.1136/bmjspcare-2018-001700

33. Dening KH, Sampson EL, De Vries K. Advance care planning in dementia: Recommendations for healthcare professionals. *Palliat Care.* (2019) 12:1178224219826579. doi: 10.1177/1178224219826579

34. Nakanishi M, Nakashima T. Features of the Japanese national dementia strategy in comparison with international dementia policies: How should a national dementia policy interact with the public health- and social-care systems? *Alzheimers Dement.* (2014) 10:468–76. doi: 10.1016/j.jalz.2013.06.005

35. Hilgeman MM, Allen RS, Snow AL, Durkin DW, DeCoster J, Burgio LD. Preserving identity and planning for advance care (PIPAC): Preliminary outcomes from a patient-centered intervention for individuals with mild dementia. *Aging Ment Health.* (2014) 18:411–24. doi: 10.1080/13607863.2013.868403

36. Tilburgs B, Koopmans R, Vernooij-Dassen M, Adang E, Schers H, Teerenstra S, et al. Educating Dutch general practitioners in dementia advance care planning: a cluster randomized controlled trial. *J Am Med Dir Assoc.* (2020) 21:837–42. doi: 10.1016/j.jamda.2019.09.010

37. Morris JN, Fries BE, Mehr DR, Hawes C, Phillips C, Mor V, et al. MDS Cognitive performance scale. *J Gerontol.* (1994) 49:M174–82. doi: 10.1093/geronj/49.4.M174

38. Yamauchi K, Ikegami N. Method of identifying and staging dementia under long-term care insurance—interrater reliability and validity of Cognitive Performance Scale (CPS). *Jpn J Geriatr Psychiatry.* (1999) 10:943–52.

39. Morris JN, Fries BE, Morris SA. Scaling ADLs within the MDS. *J Gerontol A Biol Sci Med Sci.* (1999) 54:M546–53. doi: 10.1093/gerona/54.11.M546

40. Minemawari Y, Kato T, Aso K. Cognitive function and basic activity of daily living of elderly disabled inpatients. *Nippon Ronen Igakkai Zasshi [Japan Journal of Geriatrics].* (2000) 37:225–32. doi: 10.3143/geriatrics.37.225

41. Holmstrand C, Hallberg IR, Saks K, Leino-Kilpi H, Guiteras AR, Verbeek H, et al. Associated factors of suicidal ideation among older persons with dementia living at home in eight European countries. *Aging Ment Health.* (2021) 25:1730–39. doi: 10.1080/13607863.2020.1745143

42. Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods.* (2007) 39:175–91. doi: 10.3758/BF03193146

43. Faul F, Erdfelder E, Buchner A. Lang AG. Statistical power analyses using G*Power 31: Tests for correlation and regression analyses. *Behav Res Methods.* (2009) 41:1149–60. doi: 10.3758/BRM.41.4.1149

44. Vandervoort A, Houttekier D, Van den Block L, van der Steen JT, Stichele RV, Deliens L. Advance care planning and physician orders in nursing home residents with dementia: a nationwide retrospective study among professional caregivers and relatives. *J Pain Symptom Manage.* (2014) 47:245–56. doi: 10.1016/j.jpainsymman.2013.03.009

45. O'Leary JJ, Reid N, Hubbard RE, Peel NM. Prevalence and factors associated with advance health directives in frail older inpatients. *Intern Med J.* (2022) 52:1160–66. doi: 10.1111/imj.15338

46. Brinkman-Stoppelenburg A, Rietjens JAC, van der Heide A. The effects of advance care planning on end-of-life care: a systematic review. *Palliat Med.* (2014) 28:1000–25. doi: 10.1177/0269216314526272

47. Bolt SR, van der Steen JT, Mujezinović I, Janssen DJA, Scols JMGA, Zwakhalen SMG, et al. Practical nursing recommendations for palliative care for people with dementia living in long-term care facilities during the COVID-19 pandemic: a rapid scoping review. *Int J Nurs Stud.* (2021) 113:103781. doi: 10.1016/j.ijnurstu.2020.103781

48. Leung SKY, Chan WC, Spector A, Wong GHY. Prevalence of depression, anxiety, and apathy symptoms across dementia stages: a systematic review and meta-analysis. *Int J Geriatr Psychiatry.* (2021) 36:1330–44. doi: 10.1002/gps.5556

49. McMahan RD, Barnes DE, Ritchie CS, Jin C, Shi Y, David D, et al. Anxious, depressed, and planning for the future: advance care planning in diverse older adults. *J Am Geriatr Soc.* (2020) 68:2638–42. doi: 10.1111/jgs.16754

50. Kawakami A, Kwong EWY, Lai CKY, Song MS, Boo S, Yamamoto N. Advance care planning and advance directive awareness among East Asian older adults: Japan, Hong Kong and South Korea. *Geriatr Gerontol Int.* (2021) 21:71–6. doi: 10.1111/ggi.14086

51. Bryant J, Sellars M, Waller A, Detering K, Sinclair C, Ruseckaite R, et al. Advance care planning participation by people with dementia: a cross-sectional survey and medical record audit. *BMJ Support Palliat Care.* (2021) 12:e464–8. doi: 10.1136/bmjspcare-2020-002550

52. Sussman T, Pimienta R, Hayward A. Engaging persons with dementia in advance care planning: challenges and opportunities. *Dementia.* (2020) 20:1859–74. doi: 10.1177/1471301220973059

53. Bryant J, Turon H, Waller A, Freund M, Mansfield E, Sanson-Fisher R. Effectiveness of interventions to increase participation in advance care planning for people with a diagnosis of dementia: a systematic review. *Palliat Med.* (2019) 33:262–73. doi: 10.1177/0269216318801750

54. Hopkins SA, Lovick R, Polak L, Browers B, Morgan T, Kelly MP, et al. Reassessing advance care planning in the light of COVID-19. *BMJ.* (2020) 369:m1927. doi: 10.1136/bmj.m1927

55. Sinclair C, Nolte L, White BP, Detering KM. Advance care planning in Australia during the COVID-19 outbreak: now more important than ever. *Intern Med J.* (2020) 50:918–23. doi: 10.1111/imj.14937

56. Crespo M, de Quirós MBM, Mar Gómez MM, Hornillos C. Quality of life of nursing home residents with dementia: a comparison of perspectives of residents, family, and staff. *Gerontologist.* (2012) 52:56–65. doi: 10.1093/geront/gnr080

57. Dening KH, King M, Jones L, Vickerstaff V, Sampson EL. Advance care planning in dementia: do family carriers know the treatment preferences of people with early dementia? *PLoS ONE.* (2016) 11:e0159056. doi: 10.1371/journal.pone.0159056

58. Nakabe T, Sasaki N, Uematsu H, Kunisawa S, Wimo A, Imanaka Y. The personal cost of dementia care in Japan: a comparative analysis of residence types. *Int J Geriatr Psychiatry.* (2018) 33:1243–52. doi: 10.1002/gps.4916

59. Igarashi A, Fukuda A, Teng L, Ma FF, Dorey J, Onishi Y. Family caregiving in dementia and its impact on quality of life and economic burden in Japan-web based survey. *J Mark Access Health Policy.* (2020) 8:1720068. doi: 10.1080/20016689.2020.1720068

60. Nakanishi M, Igarashi A, Ueda K, Brnabic AJM, Treuer T, Sato M, et al. Costs and resource use associated with community-dwelling patients with Alzheimer's disease in Japan: baseline results from the prospective observational GERAS-J study. *J Alzheimers Dis.* (2020) 74:127–38. doi: 10.3233/JAD-190811

61. Ohno S, Chen Y, Sakamaki H, Matsumaru N, Yoshino M, Tsukamoto K. Humanistic burden among caregivers of patients with Alzheimer's disease or dementia in Japan: a large-scale cross-sectional survey. *J Med Econ.* (2021) 24:181–92. doi: 10.1080/13696998.2021.1877149

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Who uses technical aids in old age? Exploring the implementation of technology-based home modifications in Europe

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Introduction: Home modifications and features, e.g., handrails or ramps for people using wheelchairs, should allow residents with functional limitations to maintain social participation, health, and wellbeing for aging in place. However, there is little evidence in relation to the individual characteristics shaping this implementation of technology-based home modifications. Current studies often focus on describing the distribution of certain implementations in households but do not provide information on factors predicting the implementation or detailed and multifaceted data on associations with characteristics of the older user. This article, therefore, examines the use of well-established technological aids and home modifications (e.g., ramps, handrails, automatic doors, bathroom or kitchen modifications, chair lifts, and alerting devices) in the households of older adults in Europe. We refer to Lawton's and Nahemow's concept of personal-environment fit and describe the use of technical aids across 18 countries, analyze associations with individual characteristics and social resources, and compare those associations and variance explanation between older adults in their third age ("young-old", 65–79 years) and older adults in their fourth age ("old-old", 80+).

Methods: Drawing on representative data from the Survey of Health, Ageing, and Retirement in Europe (SHARE), wave 6, a total of N = 38,553 older adults aged 65–105 years (M = 74.4 years, SD = 7.1; 55% women) were analyzed by performing hierarchical logistic regression analyses.

Results: Indicators of functioning explained the highest proportion of variance, followed by social resources, and variance explanation was higher for the fourth age than for the third age. In particular, older adults with physical limitations, a larger social network, and those who received care from a child outside the household were more likely to have home modifications installed.

Discussion: The study provides an overview of associations of diverse variables with assistive devices and modifications in the home and can serve as a starting point for public health activities concerning the heterogeneity of people aged 65 years and older.

KEYWORDS

aging in place, home modifications, technical aids, functional abilities, social network, mental health, internet use among older adults, mobility limitations

1. Introduction

"Aging in place" and "aging in the community"—the ability to live safely, independently, and comfortably in one's own home and community, regardless of age, income, or competence level—have gained public interest and become key topics for older individuals as well as in healthcare policies (1, 2). The creation of age-friendly environments entails several dimensions such as transport infrastructure, safety in the community, accessibility to houses and public spaces, and universal design (3, 4). In this context, home modifications and features, e.g., handrails or ramps for people using wheelchairs, should allow residents with functional limitations to maintain activities in their daily life. The WHO (5) also underlines the possibilities of access to the internet and assistive technologies to maintain social participation, information, and quality of life for older people in their homes. Expectations are high that technology has the potential to facilitate health prevention, independence at home, and overcoming challenges in healthcare, especially as we have now entered the so-called Decade of Healthy Aging (2021–2030) (6). According to statistics from the European Commission (7), during the next 50 years, the ratio of Europeans aged 65 years and older will increase from 20% today to 30% in 2070. In addition, 49.7% of the EU population aged 65 years and older report moderate or severe difficulties with at least one everyday activity (8).

Indeed, a growing number of research demonstrates the use and potential of technology-based home modifications, although studies also indicate that older people may face barriers when implementing these technologies. Previous studies found that the modification of grab bars is used in particular, followed by shower seats, raised toilet seats, and grab bars near the toilet for persons aged 52 or older (9) or aged 65 or older (10). These features can be classified as technical aids with a low level of digitalization. With regard to the impact of technical aids (e.g., ramps and alarm buttons) on functional health, recent studies provide evidence that modifications in the home reduce difficulties in performing (instrumental) activities of daily living. Liu and Lapane (11) examined data from two waves (N = 9,447) of the Second Longitudinal Study of Aging, a representative study of older noninstitutionalized adults aged 70 years and older from the United States. The results show that people aged 70 years and older who had modifications in their home at the baseline measurement were less likely to experience a worsening of their functional abilities after 2 years compared with older adults without modifications. Using data from the Survey of Health, Ageing, and Retirement in Europe (SHARE) for adults aged 60 years and older, Wu et al. (12) analyzed the extent to which home modifications (e.g., wide doors and grab bars) were related to health status after 3 years of implementation. Results showed that adding one modification to the house was associated with a reduction in the risk of falling by about 1.3%. In addition, the Swedish study from Petersson et al. (13) explored improvements due to the implementation of technical aids in the household. Participants who reported difficulties and feelings of insecurity in performing various (instrumental) activities of daily living (e.g., climbing stairs) at the first measure point reported better performances 2 months after the intervention.

However, there is little evidence in relation to the individual characteristics shaping this implementation of technology-based home modifications. Current studies often focus on describing the distribution of certain implementations in households but do not provide information on factors predicting the implementation. Regarding the type of technology, information and communication technologies (ICT) are often the focus of attention. Having a deeper understanding of the characteristics which influence the probability of home modifications can be useful to address more effective and sustainable interventions for aging in place and in the community.

1.1. Technical aids in the household—Characteristics and resources of older users

First, studies with European data found that a significant number of older adults make modifications to their households with country-specific differences. Wu et al. (12) reported that 22% of Europeans modified their households and that the use of assistive devices was higher in the countries studied from Western Europe (e.g., France and Germany) than in Southern European countries (e.g., Spain and Italy) (25 and 10%, respectively). A longitudinal study (14) examined older adults from five European countries (Sweden, Germany, United Kingdom, Latvia, and Hungary) regarding the use of assistive devices. They analyzed data from the European research project Enabling Autonomy, Participation, and Wellbeing in Old Age: The Home Environment as a Determinant for Healthy Aging (ENABLE AGE). Here, too, it was found that many older people had a desire for supportive modifications but did not act on them. Approximately 24% of Europeans involved in the study (N = 1,918) reported an unmet need for adaptations (e.g., aids for showering) (14).

Building on *socio-demographic characteristics*, some studies suggest that women were more likely to have home modifications than men (10, 15, 16). In addition, the probability of modifications increases with age to successfully adapt to limitations in mobility (17, 18). The European study from Wu et al. (12) confirmed that older adults aged 80 years and older (33%) were more likely to use assistive devices compared to adults between 60 and 70 years of age (22%). With regard to the influence of educational background and income, studies provide largely varying results. While some studies underline a higher educational level as a significant predictor of a higher number of applied aids (10, 19, 20), other research indicates a higher probability of modifications for persons with lower education especially regarding features to maintain mobility (21). In the study of Ishigami et al. (21) also a lower income was associated with higher use of assistive devices. However, considering the interaction of income and health status, it can be assumed that persons with higher income had fewer functional limitations, and accordingly, their need for assistive devices was lower (15).

Social support is considered an important resource for aging in place as well as aging in the community (22). Receiving help from people in their social network also indicates to enable the implementation and use of technical aids (10, 23, 24) Partners, children, or peers may recommend or discourage the use of certain devices based on their preferences and opinions. Thus, technical features such as alarm sensors may be used to reassure relatives not living close by (24). In particular, informal caregivers' need for information (e.g., seeking information to ensure the safety of the care recipient at home) and their perception of fall risk (e.g., due to past falls) correlates positively with household modifications (17, 25, 26).

Only few studies explored the associations between *mental health* and the use of assistive devices among older persons in their homes and results appear to be inconsistent. While some studies found no significant relation between mental health problems (e.g., depression, guilt, and sleep problems) and the use of assistive devices (12, 27), the results of other studies show that, for example, feelings of loneliness and use of mobility aids (walking sticks) were positively correlated (21). On the other hand, according to a US study, depressive symptoms of people aged 65 years and older decreased the likelihood of mobility aids (i.e., walkers) by about 25% while at the same time, the likelihood of personal assistance was increased (28). Moreover, a cross-sectional Swedish study found that the number of physical environmental barriers as well as lack of accessibility (e.g., dependence on mobility aids, functional limitations, narrow doors, and lack of grab bars) were negatively related to life satisfaction (29).

Functional health, along with sociodemographic variables, is the most commonly studied predictor of older adults' installation of home modifications. Previous research classifies a limited level of physical functioning as a facilitating factor for use of technological modifications in the home. Several studies show that older adults with multiple chronic conditions are more likely to use assistive devices (10, 21, 30).

In addition, a variety of studies provide evidence that limitations in (instrumental) activities of daily living (IADL/ADL) are related to a higher likelihood of the implementation of assistive technology devices in the homes of older adults (10, 12, 20, 27, 31, 32). For example, results of Pressler and Ferraro's study show that lower body impairments, in particular, that lead to severe difficulties in activities of daily living, such as climbing stairs, significantly predicted the number of assistive devices used (20).

In addition, recent studies indicate that subjectively assessed poor health is also associated with the implementation of assistive technology. Data from a Canadian longitudinal study (21) found that older adults aged 65 years and older with poor perceived health status increased their use of assistive technology. According to this study, 60% of women and 50% of men used an assistive device to support mobility, such as walkers. In contrast, 9% of women and 8% of men with excellent perceived health status used assistive devices.

Thus far, there is a significant lack of research examining the extent to which the *use of information and communication technologies* such as the internet can also be transferred to the use of assistive devices in the home (e.g., alarm buttons). However, it could be inferred that global confidence in one's own ICT skills can also apply to household modifications.

1.2. The interconnection of person, environment, and household modifications

Theoretically, the environmental press theory by Lawton and Nahemov (33) is suited to explain the connections between a person's exposure to technology and contextual conditions. The theory highlights the fit between the individual competences (e.g., physical health and cognitive competences) and the environment (e.g., home, social interactions, and neighborhood) and their interaction with each other. The level of the person includes the ability and willingness, while the environment—as a special but also socially created construct—gives the framework of what is possible or should be done. A successful balance between person and environment means that there are no significant disparities between both levels of individual competences and environmental demands. Thus, persons are influenced in their being and thinking by their environment but are also agents for changing the environment to overcome disparities. In particular, the theory conceptualizes the influence of the environment on "wellbeing" in old age or on "aging well". The authors argue that the behavior of older people is increasingly determined or shaped by environmental conditions with age, as declining resources (physical, cognitive, or social) make it more difficult to change those conditions or overcome certain barriers (33). Thus, environmental conditions gain importance for aging independently and aging in place. "Aging well" means an adequate fit of resources and environment in an interplay of its physical, social, and technical characteristics and individual needs. According to this approach, the situation can become imbalanced by an increasing need for care, when own resources and activities of daily living contrast with the circumstances in the environment, and individuals are not able to compensate or modify the situation.

Hence, the environment may influence the vulnerability of personal wellbeing and health if, for example, there are physical barriers or infrastructural deficits. However, it can also strengthen health and wellbeing in old age if, for example, technical or social support can compensate for age-related impairments (34, 35). The use of assistive devices and implementation of technical aids implies an active adaptation process in order to maintain one's own independence and continue to feel "at home" in a balance of agency (level of action and modification) and belonging (meaning, identity, and familiarity) (35).

1.3. Research aims

The present study examined the use of well-established assistive devices and home modifications (e.g., ramps, handrails, automatic doors, bathroom or kitchen modifications, chair lifts, and alerting devices) in the households of older adults in Europe by drawing on representative data from the Survey of Health, Ageing, and

Retirement in Europe (SHARE), wave 6 (36). Referring to Lawton's and Nahemow's (33) concept of person-environment fit, we explored the contribution of sociodemographic characteristics, social resources, mental health, health and functional abilities, and internet usage and computer competence in explaining if home modifications are installed in the household. Moreover, we aimed to compare those associations and variance explanations between older adults in their third age ("young-old", 65–79 years) and older adults in their fourth age ("old-old", 80+) (37, 38). We are using this distinction between both age groups given that frailty and functional limitations are statistically more associated with people aged 80 years and older. At the same time, we are aware of the heterogeneity and blurred boundaries in the transition from young-old to old-old.

2. Method

2.1. Data and participants

Data for the present study derive from the sixth wave of SHARE (Survey of Health, Ageing, and Retirement in Europe), a longitudinal panel survey including participants from the age of 50 years and older plus their co-residing partners, independent of age (36, 39–41). The fieldwork of the sixth wave of SHARE was completed in November 2015. Background information gathered in former SHARE waves was added by using the *easy* SHARE dataset (36, 42). Interviews include questions regarding health, functional abilities, household composition, economic situation, work, volunteering, and social or psychological variables. They are conducted biannually in a variety of European countries. All participants provided informed consent at the beginning of the computer-assisted personal interview (CAPI).

We restricted our analyses to those aged 65+ years. In total, data of $N = 38{,}553$ individuals from 18 countries (Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, France, Germany, Greece, Israel, Italy, Luxemburg, Poland, Portugal, Slovenia, Spain, Sweden, and Switzerland) were analyzed. Participants' age ranged from 65 to 105 years (M = 74.4 years, SD = 7.1) and 55% were women. All participants were community-dwelling older adults and did not live in nursing homes or comparable institutions.

2.2. Study variables

Our target variable implementation of technology-based home modifications was based on the question, which special features were present in the homes of participants (i.e., ramps or street level entrances, handrails, automatic or easy open doors or gates, bathroom or toilet modifications, kitchen modifications, chair lifts or stair glides, alerting devices such as button alarms or detectors, and other modifications). Due to the extremely skewed distribution (also after log transformation), we decided to use a dichotomized outcome variable with the values 0 = no modifications/special features and 1 = modifications/special features implemented. We included five blocks of predictor variables (1. background information, 2. social resources, 3. mental health, 4. health and functional abilities, and 5. internet usage and computer competence) to estimate the probability of having home modifications installed.

2.2.1. Background information

As background information, we included *gender* (0 = male, 1 = female), *age*, *education*, and *household income* (in €). For education, the country-specific categories were classified according to the International Standard Classification of Education (ISCED-97) and recoded into low/medium (ISCED 1 to 4) and high (ISCED 5 and 6).

2.2.2. Social resources

Social resources were captured via four constructs, namely *single household* (no = 0, yes = 1), *number of children* (biological and non-biological), *social network size* (0–7), and *receiving care from a child outside the household* (no = 0, yes = 1). Social network size was assessed by asking respondents to name up to seven people with whom they discuss important things (43).

2.2.3. Mental health

To indicate the mental health of participants, we included *quality of life*, assessed via the CASP-12 scale (44) which includes the domains of control, autonomy, self-realization, and pleasure (12 items, range 12 to 48, higher scores indicating higher quality of life). Moreover, *depressive symptoms* were assessed with the Euro-D Scale (45) (16 items, range 0–12 = very depressed), and *loneliness* using the Three-Item Loneliness Scale (46) (three items, range 3–9, higher scores indicating higher loneliness).

2.2.4. Health and functional abilities

Seven indicators were used to address health and functional abilities. We included the *body mass index (BMI), self-rated health*, a single item, ranging from poor (=1) to excellent (=5), *number of diseases* (e.g., hypertension, cancer, diabetes mellitus, range: 0 to 9), and *maximal grip strength* (range 1–98 kg), (47). To describe the number of limitations with *activities of daily living,* the ADL index was included (48). The modified version used in SHARE includes six activities (49). Thus, scores range from 0 to 6 with higher scores indicating more difficulties with these activities. To indicate *mobility limitations,* respondents could name up to 10 limitations in everyday activities related to mobility, e.g., walking for 100 m or picking up a small coin from a table. A dichotomous variable was used, differentiating people with no limitations (=0) from those with any limitation (=1). Moreover, *fear of falling* (no = 0, yes = 1) was included.

2.2.5. Internet usage and computer competence

The last block of predictors included *internet usage*, namely, if participants had used the internet at least once during the last 7 days (no = 0, yes = 1), and *computer skills* on a 5-point Likert scale which was recoded for our analyses with higher scores indicating higher self-rates competence (1 = poor; 5 = excellent).

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TABLE 1 Descriptive statistics for the total sample (65+ years).

Variable	*M* or %	*SD*	Range
Background information			
Gender (% female)	55.0%		
Age	74.4	7.1	65–105
Education[a]	18.9%		
Household net income (€)	23,828.3	30,049.9	0–2.526,411.0
Social resources			
Single household (% yes)	28.0%		
Number of children	2.2	1.4	0–19
Social network size	2.6	1.6	0–7
Care from child outside household (% yes)	24.0%		
Mental Health			
Quality of Life[b]	36.5	6.5	12–48
Depressive symptoms[c]	2.6	2.3	0–12
Loneliness[d]	4.1	1.5	3–9
Health and functional abilities			
Body mass index	27.0	4.5	12–99
Self-rated health[e]	2.6	1.0	1–5
Number of chronic diseases	1.5	1.3	0–9
Maximal grip strength	30.4	10.9	1–98
Activities of daily living (ADL)[f]	0.36	0.9	0–5
Mobility limitations (% yes)	60.2%		
Fear of falling (% yes)	18.3%		
IT usage and competence			
Internet usage (% yes)	33.8%		
Computer skills[g]	2.2	1.3	1–6

N = 38,553.
[a]Proportion with higher education (ISCED 5, 6); [b]CASP-12 scale, higher scores indicate higher quality of life; [c]EURO-D scale, higher scores indicate higher depression; [d]Three-Item Loneliness Scale, higher scores indicate higher loneliness; [e]higher scores indicate better health; [f]ADL index, higher scores indicate more difficulties with ADL; [g]higher scores indicate better self-rated computer skills.

Descriptive statistics for predictor variables including means, standard deviations, and range of study variables are provided in Table 1.

2.3. Statistical analyses

Binomial logistic regression analyses were performed to determine the effects of background variables, social resources, mental health, health and functional abilities, and computer competencies to predict the likelihood of having technical aids and modifications in the household. Statistical analyses were performed using SPSS version 27.0.

Key assumptions regarding binomial logistic regression analyses were met (i.e., linear relationship using the Box-Tidwell procedure, no outliers, no multicollinearity or auto-correlation) for the total sample (65+ years) as well for the analyses of the two subsamples in the third age (65–79 years) and fourth age (80+ years).

3. Results

In the total sample (65+ years), 13% of households had at least one technical modification/special feature installed. Bathroom or toilet modifications (6%) and handrails (5%) were the most common modifications. With regard to age groups, the percentage of having at least one modification at home was lower in the third age (65–79 years) with 11% compared to the fourth age (80+) with 18%.

Logistic regression analyses revealed a variance explanation of approximately 9.2% (Nagelkerke's R^2) in the total sample, with a higher variance explanation (13.3%) for the fourth-age subsample and only 7.1% among the third-age participants. As expected, the block containing health variables and functional indicators revealed the highest contribution in the total sample and both age groups, followed by social resources.

Odds ratios and confidence intervals for every single predictor are depicted in Table 2 for the total sample. For example, with respect to sociodemographic variables, older age and a higher household net income increased the likelihood of home modifications, whereas gender was not a relevant predictor. For the second block which contained social resources, the most important predictors were social network size, with each additional person named as a close confidant increasing the likelihood of implementation by 27% and receiving care from a child outside the household, which implied a 60% higher chance for home modifications. Associations for the third block of mental health resources were lower, with loneliness showing no significant effect and rather smaller effects on quality of life and depression. Within the fourth block which comprised health and functional indicators, higher limitations in activities of daily living, having mobility limitations, and reporting fear of falling most prominently increased the likelihood of having (technical) features installed with increased likelihood between 33% and 44%. Significant but small effects were found for BMI, health, and grip strength. Finally, internet usage and higher self-reported computer skills did increase the odds of home modifications, although the contribution to the variance explanation of this last block was not substantial (0.5%).

Comparing the two subsamples, some variables were of stronger importance in the fourth age (see Table 3), with larger effects for higher fear of falling (37% higher likelihood in the third age vs. 59% in the fourth age), having mobility limitations (39% in third age vs. 66% in fourth age), or lower grip strength, which was not significant in the younger sample (4% higher likelihood) but increased the likelihood of having home modifications in the older sample (15% higher likelihood). On the other hand, internet usage was only of importance among the young-old but was insignificant among the old-old.

TABLE 2 Logistic regression analysis explaining the implementation of technology-based home modifications for the total sample (65+ years).

Predictor	OR	95% CI
Background information		
Gender[a]	0.91	0.81–1.03
Age	**1.24**	1.19–1.31
Education[b]	**0.90**	0.81–0.99
Household net income	**1.14**	1.10–1.19
Social resources		
Single household[c]	0.99	0.91–1.09
Number of children	**1.05**	1.01–1.10
Social network size	**1.27**	1.23–1.32
Care from child outside household[c]	**1.60**	1.45–1.76
Mental health		
Quality of life[d]	**1.18**	1.12–1.25
Depressive symptoms[e]	**1.13**	1.07–1.19
Loneliness[f]	0.98	0.94–1.03
Health and functional abilities		
Body mass index	**1.02**	1.01–1.03
Self-rated health[g]	**1.06**	1.01–1.12
Number of chronic diseases	1.03	0.99–1.07
Maximal grip strength	**0.93**	0.88–0.99
Activities of daily living (ADL)[h]	**1.33**	1.26–1.40
Mobility limitations[i]	**1.44**	1.31–1.59
Fear of falling[c]	**1.44**	1.30–1.59
IT usage and competence		
Internet usage[j]	**1.21**	1.07–1.37
Computer skills[k]	**1.11**	1.04–1.18
Model Fit	$\chi^2 = 1094.484$ (20), $p < 0.001$, Nagelkerke's $R^2 = 0.092$	

N = 18,892; Method = Enter. OR, Odds Ratio; CI, Confidence interval.
Significant Odds Ratios in bold ($p < 0.05$).
[a]0 = male, 1 = female; [b]0 = low/medium (ISCED 1–4, 95, 97), 1 = high (ISCED 5, 6); [c]0 = no, 1 = yes.
[d]CASP-12 scale, higher scores indicate higher quality of life; [e]EURO-D scale, higher scores indicate higher depression; [f]Three-Item Loneliness Scale, higher scores indicate higher loneliness; [g]higher scores indicate better health; [h]ADL index; higher scores indicate more difficulties with ADL; [i]Limitations in mobility, arm function, and fine motor skills, 0 = no, 1 = yes; [j]Internet use within the last 7 days, 0 = no, 1 = yes; [k]higher scores indicate better self-rated computer skills.

4. Discussion

The present study explored associations between individual characteristics and the implementation of special features or modifications in the homes of older adults in Europe. Logistic regression analyses revealed that health variables and functional abilities, such as limitations in ADL, mobility, and low grip strength, were important predictors for having respective modifications at home, which was also the case for social resources, such as having a larger social network and receiving care from a child outside the household.

A higher age was predictive of having modifications at home, which was also found in previous studies (12, 17, 18). For gender, education, and income, the body of research is more inconsistent [e.g., (10, 15, 19, 20)]. Gender effects were not found in our study, which was also reported in the recent release of the American Housing Survey (50). This can also be due to a confounding relationship with other study variables that is difficult to disentangle. For example, women reported significantly lower education and income, and better social resources (i.e., network size), but lower functional abilities (e.g., activities of daily living, mobility impairments) in our sample, and these indicators were, in turn, predictive for home modification in the one or the other direction. A higher education *reduced* the likelihood of home modifications in our study, but only in the young-old sample. This direction of association was also reported by Ishigami et al. (21), but, e.g., not by Meucci et al. (10), and could be due to the fact that higher education is often associated with better physical functioning in old age (51), which relates to a lower chance of home modifications. For participants with higher income, we found a higher chance of home modifications, which corresponds to some evidence, e.g., representative samples of noninstitutionalized US adults aged 65+ years (50, 52), but not to other, equally large studies (10, 15).

The importance of social resources (i.e., network size, and care from a child outside the household) that was indicated in the present study is in accordance with the findings of Ang et al. (25), Meucci et al. (10), and Peek et al. (23), who all reported evidence that informal caregivers are initiators of household modifications in order to facilitate everyday activities and prevent accidents.

Mental health variables could only explain a rather small share of variance. Based on the results, it could only be partially confirmed that mental health issues increase the likelihood of using technical aids in the home. In contrast to some previous studies (27, 28), persons who reported depressive symptoms were more likely to use assistive technology. A possible explanation is that this association is mediated by functional limitations since depression is associated with poorer health, which in turn is associated with a higher likelihood of using assistive devices.

Consistent with other studies, our results suggest that assistive devices are applied in the environment to maintain control and agency in daily life despite increasing functional limitations, which in turn maintains a high quality of life and satisfaction (29, 53). Moreover, fear of falling was a significant predictor of installing home modifications. This finding suggests that home safety and avoidance of accidents are important to many older adults. As functional indicators were highly significant for assistive device implementation, this could be interpreted as the individual strategy to adapt to the functional limitations and barriers in the environment.

The exploratively included factors of internet usage and computer skills were rather weak predictors in our analyses. In fourth age, only self-rated skills were slightly associated with the implementation of home modifications, while in third age, higher usage and skills were predictive for home modifications. ICT

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TABLE 3 Logistic regression analyses explaining the implementation of technology-based home modifications by age group.

	65–79 years ($N = 14,852$)		80+ years ($N = 4,040$)	
Predictor	OR	95% CI	OR	95% CI
Background information				
Gender[a]	0.92	0.80–1.06	0.89	0.71–1.11
Age	**1.21**	1.12–1.31	**1.35**	**1.15–1.58**
Education[b]	**0.88**	0.78–0.99	0.93	0.75–1.17
Household net income	**1.14**	1.10–1.19	**1.16**	1.04–1.28
Social resources				
Single household[c]	0.97	0.87–1.08	1.01	0.86–1.20
Number of children	1.03	0.98–1.08	**1.10**	1.01–1.19
Social network size	**1.26**	1.20–1.31	**1.34**	1.23–1.45
Care from child outside household[c]	**1.65**	1.47–1.86	**1.49**	1.26–1.76
Mental health				
Quality of life[d]	**1.14**	1.07–1.22	**1.29**	1.16–1.44
Depressive symptoms[e]	**1.13**	1.07–1.20	**1.12**	1.01–1.24
Loneliness[f]	0.99	0.94–1.05	0.97	0.89–1.06
Health and functional abilities				
Body mass index	**1.01**	1.01–1.02	**1.04**	1.02–1.06
Self-rated health[g]	1.04	0.98–1.11	**1.13**	1.02–1.25
Number of chronic diseases	1.04	0.99–1.09	1.01	0.93–1.09
Maximal grip strengh	0.96	0.90–1.04	**0.85**	0.74–0.97
Activities of daily living (ADL)[h]	**1.31**	1.23–1.41	**1.35**	1.24–1.47
Mobility limitations[i]	**1.39**	1.24–1.54	**1.66**	1.33–2.08
Fear of falling[c]	**1.37**	1.20–1.55	**1.59**	1.34–1.89
IT usage and competence				
Internet usage[j]	**1.26**	1.10–1.45	1.01	0.75–1.38
Computer skills[k]	**1.10**	1.03–1.18	**1.17**	1.01–1.36
Model Fit	$\chi^2 = 638.40$ (20), $p < .001$		$\chi^2 = 376.55$ (20), $p < .001$	
	Nagelkerke's $R^2 = .071$		Nagelkerke's $R^2 = .133$	

Method = Enter; OR, Odds Ratio; CI, Confidence interval.
Significant Odds Ratios in bold ($p < 0.05$).
[a]0 = male, 1 = female; [b]0 = low/medium (ISCED 1–4, 95, 97), high (ISCED 5, 6); [c]0 = no, 1 = yes.
[d]CASP-12 scale, higher scores indicate higher quality of life; [e]EURO-D scale, higher scores indicate higher depression; [f]Three-Item Loneliness Scale, higher scores indicate higher loneliness; [g]higher scores indicate better health; [h]ADL index, higher scores indicate more difficulties with ADL; [i]Limitations in mobility, arm function, and fine motor skills, 0 = no, 1 = yes; [j]Internet use within the last 7 days, 0 = no, 1 = yes; [k]higher scores indicate better self-rated computer skills.

technologies are predominantly used for information seeking (e.g., reading the news), communications with others, or entertainment. In contrast, modifications in the home (e.g., ramps) serve more pragmatic purposes. In addition, older adults in our sample rated their overall computer competence as averagely poor, suggesting limited variance. Nearly half of those 65 years and older said they had never used a computer (47%).

4.1. Limitations

Our study has limitations that need to be acknowledged: the cross-sectional results do not allow causal interpretation and longitudinal analyses are needed to investigate if changes in individual characteristics, i.e., decreases in grip strength or increases in fear of falling, provoke the decision to install home modifications. Moreover, as the variance explanation was not high in total, there might be other factors that are relevant to the decision to have special features installed. For example, the length of residence in the respective household might increase the likelihood of having modifications implemented. The skewed distribution only allowed for a dichotomized and logistic approach, more detailed research is needed as well as explorative research among non-users regarding respective features and potential barriers toward adoption. As SHARE data only depict the existence of home modifications, but not actual usage, more fine-tuned assessments

would provide further insights, i.e., on the frequency of use. Strengths of the study include the large and representative sample, the combined consideration of a variety of constructs clustered in different thematic blocks, and the comparison of two theoretically derived age groups. In addition, results of previous studies, mainly from the US or Canada, can be confirmed and transferred to older adults in Europe.

4.2. Conclusion

Data from Eurostat (2023) shows that the majority of people aged 65+ years live in their own households (with other persons or alone) (54). Home modifications bear the potential to enable aging in place for older people. It was the aim of our study (1) to analyze to what extent established technical aids and home modifications (automatically opening doors, ramps, grab bars, age-appropriate adaptations in bathrooms or kitchens, stair lifts, and alarm devices) are actually available in the households of older Europeans and (2) to explore which individual characteristics are substantially associated with the implementation of modifications in the household. We conclude that, although causal explanations are not possible, some findings relate to theoretical assumptions such as the environmental press theory. The installation of home modifications can be interpreted as a compensatory strategy that addresses gaps in the person-environment fit. In the seminal study of Lawton and Nahemow (33), as well as in later work in the field of environmental gerontology (35), it is argued that successful functioning is the result of a balance between the level of challenge occurring in the close environment and an individual's abilities to meet those challenges. The decision of older adults to have home modifications installed reflects an effort to regain this balance and is embedded in their personal, social, and physical context.

We perceive our study as a contribution to exploring the implementation of technology-based home modifications in Europe. Future research could be designed to uncover the entire implementation process and expand the effects of various technical aids on health. Thus, future studies could be able to provide more scientific knowledge for older adults, but also informal caregivers, on which aids are particularly effective. In addition, future studies should examine previously researched mediators and moderators from health psychology that might impact the implementation of assistive devices. One potential mediator between functional limitations and assistive technology devices in the home is knowledge and information about what modifications are available and what steps are required to obtain reimbursement. Another potential mediator variable is accessibility to technical aids and modifications. There might be a lack of options to acquire certain assistive devices in rural settings amplified by a lack of internet access at home. Therefore, future studies regarding aging in place should examine the extent to which place of residence is related to assistive technology implementation.

Our analyses may also provide some indications for interventions in public health, although we emphasize that home environments are a context of complex and multilayered interactions (35). The positive associations of social resources and functional limitations for implementing assistive devices suggest that facilitating and hindering factors of home modifications differ among older adults. As social resources were also quite strongly related to the likelihood of implementing technical aids, older persons with few social contacts seem more vulnerable in terms of aging in the community. For socially isolated individuals, strengthening the social network in the community can be helpful to encourage social interaction with other persons who already experience modifications. Other older adults with functional limitations, e.g., in personal care, will benefit from assistance in selecting an adequate assistive. At the same time, public health stakeholders are responsible to provide better and low-threshold information about the possibilities of household modifications and to make them financially accessible. Awareness of these entangled factors is needed in order to provide tailored support that may facilitate aging in place through the use of technical aids. Therefore, the article underlines the importance of public health responses concerning the heterogeneity of older households.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found here: http://www.share-project.org/data-access.html?L=.

Author contributions

LS was responsible for conceptualizing the outline, statistical models, data analysis, and discussion. MW participated in each part of the manuscript development and contributed to data analysis and the discussion. HB organized data analysis, contributed to the discussion, and facilitated the creation of the manuscript. AF prepared the introduction, the theoretical part, and the policy background and contributed to the discussion. All authors shared the preparation of the conclusion and made comments, suggestions, and corrections to the rest of the article. 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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References

1. Centers for Disease Control and Prevention. *Designing and Building Healthy Places.* (2017). Available online at: https://www.cdc.gov/healthyplaces/terminology.htm (accessed March 26, 2022).

2. Ollevier A, Aguiar G, Palomino M, Simpelaere IS. How can technology support ageing in place in healthy older adults? A systematic review. *Public Health Rev.* (2020) 41:26. doi: 10.1186/s40985-020-00143-4

3. WHO. *Global Age-Friendly Cities: a Guide.* (2007). Available online at: https://apps.who.int/iris/handle/10665/43755 (accessed December 6, 2022).

4. WHO. *Measuring the Age-Friendliness of Cities. A Guide to Using Core Indicators: World Health Organization.* (2015). Available online at: https://apps.who.int/iris/bitstream/handle/10665/203830/9789241509695_eng.pdf (accessed December 6, 2022).

5. WHO. *Improving Access to Assistive Technology.* (2018). Available online at: https://apps.who.int/gb/ebwha/pdf_files/WHA71/A71_21-en.pdf (accessed December 6, 2022).

6. WHO. *UN Decade of Healthy Aging.* (2022). Available online at: https://www.who.int/initiatives/decade-of-healthy-ageing (accessed December 19, 2022).

7. European Commission. *European Commission Report on the Impact of Demographic Change.* (2020). Available online at: https://ec.europa.eu/info/sites/default/files/demography_report_2020_n.pdf (accessed February 3, 2022).

8. Eurostat. *Disability Statistics—Elderly Needs for Help or Assistance.* (2022). Available online at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Disability_statistics_-_elderly_needs_for_help_or_assistance#Need_for_help_with_personal_care_or_household_activities (accessed December 6, 2022).

9. Freedman VA, Agree EM. *Home Modifications: Use, Cost and Interactions With Functioning Among Near-Elderly And Older Adults*. Washington, D.C.: US Department of Health and Human Services. (2008).

10. Meucci MR, Gozalo P, Dosa D, Allen SM. Variation in the presence of simple home modifications of older americans: findings from the national health and aging trends study. *J Am Geriatr Soc.* (2016) 64:2081–7. doi: 10.1111/jgs.14252

11. Liu SY, Lapane KL. Residential modifications and decline in physical function among community-dwelling older adults. *Gerontologist.* (2009) 49:344–54. doi: 10.1093/geront/gnp033

12. Wu S, Fu Y, Yang Z. Housing condition, health status, and age-friendly housing modification in Europe: the last resort? *Build Environ.* (2022) 215:108956. doi: 10.1016/j.buildenv.2022.108956

13. Petersson I, Lilja M, Hammel J, Kottorp A. Impact of home modification services on ability in everyday life for people ageing with disabilities. *J Rehabil Med.* (2008) 40:253–60. doi: 10.2340/16501977-0160

14. Löfqvist C, Nygren C, Széman Z, Iwarsson S. Assistive devices among very old people in five European countries. *Scand J Occup Ther.* (2005) 12:181–92. doi: 10.1080/11038120500210652

15. Frochen S, Mehdizadeh S. Functional status and adaptation: measuring activities of daily living and device use in the national health and aging trends study. *J Aging Health.* (2018) 30:1136–55. doi: 10.1177/0898264317707299

16. Edwards NI, Jones DA. Ownership and use of assistive devices amongst older people in the community. *Age Ageing.* (1998). 27:463. doi: 10.1093/ageing/27.4.463

17. Freedman VA, Kasper JD, Spillman BC. Successful aging through successful accommodation with assistive devices. *J Gerontol: Series B.* (2016) 72:300–9. doi: 10.1093/geronb/gbw102

18. Harvey LA, Mitchell RJ, Lord SR, Close JC. Determinants of uptake of home modifications and exercise to prevent falls in community-dwelling older people. *Aust N Z J Public Health.* (2014) 38:585–90. doi: 10.1111/1753-6405.12243

19. Agree EM, Freedman VA, Sengupta M. Factors influencing the use of mobility technology in community-based long-term care. *J Aging Health.* (2004) 16:267–307. doi: 10.1177/0898264303262623

20. Pressler KA, Ferraro KF. Assistive device use as a dynamic acquisition process in later life. *Gerontologist.* (2010) 50:371–81. doi: 10.1093/geront/gnp170

21. Ishigami Y, Jutai J, Kirkland S. Assistive device use among community-dwelling older adults: a profile of canadians using hearing, vision, and mobility devices in the canadian longitudinal study on aging. *Can J Aging.* (2021) 40:23–38. doi: 10.1017/S0714980819000692

22. Blanchard J. Aging in community: communitarian alternative to aging in place, alone. *Generations.* (2013) 37:6–13.

23. Peek ST, Luijkx KG, Rijnaard MD, Nieboer ME, van der Voort CS, Aarts S, et al. Older Adults' reasons for Using Technology while Aging in Place. *Gerontology.* (2016) 62:226–37. doi: 10.1159/000430949

24. Luijkx K, Peek S, Wouters E. "Grandma, you should do it—it's cool" older adults and the role of family members in their acceptance of technology. *Int J Environ Res Public Health.* (2015) 12:15470–85. doi: 10.3390/ijerph121214999

25. Ang SGM, O'Brien AP, Wilson A. Understanding carers' fall concern and their management of fall risk among older people at home. *BMC Geriatr.* (2019) 19:144. doi: 10.1186/s12877-019-1162-7

26. Kim H, Zhao YL, Kim N, Ahn YH. Home modifications for older people with cognitive impairments: Mediation analysis of caregivers' information needs and perceptions of fall risks. *Int J Older People Nurs.* (2019) 14:e12240. doi: 10.1111/opn.12240

27. Tomita MR, Mann WC, Fraas LF, Stanton KM. Predictors of the use of assistive devices that address physical impairments among community-based frail elders. *J Appl Gerontol.* (2004) 23:141–55. doi: 10.1177/0733464804265606

28. Meng H, Peterson LJ, Feng L, Dobbs D, Hyer K. The use of mobility devices and personal assistance: a joint modeling approach. *Gerontol Geriatr Med.* (2019) 5:2333721419885291. doi: 10.1177/2333721419885291

29. Iwarsson S, Horstmann V, Slaug B. Housing matters in very old age—yet differently due to ADL dependence level differences. *Scand J Occup Ther.* (2007) 14:3–15. doi: 10.1080/11038120601094732

30. Gell NM, Wallace RB, LaCroix AZ, Mroz TM, Patel KV. Mobility device use in older adults and incidence of falls and worry about falling: findings from the 2011-2012 national health and aging trends study. *J Am Geriatr Soc.* (2015) 63:853–9. doi: 10.1111/jgs.13393

31. Ng BP, Lu J, Tiu GF, Thiamwong L, Zhong Y. Bathroom modifications among community-dwelling older adults who experience falls in the United States: a cross-sectional study. *Health Soc Care Community.* (2022) 30:253–63. doi: 10.1111/hsc.13398

32. Kim H, Ahn YH, Steinhoff A, Lee KH. Home modification by older adults and their informal caregivers. *Arch Gerontol Geriatr.* (2014) 59:648–56. doi: 10.1016/j.archger.2014.07.012

33. Lawton MP, Nahemow L. *Ecology and the Aging Process. The Psychology of Adult Development and Aging.* Washington, DC, US: American Psychological Association. (1973) p. 619–74. doi: 10.1037/10044-020

34. Wahl H-W, Oswald F. Environmental Perspectives on Ageing. In: Dannefer D, Phillipson C, editors. *The SAGE Handbook of Social Gerontology*. London: SAGE. (2010) p. 111–24. doi: 10.4135/9781446200933.n8

35. Wahl HW, Iwarsson S, Oswald F. Aging well and the environment: toward an integrative model and research agenda for the future. *Gerontologist.* (2012) 52:306–16. doi: 10.1093/geront/gnr154

36. Börsch-Supan A. Survey of Health, Ageing and Retirement in Europe (SHARE) Wave 6. In: *Release version: 800 SHARE-ERIC Data set.* (2022).

37. Laslett P. The third age, the fourth age and the future. *Ageing Soc.* (1994) 14:436–47. doi: 10.1017/S0144686X00001677

38. Neugarten BL. *Middle Age and Aging: A Reader in Social Psychology*. Chicago, IL: University of Chicago Press. (1968).

39. Börsch-Supan A, Brandt M, Hunkler C, Kneip T, Korbmacher J, Malter F, et al. Data resource profile: the survey of health, ageing and retirement in Europe (SHARE). *Int J Epidemiol.* (2013) 42:992–1001. doi: 10.1093/ije/dyt088

40. Bergmann M, Kneip T, De Luca G. A survey participation in the Survey of Health, Ageing and Retirement in Europe (SHARE), Wave 1-7. In: *Based on Release 7.0.0. SHARE Working Paper Series 41-2019*. Munich: MEA, Max Planck Institute for Social Law and Social Policy. (2019).

41. Malter F, Börsch-Supan A, editors. *SHARE Wave 6: Panel innovations and collecting Dried Blood Spots.* Munich: MEA, Max Planck Institute for Social Law and Social Policy. (2017).

42. Gruber S, Hunkler C, Stuck S. Generating easySHARE: Guidelines, structure, content and programming. In: *SHARE Working Paper Series (17-2014)*. Munich: MEA, Max Planck Institute for Social Law and Social Policy. (2014).

43. Schwartz E, Litwin H, Kotte M. Measuring social network and network changes in SHARE Wave 6. In: Malter F, Börsch-Supan A, editors. *SHARE Wave 6: Panel innovations and collecting Dried Blood Spots*. Munich: Max Planck Institute for Social Law and Social Policy. (2017) p. 22–39.

44. von dem Knesebeck O, Hyde M, Higgs P, Kupfer A, Siegrist J. Quality of Life and Well-Being. In: A. Börsch-Supan, A. Brugiavani, H. Jürges, J. Mackenbach, J. Siegrist, Weber G, editors. *Health, ageing and retirement in Europe – First results from the Survey of Health, Ageing and Retirement in Europe*. Mannheim: Mannheim Research Institute for the Economics of Aging (MEA). (2005) p. 199–203.

45. Prince MJ, Reischies F, Beekman AT, Fuhrer R, Jonker C, Kivela SL, et al. Development of the EURO-D scale - a European, Union initiative to compare symptoms of depression in 14 European centres. *Br J Psychiatry.* (1999) 174:330–8. doi: 10.1192/bjp.174.4.330

46. Hughes ME, Waite LJ, Hawkley LC, Cacioppo JT. A short scale for measuring loneliness in large surveys: Results from two population-based studies. *Res Aging.* (2004) 26:655–72. doi: 10.1177/0164027504268574

47. Andersen-Ranberg K, Petersen I, Frederiksen H, Mackenbach JP, Christensen K. Cross-national differences in grip strength among 50+ year-old Europeans: results from the SHARE study. *Eur J Ageing.* (2009) 6:227–36. doi: 10.1007/s10433-009-0128-6

48. Katz PP. Measures of adult general functional status: The Barthel Index, Katz Index of Activities of Daily Living, Health Assessment Questionnaire (HAQ), MACTAR patient preference disability questionnaire, and modified health assessment questionnaire (MHAQ). *Arthritis Care Res.* (2003) 49:15–27. doi: 10.1002/art.11415

49. Steel N, Huppert FA, McWilliams B, Melzer D. Physical and cognitive function. In: *Health, Wealth and Lifestyles of the Older Population of England: The 2002 English Longitudinal Study of Ageing*. London: The Institute for Fiscal Studies (2003).

50. Green L, Betz-Hamilton A, Albright B, Lee S-J, Vasquez K, Cantrell R, et al. Home modification for older adults aging in place: evidence from the American Housing Survey. *J Aging Environ.* (2022) 2022:1–12. doi: 10.1080/26892618.2022.2140466

51. Hu Y, Pikhart H, Pajak A, Kubínová R, Malyutina S, Besala A, et al. Education, material condition and physical functioning trajectories in middle-aged and older adults in Central and Eastern Europe: a cross-country comparison. *JEpidemiol Community Health.* (2016) 70:1128–35. doi: 10.1136/jech-2015-206548

52. Mathieson KM, Kronenfeld JJ, Keith VM. Maintaining functional independence in elderly adults: The roles of health status and financial resources in predicting home modifications and use of mobility equipment. *Gerontologist.* (2002) 42:24–31. doi: 10.1093/geront/42.1.24

53. Lin I-F, Wu H-S. Activity limitations, use of assistive devices or personal help, and well-being: variation by education. *J Gerontol: Series B.* (2014) 69:16–25. doi: 10.1093/geronb/gbu115

54. Eurostat. *Ageing Europe–Looking at the Lives of Older People in the EU.* (2023). Available online at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Ageing_Europe_-_looking_at_the_lives_of_older_people_in_the_EU (accessed February 6, 2023).

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Longitudinal associations of concurrent falls and fear of falling with functional limitations differ by living alone or not

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Background: Falls and fear of falling (FOF) are independent risk factors for functional limitations in older adults. However, the combined effect of falls and FOF on functional limitations and the moderating role of living alone or not is unclear. We aimed to examine (1) the independent and combined effect of falls and FOF on functional limitations in older adults and (2) whether living alone moderates these associations.

Methods: We used data from the National Health and Aging Trends Study (NHATS) and included 5,950 U.S. community-dwelling older adults aged 65 and older from Round 1 (Year 2011) and Round 2 (Year 2012). Falls and FOF were ascertained by asking participants whether they had any falls in the last year and whether they had worried about falling in the previous month at R1. Assessed functional limitations included any difficulties with mobility, self-care, or household activities at R2. Poisson regression models were used to examine the longitudinal associations of falls and FOF with functional limitations and the moderation effects of baseline living alone.

Results: Of the 5,950 participants, 16.3% had falls only; 14.3% had FOF only; 14.3% had both, and 55.1% had neither at baseline. In the adjusted model, those who experienced concurrent falls and FOF in R1 had a higher risk of functional limitations at R2 than those with neither (Mobility: Incidence risk ratio [IRR] = 1.34, 95% CI: 1.24–1.45; Self-care: IRR = 1.18, 95% CI: 1.11–1.26; Household: IRR = 1.20, 95% CI: 1.11–1.30). Moreover, living alone significantly moderated the longitudinal associations of concurrent falls and FOF with mobility activity limitations.

Conclusion: The findings suggest that strategies to improve falls and FOF together could potentially help prevent functional limitations. Older adults who live with others and have falls or FOF should receive interventions to promote their mobility activities.

KEYWORDS

falls, fear of falling, functional limitations, living alone, older adults

1. Introduction

Functional limitations are defined as reduced ability to perform basic daily activities required to live independently in a community (1). Approximately 25.7% of US adults have functional limitations (e.g., mobility, self-care), and more than half of them are 65 years and older (2). Functional limitations are associated with increased risk of stress, disability, depression, and mortality in older adults (3). In addition, the annual healthcare expenditure related to functional limitations in older adult accounts for 46.3% of the total U.S. healthcare expenditure (4). Healthcare expenditure is higher for older adults with functional limitations than those without (4, 5). Therefore, it is important to identify the modifiable risk factors for functional limitations in older adults and intervene in these risk factors.

Falls have many negative health effects, including deteriorating functional limitations in older adults (6). In the US, about 1.8 million older adults visit emergency departments for nonfatal fall injuries every year (7). Over 40% of them reported having functional limitations two months after the fall (8). Fear of falling (FOF) refers to the unhealthy avoidance of activities due to fear of falling (9). Findings of the International Mobility in Aging Study (n = 1,601) suggested that FOF is positively associated with the risk of functional limitations. Older adults with FOF excessively restricted their activities over time (10). In a cohort of 864 community-dwelling older adults in the US, our previous study findings showed that FOF independently predicted functional limitations after adjusting for falls and other covariates; and falls independently predicted functional limitations after adjusting for FOF and other covariates (11). Falls or FOF have been identified as modifiable risk factors for functional limitations (12, 13). Increasing evidence has characterized a bidirectional link between falls and FOF (14, 15). Specifically, falls in the previous year are a predictor of FOF and FOF is a predictor of subsequent falls (16). Falls and FOF often co-occur and are related, and the development of either may trigger a cascading effect that may increase risk of functional limitations (17). Considering the complicated association between falls and FOF, it is important to figure out their independent and combined effects on functional limitations to improve disability interventions for maximal impact. However, previous studies only separately investigated the influence of falls or FOF on functional limitations (8, 10, 11, 18, 19), whether falls and FOF combinedly predict functional limitations remains unclear.

Living alone in later life is often seen as an undesirable state, as most older adults who live alone are at a higher risk of falls and FOF (20–22). Studies have found that older adults who lived alone were 2–2.25 times more likely to fall and even experience multiple falls (20). A cross-sectional study of over 4,000 older adults demonstrated that those who lived alone (62.2%) had more FOF than those who did not live alone (23). Nevertheless, living alone is not an absolutely negative factor to health (24). There is evidence that people who lived alone 10 years ago were just as healthy as those who lived with others (25). Indeed, some studies showed that older adults who lived alone maintained functional independence and were less likely to experience functional limitations than those who did not live alone (26, 27). They monitored their health more diligently, were more mentally determined, and actively trained themselves to prevent functional limitations (28). Based on the above evidence, living alone might predict falls and FOF but alleviate the risk of functional limitations in older adults. To the best of our knowledge, the moderating effects of living alone in the association of falls and FOF on functional limitations have not been examined.

To address these key evidence gaps, we aimed to examine (1) whether falls and FOF in the previous year independently and combinedly predict functional limitations in the following year in older adults; and (2) whether living alone moderates the associations of falls and FOF with functional limitations. We hypothesized that falls and FOF independently and combinedly predict future functional limitations and living alone moderates these relationships.

2. Methods

The National Health and Aging Trends Study (NHATS) is an ongoing longitudinal study of Medicare beneficiaries aged 65 and older in the United States (29). The first round started in 2011 and aimed to investigate the disability trends of older adults in late life. We used the data from Round one (2011) and Round two (2012) of NHATS for this study. Of the 8,245 participants in Round one, 7,609 lived in the community and completed the sample person interview. Their response rate in Round two was 80.3% (n = 6,113). Then, 91 participants residing in nursing homes in Round two were excluded; 6,022 participants were eligible for further analysis. A total of 5,950 participants were finally included in the analysis (5,950 of 6,022; 98.8%) after excluding those with missing values on the functional limitations at follow-up (31 of 6,022; 0.5%) or independent variable (falls and FOF) and moderator (living alone) at baseline (41 of 6,022; 0.7%). Compared to those included in this analysis, the excluded participants were more likely to be older, female, and less educated (all $P < 0.05$). The NHATS study was approved by the Johns Hopkins University Institutional Review Board. The current study used publicly available and de-identified data and was deemed exempt by Xiangya School of Nursing Central South University.

2.1. Measures

2.1.1. Dependent variable: Functional limitations

Functional limitations were assessed by limitations in three mobility activities (going outside, getting around inside, and getting out of bed), four self-care activities (eating, dressing, toileting, and bathing), and five household activities (laundering, shopping, cooking, banking, and taking medications). Each activity was assessed by asking participants whether they performed any activities with any difficulty, whether they needed help from others, and whether they used any assistance devices over the last month. For all activities except getting out of bed, toileting, and eating, participants were also asked if they did them less frequently than a year ago.

Consistent with previous studies (11, 30–32), a four-category hierarchal scale was used to define the level of each activity. The score of each activity ranged from zero to three. A score of zero represented no limitations, indicating that participants could

perform the activity with no difficulty, help, assistance devices, or reduction in frequency. A score of one represented successful accommodation, indicating that participants could perform the activity less frequently or with assistance devices but with no difficulty or help. A score of two represented difficulty meaning that participants had difficulty performing the activity but did not receive assistance. A score of three represented assistance, indicating that participants performed the activity with others' help or did not perform the activity. Therefore, the mobility score (with three questions) ranged from zero to nine. The self-care score (with four questions) ranged from zero to 12. The household score (with five questions) ranged from zero to 15. A higher score indicated more functional limitations.

2.1.2. Independent variables: Falls and FOF

Falls were measured by the question-"have you fallen down over the last 12 months?" FOF was measured by the question-"did you worry about falling down in the last month?" Based on their response, the participants were classified into four categories-neither (neither falls nor FOF), falls only (had falls but not FOF), FOF only (had FOF but not falls), and both (had both falls and FOF).

2.1.3. Covariates

Demographic covariates included age (65–79 or over 80), sex (female or male), race/ethnicity (White, Black, Hispanic, or others), education (less than high school, high school, or higher than high school), and living alone (yes/no). Health-related covariates included obesity [body mass index (BMI) $\geq$30 kg/m^2, yes or no], depressive symptoms (yes or no), anxiety (yes or no), pain (yes or no), visual impairment (yes or no), hospitalization in the last 12 months (yes or no), dementia status (yes or no), number of chronic diseases (no diseases, 1–3 diseases, or $\geq$4 diseases) and Short Physical Performance Battery (SPPB).

Living alone was assessed by current living arrangement. Those who were not living with spouse/partner/others were regarded as living alone. Depressive symptoms were measured by the Patient Health Questionnaire-2 (33) and a score of 3 or higher indicated depressive symptoms. Anxiety was measured by the Generalized Anxiety Disorder-2 (33) and a score of 3 or higher indicated anxiety. Pain was measured by the question, "whether you have been bothered by pain in the last month?" Visual impairment was determined by the question, "whether you were blind or unable to see well enough to recognize people across the street or read newspaper print?" Dementia status was assessed by participants' self-reported medical diagnosis of dementia or Alzheimer's disease. Number of chronic diseases was estimated from the total count of chronic diseases, including arthritis, cancer, diabetes, heart attack, heart disease, hypertension, lung disease, osteoporosis, and stroke. SPPB consisted of a balance stand test (hold side-by-side, semi-tandem, or full tandem stances for 10 seconds), a walking speed test (walk 3 m at normal speed for two trials), and a repeated chair stand test (repeat the sit-to-stand five times as fast as possible with arms folded across the chests). The score of each test ranged from 0 (worst) to 4 (best). The score of SPPB ranged from 0 to twelve, with a higher score indicating better physical performance in the lower extremities (17, 34).

2.2. Statistical analysis

Frequencies and percentages were used to describe participants' baseline demographic and health information. Chi-squared tests were used to compare the demographic and health-related differences among the four groups (neither, falls only, FOF only, and both). Three Poisson regression models were constructed to examine whether falls and FOF (independent variable) independently and combinedly predict the three outcomes (mobility, self-care, and household limitations). An interaction term between living alone and falls and FOF was then entered into the three models to test the moderating effect. Additionally, stratified analyses were performed to determine the differential magnitude of the relationships between falls and FOF on functional limitations. All models accounted for the sociodemographic factors, health-related factors and outcome of interest at baseline.

Both incidence rate ratio (IRR) and 95% confidence intervals (CI) were reported. To account for missing data, we performed multiple imputation by chained equations (35). The IRR from ten imputed data sets was combined based on Rubin's rule. In our study, all the Poisson regressions were examined using imputed data. A $P < 0.05$ indicated statistical significance. All analyses were conducted using STATA SE version 15.0 (College Station, TX: StataCorp LP).

3. Results

3.1. Participants' characteristics

Table 1 presented the demographic and health information of the participants. Most participants were 65–79 years old (60.7%), female (58.2%), white (69.0%), and completed higher than high school education (46.8%). Approximately 16.3% of them reported falls only; 14.3% reported FOF only; 14.3% reported both; 55.1% reported neither. Compared to neither, falls only, FOF only, and both were older, less educated, more obese, more depressed, more anxious, more likely to be female and white, and more likely to have pain, visual impairment, hospitalization, dementia, chronic diseases and lower SPPB scores ($P < 0.001$). In terms of living alone, compared to neither, FOF only and both were less likely to live alone (69.1% [neither], 61.7% [FOF only], and 61.5% [Both]). Falls only and neither have similar percentages of older adults not living alone (69.1% [neither] versa 69.8% [falls only]).

3.2. Falls and FOF independently and combinedly predicted functional limitations

Figure 1 depicted the longitudinal association of functional limitations with falls and FOF after adjusting baseline sociodemographic and health-related covariates and the outcomes of interest. Compared to neither, both, falls only and FOF only had

TABLE 1 Baseline sample characteristics by baseline falls and FOF status, *n* (%).

Characteristics	Overall, *n* = 5,950 (100.0)	Neither, *n* = 3,276 (55.1)	Falls only, *n* = 970 (16.3)	FOF only, *n* = 852 (14.3)	Both, *n* = 852 (14.3)	*P*-value
Age						
65–79 years	3,611 (60.7)	2,179 (66.5)	590 (60.8)	431 (50.6)	411 (48.2)	<0.001
80+ years	2,339 (39.3)	1,097 (33.5)	380 (39.2)	421 (49.4)	441 (51.8)	
Sex, *n* (%)						
Female	3,461 (58.2)	1,736 (53.0)	557 (57.4)	599 (70.3)	569 (66.8)	<0.001
Male	2,489 (41.8)	1,540 (47.0)	413 (42.6)	253 (29.7)	283 (33.2)	
Race/ethnicity						
White	4,107 (69.0)	2,203 (67.3)	708 (73.0)	594 (69.7)	602 (70.7)	<0.001
Black	1,284 (21.6)	770 (23.5)	191 (19.7)	160 (18.8)	163 (19.1)	
Hispanic	346 (5.8)	170 (5.2)	43 (4.4)	66 (7.6)	67 (7.9)	
Other	213 (3.6)	133 (4.1)	28 (2.9)	32 (3.8)	20 (2.4)	
Education						
Less than high school	1,538 (26.1)	790 (24.3)	256 (26.6)	224 (26.5)	268 (31.7)	<0.001
High school	1,600 (27.1)	874 (26.9)	251 (26.1)	256 (30.3)	219 (25.9)	
Higher than high school	2,762 (46.8)	1,583 (48.8)	456 (47.4)	364 (43.1)	359 (42.4)	
Living alone						
No	3,992 (67.1)	2,265 (69.1)	667 (69.8)	526 (61.7)	524 (61.5)	<0.001
Yes	1,958 (32.9)	1,011 (30.9)	293 (30.2)	326 (38.3)	328 (38.5)	
Obesity						
No (<30 kg/m^2)	4,177 (72.5)	2,385 (75.0)	699 (73.9)	548 (66.4)	545 (67.3)	<0.001
Yes (≥30 kg/m^2)	1,586 (27.5)	797 (25.0)	247 (26.1)	277 (33.6)	265 (32.7)	
Depressive symptom						
No	5,032 (85.2)	2,944 (90.4)	822 (85.2)	684 (80.9)	582 (69.0)	<0.001
Yes	877 (14.8)	312 (9.6)	143 (14.8)	161 (19.1)	262 (31.0)	
Anxiety symptom						
No	5,183 (87.4)	3,046 (93.3)	868 (89.9)	684 (80.5)	585 (69.0)	<0.001
Yes	745 (12.6)	218 (6.7)	98 (10.1)	166 (19.5)	263 (31.0)	
Pain						
No	2,734 (46.0)	1,851 (56.5)	392 (40.4)	274 (31.2)	217 (25.5)	<0.001
Yes	3,214 (54.0)	1,423 (43.5)	578 (59.6)	578 (67.8)	635 (74.5)	
Visual impairment						
No	5,339 (90.1)	3,049 (93.4)	870 (89.9)	753 (88.6)	667 (78.9)	<0.001
Yes	589 (9.9)	216 (6.6)	98 (10.1)	97 (11.4)	178 (21.1)	
Hospitalization						
No	4,601 (77.4)	2,694 (82.3)	715 (73.8)	651 (76.4)	541 (63.7)	<0.001
Yes	1,343 (22.6)	579 (17.7)	254 (26.2)	201 (23.6)	309 (36.4)	
Dementia						
No	5,664 (95.2)	3,180 (97.1)	910 (94.0)	803 (94.3)	771 (90.5)	<0.001
Yes	283 (4.8)	95 (2.9)	58 (6.0)	49 (5.8)	81 (9.5)	
Number of chronic diseases						
No diseases	523 (8.8)	384 (11.7)	77 (7.9)	42 (4.9)	20 (2.4)	<0.001
1–3 diseases	3,918 (65.9)	2,230 (70.8)	627 (64.6)	513 (60.2)	458 (53.8)	
≥4 diseases	1,509 (25.4)	572 (17.5)	266 (27.4)	297 (34.9)	374 (43.9)	
SPPB Score (0–12)	6.25 ± 3.36	7.13 ± 3.12	6.25 ± 3.38	5.07 ± 3.06	3.85 ± 3.03	<0.001

FOF, fear of falling; SPPB, Short Physical Performance Battery.

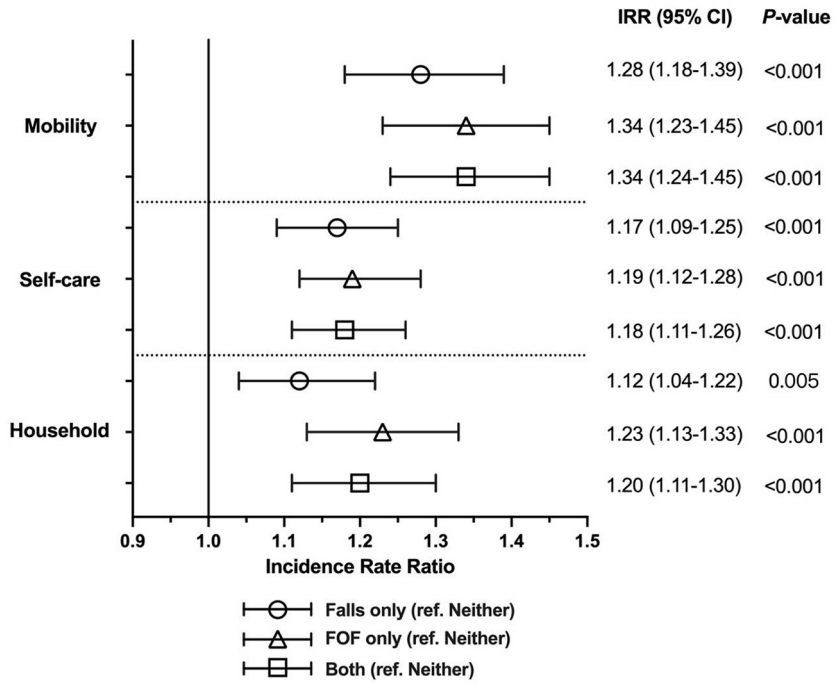

FIGURE 1
Forest plot depicting fully adjusted Poisson regression analysis of baseline falls and FOF status on functional limitations at R2. Models adjusted for sociodemographic factors (age, sex, race/ethnicity, education) and health-related factors (obesity, depressive symptoms, anxiety symptoms, bothersome pain, visual impairment, dementia, hospitalization, number of chronic diseases, and Short Physical Performance Battery) and outcome of interest at baseline. FOF, fear of falling; IRR, incidence rate ratio; CI, confidence interval.

increased risks of mobility activities limitations, self-care activities limitations and household activities limitations.

3.3. Living alone moderated the longitudinal associations of falls and FOF with functional limitations

Table 2 presented the results of the three adjusted Poisson regressions, which examined whether living alone moderated the longitudinal relationship between combined falls and FOF and functional limitations. Living alone moderated the longitudinal associations of falls and FOF with mobility limitations ($P_{\text{interaction}} < 0.01$). In contrast, no moderation effect was observed in self-care and household activities limitations, indicating that living alone did not moderate the longitudinal associations of falls and FOF with self-care and household activities limitations.

Based on the stratified analysis of living alone (Figure 2), compared to neither, falls only did not statistically significantly predict mobility (IRR = 1.12, 95% CI = 0.99–1.28, $P = 0.08$), self-care (IRR = 1.06, 95% CI = 0.95–1.19, $P = 0.30$), and household activities (IRR = 1.04, 95% CI = 0.96–1.13, $P = 0.31$) limitations in older adults who lived alone. However, among those who did not live alone, falls only was associated with a higher risk of functional limitations, with an IRR of 1.37 for mobility (95% CI = 1.24–1.52), 1.22 for self-care (95% CI = 1.12-1.33), and 1.16 for household (95% CI = 1.10–1.23) (all $P < 0.05$). Among those who lived alone or not, both and FOF only were at a higher risk of mobility, self-care and household activities limitations than neither (all $P < 0.05$).

4. Discussion

To our knowledge, this longitudinal study is the first one to simultaneously investigate the independent and combined effect of falls and FOF on functional limitations (including mobility, self-care, and household activities limitations) as well as whether living alone moderated these effects using a nationally representative sample of community-dwelling older adults in the US. The findings suggested that falls and FOF independently and combinedly predicted functional limitations and that living alone moderated the longitudinal associations of falls and FOF with mobility activities limitations. Our findings highlighted that we should identify older adults with falls or FOF who do not live alone and develop targeted interventions to prevent functional limitations.

Our study confirmed previous findings that falls and FOF independently predicted functional limitations and further demonstrated the combined effect of the two on functional limitations. Previous studies have only investigated the independent predictive roles of falls and FOF (10, 13, 36–38) and found a strong independent association between falls and functional limitations in older adults, especially for those who experience multiple falls and fall injuries (13, 36, 38). FOF is also an important risk factor for functional limitations (37). Two longitudinal studies found that older adults with FOF had significantly reduced functions (10, 39). A long duration of FOF

TABLE 2 Fully adjusted Poisson regression examining the association of living alone and concurrent falls and FOF at baseline with functional limitations outcomes at follow-up.

	Mobility[a]		Self-care[b]		Household[c]	
	IRR (95% CI)	*P*-value	IRR (95% CI)	*P*-value	IRR (95% CI)	*P*-value
Falls and FOF						
Neither	1.00 [Ref]	NA	1.00 [Ref]	NA	1.00 [Ref]	NA
Falls only	1.38 (1.24–1.52)	**<0.001**	1.21 (1.11–1.32)	**<0.001**	1.23 (1.11–1.38)	**<0.001**
FOF only	1.36 (1.23–1.50)	**<0.001**	1.21 (1.11–1.31)	**<0.001**	1.38 (1.23–1.54)	**<0.001**
Both	1.43 (1.31–1.57)	**<0.001**	1.18 (1.08–1.28)	**<0.001**	1.40 (1.26–1.56)	**<0.001**
Living alone						
No	1.00 [Ref]	NA	1.00 [Ref]	NA	1.00 [Ref]	NA
Yes	1.10 (1.00–1.22)	0.056	1.01 (0.93–1.09)	0.898	1.10 (0.98–1.23)	0.102
Falls and FOF × Living alone						
Neither × Living alone	1.00 [Ref]	NA	1.00 [Ref]	NA	1.00 [Ref]	NA
Falls only × Living alone	0.82 (0.70–0.96)	**0.013**	0.89 (0.77–1.02)	0.092	0.92 (0.78–1.09)	0.346
FOF only × Living alone	0.96 (0.82–1.11)	0.199	0.96 (0.84–1.10)	0.561	0.94 (0.81–1.10)	0.443
Both × Living alone	0.84 (0.73–0.96)	**0.010**	1.01 (0.90–1.14)	0.843	0.92 (0.79–1.06)	0.242

FOF, fear of falling; IRR, incidence rate ratio; CI, confidence interval. [a]Adjusted for sociodemographic factors (age, sex, race/ethnicity, education), health-related factors (obesity, depressive symptoms, anxiety symptoms, bothersome pain, visual impairment, dementia, hospitalization, number of chronic diseases, and Short Physical Performance Battery) and mobility activity limitation level at baseline. [b]Adjusted for sociodemographic factors, health-related factors, and self-care activity limitation level at baseline. [c]Adjusted for sociodemographic factors, health-related factors, and household activities limitation level at baseline. Bold values means that the number is statistically significant.

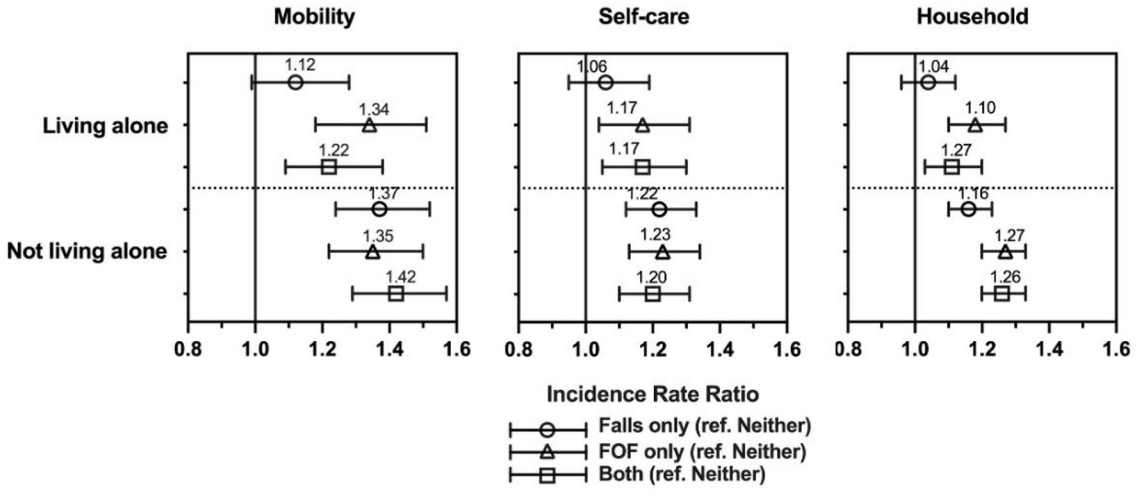

FIGURE 2
Association of baseline falls and FOF status and follow-up functional limitations stratified by living arrangement. Models adjusted for sociodemographic factors (age, sex, race/ethnicity, education) and health-related factors (obesity, depressive symptoms, anxiety symptoms, bothersome pain, visual impairment, dementia, hospitalization, number of chronic diseases, and Short Physical Performance Battery) and outcome of interest at baseline. FOF, fear of falling; IRR, incidence rate ratio.

was associated with a higher risk of decreased activities of daily living (ADL) (10, 40). Older adults with FOF are cautious in performing activities, thereby further reducing their active time (12). Previous studies demonstrated that self-limiting behaviors led to physical deterioration and increased the risk of functional limitations (12, 41), which could explain why FOF causes functional limitations. Furthermore, with the complex causal relationship between falls and FOF (14) the focus of our study was to examine

the combined effect of falls and FOF on functional limitations. Individuals who have fallen may subsequently develop FOF, which has been shown to be a direct consequence of falls. Individuals who fell might also experience previous FOF, suggesting it was a risk factor for falls (16). It is reasonable that poor fitness levels resulting from persistent FOF not only develop functional limitations but also increase the likelihood of future falls, which may reinforce the association of FOF with functional limitations. Similarly, in older adults with a history of falls, FOF also strengthened the predictive role of falls on functional limitations (14, 23). Therefore, it is not surprising that in our study, older adults with concurrent falls and FOF are at higher risks of functional limitations compared to neither.

We found that living alone moderated the association of combined effect of falls and FOF with mobility activities limitations. Among the two groups of older adults in our study (fall only and both), those who lived with others have a higher risk of mobility limitation than those who lived alone. The results of falls only showed that the risk of mobility limitations was not significant in older adults who lived alone. To date, only few studies have investigated the relationship between living alone, falls, FOF, and mobility (42, 43). In general, living alone has an impact on the frequency of falls and the occurrence of FOF in older adults (20, 44). One possible explanation is that older adults who live alone are more likely to receive less social support and thus are more likely to feel lonely and isolated, thereby increasing their risk of falls and FOF (45, 46). However, not all older adults who live alone experience loneliness or social isolation. Living alone has been demonstrated to provide some protection against functional limitations in older adults (47). A longitudinal study found that older adults living with others had more limited mobility than those who lived alone (48) because living alone to some extent forces older adults to learn to maintain a high degree of independence and self-management, a phenomenon called "biologically conditioned reflex" (49). If older adults have someone else to rely on, they may give up some opportunities of performing independent activities more easily, resulting in increased functional limitations (50). In this study, living alone reduced the risk of functional limitations in older adults with falls and FOF. Moreover, the choice to live alone could be explained by economic and cultural factors (24). Older adults with greater cultural fit and financial resources are more likely to live alone and have more independence and confidence, which may help them overcome mobility restrictions due to falls and/or FOF.

This study has important implications for research, practice, and policy on the prevention and management of functional limitations in older adults. Recognizing the combined effect of previous falls and FOF on functional limitations, clinicians should regularly examine patients with both falls and FOF on their risk of developing functional limitations. Additionally, the moderating role of living alone found in the study calls for particular attention to developing functional limitations prevention interventions for older adults with falls and FOF tailored to their living arrangement (living alone or not). This has important implications for policymakers, clinicians, and family members.

Several limitations of this study should be noted. First, the reliability and validity of measuring FOF by asking participants if they were worried about falling in the last month remain unknown. Second, measures of falls are through retrospective self-report and may suffer from recall bias and reporting errors. For older adults, the one-year fall recall window may be too long. They may only remember their injured falls. Third, the covariates we identified were limited to those collected from the NHATS database, and thus residual confounding may exist. Fourth, our study could not provide causal inference despite with longitudinal study design. However, the study has undeniable strengths. We used nationally representative longitudinal data to examine the temporal impact of falls and FOF on functional limitations. We also innovatively explored the moderating effects of living alone (yes/no) and adjusted a comprehensive list of covariates.

5. Conclusions

Our study found the independent and combined effect of falls and FOF on functional limitations and the moderating role of living alone. While making efforts to prevent falls and FOF in older adults, the government, clinicians, and caregivers should consider the social background to help older adults prevent and manage functional limitations.

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 Johns Hopkins University Institutional Review Board. The patients/participants provided their written informed consent to participate in this study.

Author contributions

KL: writing—original draft and writing—review and editing. WP: conceptualization, methodology, data analysis, and writing—original draft. SG, CL, YZ, and XH: writing—review and editing. ML: methodology and writing—review and editing. 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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References

1. Ahn J, Kim BJ. The relationships between functional limitation, depression, suicidal ideation, and coping in older Korean immigrants. *J Immigr Minor Healt.* (2015) 176:1643–53. doi: 10.1007/s10903-015-0204-2

2. Okoro CA, Hollis ND, Cyrus AC, Griffin-Blake S. Prevalence of disabilities and health care access by disability status and type among adults - United States, 2016. *Mmwr-Morbid Mortal W.* (2018) 6732:882–7. doi: 10.15585/mmwr.mm6732a3

3. Chatterji S, Byles J, Cutler D, Seeman T, Verdes E. Health, functioning, and disability in older adults–present status and future implications. *Lancet.* (2015) 3859967:563–75. doi: 10.1016/S0140-6736(14)61462-8

4. Cheng Y, Goodin AJ, Pahor M, Manini T, Brown JD. Healthcare utilization and physical functioning in older adults in the United States. *J Am Geriatr Soc.* (2020) 682:266–71. doi: 10.1111/jgs.16260

5. Fried TR, Bradley EH, Williams CS, Tinetti ME. Functional disability and health care expenditures for older persons. *Arch Intern Med.* (2001) 16121:2602–7. doi: 10.1001/archinte.161.21.2602

6. Kim J, Byun M, Kim M. Physical and psychological factors associated with poor self-reported health status in older adults with falls. *Int J Env Res Pub He.* (2020) 17:1710. doi: 10.3390/ijerph17103548

7. Stevens JA, Mack KA, Paulozzi LJ, Ballesteros MF. Self-reported falls and fall-related injuries among persons aged ≥65 years–United States, 2006. *J Safety Res.* (2008) 39:345–9. doi: 10.1016/j.jsr.2008.05.002.

8. Grisso JA, Schwarz DF, Wolfson V, Polansky M, LaPann K. The impact of falls in an inner-city elderly African-American population. *J Am Geriatr Soc.* (1992) 407:673–8. doi: 10.1111/j.1532-5415.1992.tb01958.x

9. Jung D. Fear of falling in older adults: comprehensive review. *Asian Nurs Res.* (2008) 24:214–22. doi: 10.1016/S1976-1317(09)60003-7

10. Auais M, French S, Alvarado B, Pirkle C, Belanger E, Guralnik J. Fear of falling predicts incidence of functional disability 2 years later: a perspective from an international cohort study. *J Gerontol a-Biol.* (2018) 739:1212–5. doi: 10.1093/gerona/glx237

11. Liu M, Hou T, Li Y, Sun X, Szanton SL, Clemson L et al. Fear of falling is as important as multiple previous falls in terms of limiting daily activities: a longitudinal study. *BMC Geriatr.* (2021) 211:350. doi: 10.21203/rs.3.rs-104523/v1

12. Martin FC, Hart D, Spector T, Doyle DV, Harari D. Fear of falling limiting activity in young-old women is associated with reduced functional mobility rather than psychological factors. *Age Ageing.* (2005) 343:281–7. doi: 10.1093/ageing/afi074

13. Ek S, Rizzuto D, Xu W, Calderon-Larranaga A, Welmer AK. Predictors for functional decline after an injurious fall: a population-based cohort study. *Aging Clin Exp Res.* (2021) 338:2183–90. doi: 10.1007/s40520-020-01747-1

14. Boyd R, Stevens JA. Falls and fear of falling: burden, beliefs and behaviours. *Age Ageing.* (2009) 384:423–8. doi: 10.1093/ageing/afp053

15. Goh HT, Nadarajah M, Hamzah NB, Varadan P, Tan MP. Falls and fear of falling after stroke: a case-control study. *PMR.* (2016) 812:1173–80. doi: 10.1016/j.pmrj.2016.05.012

16. Lavedan A, Viladrosa M, Jurschik P, Botigue T, Nuin C, Masot O, et al. Fear of falling in community-dwelling older adults: a cause of falls, a consequence, or both? *PLoS ONE.* (2018) 133:e194967. doi: 10.1371/journal.pone.0197792

17. Cisewski JA, Durbin LL, Bond EG, Qian M, Guralnik JM, Kasper J, et al. Reduced lower extremity functioning is associated with an increased rate of being a nondriver: the national health and aging trends study. *Phys Therapy.* (2019) 997:862–9. doi: 10.1093/ptj/pzz037

18. Whipple MO, Hamel AV, Talley K. Fear of falling among community-dwelling older adults: a scoping review to identify effective evidence-based interventions. *Geriatr Nurs.* (2018) 392:170–7. doi: 10.1016/j.gerinurse.2017.08.005

19. Ge L, Su TT, An Y, Mejia ST. The effectiveness of exergames on fear of falling in community-dwelling older adults: a systematic review. *Aging Ment Health.* (2021) 26:1–12.

20. Elliott S, Painter J, Hudson S. Living alone and fall risk factors in community-dwelling middle age and older adults. *J Commun Health.* (2009) 344:301–10. doi: 10.1007/s10900-009-9152-x

21. Das GD, Kelekar U, Rice D. Associations between living alone, depression, and falls among community-dwelling older adults in the us. *Prev Med Rep.* (2020) 20:101273. doi: 10.1016/j.pmedr.2020.101273

22. Alcolea-Ruiz N, Alcolea-Ruiz S, Esteban-Paredes F, Beamud-Lagos M, Villar-Espejo MT, Perez-Rivas FJ. Prevalence of fear of falling and related factors in community-dwelling older people. *Aten Prim.* (2021) 532:101962. doi: 10.1016/j.aprim.2020.11.003

23. Zijlstra GA, van Haastregt JC, van Eijk JT, van Rossum E, Stalenhoef PA, Kempen GI. Prevalence and correlates of fear of falling, and associated avoidance of activity in the general population of community-living older people. *Age Ageing.* (2007) 363:304–9. doi: 10.1093/ageing/afm021

24. Kharicha K, Iliffe S, Harari D, Swift C, Gillmann G, Stuck AE. Health risk appraisal in older people 1: are older people living alone an "at-risk" group? *Brit J Gen Pract.* (2007) 57537:271–6.

25. Iliffe S, Tai SS, Haines A, Gallivan S, Goldenberg E, Booroff A et al. are elderly people living alone an at risk group? *BMJ-Brit Med J.* (1992) 3056860:1001–4. doi: 10.1136/bmj.305.6860.1001

26. Michael YL, Berkman LF, Colditz GA, Kawachi I. Living arrangements, social integration, and change in functional health status. *Am J Epidemiol.* (2001) 1532:123–31. doi: 10.1093/aje/153.2.123

27. van den Brink CL, Tijhuis M, van den Bos GA, Giampaoli S, Kivinen P, Nissinen A et al. Effect of widowhood on disability onset in elderly men from three european countries. *J Am Geriatr Soc.* (2004) 523:353–8. doi: 10.1111/j.1532-5415.2004.52105.x

28. Sarwari AR, Fredman L, Langenberg P, Magaziner J. Prospective study on the relation between living arrangement and change in functional health status of elderly women. *Am J Epidemiol.* (1998) 1474:370–8. doi: 10.1093/oxfordjournals.aje.a009459

29. Freedman VA, Kasper JD. Cohort profile: the national health and aging trends study (Nhats). *Int J Epidemiol.* (2019) 484:1044–5. doi: 10.1093/ije/dyz109

30. Gill TM, Williams CS. Development and validation of a functional outcome measure in the national health and aging trends study. *J Gerontol a-Biol.* (2018) 738:1111–8. doi: 10.1093/gerona/gly091

31. Patel N, Stagg BC, Swenor BK, Zhou Y, Talwar N, Ehrlich JR. Association of co-occurring dementia and self-reported visual impairment with activity limitations in older adults. *JAMA Ophthalmol.* (2020) 1387:756–63. doi: 10.1001/jamaophthalmol.2020.1562

32. Assi L, Ehrlich JR, Zhou Y, Huang A, Kasper J, Lin FR et al. Self-reported dual sensory impairment, dementia, and functional limitations in medicare beneficiaries. *J Am Geriatr Soc.* (2021) 6912:3557–67. doi: 10.1111/jgs.17448

33. Lowe B, Wahl I, Rose M, Spitzer C, Glaesmer H, Wingenfeld K et al. A 4-item measure of depression and anxiety: validation and standardization of the patient health questionnaire-4 (Phq-4) in the general population. *J Affect Disorders.* (2010) 1221:86–95. doi: 10.1016/j.jad.2009.06.019

34. Kerber KA, Bi R, Skolarus LE, Burke JF. Trajectories in physical performance and fall prediction in older adults: a longitudinal population-based study. *J Am Geriatr Soc.* (2022) 7012:3413–23. doi: 10.1111/jgs.17995

35. Azur MJ, Stuart EA, Frangakis C, Leaf PJ. Multiple imputation by chained equations: what is it and how does it work? *Int J Meth Psych Res.* (2011) 201:40–9. doi: 10.1002/mpr.329

36. Tinetti ME, Williams CS. The effect of falls and fall injuries on functioning in community-dwelling older persons. *J Gerontol a-Biol.* (1998) 532:M112–9. doi: 10.1093/gerona/53A.2.M112

37. Delbaere K, Crombez G, Van Den Noortgate N, Willems T, Cambier D. The risk of being fearful or fearless of falls in older people: an empirical validation. *Disabil Rehabil.* (2006) 2812:751–6. doi: 10.1080/09638280500304794

38. Valderrama-Hinds LM, Al SS, Chen NW, Rodriguez MA, Wong R. Falls in Mexican older adults aged 60 years and older. *Aging Clin Exp Res.* (2018) 3011:1345–51. doi: 10.1007/s40520-018-0950-9

39. Choi K, Ko Y. characteristics associated with fear of falling and activity restriction in South Korean older adults. *J Aging Health.* (2015) 276:1066–83. doi: 10.1177/0898264315573519

40. Litwin H, Erlich B, Dunsky A. The complex association between fear of falling and mobility limitation in relation to late-life falls: a share-based analysis. *J Aging Health.* (2018) 306:987–1008. doi: 10.1177/0898264317704096

41. Scheffers-Barnhoorn MN, van Haastregt JC, Schols JM, Kempen GI, van Balen R, Visschedijk JH et al. A Multi-component cognitive behavioural intervention for the treatment of fear of falling after hip fracture (Fit-Hip): protocol of a randomised controlled trial. *BMC Geriatr.* (2017) 171:71. doi: 10.1186/s12877-017-0465-9

42. Edgren J, Karinkanta S, Rantanen T, Daly R, Kujala UM, Tormakangas T et al. Counselling for physical activity, life-space mobility and falls prevention in old age (cosmos): protocol of a randomised controlled trial. *BMJ Open.* (2019) 99:e29682. doi: 10.1136/bmjopen-2019-029682

43. Jaatinen R, Luukkaala T, Hongisto MT, Kujala MA, Nuotio MS. Factors associated with and 1-year outcomes of fear of falling in a geriatric post-hip fracture assessment. *Aging Clin Exp Res.* (2022) 349:2107–16. doi: 10.1007/s40520-022-02159-z

44. Angeles CM, Laura AM, Consuelo CM, Manuel RR, Eva AC, Covadonga GA. The effect that the otago exercise programme had on fear of falling in community dwellers aged 65-80 and associated factors. *Arch Gerontol Geriat.* (2022) 99:104620. doi: 10.1016/j.archger.2022.104620

45. Petersen N, Konig HH, Hajek A. The link between falls, social isolation and loneliness: a systematic review. *Arch Gerontol Geriat.* (2020) 88:104020. doi: 10.1016/j.archger.2020.104020

46. Martinez-Arnau FM, Prieto-Contreras L, Perez-Ros P. Factors associated with fear of falling among frail older adults. *Geriatr Nurs.* (2021) 425:1035–41. doi: 10.1016/j.gerinurse.2021.06.007

47. Tabue TM, Simo-Tabue N, Stoykova R, Meillon C, Cogne M, Amieva H et al. Feelings of loneliness and living alone as predictors of mortality in the elderly: the paquid study. *Psychosom Med.* (2016) 788:904–9. doi: 10.1097/PSY.0000000000000386

48. Hayashi C, Tanaka H, Ogata S. Assessing timewise changes over 15 months in life-space mobility among community-dwelling elderly persons. *BMC Geriatr.* (2020) 201:502. doi: 10.1186/s12877-020-01882-4

49. Schmajuk N, Larrauri J. Associative models can describe both causal learning and conditioning. *Behav Process.* (2008) 773:443–5. doi: 10.1016/j.beproc.2007.09.010

50. Wang D, Zheng J, Kurosawa M, Inaba Y, Kato N. Changes in activities of daily living (ADL) among elderly Chinese by marital status, living arrangement, and availability of healthcare over a 3-year period. *Environ Health Prev.* (2009) 142:128–41. doi: 10.1007/s12199-008-0072-7

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Mobility restriction and barrier-reduced housing among people aged 65 or older in Germany: Do those who need it live in barrier-reduced residences?

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Introduction: Older people spend a lot of time at home and in the area near where they live. Housing conditions ensure their ability to participate in social life, especially when they suffer from mobility restrictions. Barrier-free access to the residence and to rooms within the residence is a key condition for their everyday mobility. As a result, this is what we define as minimal criteria for barrier-reduced residences. This article examines the extent to which people aged 65 and over (including people with mobility issues) live in barrier-reduced housing and what factors influence the chance of living in such residences.

Data and method: Cross-sectional data from the German Ageing Survey (DEAS) 2020/21 (persons aged 65 and over, n=2,854) were used. The DEAS is a representative cross-sectional and longitudinal survey of the population aged 40 and over in Germany. In our analyses, we used logistic regression models to investigate the probability of living in a barrier-reduced residence. We defined housing as barrier-reduced when the apartment/house and the rooms inside it can be reached without steps or stairs. As explanatory variable, we considered mobility restrictions, defined as limited ability to climb a flight of stairs. In addition, the model includes other individual factors (age, gender, equivalized household income), regional factors (living in East vs. West Germany, in urban vs. rural region) and moving to the current residence after the age of 65.

Results and discussion: Of all individuals aged 65 or older, 19.3 percent live in a barrier-reduced residence. Also, of mobility-restricted elders, only 21.4 percent have such residences. The logistic regression results show that mobility restrictions are associated with a higher probability of living in a barrier-reduced residence. Compared to the lowest income group, older people in the highest income group are more likely to live in barrier-reduced housing. East Germans and people in urban areas are less likely to live in a barrier-reduced home. The likelihood of barrier-reduced living is higher among seniors who moved into their current residence after age 65. No significant differences were found for age groups and gender. The findings show that not enough seniors have barrier-reduced access to their homes and rooms, even if they suffer from mobility restrictions. Preventing functional restrictions must therefore also include improvements in the residential environment, especially in disadvantaged residential areas.

KEYWORDS

barrier-reduced housing, mobility restriction, aging in place, moving in old age, Germany

1. Introduction

Most people live in their own private household into their old age. Even though the variety of living arrangements in old age has increased in recent years, with assisted living and shared apartments, for the majority of older people living in their own, private household remains the desired form of living and also the reality they live in. Even if seniors are functionally limited or require care, they remain in their homes (1). Aging in place is the main preference both in German households and in other European countries (2). The home is increasingly becoming the center of life in old age. With increasing age and health problems, older people reduce their radius of action and spend more time in their homes and the immediate area (3). At the same time, their vulnerability to deficiencies in the home and the living environment increases. For older people, the home and its environment therefore determine their level of self-determination as they age to a significant extent (4).

Barrier-free housing is one aspect of housing quality for people of all ages and in all circumstances of life. It also makes daily life easier for families with children or younger people with functional limitations. Therefore, barrier-free living is not limited to old age, though it is especially significant for this phase of life because of the frequent age-related health problems. With an aging population and the resulting increase in the proportion of older people, the need for housing adapted to their specific needs is growing. It should at least be available to mobility-restricted older people to enable them to live independently.

How did we define barrier-free housing for our analyses? In Germany, there is no uniform, generally binding definition of barrier-free living. There are different target groups with different accessibility needs and different places and spaces with varying possibilities for intervention (5). This is reflected in a variety of legal regulations and building standards on accessibility.

When it came to defining accessibility, we considered a range of factors. Older people are often limited in their ability to climb stairs. Even the aids they need for mobility (e.g., walkers) can be a hurdle if they have to be transported up multiple flights of stairs. Freedom of movement within the home is similar to access to the home. Steps and higher thresholds are potential trip and fall hazards, and they make it difficult to move with a rollator within the home. For our study, accessibility is therefore defined according to two criteria related to the accessibility of the residence and the rooms. This can only be considered as a minimum standard, so we do not speak of barrier-free residences in the following, but rather of barrier-reduced residences. Our definition of barrier-reduced residences is limited to aspects that are essential for everyday mobility, especially for elderly with mobility restrictions: step-free access to the dwelling and step-free access to all rooms in the dwelling (see Data and methodology section). This definition of accessibility, which can be measured well with survey data, provides a good overview of the situation of barrier-free housing by minimum criteria.

In this context, it is relevant to investigate who is more likely to live in barrier-reduced housing after the age of 65 and whether people who are more in need of barrier-reduced living conditions do actually have them. Further, in this paper we investigate the role of household income in determining adequate housing for groups with special needs. In particular, we want to address the following research questions:

1. How many of those aged 65 and over live in barrier-reduced housing, i.e., how many have barrier-free access to the residence and the rooms inside it? Is there a matching of need and conditions, i.e., do people with special needs (people with mobility limitations) live in "suitable" housing?
2. What factors influence barrier-reduced housing conditions in older age? Is income a determinant of barrier-reduced housing? Are people with more needs (people with mobility restrictions) with low income levels less likely to live in adequate housing than people with higher income?

2. Data and methodology

The analyses were conducted using data from the German Ageing Survey (DEAS), a representative cross-sectional and longitudinal survey of individuals in the second half of life (6). We used data from the 2020/21 survey, which took place from November 4, 2020, to March 1, 2021. A total of 5,402 individuals aged 46 and over participated in the survey. All respondents had participated in the survey at least once before. Due to the COVID-19 pandemic, individuals were interviewed by telephone. Following the telephone interview, respondents were sent a questionnaire that could be answered in writing or online. As we want to focus on those who spend more time at home and in the neighboring area, and those who have higher probabilities of having mobility restrictions, only individuals aged 65 or over living in private households were included in our analyses ($n = 2{,}854$).

To compensate for the disproportionate sampling, data weighting was applied (7). For this purpose, marginal adjustments of the sample were made to the relative frequency of the characteristic combinations of the sample stratification of age group, sex, and part of the country in the official population statistics. The weighting factors are used for the univariate and bivariate representations.

Accessibility: In our analyses, we used the accessibility of the residence as a dependent variable. Information on the accessibility of the residence was requested in the written questionnaire – respondents were asked to assess features of their residence, such as access to the residence, accessibility of rooms, and other characteristics. The total set of potential variables was not used to define the accessibility of the residence. The proportion of respondents living in an accessible residence according to all criteria recorded in the questionnaire is very small. In 2014, according to DEAS data, it was only 2.9 percent of people aged 40–85 and 5.6 percent of those aged 70–85 (4). Therefore, in order to have a larger sample size available for the analyses on accessibility, the dependent variable was defined as a barrier-reduced residence, based on minimal criteria. Barrier-reduced housing in this sense is coded as 1 when the respondents answered positively that their "apartment or house is accessible without steps" and that "within the apartment or house, all rooms are accessible without steps," and is coded as 0 when they answered negatively. The following characteristics are included as explanatory variables (see Table 1):

Mobility restriction: As described above, we use minimal criteria of accessibility, which include barrier-free access to the residence and to the rooms in the residence. Therefore, it seems reasonable to measure functional limitations of the respondents in daily life with barriers at the residence. For this purpose, we measure respondents'

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TABLE 1 Sample characteristics of participants (*n*, %).

	n	%
Lives in barrier-reduced residence		
No	2,263	80.7
Yes	540	19.3
Mobility restriction		
Not restricted	2,132	74.8
(Severely) Restricted	718	25.2
Age group		
65–79	1,925	67.4
80 +	929	32.6
Gender		
Male	1,294	45.3
Female	1,560	54.7
Equivalized household income		
Quintile 1 - lowest	683	24.9
Quintile 2	524	19.1
Quintile 3	500	18.2
Quintile 4	558	20.3
Quintile 5 - highest	480	17.5
Region		
West Germany	2,272	79.6
East Germany	582	20.4
Regional typology		
Rural	1,025	35.9
Urban	1,829	64.1
Moving after age 65		
No	2,435	85.3
Yes	419	14.7

Source: DEAS 2020/21. Weighted number of cases and weighted frequencies.

mobility restriction with item 5 ("Climbing a flight of stairs") from the subscale "Physical Functioning" of the 36-item short-form health survey (SF-36) (8, 9): "The following questions are about activities you might do during a typical day. Does your health now limit you in these activities? Are you severely restricted, somewhat restricted or not restricted due to your current state of health?" (10). We code in 1 = "severely restricted" or "somewhat restricted," and 0 = "not restricted."

Age groups: We differentiate age groups of 65–79 and 80 years and older.

Gender: We differentiate male and female persons.

Equivalized household income: This variable contains the needs-adjusted net monthly per capita income of the household. Weighting of household size uses the modified OECD equivalent scale that is used by Eurostat and the Federal statistical Office (10). This information is introduced in the form of quintiles.

Region: We differentiate between West Germany and East Germany.

Regional typology: We differentiate rural and urban areas of living, and use information on the urban–rural type of district based on structural characteristics of the settlements (see (10)). Four district types are defined: "metropolitan districts," "urban districts" (both combined and coded by us as "urban"), "(partially) densely populated rural districts" and "sparsely populated rural districts" (both combined and coded by us as "rural").

Moving after age 65: We use the information from the questionnaire about how long the respondent has lived in the current residence and their age to calculate whether or not the person moved into this residence after age 65.

Table 1 shows that 19.3 percent of individuals aged 65 or older in Germany live in barrier-reduced housing. That is, only about one in five at this age can get into the dwelling and rooms inside it without having to climb steps. Some 80.7 percent therefore do not have barrier-free access to their dwelling and rooms.

Almost 33 percent are 80 years old or above, and about 20 percent live in East Germany. Most individuals live in an urban area (64 percent). Finally, only around 15 percent moved house after age 65, which confirms the preference of aging in place.

The probability of living in a barrier-reduced residence is estimated using multivariate logistic regression analysis with a binary dependent variable (Respondent lives in a barrier-reduced dwelling yes/no).

3. Results

3.1. Descriptive results

First, we bivariately examined the distribution of over-65 s living in barrier-reduced residences by sociodemographic and regional variables for those individuals with and without mobility restrictions.

What Figure 1 shows is that only a small percentage of people – both with and without mobility problems – live in barrier-reduced residences (21.4 and 18.6 percent respectively). However, differences between the two groups are small, meaning that the overall level of barrier-reduced housing in Germany is low. In addition, considering that older people who are still mobile at present may also develop limitations in the course of the next few years, the need for barrier-reduced housing will increase.

Men with mobility restrictions more often (26 percent) live in suitable housing than women with mobility restrictions (19 percent). We do not observe large differences between urban and rural areas for people with mobility restrictions, but we do see differences in the case of people without mobility restrictions. People living in rural areas more often live in a barrier-reduced residence than those in urban areas.

Income seems to be relevant for the accessibility of appropriate housing for people with mobility restrictions. We observe in Figure 1 that people in the upper income quintile more often live in barrier-reduced houses than people in the middle or lower quintiles. About 31 percent of people in the fifth income quintile (highest incomes) with mobility restrictions live in an adequate residence, while this is only the case for 12 percent of people in the poorest quintile. We do not observe this strong income effect on the group of people without mobility restrictions.

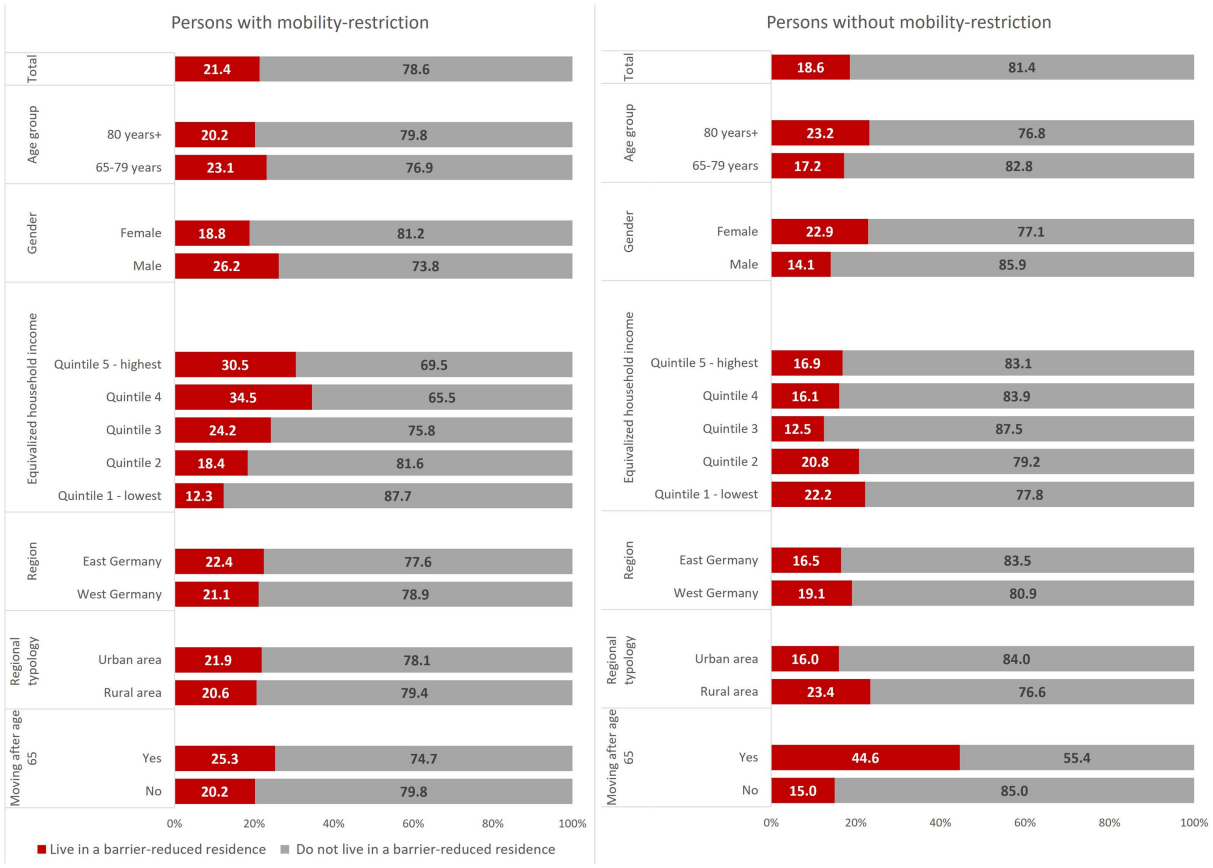

FIGURE 1
Proportions of persons with or without mobility-restriction who (do not) live in a barrier-reduced residence (%). Source: DEAS 2020/21 (*n*=2,800). Weighted frequencies.

Finally, we observe that people who moved after the age of 65 more often live in barrier-reduced residences. This is particularly the case in the group of people without mobility restrictions. In this case, 45 percent of the individuals who moved late in life live in a barrier-reduced home, while this is only the case for 15 percent of those who had not moved house. We also observe this effect among people with mobility restrictions, but to a lesser degree. While 25 percent of those who moved in later life live in an adequate home, this is only the case for 20 percent of those who had not moved.

3.2. Multivariate results

By means of a multivariate logistic regression analysis (see Table 2), we examined how individual characteristics are related to living in a barrier-reduced residence. These relationships can provide initial indications of which factors influence barrier-reduced housing in older age. In a stepwise model, we successively introduced mobility restrictions, sociodemographic factors, and regional factors, or the variable indicating whether someone has moved in old age, into the analysis.

In the first model, only mobility impairments are considered. The probability of mobility-restricted seniors living in a barrier-reduced residence is 8.2 percentage points higher than for seniors without mobility restrictions, so this health condition is an important factor in barrier-reduced housing.

Sociodemographic variables (age, gender, household income) are included in the second model. In comparison to those aged 65–79 years, the probability of living in barrier-reduced housing is 4.5 percentage points higher among people over 80. Older people who belong to the quintile with the highest income are 7.4 percentage points more likely to live in such a dwelling than the people in the poorest quintile. Controlled for age, gender, and household income, the proportion of mobility-restricted seniors living in barrier-reduced housing is 7.1 percentage points higher than in those without mobility restrictions.

In a last step (model 3), region, regional typology and the variable indicating whether the individuals had moved after the age of 65 are included in the analysis. The results of this model are:

Mobility restriction: A mobility restriction, measured by the restricted ability to climb a flight of stairs, has a positive effect on the likelihood of living in a barrier-reduced residence. Respondents who can manage a flight of stairs only with restrictions or even severe restrictions have a 5.8 percentage point higher proportion of barrier-reduced housing.

Sociodemographic characteristics: Belonging to the oldest age group (over 80s) has no significant statistical effect on the probability of living in a barrier-reduced residence after controlling for the other

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TABLE 2 Determinants of living in a barrier-reduced residence among those 65 or older.

	Model 1	Model 2	Model 3
	Marginal Effects		
Mobility restriction (ref. not restricted)			
(Severely) Restricted	0.082***	0.071***	0.058***
Age group (ref. 65–79)			
80 +		0.045***	0.013
Gender (ref. male)			
Female		−0.020	−0.021
Equivalized household income (ref. Quintile 1 - lowest)			
Quintile 2		0.032	0.029
Quintile 3		0.030	0.025
Quintile 4		0.033	0.029
Quintile 5 - highest		0.074***	0.058***
Region (ref. West Germany)			
East Germany			−0.044***
Regional typology (ref. rural)			
Urban			−0.032**
Moving after age 65 (ref. no)			
Yes			0.232***
Pseudo-R^2	0.0076	0.0145	0.0583
Observations	2,832	2,731	2,731

Source: DEAS 2020/21 (n = 2,832 – 2,731). Binary logit regression analysis. Dependent variable: Living in a barrier-reduced residence (0 = no, 1 = yes). ***$p < 0.01$ (significance). **$p < 0.05$ (significance).

characteristics considered in the model. This initially surprising finding suggests that the very old are not more likely to live in such residences than the less elderly. This means that very old age is not necessarily linked to barrier-reduced housing, but other factors, which are closely linked to old age, favor such housing.

Gender also has no statistically significant relationship to barrier-reduced housing in our results. This result might be explained by the fact that a large proportion of those over 65 live together as a couple in the same residence, making it difficult to isolate the gender effect.

There is some evidence in the literature that the economic situation of seniors may also influence how often they live in barrier-reduced housing conditions. To measure the economic situation of the respondents, we used the equivalized household income in quintiles as an indicator. After controlling for other variables, our results show a statistically significant effect of the income quintiles on the prevalence of barrier-reduced housing. Compared to the lowest income quintile, respondents in the highest income quintile have a 5.8 percentage point higher chance of living in barrier-reduced housing. However, we do not observe this effect for the other income quintiles. Only large income differences seem to influence the chance of barrier-reduced housing.

Region and regional typology: Respondents in East Germany are 4.4 percentage points less likely to live in a barrier-reduced residence than respondents in West Germany, even after controlling for mobility restrictions and sociodemographic variables. Living in urban areas reduces the chance of barrier-reduced housing by 3.2 percentage points compared to living in a rural area.

Moving after age 65: Moving after age 65 has a large positive effect on the likelihood of living in a barrier-reduced apartment. Those who moved to their current home after age 65 are 23.3 percentage points more likely to live in barrier-reduced housing than seniors who did not.

We also included the interaction effect between quintile of household income and mobility restrictions in the model to test whether people with higher incomes and restricted mobility are more likely to live in barrier-reduced housing than people with lower incomes and restricted mobility. In our model (results are not shown), such an interaction has no significant effect. Further we have tested the assumption that higher-income seniors are more likely to move at older ages than low-income seniors. This interaction between moves and income was also not significant in the model.

4. Discussion

4.1. Most older and mobility-restricted people in Germany do not live in barrier-reduced housing

We directed our analyses to barrier-reduced housing for individuals aged 65 or older in Germany, with a special focus on people with mobility restrictions. One main finding is that there is not enough barrier-reduced housing. This is true even based on our minimum criteria, which only include barrier-free access to the residence and the rooms within it. Only 19.3 percent of all over-65 s live in barrier-reduced conditions, meaning over 80 percent do not. Even among the very old over 80, only 21.3 percent are provided with barrier-reduced residences. This percentage can be assessed as very low, considering the importance of mobility in the residence and in its surrounding area for this age group. Even more serious is that only 21.3 percent of those aged 65 or older with difficulties climbing stairs live in a barrier-reduced residence. Our findings are consistent with earlier studies that showed only about 3 percent of all 40 to 85-year-olds had barrier-free housing (4). Barrier reduction in the home is not the only prerequisite for successful aging in place. As another essential aspect of housing in old age, technical support and its acceptance should be mentioned here (11).

4.2. Advanced age alone is not a key indicator for barrier-reduced housing – mobility restrictions have a significant impact

The results of our multivariate analysis show that, when controlled for other characteristics, advanced age of over 80 years does not determine whether seniors live in barrier-reduced housing or not. Other variables such as the existence of health problems, measured as whether someone suffers mild or severe mobility restrictions, increase the probability of living in barrier-reduced housing (by 5.8 percentage points). This implies that people with more needs are more likely to live in appropriate housing. However, as the descriptive results show, the percentage is still very low. According to the descriptive results,

individuals aged 80 or over are also more likely to live in barrier-reduced housing than the younger age group of individuals aged between 65 and 79. However, the moment we also control for mobility problems, the effect is not statistically significant anymore, as age and mobility restrictions are highly correlated.

4.3. High income is positively related to barrier-reduced housing

We could see in the bivariate analyses that mobility-impaired seniors in the higher income quintiles were more likely to live in barrier-reduced housing than those in the lower quintile. We also see in the multivariate model that people with high incomes live more often in barrier-reduced houses, but only in comparison to the lowest income quintile. Factors influencing barrier-reduced housing such as moving may overlay the income effect in the middle income groups. Such factors may also be socially unevenly distributed, but we cannot measure this in the model.

4.4. Less barrier-reduced housing in East Germany

In addition, our results show that regional characteristics also play a role. Older people in East Germany are less likely to live in barrier-reduced housing than older people in West Germany. It seems that there is less availability of barrier-reduced housing in East rather than West Germany. With these regional differences, it can be assumed that the income differences between East and West Germany play a role. It can also be assumed that residential buildings in East Germany are older on average than in West Germany and that this fact favors differences in barrier-free living. Other differences between both regions such as lower homeownership rates in East Germany or differences in the structural types of houses may also explain such differences.

4.5. Those moving in older age could have an advantage in barrier-reduced housing

Our analyses also show that moving in old age is correlated with barrier-reduced housing in old age. In these cases, there is a high probability that housing is adapted to the needs elderly people have when they move. This finding suggests that people moving at older ages are often motivated by changing to more appropriate (in terms of accessibility) housing. Indeed, moving after age 65 has the strongest impact on the likelihood of living in a barrier-reduced residence.

Our findings are consistent with previous findings that proved the role of long periods of residence in old age. Höpflinger (12) speaks of double aging in the case of a long period of residence – the aging of the people themselves and the aging of their home. He notes that, with a long period of residence, the dwelling and neighborhood take on a high affective significance. Therefore, a long period of residence can go hand in hand with a high level of residential satisfaction due to habituation, even in the case of housing that is not suitable for seniors.

In Germany, there are very long periods of residence and little residential mobility. It can be assumed that people in middle adulthood who are looking for a new home do not select it primarily according to the criterion of accessibility. As they grow older and become familiar with the living arrangements, neighborhood, and environment, there is little incentive to move to another, possibly barrier-reduced, residence. It is only as functional health deteriorates that barriers in the residence can become a real obstacle to daily life. By then, however, the burden of moving or conducting extensive construction work in the residence will have become disproportionately high.

What strengths and limitations do we identify in our study?

One strength is that a set of housing characteristics are collected for a representative population sample, which are necessary for the formation of the barrier-reduced housing indicator. Limitations lie in the fact that we used a panel sample for our cross-sectional analyses. Weighting factors were used to compensate for bias within the sample. The housing information is self-reported by the respondents, so the assessment of barriers is subjective and not based on objective metrics or measurements. Our results are correlations and do not show any causal effects. In addition, it must be remembered that the 2020/21 study was conducted during the COVID-19 pandemic, which may have influenced willingness to participate and response behavior.

What can we conclude from our results?

Living in a private household in old age remains a balancing act between individual living wishes, holding onto familiar places and networks, and the objective conditions and possibilities offered by the built environment for carrying out daily tasks and requirements. Aging in place therefore requires that housing is adequate to the special (and changing) needs of the older generation. If this is provided, aging in place is possible and desirable for both seniors and society. Age-appropriate housing requires there to be enough apartments with barrier-free housing standards and that these apartments are affordable to the elderly population. Our results show that the need for age-appropriate housing for the over-65 s is far from being met. An interesting question for future research is how living in inadequate housing conditions affects the probability to living in a nursing home. Barrier-reduced living in old age can be realized by modifying the existing apartment or by moving into an appropriate apartment. Both options require a great deal of financial and organizational effort on the part of the older person. It is therefore necessary to educate older people with housing advice about the options available for age-appropriate housing conversion and financial support. If older people are looking for a new apartment and are willing to bear the burdens of a move, they should be supported in finding an apartment and moving. The shortage of housing in many regions of Germany should not lead to a reduction in age-appropriate housing standards for older people.

With our analyses, we can only depict a small part of age-appropriate living, because in addition to barrier-reduced housing, a barrier-reduced living environment, local availability of essential infrastructure facilities, and social and nursing support services are also part of age-appropriate living (13). The demographic aging of the population makes it particularly necessary to pay more attention to these aspects.

Our results confirm findings from research in other countries on barrier-free housing: A study in five European countries (14) showed for people aged 75 and older, that those who had better accessible homes and who perceive their home as meaningful and useful are

more independent in daily activities and have a better sense of well-being. A study from the U.S. (15) examined factors older adults view as barriers to their aging in place plans. The study finds that for elders, barriers and conditions for safety in the home are essential and that elders need better, person-centered informed support to adapt housing conditions to their needs. Another South Korean study (16) revealed that barrier-free housing is an important choice for older people and can be adopted by them as an affordable housing option. The value of barrier-free housing can exceed its cost in this regard. If the willingness to pay of people who demand barrier-free housing is higher than the cost of it, barrier-free construction can be a sustainable marketing option in the housing market.

Policymakers in Germany have recognized that there is too little barrier-free housing and that the need will increase in view of demographic developments. Through the "Kreditanstalt für Wiederaufbau" (Reconstruction Loan Corporation), the German government has initiated a program for the age-appropriate conversion of housing, which provides funding for the removal of barriers in existing buildings (17). Germany is not an exception internationally in terms of barrier-free housing for people with functional limitations. As the OECD states in a study, there is a general lack of accessible housing for people with disabilities in OECD and EU countries. At the same time, financial barriers keep these people from housing conditions that meet their needs, especially since they often live in precarious financial conditions. However, there are also information barriers that make current housing offers and information about corresponding services difficult to reach for potential users (18). The lack of affordable housing, especially in large cities and their agglomerations, is an increasingly serious problem in Germany. There is a danger that affordable barrier-reduced housing will become unattainable for many people with disabilities, not only in old age. This must be counteracted by politics at the federal level, but also by local politics.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found here: The datasets presented in this article are available from the Research Data Centre of the German Centre of Gerontology. Requests to access the datasets should be directed to https://www.dza.de/forschung/fdz/kontaktformular.

Author contributions

SN, LRG, and ALA contributed to conception and design of the study. SN organized the database, performed the statistical analysis, and wrote the abstract and the first draft of the manuscript. LRG and ALA added parts of the sections of 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.

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References

1. Teti A, Kuhlmey A, Dräger D, Blüher S. Prädiktoren individueller Wohnmobilität älterer Frauen und Männer. *Prävention und Gesundheitsförderung*. (2012) 7:278–85. doi: 10.1007/s11553-012-0353-2

2. Pani-Harreman KE, Bours GJJW, Zander I, Kempen GIJM, van Duren JMA. Definitions, key themes and aspects of 'ageing in place': a scoping review. *Ageing Soc*. (2021) 41:2026–59. doi: 10.1017/S0144686X20000094

3. Engstler H, Menning S, Hoffmann E, Tesch-Römer C. Die Zeitverwendung älterer Menschen In: Statistisches Bundesamt, editor. *Alltag in Deutschland-Analysen zur Zeitverwendung*, vol. *43*. Stuttgart: Metzler-Poeschel (2004). 216–46.

4. Nowossadeck S, Engstler H. *Wohnung und Wohnkosten im Alter. Altern im Wandel*. Wiesbaden: Springer; (2017). p. 287–300.

5. Zapfel S, Mederer B, Roßnagel T, Puhe H. *Menschen mit Behinderung und barrierefreies Wohnen in Nürnberg*. Nürnberg: Institut für empirische Soziologie an der Friedrich-Alexander Universität Erlangen-Nürnberg (2020).

6. Klaus D, Engstler H, Mahne K, Wolff JK, Simonson J, Wurm S, et al. Cohort profile: the German ageing survey (DEAS). *Int J Epidemiol* (2017) 46:1105–g, 1105g, doi: 10.1093/ije/dyw326

7. Schiel S, Ruiz Marcos J, Schulz S, Dickmann C, Fahrenholz M. (2021). Methodenbericht Deutscher Alterssurvey (DEAS): Durchführung der 7. Erhebungswelle 2020/2021. Available at: https://www.dza.de/forschung/fdz/deutscher-alterssurvey/deas-dokumentation (Accessed October 25, 2022).

8. Ware JE, Sherbourne CD. The MOS 36-item short-form health survey (SF-36): I. conceptual framework and item selection. *Med Care*. (1992) 30:473–83. doi: 10.1097/00005650-199206000-00002

9. Bullinger M, Kirchberger I. *SF-36: Fragebogen zum Gesundheitszustand. Handbuch für die deutschsprachige Fragebogenversion*. Göttingen: Hogrefe, Verlag für Psychologie (1998).

10. Engstler H, Stuth S, Lozano Alcántara A, Luitjens M, Klaus D, Schwichtenberg-Hilmert B, et al. *German ageing survey - Deutscher Alterssurvey documentation of instruments and variables – Instrumenten- und Variablendokumentation*. Berlin: German Centre of Gerontology – Deutsches Zentrum für Altersfragen (2022).

11. Chimento-Diaz S, Sanchez-Garcia P, Franco-Antonio C, Santano-Mogena E, Espino-Tato I, Cordovilla-Guardia S. Factors associated with the acceptance of new technologies for ageing in place by people over 64 years of age. *Int J Environ Res Public Health*. (2022) 19:2947. doi: 10.3390/ijerph19052947

12. Höpflinger F. *Gut betreut und doch autark Pflegez*. (2022) 75:13–5. doi: 10.1007/s41906-022-1289-6

13. Haug S, Vetter M. Ältere Menschen im Wohnquartier Margaretenau in Regensburg – aktuelle Situation und zukünftiger Bedarf In: A Teti, E Nowossadeck, J Fuchs and H Künemund, editors. *Wohnen und Gesundheit im Alter. Vechtaer Beiträge zur Gerontologie*. Wiesbaden: Springer VS (2022)

14. Oswald F, Wahl HW, Schilling O, Nygren C, Fange A, Sixsmith A, et al. Relationships between housing and healthy aging in very old age. *Gerontologist*. (2007) 47:96–107. doi: 10.1093/geront/47.1.96

15. Brim B, Fromhold S, Blaney S. Older adults' self-reported barriers to aging in place. *J Appl Gerontol*. (2021) 40:1678–86. doi: 10.1177/0733464820988800

16. Lee SY, Yoo S. Willingness to pay for accessible elderly housing in Korea. *Int J Strateg Prop Manag*. (2019) 24:70–82. doi: 10.3846/ijspm.2019.11095

17. Aichele V, Bernot S, Hübner C, Kroworsch S, Leisering B, Litschke P, et al. *Wer Inklusion will, sucht Wege: Zehn Jahre UN-Behindertenrechtskonvention in Deutschland*. Berlin: Deutsches Institut für Menschenrechte, Monitoring-Stelle UN-Behindertenrechtskonvention (2019).

18. Plouin M, Adema W, Fron P, Roth P-M. *A crisis on the horizon*. Paris: OECD Publishing (2021).

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Are older people worse off in 2040 regarding health and resources to deal with it? - Future developments in complex health problems and in the availability of resources to manage health problems in the Netherlands

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Introduction: Developing sustainable health policy requires an understanding of the future demand for health and social care. We explored the characteristics of the 65+ population in the Netherlands in 2020 and 2040, focusing on two factors that determine care needs: (1) the occurrence of complex health problems and (2) the availability of resources to manage health and care (e.g., health literacy, social support).

Methods: Estimations of the occurrence of complex health problems and the availability of resources for 2020 were based on registry data and patient-reported data. Estimations for 2040 were based on (a) expected demographic developments, and (b) expert opinions using a two-stage Delphi study with 26 experts from policy making, practice and research in the field of health and social care.

Results: The proportion of people aged 65+ with complex health problems and limited resources is expected to increase from 10% in 2020 to 12% in 2040 based on demographic developments, and to 22% in 2040 based on expert opinions. There was high consensus (>80%) that the proportion with complex health problems would be greater in 2040, and lower consensus (50%) on an increase of the proportion of those with limited resources. Developments that are expected to drive the future changes refer to changes in multimorbidity and in psychosocial status (e.g., more loneliness).

Conclusion: The expected increased proportion of people aged 65+ with complex health problems and limited resources together with the expected health and social care workforce shortages represent large challenges for public health and social care policy.

KEYWORDS

health problems, older people, resources, health care, social care, health policy

Introduction

Demographic projections show that in most Western countries the proportion of the population aged 65+ will increase in the coming decades (1–3). In the Netherlands for instance, the proportion of people of 65 years or older is expected to increase from 20% in 2020 to 26% in 2040 (4, 5). Within this age group, the percentage of people over age 80 and 90 will increase too. Older people generally have increased health and social care needs, and thus these demographic changes will have wide-ranging implications for society as a whole and for health and social care provision in particular (6). In addition to these demographic developments, also other developments may affect how the 65+ population of 2040 will look like with regard their demand for health and care, compared to those in 2020. Insight into these developments is needed for governments to design sustainable health policy and explore policy options.

It is expected that in the future people over age 65 will differ from their predecessors, e.g., in terms of lifestyle, health literacy, digital skills, household composition and social networks. For example, it is thought that the prevalence of smoking will continue to decrease, resulting in less smoking-related health problems. Overweight and obesity, however, still seem to increase, which implies higher numbers of overweight-related health problems (5, 7–9). Besides these health-related developments, we live in an era in which profound cultural, social and economic changes are taken place that will determining the future (10, 11). Since this "package deal of changes" includes many different elements it is difficult to determine the consequences for future health and social care needs (6, 12).

One way to get more insight into the consequences of a changing 65+ population is to focus on two important elements that determine the need for care and support: (1) the complexity of the medical condition(s), – which we refer to as 'complex health problems', and (2) the availability of resources for managing health and care (13, 14). Combining these two as binary (yes/no) characteristics, gives four groups that define the need for care and support, as inspired by the clientship-model (13, 15, 16) (Figure 1). Especially the group with complex health problems as well as limited resources forms a challenge for society and health and social care provision. This group presents a frail population, with a high care need and with a high risk of developing negative health-related events. Most studies on forecasts focus on the development of health but we think it is also important to explore the forecasts on the availability of resources. The aim of this study was to obtain insight into how the 65+ population is distributed across the four groups of need for care and support in 2020, and the expected distribution in 2040, and to identify the developments that may affect the future distribution.

Data and methods

This study consisted of three parts. First, we estimated the distribution of the 65+ population for the year 2020 across the following groups; (1) complex health problems and sufficient resources, (2) complex health problems and limited resources, (3) no complex health problems and sufficient resources and (4) no complex health problems and limited resources. Second, we estimated this distribution for 2040 based on expected demographic developments only, assuming that the proportion in each group would remain the same. Third, we estimated this distribution for 2040 based on expert opinion using a two-stage Delphi study. With this study, we also assessed the expected developments that may drive the future changes in distribution, and the level of consensus on the direction these developments might take.

Estimates for 2020

The distribution of the population across the four groups of need for care and support based on the prevalence of complex health problems and the availability of resources to manage these was estimated for the year 2020 using age-sex specific data from three population-based studies.

The Nivel's Primary Care Database (Nivel Zorgregistraties eerste lijn) (17) uses routinely recorded data from healthcare providers to monitor health and health services utilization in a representative sample of the Dutch population. Diagnoses in primary healthcare are registered according to the International Classification of Primary Care (ICPC) (18). This data source provided data on age-sex specific prevalence of complex health problems for those aged 65+. The data compromises electronic medical records of patients from approximately 10% of general practices in the Netherlands (n = 1.331.882, of which 253.309 is 65+).

The National Health Monitor of the Netherlands (2016) (19) provided data on the age-sex-specific prevalence of having limited health resources for those aged 65+. It is a survey that aims to collect national, regional and local data on health, social situation and lifestyle. Municipal Health Services distribute this survey in collaboration with the National Institute for Public Health and the Environment (RIVM) commissioned by the Ministry of Health (n = almost 460,000 with a response rate of 40%).

The 6th measurement round of the Doetinchem Cohort Study (DCS) (20) provided data on: the age-sex specific prevalence of complex health problems and presence of resources in the age group 65–85 years (n = 3,500). The advantage of this dataset for these analyses is that both data on diseases, disability and resources are available (21).

The operational definition of 'complex health problems' was as close as possible to 'those having at least conditions from two of the following clusters of disease: cardiovascular/metabolic disease, respiratory/musculoskeletal disorders, depression, visual or hearing problems, cancer or severe neurological disease. The operational definition of limited resources to social.

problems was based on at least two of the following characteristics: Living alone, low educational level, receiving informal care, inability to meet basic needs and insufficient self-reliance.

Estimates 2040 based on demographic projections

The age-sex specified prevalence of (the combination of) complex health problems and the availability of resources as determined in 2020 were applied to the age-sex specified population projections of 2040 to get estimates for 2040. These projections are published yearly online by Statistics Netherlands. We used the projections published in 2020 (4).

Group	Complex Health Problems	Resources	Implications for care
1	No	Sufficient	Self-management clientship: medical condition not complex and sufficient resources such as knowledge and skills or family support to manage one's health and care
2	No	Limited	Community clientship: medical condition not complex but limited resources
3	Yes	Sufficient	Co-operation clientship: medical condition complex but sufficient resources to co-operate with care professionals and contribute to care, for instance, by self-monitoring or self-treatment
4	Yes	Limited	Network clientship: medical condition complex and limited resources.
" Introduction: there are roughly two general characteristics that will be the drivers of the (future) need for health and social care services: (a) the size of the population with complex health problems (yes/no): Complex health problems are defined as a combination of different, often chronic, illnesses which require care and support. And (b) the availability of (yes/no) Sufficient resources to manage complex health problems: Persons will differ in their ability to manage or deal with complex health problems, which is affected by the availability of personal or external resources. Personal resources include: education, income and health literacy. External resources include: availability of care providers, availability of facilities (supermarkets, healthcare facilities, etc.) and availability of a social network.			

FIGURE 1
The 'care and support' groups in the population of the thinking model used, and the introduction to the experts. Based on the clientship model (13, 15, 16).

Population estimation 2040 based on expert opinion: Delphi study

A Delphi consensus procedure was conducted between October 2020 and January 2021. Experts were invited to share, in a structured manner, their thoughts on the characteristics of the 65+ population of 2040 in terms of complex health problems and resources to manage these, and to identify the developments affecting these characteristics.

The Delphi methodology aims to systematically collect opinions from a group of experts and achieve consensus (22, 23) for topics where evidence is lacking. The use of anonymity of participants, iteration and feedback allows the participants to openly give their opinion and change their opinion during the process (24).

Expert panel

A multidisciplinary panel of 39 experts were recruited *via* email from the networks of the research team. Fields of expertise were older people and health and social care in the Netherlands. The panel included policy makers, researchers, insurers, (advocates of)older people or people with dementia and health organization advisors.

Procedure

The Delphi-process consisted of two rounds, each running for 3 weeks using the MeetingSphere and Formdesk electronic platforms. Both Delphi rounds consisted of completing an online questionnaire and participating in a guided discussion on the online platform. The responses to the questions were fed back anonymously to the participating experts before the discussion session. Experts could revisit the platform at any time during the discussion sessions and provide their suggestions or comments. The Delphi-study was anonymous for both the experts as well as the research team.

Delphi round 1

The first round of the Delphi-study was aimed at identifying developments affecting the occurrence of complex health problems and the availability of resources in the Netherlands in 2040. The project was introduced to the experts by showing an animation with an introduction of the conceptual model and the population distributions in 2020 and 2040 (demographic projections only) across the four groups of the clientship-model (13, 15, 16).

The questionnaire was pilot tested among four colleagues at the National Institute for Public Health and the Environment to make sure the questions and the procedure were clear to the participants. The questionnaire included questions on:

A. Complex health problems

- How will the future percentage of older people aged 65+ compare to the current percentage of people aged 65 +? (using a 5-point Likert scale ranging from a large decrease to a large increase)
- Which developments do you expect to affect the future percentage of older people with complex health problems? A list

of 13 potential categories (number of people with at least one chronic condition, treatment options, culture, diagnosis. Infectious diseases, lifestyle and behavior, life expectancy, mental well-being, environment, psychosocial well-being, locus of control, vitality and working conditions) was presented, and participants were invited to add to this list.

B. Resources

- How will the availability of resources amongst older people in the future compare to the availability of resources amongst the older people now? (using a 5-point Likert scale ranging from a large decrease to a large increase)
- Which developments do you expect to affect the availability of resources amongst older people in the future? A list of 12 potential categories (digital skills, health literacy, household composition, income, living conditions, independence, informal care, social network, local amenities, healthcare staff, healthcare technology) was presented, and participants were invited to add to this list.

C. Complex health problems and resources combined

- How will the future distribution of older people according to complex health problems and the availability of resources compare to the current situation? The four groups [(A) without complex health problems and with sufficient resources, (B) without complex health problems and with limited resources, (C) with complex health problems and with sufficient resources and (D) with complex health problems and with limited resources] were presented, and participants were asked to rate each group (using a 5-point Likert scale ranging from a large decrease to a large increase).

Free-text boxes were available for all questions for experts to explain their choices.

Delphi round 2

The second round of the Delphi-study was aimed at elaborating on how all the developments identified in round 1 would affect the prevalence of complex health problems and the availability of resources among older people aged 65+ in the future. In addition, the participants were asked to give their expectation on the distribution of proportions across the four groups. The participants could divide a 100% across the four groups.

Data analysis of the Delphi-study

Consensus was defined as a certain percentage of agreement. In this study, three levels of consensus were used. "High consensus" was defined as ≥75% agreement on the expected strength of the effect of a development. "Intermediate consensus" was defined as ≥62.5% agreement on the expected strength of the effect of a development. "Low consensus" was defined as <62.5% agreement. The criteria for consensus were determined before the start of the study based on literature using similar study designs (25, 26).

Results

Expert panel

From the 39 invited experts, 26 experts responded to the first questionnaire (response rate 67%). Sixteen experts responded to the second questionnaire (response rate 62%). Reasons for not participating or dropout were mainly time constraints.

Estimations for 2020 and 2040

The prevalence in 2020 of complex health problems was about 30% in people aged 65–69 years and about 80% for people aged 85 and above. The prevalence of older people with limited resources was 10 and 60%, respectively (Figure 2). All figures were higher among women compared to men.

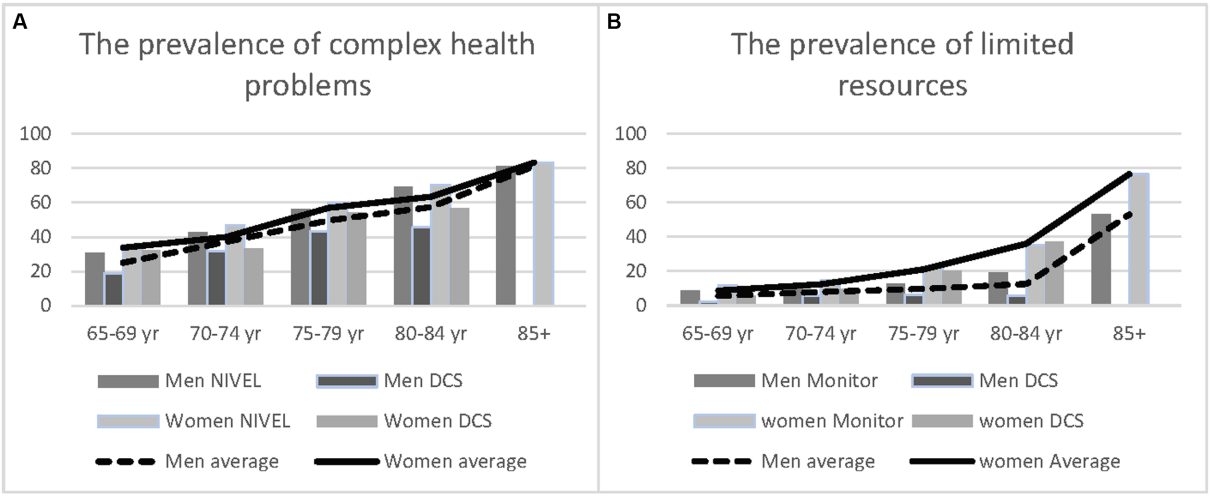
Using the age-sex-specific figures, the estimated proportion of the 65+ population with complex health problems and limited resources in the year 2020 was 10%, for complex health problems with sufficient resources 30.7%, for no complex health problems and limited resources 3.8% and for those without complex health problems or limited resources 55.6% (Figure 3). For 2040, the demographic forecasts show a shift to a larger population with complex health problems and limited resources of 11.7% mainly at the expense of those without challenges. The experts who took part in the Delphi study gave a different picture: taking all trends and developments into account the experts estimated the 65+ population with complex health problems and limited resources to be 22% (compared to 11.7%) and for those without complex health problems and limited resources 19% (compared to 4.1%).

Developments affecting complex health problems and resources

In round 1 of the Delphi-study two developments were added in relation to complex health problems and one development in relation to resources. A total of fifteen developments potentially affecting the future prevalence of complex health problems were identified (Table 1) and thirteen developments affecting the availability of resources among the 65+ in 2040 (Table 2). Explanations provided by the experts on the assumed trend for each development are reported in Tables 1, 2.

Complex health problems in 2040

Consensus on the direction of change of the developments in the next 20 years was reached for 73% of the developments (53% high and 20% intermediate). Consensus was slightly lower on how these developments affect complex health problems (Table 1). The level of consensus among the experts increased throughout the rounds. In round one, more than half of the experts (56%) expected the percentage of older people with complex health problems to



Complex health problems were defined in Nivel's primary care database (17) as conditions in at least two of the following clusters: Cardiovascular or metabolic disease (ICPC-codes: T90, K70-K71, K74-K80, K83, K89-K90), Respiratory diseases and/or musculoskeletal disorder and/or severe physical disability (R91, R95-96, L88-91, L95), Mental or psycho-social problems, including depression (ICPC-codes: P72, P74, P76, P80), Cognitive limitations and dementia (ICPC-codes: P70), Severe visual or hearing problems (ICPC-codes: F83-F84, F92-F93, H84-H86), Severe somatic diseases (ICPC-codes: N87, A79, B74, D74-77, L71, N74, R85, S77, T71, T73, U75-77, X76-77).

Complex health problems in the Doetinchem Cohort Study (20) were defined as conditions in at least two of the following clusters: Cardiovascular or metabolic disease (diabetes), Respiratory diseases and/or musculoskeletal disorder (reumatoid arthritis or osteoarthritis) and/or severe physical disability, Severe depressive complaints and/or low mental health, Severe visual or hearing problems, Cancer or severe neurological disease.

Limited resources to manage health problems is based on at least two of the following characteristics (National health monitor) (19): Living alone, low educational level, receiving informal care, 'unable to meet basic needs and insufficient independence or (DCS) living alone, receiving informal care > 3 months, a low health literacy.

FIGURE 2
The prevalence of complex health problems **(A)** and limited resources **(B)** by sex and age: estimations and population.

increase, 28% expected stability and 16% a decrease. In round two, the majority (81%) expected the percentage of older people with complex health problems to increase. Developments contributing directly or indirectly to an increase of the occurrence of complex health problems were: increased prevalence of chronic conditions, increased life expectancy, more treatment options and early detection of diseases, and increased socio-economic inequality. Experts also mentioned developments contributing directly or indirectly to a potential decrease of complex health problems; increased self-management of health, improved lifestyle and health behavior and increased self-efficacy. Even though the experts agreed that there will be an increase in cultural diversity and an increase in the vitality of older people in the next 20 year they did differ of opinion on how these developments will affect the presence of complex health problems.

Resources to deal with complex health problems in 2040

Consensus on the direction of change was reached for nine (69%) out of thirteen resources. The level of consensus among the experts increased throughout the rounds. In round one, more than a third of the experts (37%) expected the overall availability of resources to increase, 32% expected stability and 26% a decrease. In round two, 22% of the experts expected an increase of the availability of resources to manage complex health problems, half of the experts expected a decrease. Developments contributing to the expected decrease are an increase of one-person households and a decrease in the availability of both formal and informal care providers. The experts mentioned that the increase of health literacy, digital skills, educational level and independency will apply only to a part of older adults. The experts

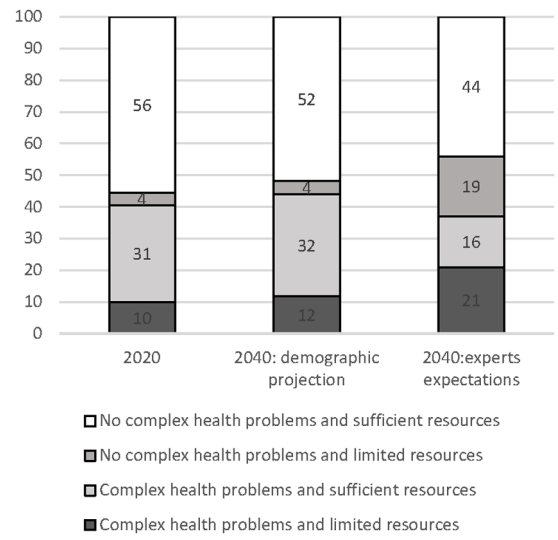


FIGURE 3
Distribution of the 65+ population across the four profiles in 2020 and 2040 based on demographic projections and experts' expectations.

mentioned that those with a low educational level, language barriers and low socio-economic position will stay behind, causing the gap between the rich and poor to increase. No consensus was reached on the developments in availability of suitable housing, income and wealth, availability of a social network and services in the neighborhood.

Discussion

This study aimed to get insight into the characteristics of the 65+ population of 2040, compared to the 65+ population in 2020, using modelling exercises and input from experts by means of a Delphi study. After taking a number of developments into account, the experts in the Delphi study expected the proportion of adults aged 65+ with complex health problems and limited resources in the Netherlands to increase from 10 to 22% in 2040. Also, this expected percentage is higher than the expected proportion of adults aged 65+ in 2040 based on demographic developments (12%). Although this figure of 22% is only an estimate, it presents reason for concern because it indicates that, when taking various developments into account, the need for care will be higher in the future.

This study shows that besides demographic developments also other developments affect the occurrence of complex health problems and the availability of resources, such as socioeconomic changes, developments in lifestyle and health, changes in living and working conditions, the increase of one-person households and decrease of formal and informal care providers. People will more often have to rely on informal care from family and friends, which in turn will have implications for the living and working conditions of the informal care providers such as work interference or change in work status and an increase of emotional stress (27–29). This will most likely negatively impact the availability of informal care.

The various developments are also expected to interact with or even amplify one another, resulting in a larger proportion of the population with complex health problems and with limited resources to deal with them. For example, improved technological possibilities are expected to facilitate diagnostics and early detection of diseases, which in turn might lead to an increase in the number of people with complex health problems. At the same time, a higher life expectancy, with chronic diseases being less lethal, results in more older people having multiple diseases, which also results in an increased number of people with complex health problems.

In this study, many experts explicitly mentioned that they expected an increased gap between different population groups regarding health status. For example, both the group of vital older people as well as the group of frail older people will become larger. So, the size of groups at both ends of the 'health continuum' are increasing. Resulting in highly different care needs amongst different groups of older people. Furthermore, the health differences between socio-economic groups and groups from diverse cultural backgrounds are expected to increase. These developments are an additional reason for concern, because socio-economic and cultural background are associated with health status.

Earlier future studies aiming to inform policymakers show similar developments as the ones identified in our study. Also, studies from other countries (Japan, United States, United Kingdom) indicate to expect increased pressure on the health and social care system (30–33). For example a study shows that if recent mortality trends continue, more people in England and Wales will need palliative care by 2040 (30). Another study showed that the age-standardized prevalence of disease will remain constant resulting in an expanding number of older people with care needs (31). Both for Japan and for United States micro-simulation modelling studies show that the need for care amongst 65 + -population will increase (32, 33).

Implications

The expectation is that health and social care needs in the 65+ population will be larger in 2040 than in 2020, and this expectation is seen regardless of the method used, expert opinions or modelling exercises. The aging population will result in a tremendous challenge in dealing with the health problems and in determining how to appropriately deliver care for older people of the future (34), while taking (cultural) background and surroundings into account. Integrated care is seen as a potential way to coordinate and provide care tailored to peoples' needs and preferences and reduce inequalities while improving patient outcomes. This can help the health system to cope with the increasing need for care. (13, 35, 36).

To deal with the increasing care needs different initiatives and measures are needed across different levels (37–39). For example on health system level support is needed for informal care provides. At the level of the living and environment, it concerns suitable housing, good cooperation and coordination amongst care and welfare professionals (integrated care) (40). At societal level, it is about image formation (the older people are not only weak and in need of help, a large part is able to continue to cope), a different way of training professionals so they are better equipped to support citizens with complex health problems (41). Initiatives may for instance focus on the reducing the increase in complex health problems, e.g., with more

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TABLE 1 Trends affecting the prevalence of complex health problems among 65+ the period 2020–2040, as expected by experts found with a Delphi study.

In the next 20years...			The total percentage of older people with complex health problem will...		
	Direction	Consensus	Direction	Consensus	Explanation
The number of people with at least one chronic condition	Increase	88%	Increase	81%	Ageing. Increase of life expectancy. Increase of obesity.
Life expectancy	Increase	81%	Increase	81%	Life expectancy increases faster than healthy life expectancy. Better healthcare techniques and more prevention.
Treatment options	Increase	100%	Increase	69%	More treatment options and technology.
Diagnostics/early detection of diseases	Increase	94%	Increase	69%	More early detection and better diagnostics ➜ increase in prevalence of chronic diseases ➜ increase in the number of people with complex health problems and decrease of mortality risk.
The influence of infectious diseases (relative to pre-corona)	Unchanged	69%	Unchanged	69%	The impact of infectious diseases (COVID-19) will remain and can lead to chronic diseases.
Mental health problems	Unchanged	63%	Unchanged	69%	
Self-management of health and care	Increase	81%	Unchanged	63%	
Socio-economic inequality	Increase	81%	Increase	63%	The gap between high and low SES is widening. Houses, school systems, digitalization play a role in this. Not everything is available to everyone in healthcare.
The influence of the environment on health (e.g. climate change)	Increase	69%	Increase	50%	More awareness and possibly increasing tension on social topics. At the same time there will be more technological advancements which creates solutions.
Cultural diversity	Increase	75%	Increase	44%	Links to the acceptance of new care options, techniques, healthy lifestyle and access to knowledge.
Vitality of older people	Increase	75%	Unchanged	44%	Increase will mainly be for a part of the population.
Manufacturability of life	Increase	56%	Unchanged	75%	

(Continued)

TABLE 1 (Continued)

In the next 20years...			The total percentage of older people with complex health problem will...		
	Direction	Consensus	Direction	Consensus	Explanation
Working conditions (including workload, workload)	Deteriorate	44%	Unchanged	63%	The increased number of flexible jobs leads to more uncertainty and stress. This can lead to staff shortages and more work pressure. Digitalization might provide relief.
Psychosocial circumstances (e.g. stress, loneliness)	Unchanged	50%	Unchanged	56%	Increasing awareness of psychosocial circumstances.
Lifestyle and behaviour	Unchanged	44%	Unchanged	44%	In some aspects habits and behaviour will improve in regard to healthy lifestyle. In other aspects it will deteriorate. The gap between people with improvements and people with a deterioration will be larger.

Blue, high consensus among experts; green, intermediate consensus; orange, low consensus, including explanations provided by the experts on the assumed trend (2020, Netherlands).

TABLE 2 Trends affecting the presence of resources to manage complex health problems among 65+ in the period 2020–2040 as expected by experts found with a Delphi study.

In the next 20years...			
	Direction	Consensus	Explanation
The number of one-person-households amongst older people	Increase	100%	More divorces which results in an increase of the number of one-person-households.
Availability of informal care providers	Decrease	100%	The demand for informal care will increase but there will be less supply of informal care.
Digital skills amongst older people	Increase	94%	The expectation is that older people will be (more) digitally skilled. But this should not be overestimated; digital developments move faster than attaining the skills. Moreover, skills should be maintained through time. In addition, the need for older people to be digitally skilled increases. As it is necessary for arranging their affairs, finding care and for their independence.
Technological possibilities	Increase	93%	More possibilities through health technology and e-health. However, its use depends on the availability, affordability and usability. There will be a gap between the possibilities and desirability.
Health and social care workforce	Decrease	93%	Ageing; higher demand for care and less people that can provide care. The professions are not attractive. Shortages in certain regions.
Health skills	Increase	79%	Increasingly, demands are made on self-reliance. Despite this increase, part of the older people will not be able to keep up.
Self-reliance	Increase	71%	People are increasingly called on being self-reliant. Self-reliance increases because of a higher education level. And with this the access to knowledge, health and healthcare increases. However, part of the older people will lag (low education level, language barriers, low socio-economic status).
Educational level	Increase	64%	The average education level increases. Which means that older people will on average have more resources available, such as a high income, health skills. But this does not apply for all older people, such as older people with a migrant background or people with low-or limited-income insurance like self-employed workers.

(Continued)

TABLE 2 (Continued)

In the next 20years...			
	Direction	Consensus	Explanation
Variation in the supply of person-centred care	Increase	64%	Technology stimulates person-centred care.
Availability of suitable housing	Increase	57%	Increase in suitable houses, however it will not be sufficient for all older people.
Income and wealth	Unchanged	36%	On one hand the incomes will be higher, on the other hand the care will be more expensive. There will be a larger difference between the poor and rich.
Availability of a social network	Decrease	43%	On one hand the social network will decrease because people are having less children, living more often alone and are becoming older. On the other hand, the social network will be more diverse, and digitalization will play a role.
Availability of services (grocery shops, care facilities etc.) in the neighbourhood	Unchanged	50%	This will depend on the region. There will be a shortage in shrinking areas. Digitalization plays a role; online ordering and e-health.

Blue, high consensus among experts; green, intermediate consensus; orange, low consensus, including explanations provided by the experts on the assumed trend (2020, Netherlands).

or better prevention strategies, and on expanding the possibilities to (self) manage the health problems of old age – e.g., programs to reduce loneliness, increase health literacy, various innovations based on technology, and promoting 'positive health' with its emphasis on 'the ability to adapt and self-manage' (42, 43). In addition, For all the different initiatives and measures the effects on reduction of the SES gap should also be taken into account.

This study illustrates the importance of not taking only 'health problems' into account but also the resources to deal with these, which is also emphasized in the research field of population segmentation based on health care needs (44–46). The clientship model (13, 15, 16), where our thinking model was based on, is now used in Finland to segment the populations and to aid the thinking of care and support needs and how to organize these (47). In particular it is used to strengthen the links and collaboration between primary care and social care and between primary care and hospital care. Because our study suggest that there will be a large growth in the size of the 65+ population with limited resources to deal with health problems, these finding urge for the care and support systems for these.

Strengths and limitations

A strength of this study is the use of a Delphi study besides demographic projections. Studies aiming to make prediction usually make use of demographic projection, however this provides only part of the picture. The Delphi study allowed to incorporate expert opinions and different perspectives to determine future demands and needs. A limitation of this study is that different data sources have been used for the prevalence of complex health problems and the availability of resources. There is no single data source for the prevalence of complex health problems in combination with the availability of resources. Therefore, we combined information from a large registry of reliable and sufficiently detailed diagnostic data, with findings from a large-scale survey, monitoring data on a broad range of factors referring to 'resources' and cohort data with both diagnostic data and information on resources to get an estimation of the year 2020. The 2040-estimations are obtained by using demographic projections only are straightforward, keeping current prevalence rates of complex health problems and availability of resources constant. However, unexpected developments such as the COVID-19 pandemic may affect future demographics and thus change the circumstances/conditions of future care. Population health and the future proportion of older people with complex health problems and limited resources are subject to other uncertain developments. So we used the input of experts by means of a Delphi method, of which the strength is the use of a diverse expert panel. A sufficiently broad variety of experts, which is a prerequisite for a valid Delphi (26) method, gave insights into what they expect the population of older people to look like in 2040. However, because the Delphi was fully anonymous no information was collected on which of the invited experts participated during the different rounds. Therefore the heterogeneity of the panel could not be confirmed throughout the different rounds. Some important perspectives may have been missed if the group of participating experts is biased. Another limitation is that the experts can all be biased in the same direction. Also, some experts mentioned that trying to visualize how complex health problems and availability of resources will evolve together, was maybe too complex a thought experiment. This might also have led to drop-out of experts after the first round of Delphi. It is further important to realize that forecasts and future estimations do not represent facts. Our results give a picture of how experts see the future, and which an how developments will play an important role in the future. This information can help in finding appropriate interventions or solutions that will help to be better prepared for the future care needs.

Conclusion

This research suggests that it is likely that a substantial part of the future 65+ population will suffer from complex health problems and will not have sufficient resources to manage these problems. This proportion is expected to be substantially higher than is expected based on demographic developments only, which is often done. A variety of developments contribute to this increase. Together with large workforce shortages in health and social care, these developments represent large challenges for health policy and asks for a fundamental redesign of the health and social care system.

Further research is needed to understand how the different developments interact and how these can be incorporated in the foresight of population health.

Data availability statement

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

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

SB, SP, and MR led the funding acquisition for the study. FB, SP, HH, RH, MR, and SB contributed to the conception and design of the study. SP and RH performed statistical analysis of the registry data and patient-reported data. FB and SB contributed to the data collection and analysis of the Delphi study. FB and SP wrote the first draft of 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.

Publisher's note

References

1. OECD. *Health Reform: Meeting the Challenge of Ageing and Multiple Morbidities*. Paris: OECD Publishing (2011).

2. Ricciardi W, Specchia ML, Marino M. Health of the elderlies and healthy ageing: challenge for Europe. *Stud Health Technol Inform*. (2014) 203:1–9.

3. Europe HSR. *Health Services Research: Helping Tackle Europe's Health Care Challenges*. Utrecht: Policy Brief Nivel (2011).

4. CBS. Population Prognosis; Sex, Age and Migration Background 2018-2060: Statistics Netherlands; (2017). Available at: https://opendata.cbs.nl/statline/#/CBS/nl/dataset/83784NED/table?dl=20E27 (Accessed March, 2022).

5. Hilderink H, Verschuuren M. *Volksgezondheid Toekomst Verkenning 2018: Een Gezond Vooruitzicht* Synthese (2018).

6. Lette M, Baan CA, van den Berg M, de Bruin SR. Initiatives on early detection and intervention to proactively identify health and social problems in older people: experiences from the Netherlands. *BMC Geriatr*. (2015) 15:1–13. doi: 10.1186/s12877-015-0131-z

7. Waidmann TA, Liu K. Disability trends among elderly persons and implications for the future. *J Gerontol Ser*. (2000) 55:S298–307. doi: 10.1093/geronb/55.5.S298

8. van Oostrom S, Pivacet S, Rietman ML, de Bruin SR, AMW S. *Ouderen Van Nu En Straks: Zijn Er Verschillen in Kwetsbaarheid? [Olderpeople Now and in the Future: Are There Differences in Frailty?]* RIVM (2015).

9. Parker MG, Thorslund M. Health trends in the elderly population: getting better and getting worse. *The Gerontologist*. (2007) 47:150–8. doi: 10.1093/geront/47.2.150

10. Van Baal P, Peters F, Mackenbach J, Nusselder W. Forecasting differences in life expectancy by education. *Popul Stud*. (2016) 70:201–16. doi: 10.1080/00324728.2016.1159718

11. Nie JX, Wang L, Tracy CS, Moineddin R, Upshur RE. Health care service utilization among the elderly: findings from the study to understand the chronic condition experience of the elderly and the disabled (succeed project). *J Eval Clin Pract*. (2008) 14:1044–9. doi: 10.1111/j.1365-2753.2008.00952.x

12. Verschuuren M, van Oers H. Population health monitoring: strengths, weaknesses, opportunities, and threats In: . *Population Health Monitoring*: Springer (2019). 197–204. doi: 10.1007/978-3-319-76562-4_10

13. Rijken M, van der Heide I. Identifying subgroups of persons with multimorbidity based on their needs for care and support. *BMC Fam Pract*. (2019) 20:1–10. doi: 10.1186/s12875-019-1069-6

14. Wallace E, Salisbury C, Guthrie B, Lewis C, Fahey T, Smith SM. Managing patients with multimorbidity in primary care. *BMJ*. (2015) 350:h176. doi: 10.1136/bmj.h176

15. Koivuniemi K, Holmberg-Marttila D, Hirsso P, Mattelmäki U. *Terveydenhuollon Kompassi: Avain Asiakkuuteen*. Helsinki: Kustannus Oy Duodecim (2014).

16. Hujala A, Taskinen H, Rissanen S, Richardson E, van Ginneken E. *How to Support Integration to Promote Care for People with Multimorbidity in Europe?* World Health Organization, Regional Office for Europe (2017).

17. Hasselaar J. *Nivel Zorgregistraties Eerste Lijn* Nivel (2022).

18. Lamberts H, Wood M. *ICPC, International Classification of Primary Care*. USA: Oxford University Press (1987).

19. CBS. *Gezondheidsmonitor Volwassenen en Ouderen 2016 [Public Health Monitor 2016]* CBS Microdata Services; Statistics Netherlands (2016).

20. Picavet HSJ, Blokstra A, Spijkerman AM, Verschuren WM. Cohort profile update: the Doetinchem cohort study 1987–2017: lifestyle, health and chronic diseases in a life course and ageing perspective. *Int J Epidemiol*. (2017) 46:1751-g. doi: 10.1093/ije/dyx103

21. Geboers B, Uiters E, Reijneveld SA, Jansen CJ, Almansa J, Nooyens AC, et al. Health literacy among older adults is associated with their 10-years' cognitive functioning and decline-the Doetinchem cohort study. *BMC Geriatr*. (2018) 18:1–7. doi: 10.1186/s12877-018-0766-7

22. Turoff M, Linstone HA. The Delphi Method-Techniques and Applications e-book. Newark: New Jersey Institute of Technology (2002).

23. Geist MR. Using the Delphi method to engage stakeholders: a comparison of two studies. *Eval Program Plann*. (2010) 33:147–54. doi: 10.1016/j.evalprogplan.2009.06.006

24. Atkinson N, Gold R. Online research to guide knowledge management planning. *Health Educ Res*. (2001) 16:747–63. doi: 10.1093/her/16.6.747

25. Ravensbergen W, Drewes Y, Hilderink H, Verschuuren M, Gussekloo J, Vonk R. Combined impact of future trends on healthcare utilisation of older people: a Delphi study. *Health Policy*. (2019) 123:947–54. doi: 10.1016/j.healthpol.2019.07.002

26. Hsu C-C, Sandford BA. The Delphi technique: making sense of consensus. *Pract Assess Res Eval*. (2007) 12:10.

27. Wilson MR, Van Houtven CH, Stearns SC, Clipp EC. Depression and missed work among informal caregivers of older individuals with dementia. *J Fam Econ Iss*. (2007) 28:684–98. doi: 10.1007/s10834-007-9081-8

28. Longacre ML, Valdmanis VG, Handorf EA, Fang CY. Work impact and emotional stress among informal caregivers for older adults. *J Gerontol B Psychol Sci Soc Sci*. (2017) 72:522–31. doi: 10.1093/geronb/gbw027

29. Vos EE, de Bruin SR, van der Beek AJ, Proper KI. "It's like juggling, constantly trying to keep all balls in the air": a qualitative study of the support needs of working caregivers taking Care of Older Adults. *Int J Environ Res Public Health*. (2021) 18:5701. doi: 10.3390/ijerph18115701

30. Etkind SN, Bone AE, Gomes B, Lovell N, Evans CJ, Higginson IJ, et al. How many people will need palliative care in 2040? Past trends, future projections and implications for services. *BMC Med*. (2017) 15:1–10. doi: 10.1186/s12916-017-0860-2

31. Guzman-Castillo M, Ahmadi-Abhari S, Bandosz P, Capewell S, Steptoe A, Singh-Manoux A, et al. Forecasted trends in disability and life expectancy in England and Wales up to 2025: a Modelling study. *Lancet Public Health*. (2017) 2:e307–13. doi: 10.1016/S2468-2667(17)30091-9

32. Chen BK, Jalal H, Hashimoto H, Suen S-c, Eggleston K, Hurley M, et al. Forecasting trends in disability in a super-aging society: adapting the future elderly model to Japan. *J Econ Ageing*. (2016) 8:42–51. doi: 10.1016/j.jeoa.2016.06.001

33. Gaudette É, Tysinger B, Cassil A, Goldman DP. Health and health care of medicare beneficiaries in 2030. *Forum Health Econ Policy Gruyter*. (2015) 18:75–96. doi: 10.1515/fhep-2015-0037

34. Fuster V, Frazer J, Snair M, Vedanthan R, Dzau V. The future role of the United States in Global Health: emphasis on cardiovascular disease. *J Am Coll Cardiol*. (2017) 70:3140–56. doi: 10.1016/j.jacc.2017.11.009

35. Leijten FR, Struckmann V, van Ginneken E, Czypionka T, Kraus M, Reiss M, et al. The Selfie framework for integrated Care for Multi-Morbidity: development and description. *Health Policy*. (2018) 122:12–22. doi: 10.1016/j.healthpol.2017.06.002

36. Reynolds J, Gadsby E, Rijken M, Stoop A, Espallargues M, Lloyd HM, et al. Measuring older peoples' experiences of person-Centred coordinated care: experience and methodological reflections from applying a patient reported experience measure in sustain. *Int J Integr Care*. (2021) 21:3. doi: 10.5334/ijic.5504

37. van Hoof J, Marston HR. Age-friendly cities and communities: state of the art and future perspectives. *Int J Environ Res Public Health*. (2021) 18:1644. doi: 10.3390/ijerph18041644

38. Greenfield EA, Buffel T. Age-friendly cities and communities: research to strengthen policy and practice. *J Aging Soc Policy*. (2022) 34:161–74. doi: 10.1080/08959420.2022.2049573

39. Lancet T. How to cope with an ageing population. *Lancet*. (2013) 382:1225. doi: 10.1016/S0140-6736(13)62080-2

40. van Hoof J, Rusinovic KM, Tavy Z, van den Hoven RFM, Dikken J, van der Pas S, et al. The participation of older people in the concept and design phases of housing in the Netherlands: a theoretical overview. *Healthcare (Basel)*. (2021) 9:301. doi: 10.3390/healthcare9030301

41. Albers M, Gobbens RJJ, Reitsma M, Timmermans OAAMJ, HLGRL N. Earning and innovation network in nursing: a concept analysis. *Nurse Educ Today*. (2021) 104:104988. doi: 10.1016/j.nedt.2021.104988

42. Huber M, Knottnerus JA, Green L, Van Der Horst H, Jadad AR, Kromhout D, et al. How should we define health? *BMJ*. (2011) 343:d4163. doi: 10.1136/bmj.d4163

43. Rudnicka E, Napierała P, Podfigurna A, Męczekalski B, Smolarczyk R, Grymowicz M. The World Health Organization (who) approach to healthy ageing. *Maturitas*. (2020) 139:6–11. doi: 10.1016/j.maturitas.2020.05.018

44. van der Laan ME, Van Offenbeek M, Broekhuis H, Slaets J. A person-Centred segmentation study in elderly care: towards efficient demand-driven care. *Soc Sci Med*. (2014) 113:68–76. doi: 10.1016/j.socscimed.2014.05.012

45. Chong JL, Lim KK, Matchar DB. Population segmentation based on healthcare needs: a systematic review. *Syst Rev*. (2019) 8:1–11. doi: 10.1186/s13643-019-1105-6

46. Minvielle E, Fourcade A, Ricketts T, Waelli M. Current developments in delivering customized care: a scoping review. *BMC Health Serv Res*. (2021) 21:1–29. doi: 10.1186/s12913-021-06576-0

47. Riihimies R, Kosunen E, Koskela T. Web-based patient segmentation in Finnish primary care: protocol for clinical validation of the navigator Service in Patients with diabetes. *JMIR Res Protoc*. (2020) 9:e20570. doi: 10.2196/20570

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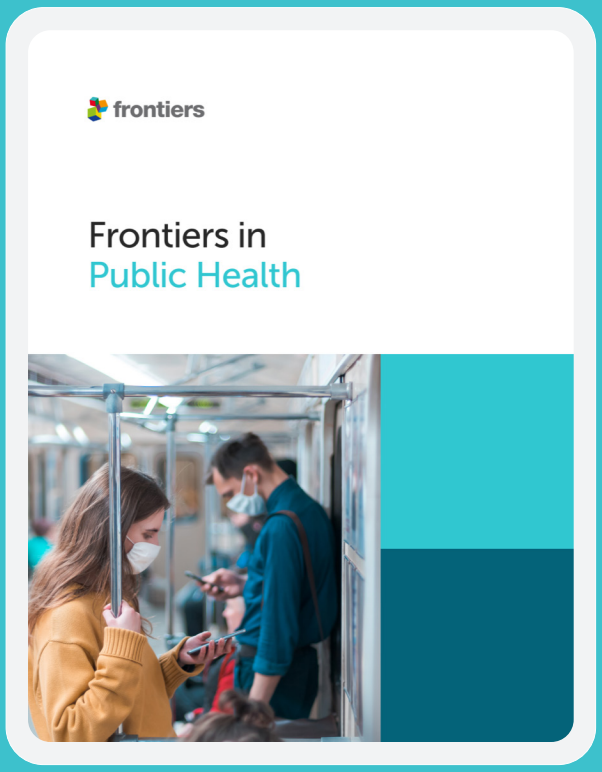

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