Social participation and health in middle-aged and older empty nesters: A study on gender differences

Yan Gao [a], Lu Chen [a], Zhihao Jia [b], Liangyu Zhao [a], Yuke Yang [a], Chenchen Liu [c,*]

[a] School of Physical Education, Shandong University, No. 17923, Jingshi Road, Lixia District, Jinan City, shandong Province, 250061, China
[b] School of Sports Science and Physical Education, Nanjing Normal University, No. 1, Wenyuan Road, Qixia District, Nanjing, Jiangsu Province, 210023, China
[c] School of Medical Information Engineering, Jining Medical University, No 133 Hehua Road, Jining City, shandong Province, 272067, China

ABSTRACT

Background: The growing population of middle-aged and older empty nesters is characterized by poorer health, and social participation (SP) has been shown to improve this situation. However, few studies have investigated specific performance and gender differences between SP and health. The present study aims to address these issues.
Methods: A total of 1207 middle-aged and older empty nesters over 45 years old were selected from the China Health and Retirement Longitudinal Study (CHARLS, 2011–2018). Random-effects analyses were used to explore the association between changes in SP (diversity, frequency, type) and changes in health status. Health status include physical health, mental health, self-reported health (SRH).
Results: Female middle-aged and olderly empty nesters have significantly poorer health and participate in SP more frequently. The higher the diversity of SP, the better the health of middle-aged and olderly empty nesters, while higher frequency is beneficial to SRH. Female's participation in sports and Internet had better mental health and SRH, and mahjong helped female's mental health. Clubs are helpful for male's SRH.
Conclusions: This study reveals the specifics of the association between SP and health status of middle-aged and older empty nesters. Therefore, all aspects of SP and gender differences should be taken into account when predicting and improving the health status. Help the government to better formulate policies to better cope with the increasing empty nest phenomenon and build a harmonious and stable society.

1. Introduction

The health of empty nesters is worse, and research has demonstrated that social participation has a positive impact on health improvement (Dawson-Townsend, 2019). Every country is experiencing population aging. 2015 data from the World Health Organization (WHO, 2015) predicts that by 2050, the global population over the age of 60 will double. China is one of the countries with a higher degree of population aging in the world. According to the report of the seventh national census, the total number of elderly people aged 60 and above has accounted for 18.7% of the total population (O'Meara, 2020). Among them, children leave home to live after reaching adulthood, leaving the older living alone or with a spouse, a group known as empty nesters (Feng & Phillips, 2022). In China, the proportion of this group is 40% and is expected to reach 90% by 2030 (Su et al., 2012). Moreover, the "empty nest phenomenon" has shown a trend of "middle-aged" (Mitchell

& Wister, 2015), and the proportion has exceeded 20% (Hu & Peng, 2015). Previous studies of empty nesters have been conducted on older adults over 60 years of age, and fewer studies have included middle-aged and older empty nesters over 45 years of age. This study will examine the health of this group of empty-nesting middle-aged and older adults and their SP. This is critical to the health of middle-aged and older adults globally.

Most studies have concluded that empty nesters are in poorer physical health, mental health, and self-rated health (SRH) than non-empty nesters (He et al., 2020; Li et al., 2022). They lack the companionship and care of children. They have more chronic diseases (Yao et al., 2019), "empty nest syndrome", and mental disorders (C. Zhang, Hou, et al., 2019), which can easily affect their SRH (Sarkar et al., 2023). However, some studies have concluded that they make no difference between healthy (Y. Zhang, 2020). There are no conclusive findings about the health status of empty nesters. In addition, most studies

consider only one or two of physical health, mental health, and SRH individually, without considering health comprehensiveness. This study will examine these three health conditions to provide a comprehensive understanding of the health status of middle-aged and older empty nesters.

Social participation (SP) can have an impact on the health of older persons and are important measures to promote healthy ageing (Tomioka et al., 2017). SP results for empty nesters vary. Some believe they have less SP among empty nesters due to social exclusion (Feng & Phillips, 2022), and some believe they have more time and freedom to have SP. SP is thought to be significantly associated with physical health and SRH (Douglas et al., 2016), and is able to reduce depression (Chiao et al., 2011). The impact of SP on health vary by gender. Some studies suggest that male empty-nest olderly people have better physical health, mental health (Thapa et al., 2018) and SRH (Li et al., 2022). For female, the frequency and autonomy of SP are more positively correlated with health than male (Tomioka et al., 2017). However, limited research has explored the impact of diversity, frequency, and type of SP on health among middle-aged and older empty nesters and the gender differences therein. Because of differences in economic development, medical conditions, and cultural factors, there may be differences in the level of health and the frequency of types of SP among Chinese people compared to other countries, especially developed countries such as Europe (Komp et al., 2013).

Both social activity and health are important factors. Most previous studies have used cross-sectional data, making it difficult to trace causal patterns. But both social activity and health are dynamic. This study therefore used a longitudinal analysis and was able to exclude the effects of other unmeasured or non-measurable individual-level confounders that could be related to SP and health. Examples include personality, childhood experiences (Zheng et al., 2022) and self-confidence. Therefore, this study has two purposes: 1) To understand the health status and SP patterns of middle-aged and older empty nesters and gender differences; 2) To consider the relationship between SP and health and gender differences. This study will help design more targeted and appropriate interventions and support related policy development.

2. Theoretical background

The impact of gender on the health and SP of empty nester older adults is thought to be explained by gender role theory. That is, gender lies in the roles that are constructed in the social environment (Townsend et al., 2023). According to traditional gender roles, females act as mothers and take on more domestic labor while males act as breadwinners. In contrast, women as mothers have a deeper attachment to their children than men as fathers. When children leave the home the parents transition to empty nest status. From this, it is hypothesized that female middle-aged and older empty nesters may have poorer health. The negative health effects of role change can be remedied by establishing new social roles, therefore women are more reliant on wider social contact for their well-being (Burn et al., 2016). Additionally the role strain (relief) perspective argues (Schulz & Raab, 2023) that both men and women face stress in organizing their daily lives, with women having more pressure to take care of their family roles. Therefore it is inferred that when children leave home, parents especially mothers are partially released from the stress of parenting and home care and based on this may have less stress and more time to engage in SP. The "role change" hypothesis role change theory (Bougea et al., 2020) suggests that empty nesters implies that role identity as a parent begins to change, and that in order to adapt to problems such as loneliness caused by the situation, social networks are maintained through active SP, new social roles are sought, and social integration is promoted. Studies have shown the positive effects of social engagement on health. Based on these theories, the following hypotheses are derived.

Hypothesis 1. Female middle-aged and older empty nesters have

poorer health.

Hypothesis 2. Female middle-aged and older empty nesters are involved in more and more varied SP.

Hypothesis 3. Frequency, diversity, and type of SP positively affect the physical health, mental health, and SRH of middle-aged and older empty nesters, with gender differences.

3. Methods

3.1. Data

The data comes from the China Health and Retirement Longitudinal Study (CHARLS), which is a comprehensive and high-quality national dataset of middle-aged and older residents in China. It was approved by the Ethics Committee of Peking University (Approval No: IRB00001052-13074). The interviewers were trained at Peking University by CHARLS staff members, and the interviews took place in respondents' homes with the use of CAPI technology (Zhao et al., 2014). These samples were followed up every two to three years thereafter. We used four waves of data: Waves 2011, 2013,2015;2018. Since middle-aged and olderly empty nesters in this study were defined as 45 years of age or older, without children or not living with children for 12 months. For the questionnaire, "Where does (XChildName(i)) live?" "How long has (XChildName(i)) lived with you and your spouse in the last year?". Two questions to filter (Q. Liu et al., 2023; Xu et al., 2023). We selected 1207 participants based on the following criteria: (1) middle-aged and older empty nesters aged 45 years or older; (2) complete information on SP and health status for all four periods. The specific selection process for the study sample is shown in Fig. 1.

3.2. Measures

3.2.1. Social participation

DA056 in CHARLS questionnaire asks respondents about 10 types of SP in the past month. However, since few respondents chose going to school, investing in stocks and taking care of others, they are not included. In addition, since less than 0.2% of respondents participated in volunteer or charity activities and providing help and care to others without economic compensation can be attributed to volunteer work, we combined these two variables into "volunteer activity". Then, respondents were further asked about their corresponding frequency.

In this study, we investigated SP from three aspects: (1) Diversity: the total number of different types of SP. It is coded as: none/1, type/$\geq$2, types; (2) Types: friend interaction, playing mahjong and cards, sports activities, club activities, volunteer activities and internet use. (3) Frequency: based on the CHARLS questionnaire, question DA057 categorized the highest frequency of SP into three groups: daily, weekly, and irregular. But since the proportion of SP performed daily was less than 0.5%, we combined the "almost daily" and almost weekly groups and recoded each SP type as "$\geq$1/week". So the highest frequency among SP is divided into three groups: none/irregularly/$\geq$1/week. Since fewer of the empty nesters participated in sports activities, club organization activities, and internet use, we classified these three categories of SP as "none/yes" (R. Wang et al., 2019).

3.2.2. Health

Since health is a multi-dimensional and general concept, we examine three indicators: physical health, mental health and SRH.

Physical health is assessed by activities of daily living (ADL) and instrumental activities of daily living (IADL). The ADL score quantifies the ability to perform 6 activities including bathing, dressing, eating, transferring from bed to chair, using the toilet and controlling urination/defecation. Specific selection of DB010 to DB015 issues in CHARLS questionnaire; the IADL score quantifies the ability to perform 6 activities including shopping, managing money, cooking, doing housework
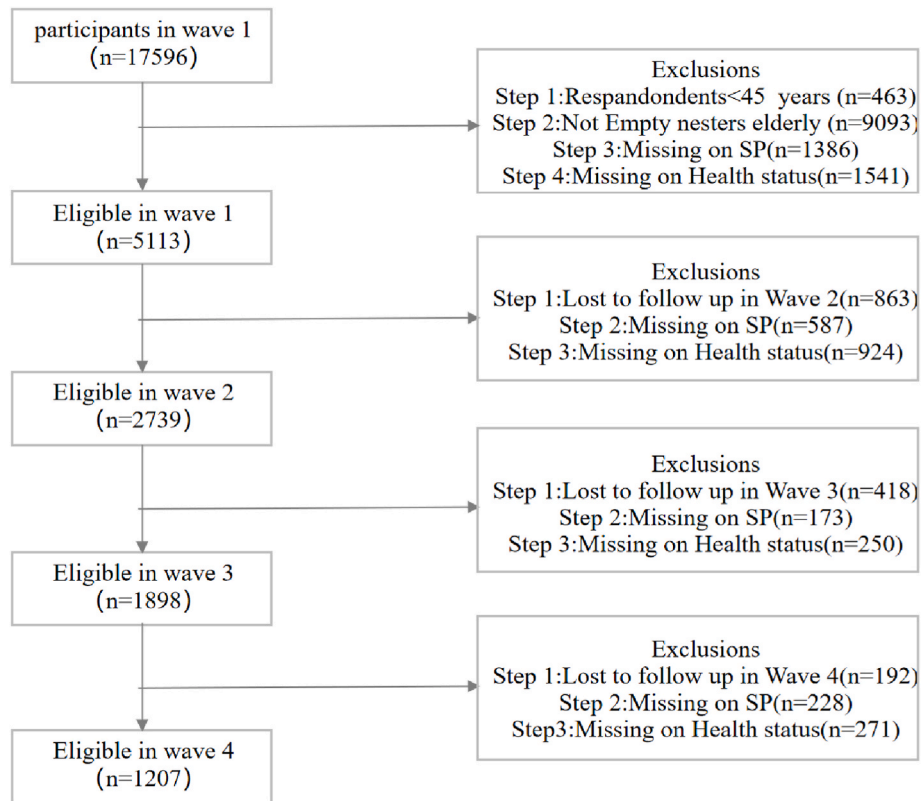
Fig. 1. Flowchart of participant selection.

and taking medicine. Specific selection CHARLS questionnaire DB016 to DB020 problem. The results were divided into four levels: 1 "no difficulty", 2 "some difficulty but able to complete", 3 "difficulty requiring help" and 4 "unable to complete". Results are measured as the sum of the scores for each item. Conversely, higher scores indicate poorer physical health (Su et al., 2020).

Mental health is assessed based on a short version of the Center for Epidemiologic Studies Depression Scale (CES-D). DC009 to DC018 in the CHARLS questionnaire are used. It consists of 10 items that refer to feelings and behaviors in the past week. Each item is measured on a 4-point scale: 0 (Rarely or none of the time (<1 day)), 1 (Some or a little of the time (1–2days)), 2 (Occasionally or a moderate amount of time (3–4days)) and 3 (Most or all of the time (5–7days)). Positively worded statements are reverse-coded before summation (items 5 and 8). The total score ranges from 0 to 30. A higher score indicates more obvious depressive symptoms. A score ≥10 points can be considered as having depressive symptoms (Wu et al., 2023).

Self-rated health (SRH) refers to an individual's subjective and personal perception of their own health which could provide a valid and relatively stable measure of perceived health status (Lee et al., 2008). Regarding the overall SRH status, a five-point Likert scale was used for the responses based on the single question in the CHARLS questionnaire: "Would you say your health is very good, good, fair, poor or very poor?". The scale for this study was as follows: "very good" = 1 point, "good" = 2 points, "fair" = 3 points, "poor" = 4 points, and "very poor" = 5 points. Higher scores indicate poor SRH in middle-aged and older adults (Boerma et al., 2016).

3.2.3. Covariates

We also selected control variables that research (Feng & Phillips, 2022; Su et al., 2020; L. Wang et al., 2019) has shown to affect physical functioning and SP in middle-aged and older empty nesters, such as age, gender, education level, marital status, chronic disease, smoking, drinking, and number of chronic diseases. See Table 1 for details.

Table 1
Definition/codes of the potential confounding variables.

Variable	Codes/definition
Gender	0 = Female; 1 = Male
Age	Continuous variable
Education	1 = Illiterate; 2 = Primary school and lower; 3 = Junior middle school; 4 = Senior middle school and higher
Marital status	0 = Single (divorced/widowed/single); 1 = Partnered (married/partnered)
Alcohol	Ever consumed any alcohol last year. 0 = No; 1 = Yes
Smoke	Ever chewed tobacco, smoked a pipe, or smoked cigarette last year. 0 = No; 1 = Yes
Number of types of on-communicable diseases (NCD)	12 item summary of any physical non-communicable diseases, including hypertension, dyslipidaemia, diabetes, cancer, chronic lung diseases, liver disease, heart attack, stroke, kidney diseases, stomach or other digestive diseases, arthritis or rheumatism, and asthma. 0 = None; 1 = 1 type; 2 = 2 types; 3 = ≥3 types
Wave (year)	1 = "2011"; 2 = "2013"; 3 = "2015"; 4 = "2018"

3.3. Data analysis

We applied chi-square analysis and independent samples t-test for health data and SP based on descriptive analysis to validate gender differences between male and female. To eliminate unobserved heterogeneity at the individual level, we used CHARLS data from four periods for longitudinal estimation. In this study, random effects (RE) are synonymous with zero correlation between observed explanatory variables and individual unobserved effects. We also used the Hausman test to determine whether to use fixed effects FE or RE. The results of the latter indicate that the null hypothesis cannot be rejected, indicating that the RE model is preferable in this paper. In addition we use the most recent

of the RE. Therefore, we used the "within-between" formulation of the random effects model and conducted three models to test the relationship of SP and health. These models were performed in Stata 15.0.

To test for robustness, the paper was tested with different age groups and removal of excess control variables. An instrumental variable approach with two-stage regression estimation is additionally used to address endogeneity and reverse causality.

This study uses the instrumental variable approach to address the endogeneity issues that may arise from reverse causation and omitted variables. Referring to previous studies, the deposits of participants were chosen as an instrumental variable. Deposits of middle-aged and older empty nesters have a large and usually positive effect on SP. We also employed a heteroscedasticity-based method to generate an additional instrumental variable (Lewbel, 2012) which can be applied when standard tools are weak or simply unavailable (Liu et al., 2020).

In addition to this, a heterogeneity analysis of urban-rural differences was done.

4. Results

4.1. Descriptive statistics

The characteristics of male and female participants in the first wave (2011) are summarized in Table 2. The average age was 60 years. Among the 1207 participants, females (52.94%), partnered (85.2%), with primary school education or below (80.3%), and affected by chronic diseases (72.8%).

Independent samples *t*-test confirms gender differences in all covariates. Compared with male respondents, female respondents lower educational attainment and a higher proportion of two or more chronic diseases (45.9% vs 40.4%). Male respondents were more likely to have a partner (89.6% vs 81.2%) and had higher rates of drinking and smoking.

4.2. Health

Table 3 shows the health status of middle-aged and older empty nesters in 2018, which varies significantly by gender. In terms of gender differences, there were significant differences in physical and mental

Table 2
Sample characteristics at baseline (2011).

Characteristics	Sex			
	Total (n = 1207)	Male (n = 568)	Female (n = 639)	p
	n (%)	n (%)	n (%)	
Age				0.000
Mean (SD)	60 (3.54)	61 (6.36)	59 (12.73)	
Education				<0.05
Illiterate	768 (63.63)	340 (59.86)	428 (66.98)	
≤Primary school	201 (16.65)	102 (17.96)	99 (15.49)	
Middle school	165 (13.67)	91 (16.02)	74 (11.58)	
≥High school	73 (6.05)	35 (6.16)	38 (5.95)	
Marital status				0.000
Single	179 (14.83)	59 (10.39)	120 (18.78)	
Partnered	1028 (85.17)	509 (89.61)	519 (81.22)	
Drinking				0.000
No	820 (67.94)	258 (45.42)	562 (87.95)	
Yes	387 (32.06)	310 (54.58)	77 (12.05)	
Smoking				0.000
No	839 (69.51)	241 (42.43)	598 (93.58)	
Yes	368 (30.49)	327 (57.57)	41 (6.42)	
Types of NCDs				<0.05
No NCD	328 (27.17)	159 (27.99)	169 (26.45)	
1 type	357 (29.58)	180 (31.69)	177 (27.70)	
2 types	251 (20.80)	119 (20.96)	132 (20.66)	
≥3 types	271 (22.45)	110 (19.37)	161 (25.20)	

Two-tailed tests ***p < 0.001, **p < 0.01, *p < 0.05.

Table 3
Respondent's health status table in wave 4 (2018).

	All (n = 1207)	Male (n = 568)	Female (n = 639)	p
SRH%				>0.05
Very good	8.12	7.39	8.76	
Good	7.95	8.45	7.51	
Fair	49.05	50.18	48.04	
Poor	26.59	25.35	27.70	
Very poor	8.29	8.63	7.98	
Mental health				0.000
Mean (SD)	9.42 (6.72)	8.1 (6.23)	10.6 (6.91)	
Physical health				0.000
Mean (SD)	14.12 (4.15)	13.89 (4.37)	14.33 (3.94)	

N.B. To some variables, the total percentage may not equal to 100 due to rounding.

health for both males and females. It shows that both female respondents had poorer health than males, especially in physical and mental health.

4.3. SP

As an example, the descriptive statistics of SP for the 2018 survey results are shown in Table 4. A relatively large proportion did not participate in SP. In addition, they participated in only one type of activity at least twice a week. The most popular choices were socializing with friends and playing mahjong. There were gender differences in SP patterns. There is a significant difference in SP frequency between males and females in 2018, specifically looking at the values showing that females participate more frequently. There are gender differences in mahjong, sports, and interaction with friends. This is specifically seen in that females prefer to interact with friends and participate in sports. Males are more involved in mahjong and card games (see Table 5).

Table 4
SP of the selected respondents (%).

	Wave 4 (2018)			p
	All (n = 1207)	Male (n = 568)	Female (n = 639)	
Diversity				>0.05
None	47.06	49.47	44.91	
1 type	32.39	30.11	34.43	
≥2 type	20.55	20.42	20.66	
Frequency				<0.05
None	47.06	49.47	44.91	
Not regularly	14.91	16.55	13.46	
≥1/week	38.03	33.98	41.63	
Voluntary activities				>0.05
None	87.82	88.20	87.48	
Not regularly	9.53	9.15	9.86	
≥1/week	2.65	2.64	2.66	
Mahjong, cards, chess or other clubs				>0.05
None	80.94	78.35	83.26	
Not regularly	6.13	6.87	5.48	
	12.92	14.79	11.27	
Interacting with friends				>0.05
None	66.11	67.78	64.63	
Not regularly	11.52	12.15	10.95	
≥1/week	22.37	20.07	24.41	
Sports or social clubs				<0.05
No	93.79	97.01	90.92	
Yes	6.21	2.99	9.08	
Internet				>0.05
No	92.29	92.78	91.86	
Yes	7.71	7.22	8.14	
Community organization				>0.05
No	97.10	97.18	97.03	
Yes	2.90	2.82	2.97	

Two-tailed tests ***p < 0.001, **p < 0.01, *p < 0.05.

Table 5
Association between mental health and SP using RE.

	Model 1			Model 2			Model 3		
	All β (95% CI)	Male β (95% CI)	Female β (95% CI)	All β (95% CI)	Male β (95% CI)	Female β (95% CI)	All β (95% CI)	Male β (95% CI)	Female β (95% CI)
Diversity	−0.582*** (−0.766,-0.398)	−0.602*** (−0.880,-0.324)	−0.650*** (−0.955,-0.344)	−0.486** (−0.791,-0.180)	−0.473 (−0.950,0.004)	−0.475 (−1.000,0.051)	−0.137 (−0.505,0.231)	−0.290 (−0.912,0.332)	0.534 (−0.174,1.242)
Frequency				−0.115 (−0.405,0.175)	−0.137 (−0.548,0.274)	−0.178 (−0.612,0.255)	−0.033 (−0.356,0.290)	−0.174 (−0.618,0.270)	−0.076 (−0.546,0.393)
Type									
Interacting							−0.074 (−0.360,0.213)	0.100 (−0.307,0.506)	−0.408 (−0.850,0.034)
Mahjong							−0.365* (−0.670,-0.060)	−0.077 (−0.497,0.344)	−0.803** (−1.284,-0.323)
Sports							−1.293*** (−1.954,-0.633)	−0.819 (−1.794,0.156)	−1.906*** (−2.851,-0.960)
Community organization							−0.806 (−1.800,0.187)	−0.676 (−2.035,0.684)	−1.124 (−2.577,0.328)
Internet							−1.380** (−2.280,-0.481)	−0.936 (−2.143,0.271)	−2.002** (−3.361,-0.642)
Voluntary activities							−0.293 (−0.683,0.098)	−0.224 (−0.776,0.328)	−0.569 (−1.160,0.023)
Marry	0.216*** (0.095,0.337)	0.242** (0.065,0.419)	0.197* (0.030,0.363)	0.216*** (0.095,0.338)	0.243** (0.066,0.420)	0.198* (0.031,0.364)	0.217*** (0.095,0.338)	0.241** (0.063,0.419)	0.208* (0.042,0.374)
Educational level	−0.058 (−0.179,0.062)	0.026 (−0.131,0.183)	−0.153 (−0.339,0.033)	−0.059 (−0.180,0.061)	0.024 (−0.133,0.180)	−0.157 (−0.343,0.030)	−0.051 (−0.173,0.071)	0.015 (−0.143,0.174)	−0.142 (−0.329,0.046)
Types of NCDs	0.574*** (0.463,0.685)	0.554*** (0.400,0.708)	0.621*** (0.462,0.780)	0.577*** (0.465,0.688)	0.553*** (0.398,0.707)	0.624*** (0.465,0.783)	0.600*** (0.489,0.712)	0.562*** (0.408,0.717)	0.645*** (0.486,0.804)
Smoking	0.342 (−0.069,0.753)	0.538* (0.080,0.996)	−0.187 (−0.971,0.598)	0.342 (−0.069,0.753)	0.534* (0.075,0.992)	−0.171 (−0.957,0.615)	0.329 (−0.081,0.739)	0.533* (0.074,0.993)	−0.237 (−1.020,0.546)
Drinking	−0.372* (−0.728,-0.016)	−0.617** (−1.046,-0.188)	−0.057 (−0.652,0.537)	−0.375* (−0.731,-0.018)	−0.620** (−1.049,-0.191)	−0.058 (−0.653,0.536)	−0.340 (−0.696,0.016)	−0.582** (−1.014,-0.151)	−0.011 (−0.604,0.581)
Age	−0.047** (−0.077,-0.017)	−0.053* (−0.094,-0.012)	−0.032 (−0.075,0.010)	−0.046** (−0.076,-0.016)	−0.053* (−0.094,-0.012)	−0.032 (−0.074,0.010)	−0.038* (−0.068,-0.008)	−0.049* (−0.090,-0.007)	−0.028 (−0.070,0.014)
Sex	−1.758*** (−2.320,-1.197)			−1.776*** (−2.340,-1.213)			−1.834*** (−2.398,-1.271)		

CI = confidence interval.
Two-tailed tests ***p < 0.001, **p < 0.01, *p < 0.05.

4.4. Correlation between SP and health

This paper utilizes RE to test the effect of SP on the health of middle-aged and olderly empty nesters. Model 1 all showed that multiple types of SP were associated with better mental health (diversity: $\beta = -0.582$, 95% CI: 0.766, -0.398). Frequency was not significantly associated with mental health. However, the inclusion of type in Model 3 changed the results, with neither frequency nor diversity significantly associated with mental health. Frequency of SP types such as mahjong, sports and internet were found to be significantly and positively associated with better mental health in the all and in female middle-aged and older empty nesters (mahjong all: $\beta = -0.365$, 95% CI: 0.670, -0.060; sports all: $\beta = -1.293$, 95% CI: 1.954, -0.633); internet all: $\beta = -1.380$, 95% CI: 2.280, -0.481; Mahjong female: $\beta = -0.803$, 95% CI: 1.284, -0.323; sports female: $\beta = -1.906$, 95% CI: 2.851, -0.960; internet female: $\beta = -2.002$, 95% CI: 3.361, -0.642). However, for male, SP was not significantly associated with mental health.

Table 6 shows the effect of SP on physical health. All three models confirmed that SP diversity was significantly associated with a decrease in disability status, implying an improvement in physical health.

The addition of the frequency variable resulted in a non-significant relationship between frequency and physical health. After adding the type variable, female participation frequency and disability were significantly negatively associated. No significant impact of type variables on physical health was found.

In examining the effects of SP on SRH, the results presented in Table 7 show that when the frequency variable was reintroduced, the effects of the diversity variables ranged from significant to non-significant. However, the frequency variable was significantly associated with SRH (frequency: $\beta = -0.085$, 95% CI: 0.145, -0.024). Model 3 showed that among female middle-aged and olderly empty nesters, participation in sports was significantly and negatively associated with SRH (sports: $\beta = -0.204$, 95% CI: 0.381, -0.028), indicating that the higher the frequency of participation in sports, the better the SRH. In contrast, the frequency of participation in club-organized activities was significantly associated with SRH among male middle-aged and olderly empty nesters (Community organization: $\beta = -0.431$, 95% CI: 0.715, -0.147).

4.5. Robustness checks

Most of these associations remained robust when age 60 was used as the age stratification in the fixed-effects model regression, with the main change being that the positive effect of mahjong participation and mental health was not significant for middle-aged and older empty nesters over 60. It may be related to the winning and losing of mahjong and the fixation of the friendship circle. Second, the significant associations between SP and health remained unchanged after removing the control variables of smoking and drinking (Specific results are available upon request).

4.6. Endogeneity test

The frequency, diversity, and impact of SP on physical health, mental health, and sexual and reproductive health were estimated using 2SLS and lewbel (2012). Considering that interaction, community, and volunteering did not influence the health, this section does not cover tests of these SP categories. Based on the fact that all of the first-stage F exceeded 10, it can be determined that the regression does not have a weak IV, which indicates that the chosen IV is valid. The two-stage regressions and Lewbel estimates show that the effects of SP frequency, diversity, mahjong, card playing, exercise, and internet access on physical health, mental health, and self-assessed health of older adults are statistically significantly negative at the 1% level. Therefore, it can be assumed that all of these effects are causal. The results are more significant compared to the results of the RE model (Specific results are

available upon request).

4.7. Heterogeneity test

This paper explores the impact of SP on health by categorizing respondents into rural and urban groups based on their place of residence. Specifically, only diversity of SP was significantly positively associated with health for urban middle-aged and older empty nesters. For rural middle-aged and older empty nesters, diversity of SP had a positive effect on all three categories of health. Mahjong, sports and voluntary activities had a positive effect on mental health. And frequency of SP, community activities and internet access had a positive effect on SRH (Specific results are available upon request). This shows that SP has a greater effect on improving the health of rural middle-aged and older empty nesters compared to urban middle-aged and older empty nesters. The possible reason for this is that the good neighborhood socio-cultural environment in rural areas, which provides regular venues for SP such as senior citizen associations, allows for more frequency and variety, making the positive impact of SP on the health of rural middle-aged and older empty nesters even greater. This suggests that SP is conducive to reducing health inequalities between different socioeconomic groups of middle-aged and older empty nesters.

5. Discussion

Our study found that female middle-aged and older empty nesters had significantly poorer health and a higher frequency of participation in SP. The greater the variety of SP, the better the health status. The higher the frequency, the better the SRH. There were gender differences in the effects of specific types of SP on mental health and SRH. Specifically, there were the following valuable findings.

5.1. Health

The findings suggest that female middle-aged and older empty nesters have worse health. This may be because their self-health management awareness is weaker (Liang & Wu, 2014) and use medical and health services less frequently (Zhou et al., 2015). They rely more on their children as mothers than male (Bougea et al., 2020), because of the characteristics of empty nesters, their children are not around. As a result, they experience greater loneliness and psychological pressure due to their more delicate emotions, so mental health is worse (C. Zhang, Xue, et al., 2019). Therefore, various measures to strengthen health should have a sensitive awareness of gender issues especially female middle-aged and older empty nesters.

5.2. SP patterns

SP rate of middle-aged and older empty nesters in China is lower than other countries, and the type of preference is different. This may be related to China's lower economic status (van Hees et al., 2020), as well as different cultural values. In addition, China lacks policy support for SP like European countries (Komp et al., 2013).

This study outlines significant gender differences in SP. Female participate more in SP than male, and the frequency is higher. Women have worse mental health, so they need to place their emotions in SP to reduce loneliness (Zhai et al., 2015). Therefore, it is necessary to encourage male middle-aged and older empty nesters to participate more social activities.

5.3. The relationship and gender differences between SP and health

It has been found that greater diversity of SP is associated with better health. Diversity of SP affects SRH. This study complements existing longitudinal studies and studies of middle-aged and older empty nesters. More diverse means a wider social network, easier access to happiness,

Table 6
Association between physical health and SP using RE.

	Model 1			Model 2			Model 3		
	All β (95%CI)	Male β (95%CI)	Female β (95%CI)	All β (95%CI)	Male β (95%CI)	Female β (95%CI)	All β (95%CI)	Male β (95%CI)	Female β (95% CI)
Diversity	−0.409*** (-0.513,-0.305)	−0.443*** (-0.613,-0.273)	−0.376*** (-0.538,-0.214)	−0.287** (-0.466,-0.109)	−0.327* (-0.628,-0.026)	−0.003 (-0.290,0.283)	−0.284* (-0.500,-0.067)	−0.263 (-0.658,0.131)	0.165 (-0.224,0.554)
Frequency				−0.143 (-0.313,0.027)	−0.122 (-0.382,0.139)	−0.376** (-0.614,-0.137)	−0.193* (-0.382,-0.004)	−0.133 (-0.414,0.148)	−0.424** (-0.682,-0.166)
Type									
Interacting							0.156 (-0.010,0.322)	0.069 (-0.186,0.324)	0.085 (-0.156,0.325)
Mahjong							−0.107 (-0.277,0.062)	−0.115 (-0.371,0.141)	−0.240 (-0.490,0.010)
Sports							−0.260 (-0.639,0.120)	−0.255 (-0.868,0.357)	−0.444 (-0.952,0.063)
Community organization							−0.275 (-0.852,0.302)	−0.544 (-1.396,0.308)	−0.169 (-0.966,0.628)
Internet							−0.323 (-0.833,0.188)	−0.165 (-0.913,0.584)	−0.643 (-1.362,0.077)
Voluntary activities							0.092 (-0.137,0.321)	0.008 (-0.341,0.358)	−0.012 (-0.337,0.314)
Marry	−0.027 (-0.095,0.040)	0.029 (-0.079,0.136)	−0.072 (-0.158,0.015)	−0.027 (-0.094,0.040)	0.030 (-0.078,0.138)	−0.068 (-0.155,0.018)	−0.027 (-0.094,0.041)	0.027 (-0.081,0.134)	−0.066 (-0.152,0.020)
Educational level	−0.089** (-0.156,-0.022)	−0.039 (-0.134,0.056)	−0.136** (-0.232,-0.039)	−0.091** (-0.158,-0.024)	−0.040 (-0.135,0.055)	−0.141** (-0.237,-0.045)	−0.079* (-0.147,-0.011)	−0.035 (-0.131,0.061)	−0.122* (-0.219,-0.025)
Types of NCDs	0.331*** (0.274,0.389)	0.331*** (0.243,0.419)	0.344*** (0.267,0.421)	0.335*** (0.277,0.393)	0.331*** (0.242,0.419)	0.348*** (0.271,0.425)	0.340*** (0.282,0.398)	0.334*** (0.246,0.423)	0.357*** (0.280,0.434)
Smoking	−0.001 (-0.232,0.230)	−0.072 (-0.352,0.208)	0.093 (-0.326,0.512)	−0.001 (-0.232,0.230)	−0.075 (-0.355,0.205)	0.123 (-0.296,0.542)	−0.005 (-0.236,0.226)	−0.075 (-0.356,0.205)	0.102 (-0.317,0.520)
Drinking	−0.074 (-0.278,0.130)	−0.176 (-0.443,0.090)	0.030 (-0.290,0.350)	−0.077 (-0.281,0.127)	−0.180 (-0.447,0.087)	0.028 (-0.292,0.347)	−0.068 (-0.273,0.136)	−0.173 (-0.441,0.096)	0.042 (-0.277,0.362)
Age	0.048*** (0.034,0.062)	0.040*** (0.019,0.062)	0.059*** (0.041,0.077)	0.049*** (0.035,0.063)	0.041*** (0.019,0.062)	0.060*** (0.042,0.078)	0.051*** (0.037,0.065)	0.043*** (0.022,0.064)	0.061*** (0.042,0.079)
Sex	−0.295* (-0.551,-0.039)			−0.317* (-0.575,-0.060)			−0.310* (-0.568,-0.051)		

CI = confidence interval.

Two-tailed tests ***p < 0.001, **p < 0.01, *p < 0.05.

Table 7
Association between SRH and SP using RE.

	Model 1			Model 2			Model 3		
	All β (95%CI)	Male β (95%CI)	Female β (95%CI)	All β (95%CI)	Male β (95%CI)	Female β (95%CI)	All β (95%CI)	Male β (95%CI)	Female β (95% CI)
Diversity	−0.117***	−0.096***	−0.162***	−0.043	−0.039	−0.108*	0.005	−0.011	−0.033
	(−0.152,−0.082)	(−0.150,−0.041)	(−0.217,−0.107)	(−0.106,0.021)	(−0.141,0.063)	(−0.210,−0.005)	(−0.073,0.083)	(−0.147,0.124)	(−0.173,0.107)
Frequency				−0.085**	−0.059	−0.054	−0.087*	−0.072	−0.068
				(−0.145,−0.024)	(−0.148,0.031)	(−0.140,0.032)	(−0.154,−0.020)	(−0.168,0.024)	(−0.161,0.025)
Type									
Interacting							0.007	0.018	0.010
							(−0.051,0.065)	(−0.068,0.103)	(−0.076,0.095)
Mahjong							−0.018	−0.001	−0.022
							(−0.073,0.038)	(−0.082,0.081)	(−0.106,0.062)
Sports							−0.154*	−0.019	−0.204*
							(−0.284,−0.023)	(−0.226,0.187)	(−0.381,−0.028)
Community organization							−0.281**	−0.431**	−0.120
							(−0.483,−0.079)	(−0.715,−0.147)	(−0.408,0.167)
Internet							−0.141	−0.061	−0.209
							(−0.314,0.031)	(−0.307,0.184)	(−0.454,0.037)
Voluntary activities							−0.060	−0.021	−0.071
							(−0.142,0.021)	(−0.140,0.099)	(−0.189,0.047)
Marry	0.001	0.014	−0.002	0.002	0.014	−0.001	0.002	0.012	−0.000
	(−0.021,0.023)	(−0.020,0.047)	(−0.030,0.026)	(−0.020,0.023)	(−0.019,0.048)	(−0.030,0.027)	(−0.020,0.023)	(−0.022,0.046)	(−0.029,0.028)
Educational level	0.067***	0.072***	0.054***	0.066***	0.072***	0.054**	0.070***	0.072***	0.060***
	(0.045,0.089)	(0.042,0.103)	(0.023,0.086)	(0.044,0.088)	(0.041,0.103)	(0.022,0.085)	(0.048,0.093)	(0.041,0.104)	(0.028,0.093)
Types of NCDs	0.097***	0.106***	0.097***	0.098***	0.106***	0.097***	0.101***	0.107***	0.100***
	(0.079,0.114)	(0.081,0.131)	(0.073,0.120)	(0.081,0.115)	(0.081,0.131)	(0.074,0.120)	(0.084,0.118)	(0.082,0.133)	(0.076,0.123)
Smoking	0.057	0.216***	−0.315***	0.057	0.215***	−0.311***	0.050	0.209***	−0.320***
	(−0.020,0.134)	(0.127,0.305)	(−0.459,−0.171)	(−0.019,0.134)	(0.126,0.304)	(−0.455,−0.167)	(−0.027,0.126)	(0.120,0.299)	(−0.464,−0.176)
Drinking	−0.065	0.054	−0.225***	−0.067	0.052	−0.226***	−0.058	0.060	−0.215***
	(−0.135,0.004)	(−0.034,0.142)	(−0.337,−0.114)	(−0.137,0.002)	(−0.036,0.140)	(−0.337,−0.114)	(−0.128,0.012)	(−0.028,0.148)	(−0.326,−0.103)
Age	−0.001	0.005	−0.004	−0.000	0.005	−0.004	0.000	0.006*	−0.003
	(−0.005,0.003)	(−0.001,0.010)	(−0.009,0.001)	(−0.004,0.003)	(−0.000,0.011)	(−0.009,0.002)	(−0.003,0.004)	(0.001,0.012)	(−0.009,0.002)
Sex	−0.018			−0.032			−0.041		
	(−0.088,0.051)			(−0.102,0.039)			(−0.112,0.029)		

CI = confidence interval.
Two-tailed tests ***p < 0.001, **p < 0.01, *p < 0.05.

better mental health, and increased physical participation (Guo et al., 2018; Kanamori et al., 2014). In Model 2, it is the addition of the frequency variable to diversity. In a study of SP frequency, it was found that SP frequency was related to SRH consistent with previous studies (Dawson-Townsend, 2019). However, unlike previous studies SP frequency was not associated with physical and mental health (Peng et al., 2022; Vozikaki et al., 2017). It shows that blindly increasing the frequency of SP can only increase the self-perception of health by itself, but the fact is not beneficial to health. Therefore, it is recommended that middle-aged and older empty nesters participate in a rich variety of SP to improve their overall health.

It is worth noting that the effects of SP on health varied by type of SP and that there were gender differences, which is consistent with the findings of a Korean study (Lee et al., 2008). Specifically, for mental health, women who participate in mahjong, sports and internet activities have better mental health, which is not reflected in men. Among the types of activities that have a positive impact on SRH, club activities are for male and sports are for female.

In China, playing mahjong as a traditional entertainment activity is significantly negatively correlated with depressive symptoms (R. Wang et al., 2019). Participating in playing cards and mahjong increases social contact and obtains more social support (Umberson & Karas Montez, 2010) which can predict a decrease in depression levels while men do not (Kendler et al., 2005). Mahjong is a social activity in which men regularly participate and in which they have a fixed level of social support. Female, on the other hand, are less involved and gain more significant benefits once they start to change. Therefore, social support may be an important reason why female's mental health benefits from mahjong.

The present study found that female participation in physical activity was associated with better SRH and mental health. People can cultivate their sentiment and achieve mental pleasure through sports exercises (Jing et al., 2017), have enough confidence in their own lives, and have better SRH (Hamar et al., 2013). However, this effect is not reflected in the male group. This may be because sports exercises commonly seen in the Chinese older population are square dancing and Tai Chi, and most participants are middle-aged and older women, which can improve their identity (Yang & Qin, 2022) and make up for the role loss caused by children leaving home, thereby improving their SRH. Contrary to previous research (Gao et al., 2018), sports exercises have no effect on the physical health, indicating that at the longitudinal level, sports exercises have limited long-term benefits for physical health and cannot offset the harm caused by aging (Peng et al., 2022).

For female, participation in the Internet is positively associated with mental health. The Internet helps them maintain social relationships and reduce social isolation, providing positive effects on their psychological condition (Sun et al., 2020). And the Internet enhances social adjustment and life satisfaction. Similarly, it is not reflected in male. The reason for analysis may be that female are more willing to discuss problems, such as seeking emotional support on the Internet (Gao et al., 2018). It may also be related to the fact that women have severe mental health problems and are more likely to benefit from them by performing diverse tasks (Sun et al., 2020).

Club activities were the only type found to have an effect on the health of male participants and were only associated with SRH. Club organization activities can improve SRH and well-being (Carr et al., 2015). Potential reasons for this difference may be that men and women play different social roles (Antonucci & Akiyama, 1987). Male bear the responsibility of earning money to support their families, while female take care of their families more. Therefore, in China, male have less responsibility for family homework. Participating in club activities provides specific social roles for male, thus improving SRH.

Unlike common results in other countries, this study did not find an effect of volunteering on health. In the Australian, there were more participants engaged in voluntary work. Studies have suggested that empty nests compensate for the loss of social roles associated with empty

nesting by volunteering (Burn et al., 2016; Kim, 2013). However, in this study, the reason for the lower number of people participating in voluntary activities may exista selection bias that influenced our results. It may also be related to the volunteering which may counteract the positive effects on health (Wahrendorf et al., 2016), especially in China where socioeconomic underdevelopment. Future research could therefore examine the heterogeneity of the health effects of volunteering in China versus other countries, looking for evidence of impact.

5.4. Strengths and limitations

The strengths of our study are that the respondents supplemented a middle-aged and older group of empty nesters, conducted a longitudinal study, and explored the relationship between the three types of health and the diversity, frequency, and variety of SP through gender differences. There are also some limitations to this study. The sample size of people who participate in volunteer activities or community organizations or use the Internet is significantly smaller than the minimum sample size for rejecting the null hypothesis. In this case, the relationship between volunteerism, community activism, and Internet use and health needs further research with a larger sample size.

6. Conclusion

Our findings suggest that for middle-aged and older empty nesters, engaging in a rich variety of SP means better health and higher SP frequency predicts higher SRH. Moreover, the association between SP and the health of middle-aged and olderly empty nesters did vary by type of SP as well as by gender. These findings have important implications for healthy aging in China. This study aims to draw attention to the rich variety of SP that can be used to focus on and improve the health of middle-aged and olderly empty nesters. The government and community workers need to pay attention specially to the health of female empty nesters and provide better socialization venues and activities to encourage participation in social activities. It also provides personalized and differentiated services for middle-aged and older empty nesters with different health conditions, genders and background characteristics. It is also possible to generate effects for SP among urban middle-aged and older empty nesters to influence their health by enhancing social venues and activities for them. Our study will inform health services researchers and policy makers on how to intervene and improve the health of empty-nesting middle-aged and older adults.

Declaration of competing interest

None.

CRediT authorship contribution statement

Yan Gao: Writing – review & editing, Methodology, Conceptualization. **Lu Chen:** Writing – review & editing, Writing – original draft, Data curation. **Zhihao Jia:** Supervision, Conceptualization. **Liangyu Zhao:** Writing – review & editing, Supervision. **Yuke Yang:** Writing – review & editing. **Chenchen Liu:** Supervision, Conceptualization.

Data availability

The data are publicly available for download on the charls website (https://charls.charlsdata.com/index/zh-cn.html).

Acknowledgement

There are no acknowledgments in this article.

References

Antonucci, T., & Akiyama, H. (1987). An Examination of sex-differences in social support among older men and women. *Sex Roles, 17*(11–12), 737–749. https://doi.org/10.1007/BF00287685

Boerma, T., Hosseinpoor, A. R., Verdes, E., & Chatterji, S. (2016). A global assessment of the gender gap in self-reported health with survey data from 59 countries. *BMC Public Health, 16*(1), 675. https://doi.org/10.1186/s12889-016-3352-y

Bougea, A., Despoti, A., & Vasilopoulos, E. (2020). Empty-nest-related psychosocial stress: Conceptual issues, future directions in economic crisis. *Psychiatrike = Psychiatriki, 30*, 329–338. https://doi.org/10.22365/jpsych.2019.304.329

Burn, K., Dennerstein, L., Browning, C., & Szoeke, C. (2016). Patterns of social engagement in the transition to later life. *Maturitas, 88*, 90–95. https://doi.org/10.1016/j.maturitas.2016.03.016

Carr, D. C., Fried, L. P., & Rowe, J. W. (2015). Productivity & engagement in an aging America: The role of volunteerism. *Dædalus, 144*(2), 55–67. https://doi.org/10.1162/DAED_a_00330

Chiao, C., Weng, L.-J., & Botticello, A. L. (2011). Social participation reduces depressive symptoms among older adults: An 18-year longitudinal analysis in Taiwan. *BMC Public Health, 11*(1). https://doi.org/10.1186/1471-2458-11-292. Article 1.

Dawson-Townsend, K. (2019). Social participation patterns and their associations with health and well-being for older adults. *SSM - Population Health, 8*, Article 100424. https://doi.org/10.1016/j.ssmph.2019.100424

Douglas, H., Georgiou, A., Westbrook, J., Douglas, H., Georgiou, A., & Westbrook, J. (2016). Social participation as an indicator of successful aging: An overview of concepts and their associations with health. *Australian Health Review, 41*(4), 455–462. https://doi.org/10.1071/AH16038

Feng, Z., & Phillips, D. R. (2022). *Social exclusion and health outcomes among empty nest and non-empty nest older people in China* (Vols. 1–28). Ageing & Society. https://doi.org/10.1017/S0144686X22000149

Gao, M., Sa, Z., Li, Y., Zhang, W., Tian, D., Zhang, S., & Gu, L. (2018). Does social participation reduce the risk of functional disability among older adults in China? A survival analysis using the 2005–2011 waves of the CLHLS data. *BMC Geriatrics, 18*(1), 224. https://doi.org/10.1186/s12877-018-0903-3

Guo, Q., Bai, X., & Feng, N. (2018). Social participation and depressive symptoms among Chinese older adults: A study on rural–urban differences. *Journal of Affective Disorders, 239*, 124–130. https://doi.org/10.1016/j.jad.2018.06.036

Hamar, B., Coberley, C. R., Pope, J. E., & Rula, E. Y. (2013). Impact of a senior fitness program on measures of physical and emotional health and functioning. *Population Health Management, 16*(6), 364–372. https://doi.org/10.1089/pop.2012.0111

He, W., Jiang, L., Ge, X., Ye, J., Yang, N., Li, M., Wang, M., & Han, X. (2020). Quality of life of empty-nest elderly in China: A systematic review and meta-analysis. *Psychology Health & Medicine, 25*(2), 131–147. https://doi.org/10.1080/13548506.2019.1695863

Hu, Z., & Peng, X. (2015). Household changes in contemporary China: An analysis based on the four recent censuses. *The Journal of Chinese Sociology, 2*(1), 9. https://doi.org/10.1186/s40711-015-0011-0

Jing, L.-W., Wang, F.-L., Zhang, X.-L., Yao, T., & Xing, F.-M. (2017). Occurrence of and factors influencing elderly homebound in Chinese urban community. *Medicine, 96*(26), Article e7207. https://doi.org/10.1097/MD.0000000000007207

Kanamori, S., Kai, Y., Aida, J., Kondo, K., Kawachi, I., Hirai, H., Shirai, K., Ishikawa, Y., & Suzuki, K. (2014). Social participation and the prevention of functional disability in older Japanese: The JAGES cohort study. *PLoS One, 9*(6), Article e99638. https://doi.org/10.1371/journal.pone.0099638

Kendler, K. S., Myers, J., & Prescott, C. A. (2005). Sex differences in the relationship between social support and risk for major depression: A longitudinal study of opposite-sex twin pairs. *American Journal of Psychiatry, 162*(2), 250–256. https://doi.org/10.1176/appi.ajp.162.2.250

Kim, S. H. (2013). Benefits of volunteering to physical health, depression, social support, and meaning in life among older adults. *Journal of the Korea Gerontological Society, 33*(1), 53–66.

Komp, K., van Kersbergen, K., & van Tilburg, T. (2013). Policies for older volunteers: A study of Germany and Italy, 1990–2008. *Journal of Aging Studies, 27*(4), 443–455. https://doi.org/10.1016/j.jaging.2013.10.003

Lee, H. Y., Jang, S.-N., Lee, S., Cho, S.-I., & Park, E.-O. (2008). The relationship between social participation and self-rated health by sex and age: A cross-sectional survey. *International Journal of Nursing Studies, 45*(7), 1042–1054. https://doi.org/10.1016/j.ijnurstu.2007.05.007

Li, W., Yang, S., Li, J., Li, Z., Yan, C., Gui, Z., & Zhou, C. (2022). Social capital and self-rated health among Chinese rural empty nesters: A multiple mediation model through sleep quality and psychological distress. *Journal of Affective Disorders, 298*, 1–9. https://doi.org/10.1016/j.jad.2021.11.016

Liang, Y., & Wu, W. (2014). Exploratory analysis of health-related quality of life among the empty-nest elderly in rural China: An empirical study in three economically

developed cities in eastern China. *Health and Quality of Life Outcomes, 12*, 59. https://doi.org/10.1186/1477-7525-12-59

Liu, Z., Li, J., Rommel, J., & Feng, S. (2020). Health impacts of cooking fuel choice in rural China. *Energy Economics, 89*, Article 104811. https://doi.org/10.1016/j.eneco.2020.104811

Liu, Q., Yu, Y., Wu, X., Sun, Y., Lyu, Y., Cao, K., Wang, Y., & Geng, L. (2023). Demand for community medical-nursing combined services among the empty-nest elderly in China: A qualitative study. *Health and Social Care in the Community, 2023*, Article e2173057. https://doi.org/10.1155/2023/2173057

Mitchell, B. A., & Wister, A. V. (2015). Midlife challenge or welcome departure? Cultural and family-related expectations of empty nest transitions. *The International Journal of Aging and Human Development, 81*(4), 260–280. https://doi.org/10.1177/0091415015622790

O'Meara, S. (2020). How health research will support China's ageing population. *Nature, 578*(7793), Article S1–S3. https://doi.org/10.1038/d41586-020-00279-y

Peng, C., luo, wei, & li, yue (2022). The influence of social participation on the multidimensional health of empty nest elderly: Evidence from China [preprint]. In *Review.* https://doi.org/10.21203/rs.3.rs-2229316/v1

Sarkar, M., Kasemi, N., Majumder, M., Sk, M. A., Sarkar, P., Chowdhury, S., Roy, D., & Halder, M. (2023). Physical and mental health among older parents: Does offspring migration and living arrangement matter? Findings from longitudinal aging survey in India (2017-18). *SSM - Population Health, 24*, Article 101503. https://doi.org/10.1016/j.ssmph.2023.101503

Schulz, F., & Raab, M. (2023). When the last child moves out: Continuity and convergence in spouses' housework time. *Journal of Marriage and Family, 85*(1), 305–320. https://doi.org/10.1111/jomf.12873

Su, D., Chen, Z., Zhang, J., Gong, G., Guo, D., Tan, M., Zhang, Y., Liu, Y., Chen, X., Chen, X., & Chen, Y. (2020). Effect of social participation on the physical functioning and depression of empty-nest elderly in China: Evidence from the China health and retirement longitudinal survey (CHARLS). *International Journal of Environmental Research and Public Health, 17*(24). https://doi.org/10.3390/ijerph17249438. Article 24.

Su, D., Wu, X.-N., Zhang, Y.-X., Li, H.-P., Wang, W.-L., Zhang, J.-P., & Zhou, L. (2012). Depression and social support between China' rural and urban empty-nest elderly. *Archives of Gerontology and Geriatrics, 55*(3), 564–569. https://doi.org/10.1016/j.archger.2012.06.006

Sun, X., Yan, W., Zhou, H., Wang, Z., Zhang, X., Huang, S., & Li, L. (2020). Internet use and need for digital health technology among the elderly: A cross-sectional survey in China. *BMC Public Health, 20*(1), 1386. https://doi.org/10.1186/s12889-020-09448-0

Thapa, D. K., Visentin, D., Kornhaber, R., & Cleary, M. (2018). Migration of adult children and mental health of older parents 'left behind': An integrative review. *PLoS One, 13*(10), Article e0205665. https://doi.org/10.1371/journal.pone.0205665

Tomioka, K., Kurumatani, N., & Hosoi, H. (2017). Positive and negative influences of social participation on physical and mental health among community-dwelling elderly aged 65-70 years: A cross-sectional study in Japan. *BMC Geriatrics, 17*, 111. https://doi.org/10.1186/s12877-017-0502-8

Townsend, C. H., Kray, L. J., & Russell, A. G. (2023). Holding the belief that gender roles can change reduces women's work–family conflict. *Personality and Social Psychology Bulletin.* , Article 01461672231178349. https://doi.org/10.1177/01461672231178349

Umberson, D., & Karas Montez, J. (2010). Social relationships and health: A flashpoint for health policy. *Journal of Health and Social Behavior, 51*(1_suppl), S54–S66. https://doi.org/10.1177/0022146510383501

van Hees, S. G. M., van den Borne, B. H. P., Menting, J., & Sattoe, J. N. T. (2020). Patterns of social participation among older adults with disabilities and the relationship with well-being: A latent class analysis. *Archives of Gerontology and Geriatrics, 86*, Article 103933. https://doi.org/10.1016/j.archger.2019.103933

Vozikaki, M., Linardakis, M., Micheli, K., & Philalithis, A. (2017). Activity participation and well-being among European adults aged 65 years and older. *Social Indicators Research, 131*(2), 769–795. https://doi.org/10.1007/s11205-016-1256-y. Scopus.

Wahrendorf, M., Blane, D., Matthews, K., & Siegrist, J. (2016). Linking quality of work in midlife to volunteering during retirement: A European study. *Journal of Population Ageing, 9*(1), 113–130. https://doi.org/10.1007/s12062-015-9129-8

Wang, R., Chen, Z., Zhou, Y., Shen, L., Zhang, Z., & Wu, X. (2019). Melancholy or mahjong? Diversity, frequency, type, and rural-urban divide of social participation and depression in middle- and old-aged Chinese: A fixed-effects analysis. *Social Science & Medicine, 238*, Article 112518. https://doi.org/10.1016/j.socscimed.2019.112518

Wang, L., Liu, W., Liang, Y., & Wei, Y. (2019). Mental health and depressive feeling of empty-nest elderly people in China. *American Journal of Health Behavior, 43*(6), 1171–1185. https://doi.org/10.5993/AJHB.43.6.14

WHO. (2015). *World report on Ageing and health.*

Wu, J., Glaser, K., & Avendano, M. (2023). Does the transition to grandparenthood influence the health and well-being of older people? Evidence from the CHARLS study in China. *SSM - Population Health, 21*, Article 101328. https://doi.org/10.1016/j.ssmph.2022.101328

Xu, S., Yang, X., Liu, J., Chong, M. K., Cheng, Y., Gong, W., & Zou, G. (2023). Health and wellbeing among the empty nest and non-empty nest elderly in China—results from a national cross-sectional study. *PLoS One, 18*(9), Article e0291231. https://doi.org/10.1371/journal.pone.0291231

Yang, J., & Qin, T. (2022). Chinese square-dancing: A description of group cultural life. *Sociological Research Online, 136078042210966.* https://doi.org/10.1177/13607804221096687

Yao, Y., Ding, G., Wang, L., Jin, Y., Lin, J., Zhai, Y., Zhang, T., He, F., & Fan, W. (2019). Risk factors for depression in empty nesters: A cross-sectional study in a coastal city

of zhejiang province and China. *International Journal of Environmental Research and Public Health, 16*(21). https://doi.org/10.3390/ijerph16214106. Article 21.

Zhai, Y., Yi, H., Shen, W., Xiao, Y., Fan, H., He, F., Li, F., Wang, X., Shang, X., & Lin, J. (2015). Association of empty nest with depressive symptom in a Chinese elderly population: A cross-sectional study. *Journal of Affective Disorders, 187*, 218–223. https://doi.org/10.1016/j.jad.2015.08.031

Zhang, Y. (2020). Are empty-nest elders unhappy? Re-Examining Chinese empty-nest elders' subjective well-being considering social changes. *Frontiers in Psychology, 11*. https://www.frontiersin.org/articles/10.3389/fpsyg.2020.00885.

Zhang, C., Hou, L., Zheng, X., Zhu, R., Zhao, H., Lu, J., Cheng, J., Yang, X. Y., & Yang, T. (2019). Risk factors of mental disorders among empty and non-empty nesters in shanxi, China: A cross-sectional study. *Health and Quality of Life Outcomes, 17*, 18. https://doi.org/10.1186/s12955-019-1088-y

Zhang, C., Xue, Y., Zhao, H., Zheng, X., Zhu, R., Du, Y., Zheng, J., & Yang, T. (2019). Prevalence and related influencing factors of depressive symptoms among empty-nest elderly in Shanxi, China. *Journal of Affective Disorders, 245*, 750–756. https://doi.org/10.1016/j.jad.2018.11.045

Zhao, Y., Hu, Y., Smith, J. P., Strauss, J., & Yang, G. (2014). Cohort profile: The China health and retirement longitudinal study (CHARLS). *International Journal of Epidemiology, 43*(1), 61–68. https://doi.org/10.1093/ije/dys203

Zheng, X., Fang, Z., Shangguan, S., & Fang, X. (2022). Associations between childhood maltreatment and educational, health and economic outcomes among middle-aged Chinese: The moderating role of relative poverty. *Child Abuse & Neglect, 130*, Article 105162. https://doi.org/10.1016/j.chiabu.2021.105162

Zhou, C., Ji, C., Chu, J., Medina, A., Li, C., Jiang, S., Zheng, W., Liu, J., & Rozelle, S. (2015). Non-use of health care service among empty-nest elderly in shandong, China: A cross-sectional study. *BMC Health Services Research, 15*(1), 294. https://doi.org/10.1186/s12913-015-0974-1