FALL OCCURRENCE AND ASSOCIATION WITH KNOWLEDGE AND PRACTICE ON FALL PREVENTION AMONG ELDERLY RESIDENTS IN NURSING HOMES, PR CHINA

Muzheng Li[1,2], Eva Nabiha Zamri[1], Kun Liu [2], Nurdiana Zainol Abidin[1] and Xifan Mei[3]

[1]Department of Community Health, Advanced Medical and Dental Institute, Universiti Sains Malaysia, Pulau Pinang, Malaysia; [2]Medical College of Jinzhou Medical University, Jinzhou City, Liao Ning Province, PR China; [3]Department of Orthopedics, Third Affiliated Hospital of Jinzhou Medical University, Jinzhou City, Liao Ning Province, PR China

Abstract. Falls among the elderly are of a significant global health concern. While falls in nursing homes are a growing issue, limited attention has been given to the role of the residents' knowledge and practices in fall prevention, particularly in nursing homes in China. We used a cross-sectional study to determine the prevalence of falls and their association with knowledge and practices in fall prevention among the elderly (n = 341), age 60 years and above, residing in nursing homes in three districts of Jinzhou City, Liaoning Province, PR China. Data were collected using validated structured questionnaires and evaluated using a logistic regression analysis, with results reported as odds ratios (ORs) and 95% confidence intervals (CIs). Participants (28%) experienced at least one fall in the previous 12 months. The multivariate analysis revealed that a higher score in knowledge of fall prevention was significantly associated with greater occurrence of falls (adjusted odds ratio (aOR) = 1.16; 95% CI: 1.06-1.27, p-value = 0.002), while there was no significant association with practice in fall prevention. The female sex (aOR = 1.76; 95% CI: 1.03-2.99, p-value = 0.038), a history of stroke (aOR = 3.12, 95% CI: 1.64-5.93, p-value = 0.001), and impaired mobility (aOR = 2.07, 95% CI: 1.21-3.55, p-value = 0.008) were positively associated with falls. However, having completed a college education was inversely associated with fall occurrence (aOR = 0.40, 95% CI: 0.17-0.98, p-value = 0.044). In conclusion, falls were common among elderly residents in nursing homes in Jinzhou City. These findings underscore the importance of implementing targeted interventions that extend beyond a knowledge-based approach to effectively reduce incidents of falls within this at-risk growing population.

Keywords: elderly, fall, knowledge, nursing home, practice, prevention

Correspondence: Eva Nabiha Zamri, Department of Community Health, Advanced Medical and Dental Institute, Universiti Sains Malaysia, Kepala Batas, Pulau Pinang 13200, Malaysia
Telephone number: +60 19 2184647 E-mail: evazamri@usm.my

INTRODUCTION

Falls among the elderly represent a major global public health issue, causing approximately 684,000 deaths annually and serving as a critical contributor to morbidity, disability, hospitalization, and mortality worldwide (WHO, 2021). Each year, it is estimated that around 37.3 million falls occur, which are severe enough to require medical attention. The Western Pacific and Southeast Asia regions account for 60% of global fatalities from falls (Thakur and Han, 2021). In addition to the high mortality burden, the economic burden associated with falls is also substantial. A study in the United States reported that fall-related medical expenses total USD50.0 billion in 2015 (Florence *et al*, 2018). In China, the average hospitalization cost from a fall of the elderly is USD88,000 (Su *et al*, 2021).

Amid China's rapidly aging population, the development of institutional elderly care has expanded substantially. By the end of 2023, the country had approximately 8.2 million beds across a range of elderly care facilities, reflecting the growing demand for professional caregiving services (The State Council of the People's Republic of China, 2024). Although traditional Chinese culture has long prioritized family-based caregiving, recent studies indicate a gradual but notable shift in positive public attitudes toward institutional care for the elderly (Sun *et al*, 2021). For example, in a multi-province survey, the proportion of older adults willing to consider placement in a nursing home increased from 11.2% in 2017 to 45.4% in 2019 (Luo *et al*, 2018; Wang *et al*, 2020). This trend underscores a broader transformation in societal

perceptions of aging and caregiving in contemporary China.

However, nursing homes constitute high-risk areas for falls among the elderly. A meta-analysis reported a pooled fall rate of 43% among the elderly in nursing homes (Shao *et al*, 2023). Another study found that the prevalence of falls among nursing home residents was three times higher than that among community-dwelling older adults (Cooper, 2017). The high risks of falls among the elderly living in nursing homes are due to such factors as advanced age, chronic illness, polypharmacy, cognitive decline, and reduced mobility (Fonad *et al*, 2008; Zaninotto *et al*, 2020).

A Fall Prevention Education (FPE) program has enhanced knowledge on fall prevention among older adults and serves as an effective strategy to mitigate fall incidents (Ott, 2018). In addition, several studies support the efficacy of multifactorial interventions, including exercise training, environmental modifications and foot care, in reducing fall risks (Abrahamson *et al*, 2013; Kamei *et al*, 2015; Ong *et al*, 2021). Many studies on fall prevention are based on the knowledge-attitude-practice (KAP) model, and predominantly focus on community-dwelling older adults, with relatively limited attention given to residents in nursing homes (Laing *et al*, 2011; Tang *et al*, 2023).

Moreover, most health interventions primarily aim to enhance knowledge of fall prevention and often assess outcomes based solely on knowledge improvement, rather than examining actual fall occurrence. Few studies have directly explored the relationship between knowledge and practice on fall prevention with the actual occurrence of falls (Goh *et al*, 2021; Tang *et al*, 2023). A study in Vietnam reported a significant association between knowledge on fall prevention (B (regression coefficient) = -8.45, 95% confidence interval (CI) = -9.16 to -7.76) and practice on fall prevention (B = -5.92, 95% CI = -6.29 to -5.55) with the occurrence of falls among

community-dwelling older adults (Tang *et al*. 2023). Similarly, a study in Malaysia among community-dwelling older adults found that the mean knowledge and behavior scores are lower, but not significant, among fallers compared to non-fallers (Goh *et al*, 2021). The variation in the findings' results highlights the importance of examining this relationship across different populations and settings.

China, which has the largest elderly population in the world, people 60 years old and above exceed 300 million by the end of 2024, accounting for 22.0% of the total population (National Bureau of Statistics of China, 2025). This demographic shift indicates that China has entered an aging society, highlighting the critical nature of addressing aging-related issues. Regional disparities in aging trends are pronounced, with Liaoning Province, a coastal province in northeastern China, having the most significant aging pattern, where 25.72% of residents are elderly, well above the national average. Within Liaoning Province, Jinzhou City stands out, with 28.59% of its population 60 years and above of age (National Bureau of Statistics, 2021). The concentrated demographic aging in regions like Jinzhou city poses significant public health challenges, particularly in the high occurrence of falls among elderly residents of nursing homes. Given the impact of rapid population aging and existing healthcare system limitations, understanding the factors influencing falls in nursing homes is critical and urgent.

Thus, we set out to determine the prevalence of falls and assess the association between knowledge and practice in fall prevention and the occurrence of falls among the elderly residents in nursing homes of Jinzhou City, Liaoning Province, PR China. Ultimately, the findings of this study are expected to support strategic interventions aimed at reducing falls, thereby enhancing the overall quality of life among this vulnerable population.

MATERIALS AND METHODS

Study design, setting and participants

We conducted a cross-sectional study among elderly residents in nursing homes across three urban districts of Jinzhou City, Liaoning Province, PR China, from December 2023 to December 2024 (Fig 1). Inclusion criteria were: ≥60 years of age, with functional communication abilities without significant cognitive impairment, able to read and understand information, and capable of walking independently. Exclusion criteria were: severe mental impairment, unstable vital signs or prolonged bedridden status.

Sample size calculation

The sample size was determined using an OpenEpi version 3.01 (http://www.openepi.com/Menu/OE_Menu.htm), an open-source software for epidemiological statistics. The calculation was based on a 95% confidence level, a 5% margin of error and an additional 20% to account for potential non-responses. A random sampling method was employed to recruit 341 eligible elderly residents from selected nursing homes, a number based on an odds ratio of 2.46 with a power of 80%, 95% confidence level, a two-sided test, and a potential 20% non-response rate as previously described (Gamage, 2018).

Sampling method

We employed a multistage cluster random sampling method to select eligible participants from 80 nursing homes consisting of 17 in Guta District, 45 in Linghe District and 18 in Tahe District of Jinzhou City. In the first stage, we randomly selected 50% of nursing homes in each selected district using a computer-generated random sequence, yielding 40 nursing homes. In the second stage, we employed a universal sampling method whereby all residents within the selected nursing homes who met the predefined inclusion criteria were invited to participate in the study (Fig 2).

Data collection

Collection of data was conducted by a trained research team led by the primary researcher. All team members underwent a comprehensive training course, covering data collection methods and essential precautionary measures to ensure accurate, consistent and respectful interactions with participants throughout the data collection process. Before the data collection, the research team contacted every nursing home manager individually, either by phone or via an in-person meeting, to explain the study's purpose and procedures and to obtain permission to conduct the study.

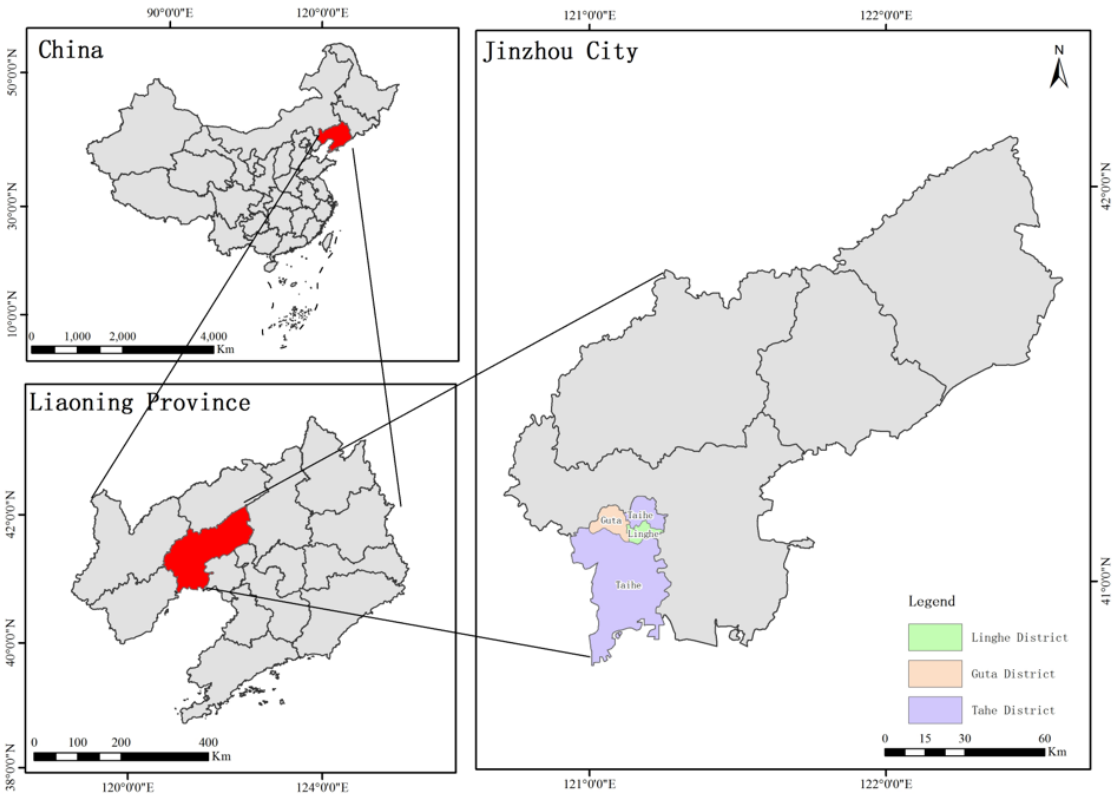

Fig 1 - Map of the study districts, Jinzhou City, Liaoning Province, PR China

Km: kilometers

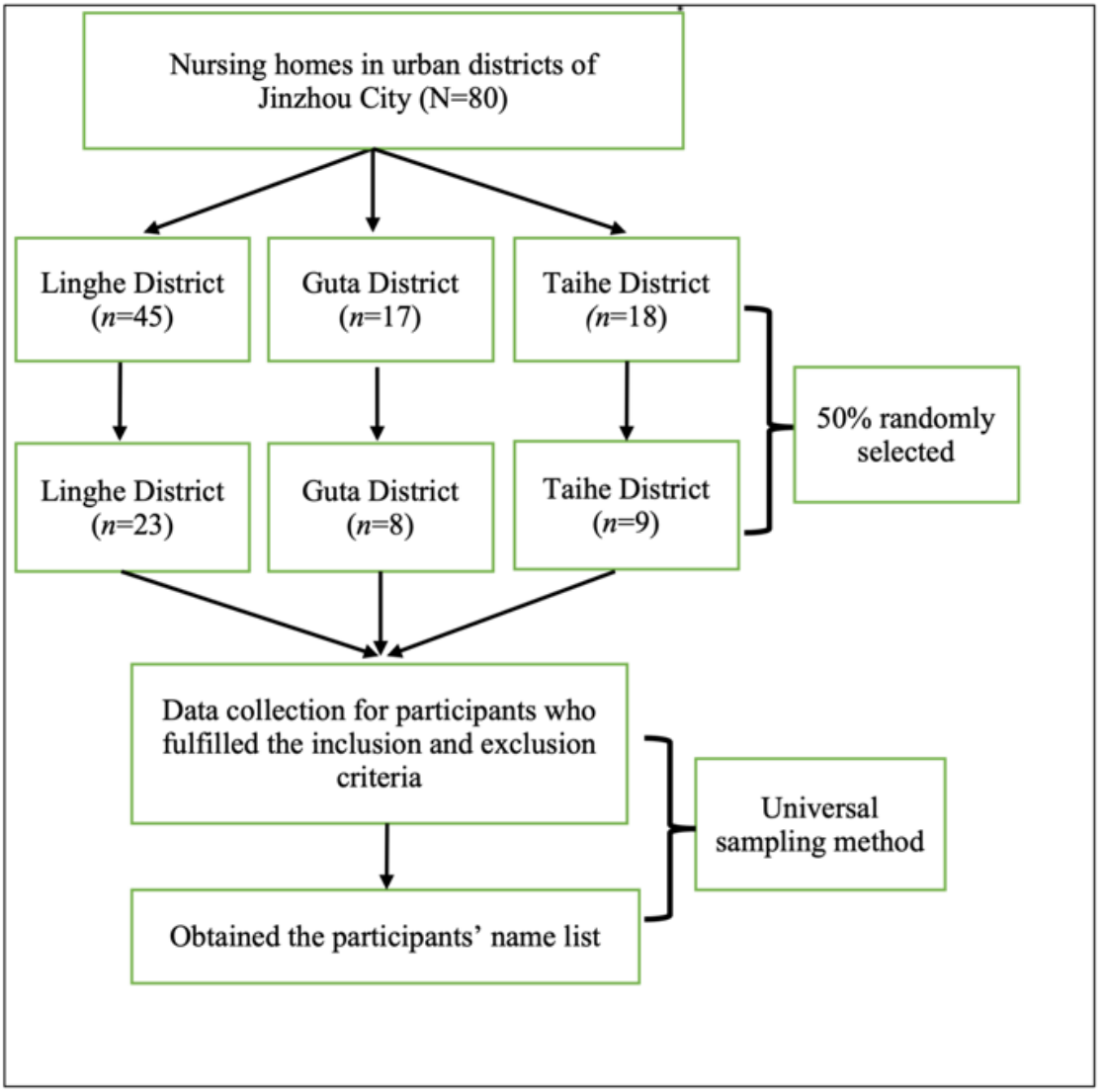

Fig 2 - Sampling method and subjects' recruitment

Data were collected using structured questionnaires administered through face-to-face interviews and with objective performance measures. The structured questionnaire includes socio-demographic characteristics, fall history, health-related factors assessment, depression symptoms, and information on knowledge and

practice on fall prevention. For objective measurement, mobility was assessed using the Timed Up and Go (TUG) test (Wang *et al*, 2021), conducted by trained assessors under the primary researcher's supervision. All assessments were carried out in a safety-controlled environment with appropriate precautions to ensure participant safety.

Study instruments

Socio-demographic and health-related factors: Information on age, gender, level of education, previous occupation, and marital status was collected directly from participants. Health-related factors, including chronic diseases - hypertension, diabetes, chronic kidney disease, chronic obstructive pulmonary disease (COPD), peripheral vascular disease (PVD) - and history of stroke, were obtained from medical records and self-reports. Medication intake was categorized as follows: no medication, single medication or two or more medications.

Occurrence of falls: Falls were defined as unintentional events leading to a loss of balance (Sharif *et al*, 2018). Participants were asked if they had fallen in the past 12 months and, if so, how many times (Rodrigues *et al*, 2014; Lee *et al*, 2021).

Depression symptoms: Depression was assessed using the 15-item Geriatric Depression Scale (GDS-15), which measures mood, activity level, irritability, withdrawal symptoms, and distressing thoughts (Zhang *et al*, 2022). The GDS-15 consists of binary response items with 0 = 'No' and 1 = 'Yes'. The total score is categorized as follows: 0-4: normal, 5-9: mild depression, 10-15: severe depression. The GDS-15 demonstrated good psychometric properties (Cronbach's α >0.8) and cultural suitability for the Chinese elderly population (Chau *et al*, 2006; Sun *et al*, 2017).

Knowledge and practice of fall prevention: Information on knowledge and practice on fall prevention was adopted from a validated knowledge-attitude-

practice (KAP) questionnaire (Chen, 2016). The instrument assesses participants' knowledge and practice related to fall prevention.

The knowledge section consists of 11 items covering two domains: (i) pathology and physical activity (*eg*, chronic disease, exercise) and (ii) psychological and environmental factors (*eg*, mood, home safety). Each item is scored as 0 (wrong), 1 (uncertain) or 2 (correct), with a total score ranging from 0 to 22, where higher scores indicate greater knowledge of fall prevention. Exploratory factor analysis identifies two factors, covering 53.67% of the variance (Factor 1: Cronbach's α = 0.827; Factor 2: Cronbach's α = 0.745); the test-retest reliability coefficient is 0.734 and 0.620 respectively (Chen, 2016).

The practice section consists of 15 items assessing three domains: (i) active prevention behavior (*eg*, exercise, medication management), (ii) home safety modification, and (iii) safe mobility practice (*eg*, footwear, assistance device). Each item is scored on a scale from 0 (never) to 3 (always), with a total score ranging from 0 to 45, where a higher score indicates better fall prevention practice. Exploratory factor analysis identifies three factors, covering 54.19% of the variance (Factor 1: Cronbach's α = 0.785; Factor 2: Cronbach's α = 0.860; Factor 3: Cronbach's α = 0.548); test-retest reliability coefficient is 0.540, 0.687 and 0.703, respectively (Chen, 2016).

The psychometric properties are to confirm that knowledge on fall prevention and practice of the fall prevention scales possesses acceptable validity and reliability, supporting their suitability for assessing fall prevention knowledge and practice among the elderly.

Mobility measurement: The TUG test evaluates participants' mobility (balance, gait). Participants are timed as they rose from a chair, walked 3 meters turned, and returned to their seats. A shorter time indicates better mobility and lower fall risk, while a longer time suggests the presence of a

mobility issue and increased fall risk. TUG test ≥13.5 seconds is the threshold prediction time of fall risk (Borowicz *et al*, 2016; Long *et al*, 2020). During the test session, a safe environment was ensured, with two assessors assisting to prevent a potential fall.

Statistical analysis

Categorical variables were presented as frequencies and percentages. Normal distributed continuous variables were summarized as mean and standard deviation (SD), while non-normal distributed continuous variables were reported as median with interquartile range (IQR). Logistic regression analysis was performed to explore the relationship between the associated factors (socio-demographic factors, health-related factors, depression symptoms, mobility, knowledge and practice of fall prevention) and fall occurrence in the past 12 months, with results presented as odds ratio (OR) and 95% confidence intervals (CI). Significant variables in the univariate logistic regression were included in the multivariate analysis. Interaction and multicollinearity tests were conducted before presenting the final analysis results. Statistical significance was set at a p-value <0.05. Data were analyzed using the International Business Machines Statistical Package for the Social Sciences (IBM SPSS), version 27.0 (IBM Corp, Armonk, NY).

Ethical approval

The study protocols were approved by the Research Ethics Committee of Universiti Sains Malaysia (Protocol no: USM/JEPeM/PP/23070555). Before data collection commenced, we obtained an official list of all registered nursing homes from the Jinzhou Civil Affairs Bureau and contacted the administrators of the selected nursing homes to obtain permission and cooperation. Before enrollment, participants were informed about the study's purpose, potential benefits, risks, their rights, and responsibilities. Participants were informed that they could withdraw

at any time from the study without affecting their access to care or services in the nursing homes. Prior written informed consent was obtained from each participant.

RESULTS

Descriptive analysis

Of the original 341 participants, 4 were excluded due to missing data on their fall history leaving us with 337 participants enrolled. The average age (mean ± SD) of the participants was 76.8 ± 8.2; with 53.7% male (Table 1). Greater than 75% of the participants had no chronic disease, such as diabetes, chronic kidney disease, history of stroke, COPD, and PVD; 18% exhibited depressive symptoms; 28% reported a fall in the past 12 months; and 47% had mobility impairment. The median (IQR) of the knowledge score of the participants was 18.0 (16.0-21.0), and the practice score (mean ± SD) was 26.2 ± 6.4 (Table 1).

Inferential analysis

The univariate analysis of factors associated with fall occurrence among the participants revealed that the occurrence among three age groups was not statistically significant; a significantly more females (55%) experienced falls than males (45%) (p-value = 0.039); and widowed participants reported the highest fall rate (55%) compared to married (31%) and single participants (14%) (p-value = 0.015) (Table 2).

The univariable analysis of factors associated with falls showed significant association with sex, level of education, history of stroke, medication intake, mobility status, and knowledge and practice of fall prevention. Interestingly, there was no significant difference in median (IQR) knowledge score on fall prevention between participants who did and did not experience falls in the past 12 months (19 (16-22) vs 18 (16-20)). However, the mean ± SD practice score is significantly higher among those who had falls in the past 12 months compared to those who did not (27.7 ± 6.6 vs 25.6 ± 6.3, p-value <0.05) (Table 2).

Table 1

Characteristics of participants in nursing homes, Jinzhou City, Liaoning Province, PR China (N = 337)

Characteristic	Frequency* *n* (%)
Age group	
60-69 years	78 (23)
70-79 years	115 (34)
≥80 years	144 (43)
Average age (years), mean ± SD	76.8 ± 8.2
Sex	
Male	181 (54)
Female	156 (46)
Level of education	
Primary school or below	150 (44)
Secondary school	140 (41)
College or above	46 (14)
No information	1 (1)
Previous occupation	
Worker	67 (20)
Government officer or institutional personnel	80 (24)
Farmer	57 (16)
Others	132 (39)
No information	1 (1)
Marital status	
Single	58 (17)
Widowed	142 (42)
Married (living with spouse)	136 (40)
No information	1 (1)

Table 1 (cont)

Characteristic	Frequency* *n* (%)
Hypertension	
No	161 (48)
Yes	165 (49)
No record	11 (3)
Diabetes	
No	261 (77)
Yes	65 (20)
No record	11 (3)
Chronic kidney disease	
No	312 (93)
Yes	14 (4)
No record	11 (3)
History of stroke	
No	269 (80)
Yes	57 (17)
No record	11 (3)
Chronic obstructive pulmonary disease	
No	306 (91)
Yes	20 (6)
No record	11 (3)
Peripheral vascular disease	
No	283 (84)
Yes	43 (13)
No record	11 (3)

Table 1 (cont)

Characteristic	Frequency* *n* (%)
Current medication intake	
No medication	113 (33)
Single medication	129 (39)
≥2 medications	84 (25)
No record	11 (3)
Depression symptom (GDS-15 score)	
Normal (0-4)	262 (78)
Mild depression (5-9)	52 (15)
Severe depression (10-15)	10 (3)
No record	13 (4)
Depression score, median (IQR)	2.0 (1.0-4.0)
Mobility	
Normal mobility (TUG <13.5 seconds)	165 (49)
Impaired mobility (TUG ≥13.5 seconds)	158 (47)
No record	14 (4)
TUG (seconds), median (IQR)	13.3 (11.1-17.7)
Occurrence of falls in the past 12-months	
Yes	94 (28)
No	243 (72)
Knowledge score on fall prevention, median (IQR)	18.0 (16.0-21.0)
Practice scores on fall prevention, mean ± SD	26.2 ± 6.4

Note: Depression was assessed using the 15-item Geriatric Depression Scale (GDS-15) while TUG test was used to measure participants' mobility. Knowledge score was assessed using questionnaire developed by the authors and the scores ranged between 0-22. Practice score was assessed using questionnaire developed by the authors and the scores ranged between 0-45.

*Unless otherwise stated

IQR: interquartile range; SD: standard deviations; TUG: Time Up and Go

Table 2

Univariate analysis of factors associated with falls among elderly in nursing homes, Jinzhou City, Liaoning Province, PR China

Variable	Occurrence of fall in the past 12 months			
	Frequency*, *n* (%)		*p*-value†	OR (95% CI)
	No-fall	Fall		
Socio-demographic factors				
Age group (N = 337 with 246 no-falls and 94 falls)				
60-69 years	57 (23)	21 (23)	0.753	1.0
70-79 years	80 (33)	35 (37)		1.19 (0.63-2.25)
≥80 years	106 (44)	38 (40)		0.97 (0.52-1.81)
Sex (N = 337 with 246 no-falls and 94 falls)			0.039	
Male	139 (57)	42 (45)		1.0
Female	104 (43)	52 (55)		1.66 (1.02-2.67)
Level of education (N = 336)			0.070	
Primary school or below	100 (41)	50 (54)		1.0
Secondary school	105 (43)	35 (37)		0.67 (0.40-1.11)
College or above	38 (16)	8 (9)		0.42 (0.18-0.97)
Marital status (N =336 with 246 no-falls and 93 falls)			0.015	
Single	45 (19)	13 (14)		1.0
Widowed	91 (37)	51 (55)		1.94 (0.96-3.93)
Married	107 (44)	29 (31)		0.94 (0.48-1.97)

Table 2 (cont)

Variable	Occurrence of fall in the past 12 months			
	Frequency*, *n* (%)		*p*-value†	OR (95% CI)
	No-fall	Fall		
Previous occupation (N =336 with 246 no-falls and 93 falls)			0.132	
Worker	51 (21)	16 (17)		1.0
Government officer or institutional personnel	59 (24)	21 (23)		1.14 (0.54-2.40)
Farmer	34 (14)	23 (25)		2.16(0.99-4.67)
Others	99 (41)	33 (35)		1.06 (0.54-2.11)
Health-related factors				
Hypertension (N =326 with 236 no-falls and 90 falls)			0.110	
No	123 (52)	38 (42)		1.0
Yes	113 (48)	52 (58)		1.49 (0.91-2.43)
Diabetes (N =326 with 236 no-falls and 90 falls)			0.524	
No	191 (81)	70 (78)		1.0
Yes	45 (19)	20 (22)		1.21 (0.67-2.19)
Chronic kidney disease (N =326 with 236 no-falls and 90 falls)			0.254	
No	224 (95)	88 (98)		1.0
Yes	12 (5)	2 (2)		0.42 (0.09-1.93)
COPD (N =326 with 236 no-falls and 90 falls)			0.445	
No	223 (94)	83 (92)		1.0
Yes	13 (6)	7 (8)		1.45 (0.56-3.75)

Table 2 (cont)

Variable	Occurrence of fall in the past 12 months			
	Frequency*, *n* (%)		*p*-value†	OR (95% CI)
	No-fall	Fall		
Health-related factors				
History of stroke (N =326 with 236 no-falls and 90 falls)			0.000	
No	206 (87)	63 (70)		1.0
Yes	30 (13)	27 (30)		2.94 (1.63-5.32)
Peripheral vascular disease (N =326 with 236 no-falls and 90 falls)			0.679	
No	206 (87)	77 (86)		1.0
Yes	30 (13)	13 (4)		1.16 (0.58-2.34)
Current medication intake (N =326 with 236 no-falls and 90 falls)			0.078	
No medication	87 (37)	26 (29)		1.0
Single medication	96 (41)	33 (37)		1.15 (0.64-2.08)
≥2 medications	53 (22)	31 (34)		1.96 (1.05-3.65)
Depression symptoms (N = 324 with 235 no-falls and 89 falls)			0.633	
Normal (0-4)	193 (82)	69 (78)		1.0
Mild depression (5-9)	35 (15)	17 (19)		1.36 (0.72-2.58)
Severe depression (10-15)	7 (3)	3 (3)		1.20 (0.30-4.77)

Table 2 (cont)

Variable	Occurrence of fall in the past 12 months			
	Frequency*, *n* (%)		*p*-value†	OR (95% CI)
	No-fall	Fall		
Health-related factors				
Mobility (N = 323 with 234 no-falls and 89 falls)			0.002	
Normal mobility (TUG <13.5 seconds)	132 (56)	33 (37)		1.0
Impaired mobility (TUG ≥13.5 seconds)	102 (44)	56 (63)		2.20 (1.33-3.63)
Knowledge score on fall prevention, median (IQR)	18 (16-20)	19 (16-22)	0.010	1.11 (1.02-1.20)
Practice score on fall prevention, mean ± SD	25.6 ± 6.3	27.7 ± 6.6	0.009	1.06 (1.01-1.10)

Note: N varies due to missing data. Depression was assessed using the 15-item Geriatric Depression Scale (GDS-15) while TUG test was used to measure participants' mobility. Knowledge score was assessed using questionnaire developed by the authors and the scores ranged between 0-22. Practice score was assessed using questionnaire developed by the authors and the scores ranged between 0-45.

*Unless otherwise stated; †Significant when *p*-value <0.05

CI: confidence interval; COPD: chronic of pulmonary disease; IQR: interquartile range; OR: odds ratio; TUG: Time Up and Go

The multivariate analysis using the forward likelihood ratio (LR) method revealed that all variables that were significant in the univariate analysis still remained significant, except for practice on fall prevention and current medication intake (Table 3). Females had a significantly greater likelihood of falls compared to males (aOR = 1.76; 95% CI: 1.03-2.99, *p*-value = 0.038); education level showed a protective trend: individuals with secondary school education or higher had a reduced occurrence of falls (aOR = 0.40; 95% CI: 0.17-0.98, *p*-value = 0.044) compared to those with primary education or lower; a history of stroke (aOR = 3.12; 95% CI: 1.64-5.93, *p*-value = 0.001) and impaired mobility (aOR = 2.07; 95% CI: 1.21-3.55, *p*-value = 0.008) were associated with a higher occurrence of falls; and, surprisingly, higher knowledge on fall prevention was associated to an increased occurrence of falls (aOR = 1.16; 95% CI: 1.06-1.27, *p*-value = 0.002) (Table 3)

We also conducted comprehensive diagnostic tests to assess model fitness, including interaction effects, multicollinearity, model fitness, and outlier identification. The final logistic regression model demonstrated no multicollinearity concerns (maximum variance inflation factor (VIF) = 1.059, with all VIFs <2), no significant interaction effects (all *p*-values >0.05) and satisfactory goodness-of-fit (Hosmer-Lemeshow χ^2 = 12.567, *p*-value = 0.128; AUC = 0.705, 95% CI: 0.641-0.770). The model was considered reliable and well-fitted for the collected data.

DISCUSSION

We embarked to determine the prevalence of falls and their association with knowledge and practices on fall prevention among elderly residents in nursing homes in three districts, Jinzhou City, Liaoning Province. We observed that the occurrence of falls in the past year among elderly residents in Jinzhou City nursing homes (28%) was in close agreement with

Table 3

Factors associated with fall among elderly in nursing homes, Jinzhou City, Liaoning Province, PR China

Variable	Model (Forward: LR)	
	aOR (95% CI)	p-value
Sex		
Male	1.0	
Female	1.76 (1.03-2.99)	0.038
Level of education		
Primary school or below	1.0	
Secondary school	0.55 (0.31- 0.97)	0.040
College or above	0.40 (0.17-0.98)	0.044
History of stroke		
No	1.0	
Yes	3.12 (1.64-5.93)	0.001
Mobility		
Normal mobility (TUG <13.5 seconds)	1.0	
Impaired mobility (TUG ≥13.5 seconds)	2.07 (1.21-3.55)	0.008
Knowledge score of fall prevention	1.16 (1.06-1.27)	0.002

Note: TUG test was used to measure participants' mobility while knowledge score was assessed using questionnaire developed by the authors and the scores ranged between 0-22.

aOR: adjusted odds ratio; CI: confidence interval; LR: likelihood ratio; TUG: Time Up and Go

the findings of a study of nursing homes (27.1%) conducted in Italy (Castaldo *et al*, 2020), but higher than those of community-dwelling elderly in nursing homes from Southeast Asia, namely Indonesia

(12.8%) (Pengpid and Peltzer, 2018), Malaysia (4.07%) (Yeong *et al*, 2016) and Singapore (21.1%) (De Roza *et al*, 2022); however, the prevalence is much higher (38-50%) for nursing home residents (Shao *et al*, 2023). The differences in fall rates between nursing home and community-dwelling elderly residents could be attributed to variations in environmental conditions and healthcare-related factors. The high prevalence in nursing homes highlights the importance of targeting fall prevention strategies in these residences.

We noted that the sex of the elderly participants was significantly associated with falls, with females having 1.8 times higher chance of falls compared to males, a finding consistently reported in previous studies (Megalla *et al*.2023). This might be attributed to physiological changes experienced by post-menopausal women, which include reduced bone density, muscle strength and joint stability, resulting in impaired balance and decreased physical function, leading to the increased susceptibility to falls (Agrawal and Verma, 2013; Khadilkar and Mandlik, 2015; Pecina *et al*, 2016). Therefore, promoting bone health and balance training among elderly women should help mitigate these risks (Deandrea *et al*, 2010; Dixe *et al*, 2021).

Our findings agree with a study showing that higher educational attainment correlates with a reduced risk of falls (Bally *et al*, 2023). We observed a lower probability of falls among participants with higher levels of education. Elderly individuals with better education may have better access to knowledge in precautionary health practices (Andrade *et al*, 2017; Chesser *et al*, 2018).

Among chronic diseases, we found that a history of stroke was the prominent factor (30%) associated with the occurrence of falls, similar to previous studies showing ~ 40% of stroke survivors experiencing falls within the first-year post-diagnosis (Nyberg and Gustafson, 1995; Langhorne *et*

al, 2000; Lamb *et al*, 2003). The association of a history of stroke with fall risk could be attributed to issues in balance and muscle coordination, underscoring the need for specialized rehabilitation support for these individuals (Campbell and Matthews, 2010; Langhorne *et al*, 2011).

Our survey showed that over 50% of elderly individuals with impaired mobility had previous occasions of falls, twice as likely as those with normal mobility, consistent with a previous research on elderly living in a community setting (Wang *et al*, 2021). Mobility impairments compromise balance and muscle strength, making it difficult to avoid obstacles and maintain stability.

The importance of knowledge and practice on fall prevention among the elderly has gained recent research attention (Souza *et al*, 2022; Tang *et al*, 2023). However, existing evidences are inconsistent, and to date, no study has focused on nursing homes in China. Surprisingly, we observed that elderly individuals with higher knowledge scores on fall prevention had a slightly higher occurrence of falls (OR = 1.16, 95% CI: 1.06-1.27, *p*-value = 0.002). This finding contrasts with previous studies demonstrating that an increase in knowledge of fall prevention reduces the occurrence of falls (Ong *et al*, 2021). Our findings indicated that knowledge alone might not be sufficient in preventing falls and that other factors had to be taken into consideration, such as physical limitations and health conditions. These findings support the notion that physical inabilities in balance and mobility are more associated with fall risk than lack of preventive knowledge alone (Haines *et al*, 2011; Ott, 2018; Ong *et al*, 2021). In addition, individuals who have experienced previous falls may possess better knowledge due to heightened self-awareness in precautionary measures (Lach, 2005; Boyd and Stevens, 2009). We noted that while knowledge of fall prevention was essential,

to effectively reduce falls, this knowledge must be accompanied by practical activities, such as strengthening of the lower limb, balance and gait exercises, and improvements to the environmental conditions.

Our univariate analysis confirmed that participants with higher fall prevention knowledge scores were more likely to have had an occurrence of falls. Almost 50% of participants with mobility impairment use ambulatory aids. Similarly, Roman de Mettelinge *et al* (2015) reported that elderly individuals with impaired mobility were more reliant on supportive devices, yet remained at a high risk of falls. The elderly who rely on walkers often do so due to limitations in their mobility, whereas those with better functional mobility tend not to rely on such devices in their daily life. However, this association did not hold up in our multivariate analysis, confirming that practice on fall prevention was not as influential as other variables in reducing the risk of falls. Nevertheless, the significant correlation between knowledge and practice on fall prevention suggests that practice may still play a supportive role in fall prevention when integrated with knowledge on fall prevention in structured programs. Given the unexpected association between a higher score in knowledge on fall prevention and an increase in fall risk, this highlights the need for a more holistic fall prevention strategy, which not only promotes knowledge but also compensates for its limitations through hands-on training, behavioral reinforcement, and environmental modifications within nursing homes.

Nonetheless, the study has several limitations. Firstly, the cross-sectional study design limits the ability to establish causal relationships among knowledge, practice and the occurrence of falls. Secondly, self-reported data may be subject to recall bias, especially regarding falls in the previous 12

months; however, this fall-related tool used here has been employed in previous studies, supporting its acceptability as a measurement tool. Furthermore, we adapted an established questionnaire to enhance the accuracy and reliability of the findings. Lastly, the data obtained from multiple nursing homes strengthened the generalizability of the results to the nursing home population in Jinzhou City, but cannot be assumed to apply to other nursing homes across China.

In conclusion, our survey showed that falls were prevalent among elderly residents in nursing homes in three districts of Jinzhou City, Liaoning Province. Despite having good fall prevention knowledge, the elderly remained at risk, suggesting that knowledge alone might not significantly reduce the risk of falls. Our findings highlight the need for comprehensive, multi-faceted interventions, which extend beyond solely knowledge-based approaches to address practical measures to reduce fall risks among the elderly in nursing homes. Future multi-center interventional studies are warranted to evaluate the impact of integrated strategies, including environmental modifications, staff education and individualized physical activity programs, to decrease the prevalence of falls among the elderly in nursing homes in the country.

ACKNOWLEDGEMENTS

The authors express their sincere gratitude to the nursing homes in PR China for their assistance in facilitating this study, all elderly residents and staff in the participating nursing homes for their time and cooperation and Wanzheng Li and the rehabilitation therapy college students for their valuable assistance and cooperation during the data collection process.

CONFLICT OF INTEREST DISCLOSURE

The authors declare no conflict of interest.

REFERENCES

Abrahamson K, Davila H, Mueller C, Inui T, Arling G. Examining the lived experience of nursing home quality improvement: the case of a multifacility falls reduction project. *J Gerontol Nurs* 2013; 39(9): 24-33.

Agrawal T, Verma AK. Cross sectional study of osteoporosis among women. *Med J Armed Forces India* 2013; 69(2): 168-71.

Andrade I, Silva C, Martins AC. Application of the Health Literacy INDEX on the development of a manual for prevention of falls for older adults. *Patient Educ Couns* 2017; 100(1): 154-9.

Bally ELS, Ye L, van Grieken A, *et al*. Factors associated with falls among hospitalized and community-dwelling older adults: the APPCARE study. *Front Public Health* 2023; 11: 1180914.

Borowicz A, Zasadzka E, Gaczkowska A, Gawłowska O, Pawlaczyk M. Assessing gait and balance impairment in elderly residents of nursing homes. *J Phys Ther Sci* 2016; 28(9): 2486-90.

Boyd R, Stevens JA. Falls and fear of falling: burden, beliefs and behaviours. *Age Ageing* 2009; 38(4): 423-8.

Campbell GB, Matthews JT. An integrative review of factors associated with falls during post-stroke rehabilitation. *J Nurs Scholarsh* 2010; 42(4): 395-404.

Castaldo A, Giordano A, Antonelli Incalzi R, Lusignani M. Risk factors associated with accidental falls among Italian nursing home residents: a longitudinal study (FRAILS). *Geriatr Nurs* 2020; 41(2): 75-80.

Chau J, Martin CR, Thompson DR, Chang AM, Woo J. Factor structure of the Chinese version of the Geriatric Depression Scale. *Psychol Health Med* 2006; 11(1): 48-59.

Chen Y. Reliability and validity of fall prevention knowledge, attitude, practice questionnaire for older adults in long-term care facilities. *Chin J Nurs Educ* 2016; 13(3): 165-9. [In Chinese]

Chesser AK, Woods NK, Reyes J, Rogers NL. Health literacy and older adults: fall prevention and health literacy in a Midwestern state. *J Aging Res Healthc* 2018; 2(2): 31-40.

Cooper R. Reducing falls in a care home. *BMJ Qual Improv Rep* 2017; 6(1): u214186.w5626.

De Roza JG, Ng DWL, Mathew BK, *et al*. Factors influencing fear of falling in community-dwelling older adults in Singapore: a cross-sectional study. *BMC Geriatr* 2022; 22(1): 186.

Deandrea S, Lucenteforte E, Bravi F, Foschi R, La Vecchia C, Negri E. Risk factors for falls in community-dwelling older people: a systematic review and meta-analysis. *Epidemiology* 2010; 21(5): 658-68.

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(21): 11543.

Florence CS, Bergen G, Atherly A, Burns E, Stevens J, Drake C. The medical costs of fatal falls and fall injuries among older adults. *J Am Geriatr Soc* 2018; 66(4): 693-8.

Fonad E, Wahlin TB, Winblad B, Emami A, Sandmark H. Falls and fall risk among nursing home residents. *J Clin Nurs* 2008; 17(1): 126-34.

Gamage N, Rathnayake N, Alwis G. Knowledge and perception of falls among community dwelling elderly: a study from Southern Sri Lanka. *Curr Gerontol Geriatr Res* 2018; 2018: 7653469.

Goh JW, Singh DKA, Mesbah N, Hanafi AAM, Azwan AF. Fall awareness behaviour and its associated factors among community dwelling older adults. *BMC Geriatr* 2021; 21(1): 226.

Haines TP, Hill A-M, Hill KD, *et al*. Patient education to prevent falls among older hospital inpatients: a randomized controlled trial. *Arch Intern Med* 2011; 171(6): 516-24.

Kamei T, Kajii F, Yamamoto Y, *et al*. Effectiveness of a home hazard modification program for reducing falls in urban community-dwelling older adults: a randomized controlled trial. *Jpn J Nurs Sci* 2015; 12(3):184-97.

Khadilkar AV, Mandlik RM. Epidemiology and treatment of osteoporosis in women: an Indian perspective. *Int J Womens Health* 2015; 7: 841-50.

Lach HW. Incidence and risk factors for developing fear of falling in older

adults. *Public Health Nurs* 2005; 22(1): 45-52.

Laing SS, Silver IF, York S, Phelan EA. Fall prevention knowledge, attitude, and practices of community stakeholders and older adults. *J Aging Res* 2011; 2011: 395357.

Lamb SE, Ferrucci L, Volapto S, Fried LP, Guralnik JM. Risk factors for falling in home-dwelling older women with stroke: the Women's Health and Aging Study. *Stroke* 2003; 34(2): 494-501.

Langhorne P, Bernhardt J, Kwakkel G. Stroke rehabilitation. *Lancet* 2011; 377(9778): 1693-702.

Langhorne P, Stott DJ, Robertson L, *et al*. Medical complications after stroke: a multicenter study. *Stroke* 2000; 31(6): 1223-9.

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(17): 9356.

Long J, Cai T, Huang X, Zhou Y, Kuang J, Wu L. Reference value for the TUGT in healthy older people: a systematic review and meta-analysis. *Geriatr Nurs* 2020 ; 41(3) : 325-30.

Luo M, Xue Y, Zhang S, *et al*. What factors influence older people's intention to enrol in nursing homes? A cross-sectional observational study in Shanghai, China. *BMJ Open* 2018; 8(9): e021741.

Megalla M, Ditkowsky J, Parulekar MS, Gelman S. Socioeconomic factors associated with increased risk of falls in older adults. *Am J Lifestyle Med* 2023; 19(3): 419-30.

National Bureau of Statistics. Main data of the seventh national census, 2021 [cited 2025 May 20]. Available from: URL: https://www.stats.gov.cn/sj/zxfb/202302/t20230203_1901080.html

National Bureau of Statistics of China. Statistical communiqué of the People's Republic of China on the 2024 National Economic and Social Development, 2025 [cited 2025 May 20]. Available from: URL: https://www.stats.gov.cn/english/PressRelease/202502/t20250228_1958822.html

Nyberg L, Gustafson Y. Patient falls in

stroke rehabilitation. A challenge to rehabilitation strategies. *Stroke* 1995; 26(5): 838-42.

Ong MF, Soh KL, Saimon R, Wai MW, Mortell M, Soh KG. Fall prevention education to reduce fall risk among community-dwelling older persons: a systematic review. *J Nurs Manag* 2021; 29(8): 2674-88.

Ott LD. The impact of implementing a fall prevention educational session for community-dwelling physical therapy patients. *Nurs Open* 2018; 5(4): 567-74.

Pecina JL, Romanovsky L, Merry SP, Kennel KA, Thacher TD. Comparison of clinical risk tools for predicting osteoporosis in women ages 50-64. *J Am Board Fam Med* 2016; 29(2): 233-9.

Pengpid S, Peltzer K. Prevalence and risk factors associated with injurious falls among community-dwelling older adults in Indonesia. *Curr Gerontol Geriatr Res* 2018; 2018: 5964305.

Rodrigues IG, Fraga GP, Barros MB. Falls among the elderly: risk factors in a population-based study. *Rev Bras Epidemiol* 2014; 17(3): 705-18.

Roman de Mettelinge T, Cambier D. Understanding the relationship between walking aids and falls in older adults: a prospective cohort study. *J Geriatr Phys Ther* 2015; 38(3): 127-32.

Shao L, Shi Y, Xie XY, Wang Z, Wang ZA, Zhang JE. Incidence and risk factors of falls among older people in nursing homes: systematic review and meta-analysis. *J Am Med Dir Assoc* 2023; 24(11): 1708-17.

Sharif SI, Al-Harbi AB, Al-Shihabi AM, Al-Daour DS, Sharif RS. Falls in the elderly: assessment of prevalence and risk factors. *Pharm Pract (Granada)* 2018; 16(3): 1206.

Souza LF, Batista REA, Camapanharo CRV, Costa PCPD, Lopes MCBT, Okuno MFP. Factors associated with risk, perception and knowledge of falls in elderly people. *Rev Gaucha Enferm* 2022; 43: e20200335.

Sun C, Zhou R, Cui Y, *et al*. The adaptation of older adults' transition to nursing homes in mainland China: a qualitative study. *J Transcult Nurs* 2021; 32(4): 318-25.

Sun XY, Li YX, Yu CQ, Li LM. Reliability and validity of depression scales of Chinese version: a systematic

review. *Zhonghua Liu Xing Bing Xue Za Zhi* 2017; 38(1): 110-6. [In Chinese]

Tang HT, Vu HM, Tang HT, *et al*. Knowledge, attitude and practice on fall risk factors and prevention among rural older community-dwellers in Vietnam. *PLoS One* 2023; 18(11): e0295119.

Thakur N, Han CY. Country-specific interests towards fall detection from 2004-2021: an open access dataset and research questions. *Data* 2021; 6(8): 92.

The State Council of the People's Republic of China. China improves home-based care services for senior citizens, 2024 [cited 2025 Mar 02]. Available from: URL: https://english.www.gov.cn/news/202401/15/content_WS65a469f4c6d0868f4e8e313d.html

Wang J, Chen X, Sun X, *et al*. The application of 'Timed up and Go' test in fall screening of elderly people in Shanghai: a cross-sectional study. *Iran J Public Health* 2021; 50(12): 2567-75.

Wang Z, Xing Y, Yan W, *et al*. Effects of individual, family and community factors on the willingness of institutional elder care: a cross-sectional survey of the elderly in China. *BMJ Open* 2020; 10(2): e032478.

World Health Organization (WHO). Falls, 2021 [cited 2025 Jan 31]. Available from: URL: https://www.who.int/news-room/fact-sheets/detail/falls

Yeong UY, Tan SY, Yap JF, Choo WY. Prevalence of falls among community-dwelling elderly and its associated factors: a cross-sectional study in Perak, Malaysia. *Malays Fam Physician* 2016; 11(1): 7-14.

Zaninotto P, Huang YT, Di Gessa G, Abell J, Lassale C, Steptoe A. Polypharmacy is a risk factor for hospital admission due to a fall: evidence from the English Longitudinal Study of Ageing. *BMC Public Health* 2020; 20(1): 1804.

Zhang C, Zhang H, Zhao M, *et al*. Psychometric properties and modification of the 15-item geriatric depression scale among Chinese oldest-old and centenarians: a mixed-methods study. *BMC Geriatr* 2022; 22(1): 144.