Research Square

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Patterns of fall risk appraisal and their associations with fall prevention behaviors among community-dwelling older adults: A cross-sectional study

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Abstract

Background

Fall risk appraisal plays an important role in effective fall prevention among older adults. However, research on the FRA patterns and their relationship with fall prevention behaviors remains limited. This study aimed to identify patterns of FRA, investigate their influencing factors, and examine their associations with fall prevention behaviors.

Methods

This cross-sectional study was conducted with a convenience sample of 324 older adults in three community health centers from September 2024 to January 2025 in Yinchuan, China. Fall risk appraisal patterns were determined using the Timed Up and Go (TUG) test as an objective measure (i.e., physiological fall risk) and the Fall Risk Perception Questionnaire for Community-Dwelling Older Adults (FRPQ-CDOAs) as a subjective measure (i.e., perceived fall risk). Fall prevention behaviors were assessed using the Chinese version of Falls Behavioral (FaB-C) Scale. Chi-square tests and logistic regression were used to investigate the influencing factors of fall risk appraisal patterns. Multivariate linear regression was used to examine their associations with fall prevention behaviors.

Results

Three distinct patterns of fall risk appraisal were identified: “risk-aware” (congruent physiological risk and perceived risk, n = 124), “risk-anxious” (low physiological risk but high perceived risk, n = 85), and “risk-taker” (high physiological risk but low perceived risk, n = 133). Significant differences across patterns were observed in marital status, self-rated economic status, self-rated health status, smoking and drinking status, hearing impairment, and fear of falling ($P < 0.05$). Fall prevention behaviors were lower in the “risk-taker” group ($\beta = -3.27$, 95% CI: −6.47 to − 0.07), whereas no significant association was found for the “risk-anxious” group.

Conclusions

Perceived fall risk does not consistently align with physiological risk. Maladaptive fall risk appraisal poses a barrier for effective fall prevention. These findings highlight the need for tailored interventions to foster a more realistic understanding of personal fall risk. Future research should validate these findings in larger samples and more diverse populations.

Clinical trial number:

Not applicable.

Introduction

Falls represent a major public health issue globally, causing an estimated 684,000 deaths annually with over 80% occurring in low- and middle-income countries (1). In China, falls have emerged as the leading cause of injury-related mortality among adults aged 60 and above (2), and most falls occur in domestic and community settings (3). Fall risk assessment is the first step in fall prevention, as it informs risk classification and guides appropriate intervention (4). Recent literature has increasingly recognized the importance of fall risk perception (5, 6). The *World guidelines for falls prevention and management for older adults: a global initiative* highlights the need to understand how older adults perceive their own fall risk (7). It reflects a people-centered approach that emphasizes personal responsibility and active engagement in fall management. However, maladaptive fall risk appraisal (FRA) is common among older adults, i.e., the discrepancy between physiological and perceived fall risk. It includes

two primary patterns: “risk-taker” (low perceived risk despite high physiological risk) and “risk-anxious” (high perceived risk despite low physiological risk).

Evidence suggests that maladaptive FRA may contribute to gaps between fall prevention guidelines and real-world practices (8). Hence, it is a key priority to identify individuals with maladaptive FRA. Tailored interventions can then be designed to help older adults raise risk awareness and promote effective fall prevention. While the prevalence of maladaptive FRA ranges from 31% to 68.7% in prior studies (9–13), its rate among community-dwelling older adults in China remains unclear. Another gap is that, perceived fall risk in previous studies were primarily assessed by the Falls Efficacy Scale-International (FES-I) which was used to measure fear of falling (FoF) and fall-related efficacy (14). However, these two constructs are distinct from, though related to fall risk perception. While FoF focuses on the perceived severity of potential fall outcomes, fall efficacy emphasize the perceived likelihood of avoiding falls (15). Rather, according to the Health Belief Model (16), fall risk perception is a comprehensive construct that captures an individual's subjective assessment of both the potential severity and likelihood of a fall during daily activities.

Fall prevention behaviors refer to actions or habits undertaken to prevent falls (17). Maladaptive FRA, however, may lead to counterproductive attitudes towards fall prevention. Few studies have investigated the effects of maladaptive FRA on physical activity, though with contradictory results. One study found that “risk-anxious” older adults had a lower volume and intensity of physical activity (18). Another study found that “risk-taker” individuals engaged in less everyday walking activities (19). In these studies, physical activity was considered a surrogate measure of exposure to fall risk, and reduced participation was interpreted as an individual's action to avoid falls. However, restricting physical activity represents only one part of fall prevention behaviors. It is necessary to understand older adults’ day-to-day activities that either mitigate or contribute to fall risk.

To date, there is no direct evidence linking maladaptive FRA with fall prevention behaviors. Previous research has examined the associations between fall prevention behaviors with other fall-related psychological concepts, such as FoF and fall efficacy. Higher FoF is related to a higher level of fall prevention behaviors (20), and an increase in perceived self-efficacy reduces individuals’ protective intention (21). Building on these associations, we hypothesized that “risk-taker” individuals would engage in less fall prevention behaviors because they are overconfidence about their physical capacities, while “risk-anxious” individuals who are influenced by FoF may adopt more protective behaviors. Therefore, this study aims to investigate the characteristics of FRA and its relationship with fall prevention behaviors among community-dwelling older adults in China. Specific objectives are to: (1) characterize patterns of FRA, (2) identify factors associated with these patterns, and (3) examine the associations between these patterns and fall prevention behaviors.

Methods

Study design and participants

A cross-sectional survey was conducted between September 2024 and January 2025.

Using convenience sampling, eligible older adults were recruited from three community health service centers in Yinchuan City, Ningxia Hui Autonomous Region, China. This study adhered to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.

The inclusion criteria were: (1) aged 60 years or older; (2) permanent community-dwelling residents (having lived locally for one year or more at the time of the study); and (3) able to walk independently or with assistive devices. Exclusion criteria were as follows: (1) unable to communicate normally due to significant hearing or speech impairments; (2) diagnosed with dementia or cognitive impairment by a medical institution; (3) suffering from severe illnesses, such as end-stage heart failure, respiratory failure, or advanced cancer; or (4) participating in other health-related intervention studies.

Measurements

Physiological fall risk

Physiological fall risk was evaluated by the Timed Up and Go (TUG). TUG is both sensitive and specific in identifying community-dwelling older adults that are at risk of falling (22). The participant is seated on a standard-height chair (approximately 46 cm). A marker line is placed on the floor 3 meters away from the chair. Following the investigator's verbal "start" command, the participant stands up from the chair, walks at a normal pace to the marker line, returns to the chair, turns around, and sits back down. The investigator closely monitors and ensures the participant's safety. The time from the initiation of standing to the point of full seated rest is recorded in seconds. Extreme values were imputed using the 1st and 99th percentiles. Based on the established cut-off for Chinese older adults, a TUG time ≥14.0 s was considered as high fall risk (23). Recent evidence suggests 10.0 s as the threshold distinguishing low-risk from moderate-risk (24). Accordingly, in this study, participants were categorized as follows: ≤10.0s indicated low risk, 10.1–13.9s indicated moderate risk, and ≥14.0s indicated high physiological fall risk.

Perceived fall risk

Fall Risk Perception Questionnaire for Community-Dwelling Older Adults (FRPQ-CDOAs) was used to assess perceived fall risk (25). Developed based on the Health Belief Model [5], the FRPQ-CDOAs consists of three subfactors and 17 items: perceived biological-behavioral susceptibility to falls (eight items), perceived social-environmental susceptibility to falls (five items), and perceived severity of falls (four items). Participants were asked to rate their perception of risk of falling on a five-point Likert scale (1~5). Total scores can range from 17 to 85, and higher scores indicate higher perceived fall risk. This questionnaire has good internal consistency (Cronbach's α = 0.913), and the content validity index was 0.940. Following a previous study in Chinese population (26), perceived fall risk were divided into low, moderate, or high based on tertiles of the sample distribution.

Fall prevention behaviors

Fall prevention behaviors were assessed using the Chinese version of Falls Behavioral (FaB-C) Scale (27). The original FaB scale with 30 items, was designed to evaluate behavioral factors that could potentially protect against falling for community-dwelling older adults (28). Participants rated how well each statement described their everyday actions, for example, "I get help when I need to reach something very high." Responses were scored from 1 (never) to 4 (always) with 0 for "does not apply". The FaB scale has demonstrated strong validity with a Cronbach's α of 0.84 and a content validity index of 0.93. For the adapted FaB-C scale, the Cronbach's α was 0.805 after removing one item, indicating acceptable internal consistency (27). Prior to analysis, five items (items 7-10 and 22) were reverse-scored so that higher scores consistently reflected the presence of protective behaviors, and lower scores indicated absence of protection. Total scores ranged from 16 (risky fall behaviors) to 116 (safest falls prevention behaviors), with higher scores reflecting greater engagement in prevention behaviors.

Covariates

A self-administered general information questionnaire was employed to collect sociodemographic, behavioral, and health-related covariates. Sociodemographic covariates included age (60–69, 70–79, or ≥80 years), gender (male vs. female), education level (primary school and below, junior secondary/vocational school, senior secondary/college, or bachelor's degree and above), marital status (married vs. divorced/widowed/unmarried), living arrangements (living alone vs. living with others), self-rated economic status (strained, break-even, or surplus). Behavioral covariates were collected on smoking status (never vs. ever/current), alcohol drinking status (never vs. ever/current), sleep duration (<6h, 6-8h, or >8h), and regular physical exercise (yes vs. no).

Health-related covariates consisted of: (1) self-rated health status, categorized as poor, fair, good, or very good; (2) visual impairment, assessed by asking whether the participant had experienced a decline in vision in the past six months; (3) hearing impairment, evaluated similarly for decline in hearing; (4) number of chronic conditions, grouped as 0, 1–2, or ≥3; (5) number of medications regularly used, classified as 0, 1–2, or ≥3; (6) activities of daily living (ADL) impairment, assessed using the Katz ADL index [9], with impairment defined as difficulty in any item; (7) depressive symptoms, measured with the Patient Health Questionnaire-9 (PHQ-9) [10]. where a score >4 indicates clinically relevant symptoms; (8) history of falls (yes/no); (9) fear of falling (yes/no); and (10) self-reported balance problems, determined by asking whether the participant felt unsteady while standing or walking.

Data collection

Data were collected between September 2024 and January 2025 through face-to-face, one-on-one interviews. Trained data collectors explained the study purpose and questionnaire procedures using standardized instructions. Interviews proceeded only after written informed consent was obtained. Participants completed the survey independently if capable; otherwise, data collectors administered it verbally using neutral wording. Ambiguous responses were clarified through follow-up questions to minimize potential bias. The TUG test was conducted after questionnaire was completed. All data were collected on-site and reviewed immediately for completeness, with any missing items addressed in real time.

Statistical analysis

Data were entered into the database using a double-entry method via EpiData 3.0 software. Data consistency and accuracy were checked prior to analysis. The normality of continuous variables was assessed using the Kolmogorov–Smirnov test. Normally distributed continuous variables are reported as mean ± standard deviation (SD), while non-normally distributed variables are reported as median and interquartile range (IQR). Categorical variables are presented as frequencies and percentages.

A descriptive analysis was used to compare TUG and FRPQ-CDOAs score across baseline characteristics. For normally distributed continuous variables (i.e., TUG), the independent samples t-test was used for comparisons between two groups, and one-way analysis of variance (ANOVA) for comparisons among three or more groups. For non-normally distributed continuous variables (i.e., FRPQ-CDOAs), the Mann-Whitney U test was applied for two-group comparisons, and the Kruskal-Wallis H test for comparisons involving three or more groups.

Based on the cut-off values for TUG and FRPQ-CDOAs score, participants were classified into three FRA patterns reflecting the discrepancy between both physiological and perceived fall risks: “risk-aware” (congruent physiological risk and perceived risk), “risk-anxious” (low physiological risk but high perceived risk), and “risk-taker” (high physiological risk but low perceived risk) (Figure 1). Pearson’s chi-square tests were used to compare baseline characteristics among these patterns. Multivariable logistic regression was then applied to identify factors associated with different fall risk appraisal patterns. The dependent variables were three FRA patterns, while independent variables included all characteristics that showed statistical significance in the chi-square tests. Given the exploratory objective of identifying influencing factors, we prioritized minimizing Type II errors (false negatives) over strictly controlling for multiple comparisons in the logistic regression models. Therefore, formal adjustments (e.g., Bonferroni correction) were not applied. Odds ratios (OR) and 95% confidence interval (CI) were reported.

To further examine the associations between fall prevention behaviors and FRA patterns, multivariate linear regression was performed after adjusting for all covariates. The significance level was set at < 0.05 for all statistical tests. All analyses were performed using StataSE 16.1 (StataCorp, TX).

Results

Baseline characteristics

A total of 350 questionnaires were distributed, with 342 valid responses collected (effective response rate: 98.9%). The mean age of the sample was 70 years (SD = 7.0). Age distribution was as follows: 60–69 years (48.8%), 70–79 years (37.4%), and 80 years or older (13.7%). The male-to-female ratio was equal. The mean TUG score was 11.6 (SD = 3.9), while the median score on the FRPQ-CDOA was 67 (IQR: 60–74). Detailed baseline characteristics are presented in Table 1.

Influencing factors of FRA patterns

According to the TUG cut-off, 116 participants (33.9%) were classified as having low physiological fall risk, 160 (46.8%) as moderate, and 66 (19.3%) as high. Based on the FRPQ-CDOAs cut-off, 103 (30.1%) were categorized as having low perceived fall risk, 115 (33.6%) as moderate, and 124 (36.3%) as high. Integrating the physiological and perceived risk categories, a quarter of participants (n = 85, 24.9%) were classified as “risk-anxious”, while 38.9% (n = 133) were “risk-taker”. Only 36.3% (n = 124) of participants were aware of their fall risks (Table 2).

In the univariate analysis (Table 3), significant differences were observed among participants with the three FRA patterns in terms of marital status, self-rated economic status, self-rated health status, smoking status, drinking status, hearing impairment, and FoF (all $P < 0.05$). The results of multivariate logistic regression analysis are shown in Table 4. When comparing the “risk-anxious” group to the “risk-aware” group, unmarried status (i.e., divorced or widowed) was significantly associated with a lower likelihood of being an anxious person relative to their married counterparts (OR = 0.35, 95% CI: 0.15–0.83). Additionally, participants who self-rated their health as “very good” had a higher probability of belonging to the “risk-anxious” group (OR = 4.02, 95% CI: 1.16–13.91). In the direct comparison between the “risk-taker” and “risk-anxious” groups, participants with a break-even self-rated economic status were less likely to be classified as “risk-anxious” than those with a strained economic status (OR = 0.44, 95% CI: 0.22–0.91). Conversely, fair self-rated health (OR = 3.65, 95% CI: 1.24–10.80), hearing impairment (OR = 2.35, 95% CI: 1.23–4.47), and FoF (OR = 2.40, 95% CI: 1.17–4.92) were associated with a significantly increased likelihood of “risk-anxious” membership.

Associations between FRA patterns and fall prevention behaviors

Table 5 presents the associations between FRA patterns and fall prevention behaviors with all potential covariates adjusted. Compared to the “risk-aware” group, the “risk-taker” group engaged in significantly fewer fall prevention behaviors (β = -3.27, 95% CI: -6.47 to -0.07). No such association was observed for the "risk-anxious" group (β = -1.16, 95% CI: -3.94 to 1.62). To further examine the influence of perceived risk level on fall prevention behaviors, comparisons were conducted within the "risk-aware" subgroup. Using "low physiological–low perceived risk" as the reference, individuals with "high physiological–high perceived risk" took the most fall prevention behaviors (β = 14.41, 95% CI: 5.80–23.03), followed by those with "moderate physiological–moderate perceived risk" (β = 8.39, 95% CI: 2.54–14.24).

Table 1. Comparison of physiological and perceived fall risk (n=342)

Variables	N (%)	TUG Mean±SD	t/F	*P*	FRPQ-CDOAs Median (IQR)	Z/H	*P*
Age			23.020	<0.001		14.330	<0.001
60-69	167 (48.8)	10.3±3.0			65.0 (58.0, 71.0)		
70-79	128 (37.4)	12.3±4.0			68.5 (63.0, 76.0)		
≥80	47 (13.7)	14.1±4.8			68.0 (64.0, 76.0)		
Gender			-5.235	<0.001		-2.870	0.004
Male	171 (50.0)	10.5±3.4			66.0 (58.0, 72.0)		
Female	171 (50.0)	12.7±4.1			68.0 (63.0, 75.0)		
Educational level			10.980	<0.001		5.206	0.157
Primary school and below	153 (44.7)	12.7±4.0			68.0 (60.0, 74.0)		
Junior secondary/vocational school	117 (34.2)	11.3±3.7			67.0 (62.0, 75.0)		
Senior secondary/college	50 (14.6)	9.5±3.6			64.0 (57.0, 73.0)		
Bachelor's degree and above	22 (6.4)	10.3±2.5			64.0 (58.0, 68.0)		
Marital status			-4.326	<0.001		-0.400	0.689
Married	290 (84.8)	11.2±3.8			67.0 (60.0, 74.0)		
Others *	52 (15.2)	13.7±3.9			68.0 (61.0, 74.0)		
Living arrangements			0.778	0.440		-0.029	0.980
Living alone	43 (12.6)	12.0±3.5			67.0 (60.0, 74.0)		
Living with others #	299 (87.4)	11.5±4.0			67.0 (60.0, 74.0)		
Self-rated economic status			9.160	<0.001		2.738	0.250
Strained	120 (35.1)	11.4±3.8			66.5 (59.0, 72.5)		
Break-even	134 (39.2)	12.6±4.2			67.0 (60.0, 74.0)		
Surplus	88 (25.7)	10.4±3.3			68.0 (63.0, 76.0)		
Self-rated health status			17.050	<0.001		30.029	<0.001
Poor	45 (13.2)	14.5±4.6			71.0 (65.0, 78.0)		
Fair	109 (31.9)	12.1±3.8			68.0 (65.0, 76.0)		
Good	144 (42.1)	10.9±3.5			64.0 (56.0, 71.0)		
Very Good	44 (12.9)	9.5±2.7			64.0 (50.5, 74.5)		
Smoking status			2.798	0.005		0.794	0.427
Never	217 (63.5)	12.0±4.1			68.0 (61.0, 75.0)		
Ever/Current	125 (36.5)	10.8±3.4			66.0 (60.0, 73.0)		
Drinking status			3.017	0.003		0.303	0.762
Never	224 (65.5)	12.1±4.2			67.0 (61.0, 74.0)		
Ever/Current	118 (34.5)	10.7±3.2			67.0 (60.0, 74.0)		

Sleep duration			12.840	<0.001		11.601	0.003
<6h	136 (39.8)	12.9±4.2			68.5 (62.5, 77.0)		
6-8h	170 (49.7)	10.9±3.6			66.0 (60.0, 72.0)		
>8h	36 (10.5)	10.2±2.9			65.0 (55.5, 71.0)		
Visual impairment			-3.200	0.002		-4.823	<0.001
No	153 (44.7)	10.8±3.5			64.0 (54.0, 71.0)		
Yes	189 (55.3)	12.2±4.2			69.0 (64.0, 75.0)		
Hearing impairment			-1.736	0.083		-6.399	<0.001
No	195 (57.0)	11.3±3.9			64.0 (56.0, 70.0)		
Yes	147 (43.0)	12.0±3.9			71.0 (65.0, 77.0)		
Regular exercise			1.484	0.139		0.309	0.757
No	57 (16.7)	12.3±4.0			68.0 (62.0, 74.0)		
Yes	285 (83.3)	11.5±3.9			67.0 (60.0, 74.0)		
Number of chronic conditions			7.960	<0.001		33.366	<0.001
0	84 (24.6)	10.3±2.9			63.0 (51.5, 69.0)		
1-2	166 (48.5)	11.7±3.8			67.0 (62.0, 75.0)		
≥3	92 (26.9)	12.6±4.6			69.5 (65.0, 77.0)		
Number of medications used			15.280	<0.001		31.809	<0.001
0	101 (29.5)	10.1±3.1			63.0 (54.0, 69.0)		
1-2	159 (46.5)	11.7±3.6			68.0 (63.0, 76.0)		
≥3	82 (24.0)	13.2±4.7			69.0 (64.0, 77.0)		
ADL impairment			-6.826	<0.001		-3.291	0.001
No	320 (93.6)	11.2±3.5			67.0 (60.0, 73.5)		
Yes	22 (6.4)	16.8±6.2			74.0 (68.0, 80.0)		
Depressive symptoms			-5.815	<0.001		-2.666	0.008
No	255 (74.6)	10.9±2.9			67.0 (60.0, 72.0)		
Yes	87 (25.4)	13.6±5.5			69.0 (62.0, 77.0)		
Fall history within 1 year			-3.874	<0.001		-2.826	0.005
No	270 (78.9)	11.2±3.6			66.5 (59.0, 74.0)		
Yes	72 (21.1)	13.2±4.7			70.0 (64.5, 75.0)		
Fear of falling			-2.982	0.003		-5.094	<0.001
No	79 (23.1)	10.5±3.1			61.0 (50.0, 68.0)		
Yes	263 (76.9)	11.9±4.1			68.0 (63.0, 75.0)		
Balance problem			-7.334	<0.001		-4.653	<0.001
No	167 (48.8)	10.5±2.8			65.0 (58.0, 72.0)		
Yes	128 (37.4)	13.6±4.9			69.0 (65.0, 77.0)		

Abbreviations: TUG, Timed Up and Go; FRPQ-CDOAs, Fall Risk Perception Questionnaire for Community-Dwelling Older Adults; SD, standard deviation; IQR, interquartile range; ADL, activities of daily living.

Notes: *P*<0.05: statistically significant. * Includes divorced and widowed. # Includes Living with spouse only, living with children/grandchildren only, and living with spouse and children/grandchildren

Table 2. Levels of physiological fall risk and perceived fall risk.

Variables	N (%)
Physiological fall risk	
Low	116 (33.9)
Moderate	160 (46.8)
High	66 (19.3)
Perceived fall risk	
Low	103 (30.1)
Moderate	115 (33.6)
High	124 (36.3)
Fall risk appraisal pattern	
Risk-aware	124 (36.3)
Risk-anxious	85 (24.9)
Risk-taker	133 (38.9)

Table 3. Comparison of characteristics by fall risk appraisal patterns among older adults (n=342)

Variables	Risk-aware (N=124)	Risk-taker (n=85)	Risk-anxious (n=133)	χ^2	*P*
Age, n (%)				7.041	0.134
60-69	67 (54.0)	36 (42.4)	64 (48.1)		
70-79	40 (32.3)	32 (37.6)	56 (42.1)		
≥80	17 (13.7)	17 (20.0)	13 (9.8)		
Gender, n (%)				5.583	0.061
Male	72 (58.1)	36 (42.4)	63 (47.4)		
Female	52 (41.9)	49 (57.6)	70 (52.6)		
Educational level, n (%)				8.556	0.200
Primary school and below	53 (42.7)	47 (55.3)	53 (39.8)		
Junior secondary/vocational school	46 (37.1)	25 (29.4)	46 (34.6)		
Senior secondary/college	17 (13.7)	7 (8.2)	26 (19.5)		
Bachelor's degree and above	8 (6.5)	6 (7.1)	8 (6.0)		
Marital status, n (%)				8.132	**0.017**
Married	100 (80.6)	68 (80.0)	122 (91.7)		
Others	24 (19.4)	17 (20.0)	11 (8.3)		
Living arrangements, n (%)				0.058	0.971
Living alone	16 (12.9)	11 (12.9)	16 (12.0)		
Living with others	108 (87.1)	74 (87.1)	117 (88.0)		
Self-rated economic status, n (%)				19.619	**<0.001**
Strained	46 (37.1)	26 (30.6)	48 (36.1)		
Break-even	49 (39.5)	47 (55.3)	38 (28.6)		
Surplus	29 (23.4)	12 (14.1)	47 (35.3)		
Self-rated health status, n (%)				14.999	**0.020**
Poor	19 (15.3)	13 (15.3)	13 (9.8)		
Fair	40 (32.3)	18 (21.2)	51 (38.3)		
Good	56 (45.2)	42 (49.4)	46 (34.6)		
Very Good	9 (7.3)	12 (14.1)	23 (17.3)		
Smoking status, n (%)				6.522	**0.038**
Never	68 (54.8)	60 (70.6)	89 (66.9)		
Ever/current	56 (45.2)	25 (29.4)	44 (33.1)		
Drinking status, n (%)				6.668	**0.036**
Never	72 (58.1)	64 (75.3)	88 (66.2)		
Ever/current	52 (41.9)	21 (24.7)	45 (33.8)		
Sleep duration, n (%)				1.127	0.890

<6h	46 (37.1)	36 (42.4)	54 (40.6)		
6-8h	63 (50.8)	40 (47.1)	67 (50.4)		
>8h	15 (12.1)	9 (10.6)	12 (9.0)		
Visual impairment, n (%)				3.130	0.209
No	53 (42.7)	45 (52.9)	55 (41.4)		
Yes	71 (57.3)	40 (47.1)	78 (58.6)		
Hearing impairment, n (%)				8.151	**0.017**
No	74 (59.7)	57 (67.1)	64 (48.1)		
Yes	50 (40.3)	28 (32.9)	69 (51.9)		
Regular exercise, n (%)				4.054	0.132
No	27 (21.8)	10 (11.8)	20 (15.0)		
Yes	97 (78.2)	75 (88.2)	113 (85.0)		
Number of chronic conditions, n (%)				4.925	0.295
0	38 (30.6)	21 (24.7)	25 (18.8)		
1-2	55 (44.4)	42 (49.4)	69 (51.9)		
≥3	31 (25.0)	22 (25.9)	39 (29.3)		
Number of medications used, n (%)				6.743	0.150
0	42 (33.9)	27 (31.8)	32 (24.1)		
1-2	52 (41.9)	34 (40.0)	73 (54.9)		
≥3	30 (24.2)	24 (28.2)	28 (21.1)		
ADL impairment, n (%)				1.415	0.493
No	115 (92.7)	78 (91.8)	127 (95.5)		
Yes	9 (7.3)	7 (8.2)	6 (4.5)		
Depressive symptoms, n (%)				2.067	0.356
No	97 (78.2)	59 (69.4)	99 (74.4)		
Yes	27 (21.8)	26 (30.6)	34 (25.6)		
Fall history within 1 year, n (%)				1.200	0.549
No	94 (75.8)	68 (80.0)	108 (81.2)		
Yes	30 (24.2)	17 (20.0)	25 (18.8)		
Fear of falling, n (%)				7.846	**0.020**
No	31 (25.0)	27 (31.8)	21 (15.8)		
Yes	93 (75.0)	58 (68.2)	112 (84.2)		
Balance problem, n (%)				0.544	0.762
No	77 (62.1)	56 (65.9)	88 (66.2)		
Yes	47 (37.9)	29 (34.1)	45 (33.8)		

Notes: χ^2: chi-square test. *P*<0.05: statistically significant. Bold text indicates statistical significance.

Table 4. Multivariate logistic regression modeling of factors associated with fall risk appraisal patterns among older adults

Variables	Risk-taker vs. Risk-aware *		Risk-anxious vs. Risk-aware *		Risk-anxious vs. Risk-taker *	
	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Marital status						
Married	1.00 (reference)		1.00 (reference)		1.00 (reference)	
Others	1.06 (0.49, 2.29)	0.876	0.35 (0.15, 0.83)	**0.017**	0.45 (0.16, 1.26)	0.129
Self-rated economic status						
Strained	1.00 (reference)		1.00 (reference)		1.00 (reference)	
Break-even	1.62 (0.83, 3.14)	0.158	0.64 (0.34, 1.21)	0.171	0.44 (0.22, 0.91)	**0.025**
Surplus	0.65 (0.25, 1.65)	0.363	1.37 (0.66, 2.87)	0.398	2.58 (0.98, 6.77)	0.055
Self-rated health status						
Poor	1.00 (reference)		1.00 (reference)		1.00 (reference)	
Fair	0.59 (0.22, 1.59)	0.288	1.98 (0.84, 4.66)	0.117	3.65 (1.23, 10.80)	**0.019**
Good	1.06 (0.41, 2.73)	0.911	1.27 (0.53, 3.04)	0.595	1.26 (0.42, 3.75)	0.676
Very Good	1.95 (0.52, 7.32)	0.324	4.02 (1.16, 13.91)	**0.028**	2.04 (0.52, 8.10)	0.310
Smoking status						
Never	1.00 (reference)		1.00 (reference)		1.00 (reference)	
Ever/current	0.71 (0.28, 1.83)	0.480	0.73 (0.34, 1.57)	0.417	0.52 (0.19, 1.43)	0.208
Drinking status						
Never	1.00 (reference)		1.00 (reference)		1.00 (reference)	
Ever/current	0.52 (0.20, 1.35)	0.181	0.86 (0.40, 1.84)	0.688	2.18 (0.80, 5.93)	0.129
Hearing impairment						
No	1.00 (reference)		1.00 (reference)		1.00 (reference)	
Yes	0.75 (0.40, 1.41)	0.373	1.69 (0.99, 2.90)	0.057	2.35 (1.23, 4.47)	**0.010**
Fear of falling						
No	1.00 (reference)		1.00 (reference)		1.00 (reference)	
Yes	0.79 (0.39, 1.57)	0.502	1.95 (0.97, 3.92)	0.061	2.40 (1.17, 4.92)	**0.017**

Abbreviations: OR, Odds ratios; CI, confidence interval.

Notes: * The reference category. *P*<0.05: statistically significant. Bold text indicates statistical significance.

Table 5. Associations between fall risk appraisal patterns and fall prevention behaviors

Variables	β	SE	*P*	95% CI
Fall risk appraisal patterns (Ref: Risk-aware)				
Risk-taker	-3.27	1.63	0.046	(-6.47, -0.07)
Risk-anxious	-1.16	1.41	0.411	(-3.94, 1.62)
Age (Ref: 60-69)				
70-79	6.12	1.49	<0.001	(3.18, 9.05)
≥80	8.40	2.05	<0.001	(4.37, 12.43)
Gender (Ref: Male)				
Female	2.10	1.86	0.259	(-1.55, 5.75)
Educational level (Ref: Primary school and below)				
Junior secondary/vocational school	1.62	1.43	0.258	(-1.19, 4.43)
Senior secondary/college	0.63	2.25	0.782	(-3.81, 5.05)
Bachelor's degree and above	6.08	2.86	0.034	(0.45, 11.72)
Marital status (Ref: Married)				
Others	-1.85	2.32	0.426	(-6.41, 2.71)
Living arrangements (Ref: Living alone)				
Living with others	-0.35	2.42	0.884	(-5.12, 4.41)
Self-rated economic status (Ref: Strained)				
Break-even	0.32	1.44	0.822	(-2.51, 3.16)
Surplus	-1.14	1.73	0.510	(-4.55, 2.26)
Self-rated health status (Ref: Poor)				
Fair	-1.92	2.05	0.350	(-5.94, 2.11)
Good	-3.64	2.59	0.160	(-8.73, 1.44)
Very Good	-1.50	3.28	0.648	(-7.94, 4.95)
Smoking status (Ref: Never)				
Ever/current	-2.02	2.09	0.333	(-6.13, 2.08)
Drinking status (Ref: Never)				
Ever/current	-1.84	1.84	0.316	(-5.45, 1.77)
Sleep duration (Ref: <6h)				
6-8h	-1.21	1.27	0.344	(-3.71, 1.30)
>8h	-4.13	2.30	0.074	(-8.65, 0.40)
Visual impairment (Ref: No)				
Yes	-2.83	1.42	0.047	(-5.62, -0.04)
Hearing impairment (Ref: No)				
Yes	0.74	1.29	0.569	(-1.80, 3.28)
Regular exercise (Ref: No)				

Yes	-0.06	1.80	0.976	(-3.59, 3.49)
Number of chronic conditions (Ref: 0)				
1-2	-0.31	2.81	0.912	(-5.84, 5.22)
≥3	-0.31	2.98	0.918	(-6.16, 5.55)
Number of medications used (Ref: 0)				
1-2	3.47	2.74	0.207	(-1.92, 8.86)
≥3	3.13	3.09	0.311	(-2.95, 9.21)
ADL impairment (Ref: No)				
Yes	2.22	2.20	0.313	(-2.11, 6.55)
Depressive symptoms (Ref: No)				
Yes	0.30	1.55	0.848	(-2.76, 3.36)
Fall history within 1 year (Ref: No)				
Yes	0.51	1.56	0.743	(-2.56, 3.58)
Fear of falling (Ref: No)				
Yes	-0.36	1.43	0.802	(-3.17, 2.45)
Balance problem (Ref: No)				
Yes	2.92	1.70	0.086	(-0.42, 6.26)

Abbreviations: β, Beta coefficient; SE, standard error; CI, confidence interval.

Notes: Ref, reference comparison category. *P*<0.05: statistically significant.

Discussion

By combining physiological and perceived fall risks, this study identified three FRA patterns among community-dwelling older adults: risk-aware, risk-anxious, and risk-taker. Each pattern was characterized by unique demographic profiles, behavioral tendencies, and health conditions. Additionally, we examined the relationship between these FRA patterns and actual fall prevention behaviors. Specifically, individuals in the “risk-taker” group were found to engage in fewer prevention behaviors compared to their “risk-aware” counterparts.

Overall, old adults exhibited moderate levels of both physiological and perceived fall risk in this study. However, approximately 64% had disparities between objective and subjective fall risks, indicating a maladaptive FRA characterized as either “risk-taker” or “risk-anxious”. This proportion varies across studies from different regions and populations. For example, an Australian study of 500 community-dwelling older adults aged 70–90 years found that 30.8% displayed such discrepancies (13), while studies conducted in the United States (n=102, age ≥65 years) (9) and Thailand (n=433, age ≥60 years) (10) reported proportions exceeding 50%. The between-study comparability is limited by the differences in measurement tools. Physiological fall risk has been measured using tools such as the Physiological Profile Assessment (PPA), the BTrackS Balance Test (BBT), or the full-tandem stand test. The present study employed the TUG test to evaluate physiological fall risk, which provides a rapid assessment of functional strength, mobility, and dynamic balance. Regarding perceived risk assessment, prior studies often used the FES-I, whereas this study utilized a validated fall risk perception scale specifically designed for community-dwelling older adults.

This study identified several factors associated with membership in distinct FRA patterns. Among socioeconomic characteristics, being married was associated with a higher likelihood of being risk-anxious rather than risk-aware. This finding

aligns with previous research indicating that married older adults suffer from greater FoF compared to those who have never been married (29). In contrast, those who are divorced or widowed may develop greater psychological resilience, which facilitates a more accurate self-assessment of their risk of falls. Additionally, we found that participants who perceived their economic status as break-even were less likely to be classified as risk-anxious than those who reported a strained financial situation. It suggests greater economic stability can foster a sense of security, thereby diminishing perceived vulnerability to falls. In terms of behavioral lifestyles, it is noteworthy that the “risk-aware” group comprised a higher proportion of smokers and alcohol drinkers, although pairwise comparisons did not reach statistical significance. Smoking is generally associated with risk-seeking attitude and risky decision-making on health management (30), while alcohol consumption does not affect individual risk-taking (31). Our study provides a novel insight that both smoking and alcohol drinking behaviors may serve as potential protective factors of rational fall risk awareness. However, this finding should be interpreted with caution and warrants more investigation in future studies.

Health-related factors also play an important role in the formation of maladaptive FRA. Unexpectedly, individuals with better self-rated health showed higher odds of being “risk-anxious”. This contrasts with existing evidence, in which better self-rated health was linked to less fall-related concern among older adults (32). One possible interpretation is that positive health perceptions encourage health-conscious behaviors, so those with favorable self-rating are alert to potential danger and overestimate their fall risk. Prior research presents inconsistent findings regarding the correlation between visual impairment and maladaptive FRA (10, 11). This study collected information on dual sensory impairment and found that participants with hearing impairment, but not visual impairment, were more likely to exhibit risk-anxious tendencies. Auditory deficits may lead older adults to recognize declines in physical function and amplify their perception of fall-related risks. FoF was highly prevalent in our sample, affecting over 75% of participants. This fear is often accompanied by symptoms such as anxiety, dizziness, or palpitations during activity attempts (33). The FRPQ-CDOAs scale used in this study comprises two primary dimensions (e.g., perceived severity and perceived susceptibility), while FoF emphasizes the perceived severity of fall-related outcomes. This conceptual overlap helps explain why individuals in the “risk-anxious” group reported significantly higher levels of FoF.

Moving beyond a single focus solely on either perceived risk or physiological risk, this study examined their discrepancy and investigated how maladaptive FRA relates to prevention behaviors. We found that participants identified as “risk-takers” showed less willingness to engage in preventive actions. This group is characterized by overestimating their physical capacity and underestimating fall risk. Older adults in this group overlook environmental and behavioral risk factors in daily life, and consequently adopt risk-taking behavioral patterns.As suggested in other work, risk-anxious individuals would engage in more prevention behaviors (18). However, this association was not observed in our findings. It may be that, apart from risk perception, health-promoting behavior can be driven by other factors (e.g. social support (34)). Future studies can investigate potential mediating or moderating variables that influence the gap between risk perception and preventive action. Within the “risk-aware” group, individuals with congruently higher levels of both physiological and perceived risk exhibited a stronger tendency for preventive practices, likely influenced by the activity-restricting effect of elevated risk awareness (35).

This study has important implications for fall prevention. The concept of fall risk perception recognizes older adults as “active agents” of their own health, encouraging proactive self-management of fall risk. However, perceived fall risk does not always align with physiological risk. Therefore, a comprehensive assessment integrating both subjective perception and objective risk is recommended. These influencing factors identified in this study help characterize individuals belonging to the three distinct FRA patterns. Moreover, these factors can provide a basis for exploring the formation mechanisms of maladaptive FRA, which is crucial for developing effective interventions. Based on existing evidence, tailored interventions should be designed for each group. For example, individuals in the “risk-anxious” category may benefit from cognitive behavioral therapy (CBT) aimed at mitigating excessive FoF (36). For those “risk-takers”, interventions should focus on enhancing risk awareness. In addition to essential fall prevention education (37), technology-assisted strategies, such as wearable devices and sensors, offer an alternative approach. Collected data can be used to generate real-time, tangible feedback (e.g., fall risk probability score) (38). It helps older adults intuitively recognize dynamic changes in fall risk and increase their awareness.

Limitations

First, this study employed a convenience sampling method, with participants recruited from communities within a single city. The sample consisted predominantly of adults aged 60–69, and the majority had attained only primary education or below. As such, the generalizability of the findings is limited. Further validation is warrant through multi-center studies covering diverse geographic regions, age groups, and educational backgrounds. Second, fall risk assessment is performed infrequently in primary care settings in China. Given considerations of cost and feasibility, a simple and clinically practical screening tool, i.e., the TUG test, was selected to assess physiological fall risk. However, reliance on a single measure may not fully capture the multifactorial nature of fall predictors. Finally, while the TUG is typically dichotomized to identify individuals at risk of falling, this study attempted to categorize it into three levels based on prior findings. However, the predictive accuracy and clinical utility of this three-level classification requires further verification. Meanwhile, the cut-off for FRPQ-CDOAs were derived empirically from tertiles of the sample distribution. We acknowledge that the cut-off values for both the TUG test and FRPQ-CDOAs should be regarded as exploratory in this study. It is necessary to externally validate these values and examine whether similar risk-discrepancy categories apply to older adults with specific clinical characteristics.

Conclusion

There is a notable disparity between physiological and perceived fall risk among community-dwelling older adults. According to the disparity, three FRA patterns FRA were identified: risk-aware, risk-anxious, and risk-taker. Several factors were associated with these patterns. Moreover, risk-takers engaged in fewer fall prevention behaviors compared to the “risk-aware” group. These findings underscore the importance of tailored fall prevention education and intervention strategies to help older adults foster a more realistic understanding of fall risk.

Abbreviations

FRA: Fall risk appraisal

FES-I: Falls Efficacy Scale-International

FoF: Fear of falling

TUG: Timed Up and Go

FRPQ-CDOAs: Fall Risk Perception Questionnaire for Community-Dwelling Older Adults

FaB: Falls Behavioral

Declarations

Authors' contributions: Shuomin Wang: conceptualisation, investigation, visualization, methodology, formal analysis, and writing-original draft; Mengting Dai: investigation and writing– review & editing; Xiao Tian: investigation and writing– review & editing; Ruiqi Zhang: writing– review & editing; Kehan Liu: writing– review & editing; Hong Lin: writing– review & editing; Minhui Liu: project administration, methodology, and writing-review & editing. All the authors had full access to all the data in the study and had final responsibility for the decision to submit for publication.

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Ethics approval and consent to participate: This study was granted by the Ethical Review Board of Xiangya School of Nursing, Central South University (No. E2024110) and adhered to the Declaration of Helsinki. Formal administrative permissions were

obtained from both participating community health centers. Before the survey, investigators thoroughly explained the interview content, methods, and purpose to participants. Participation was voluntary, and written informed consent was obtained from each participant. Investigators acknowledged potential concerns of participants and ensured they were informed that the study would not cause any physical or psychological harm. All participants' information was stored under coded identifiers. Data were kept strictly confidential, used solely for this study, and securely maintained throughout the research process.

Consent for publication: Not applicable.

Declaration of conflicts of interest: None.

Data availability: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Figures

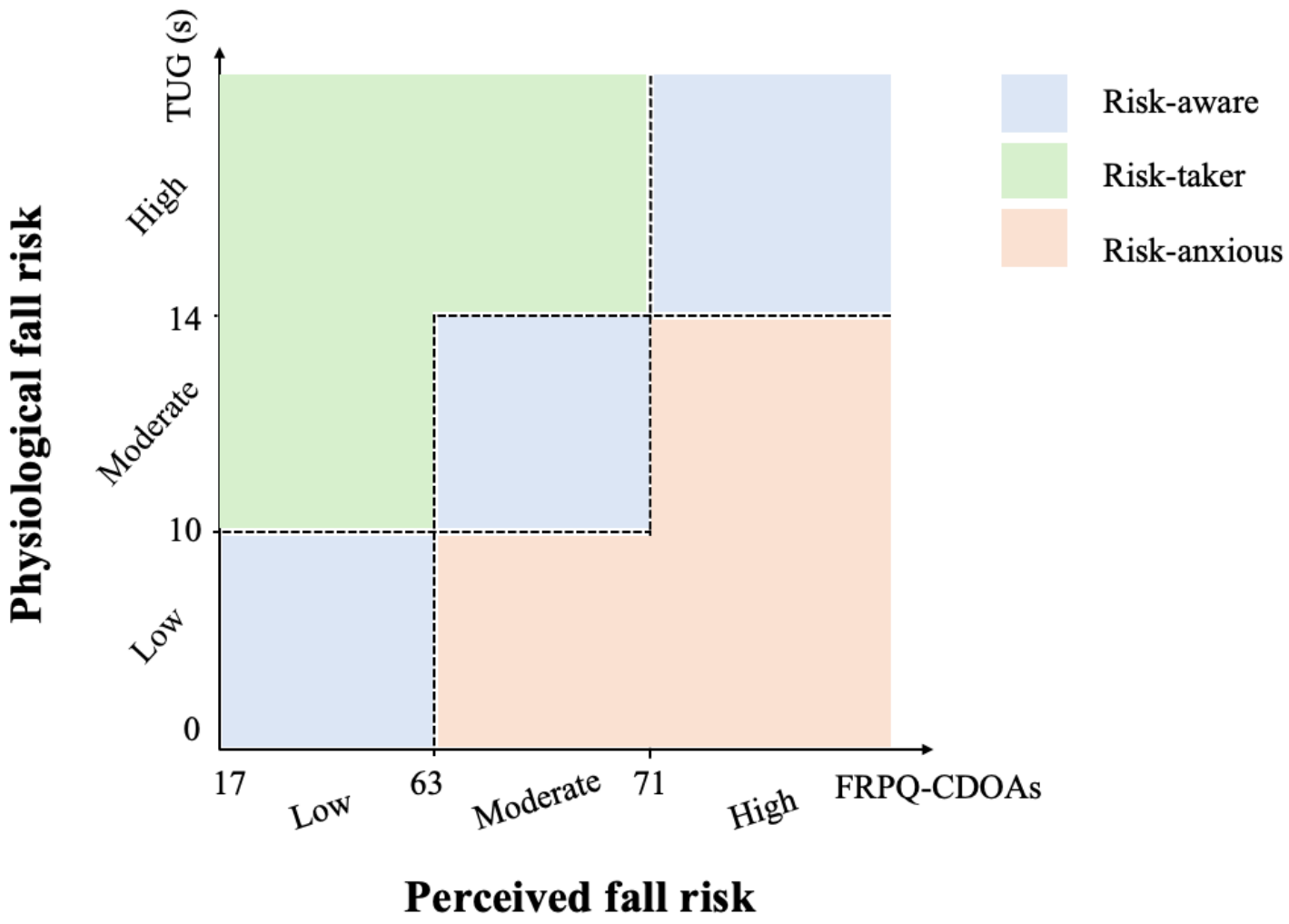


Figure 1

Physiological fall risk versus perceived fall risk. TUG, Timed Up and Go; FRPQ-CDOAs, Fall Risk Perception Questionnaire for Community-Dwelling Older Adults.