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Exploring the Impact of ADL, Average Walking Speed, and Arthritis History on Fall Risk Among Chinese Older Adults

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Abstract. This study was designed to examine the impact of ADL (Activities of Daily Living), average walking speed, and arthritis history on fall risk among middle-aged and older adults aged 45-100 in China. The data for this study come from 7,367 individuals aged 45-100 surveyed in the 2014 China Health and Retirement Longitudinal Study (CHARLS). T-tests were used in this paper to explore differences between the fall group and the non-fall group; chi-square tests to examine differences, bivariate analysis for associations among categorical variables, and establish a multivariate logistic regression model to identify independent influencing factors for fall risk in middle-aged and older adults. To explore the moderating effect of age, age-stratified models were conducted. The analysis revealed that ADL, average walking speed, and arthritis history are significant influencing factors for fall risk among middle-aged and older adults aged 45-100. There is a strong graded dose-response relationship between the degree of ADL impairment and fall risk. An increase in average walking speed reduced the risk of falls among middle-aged and older adults. The proportion of individuals with a history of arthritis was significantly higher in the fall group.

Keywords: Falls, ADL, Change in Walking Speed, Arthritis History

1. Introduction

Falls represent a major public health concern within China's aging population, ranking as a leading cause of injury-related mortality among older adults [1, 2]. Beyond physical injury, falls can induce a fear of falling, leading to reduced activity, functional decline, and diminished quality of life [3, 4]. Therefore, taking necessary preventive measures to reduce fall risk in middle-aged and older adults is crucial.

Recognized risk factors for falls include gender, impairment in Activities of Daily Living (ADL), gait speed, and chronic conditions such as arthritis [5-7]. However, since cross-sectional gait speed measurement is considered to have low overall predictive value for fall risk, this study primarily investigates the impact of changes in average walking speed on fall risk factors in middle-aged and older adults, while also exploring its interaction with other risk factors on fall risk. Therefore, this study used CHARLS data to explore the impact of ADL, average walking speed, and arthritis history on fall risk among Chinese middle-aged and older adults and to develop a predictive model.

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2. Research subjects and methods

2.1. Research subjects

This study utilized data from the nationally representative 2014 China Health and Retirement Longitudinal Study (CHARLS). After excluding participants under 45, over 100 years old, and those with missing data or outliers, 7,367 individuals were included in the analysis

2.2. Research indicators

2.2.1. Exposure factors

This study selected key exposure factors related to physical function and musculoskeletal chronic diseases, including basic six-item ADL (eating, dressing, getting in/out of bed, bathing, using the toilet, and controlling urination/defecation), average walking speed, and arthritis history .The basic six activities of daily living (ADL) were scored according to the standard questionnaire of the China Health and Retirement Longitudinal Study (CHARLS), ranging from 0 (no difficulty in all functions) to 6 (difficulty in all functions). The higher the score, the more functions with difficulty(Table 1).

Table 1. The name and description of predictor variables

variable	Description
Age	Years (range: 45 to 100)
Gender	Male/Female
Average walking speed	Meters per second (m/s), average of two 2.5-meter walks
Adlab_c (Activities of Daily Living	Score from 0 (no difficulty) to 6 (difficulty in all 6 ADLs)
Stroke	Physician-diagnosed history of stroke (Yes / No)
Arthritis	Physician-diagnosed history of arthritis (Yes / No)
Drinking	History of alcohol consumption (Yes / No)

2.2.2. Outcome factor and covariates

The outcome factor of this study was whether a fall occurred in the past year among middle-aged and older adults aged 45-100. Meanwhile, covariates included age, gender, stroke history, and drinking history. These variables were all identified as potential confounding factors and adjusted for in the models.

2.3. Statistical methods

Statistical analyses were performed using R software. Descriptive data are presented as means ± standard deviations or counts (percentages). We used the t-test to handle continuous variables and the chi-square test to handle categorical variables when comparing the fallers with the non-fallers. To identify independent risk factors, a multivariable logistic regression model was fitted, adjusting for all pre-specified exposure variables and covariates. Furthermore, to assess potential effect modification by age, the analysis was stratified into three groups (45–64, 65–70, and 71–95 years

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based on tertiles), and the logistic regression model was re-established within each stratum to examine the consistency of the associations.

3. Research results

3.1. Overview of the impact of physical function and musculoskeletal chronic diseases on falls in Chinese older adults

Univariate analysis revealed significant differences in baseline characteristics between the fall and non-fall groups (Table 2). The fall group had a significantly higher proportion of females and individuals with a history of stroke or arthritis. A clear gradient was observed between the degree of ADL impairment and fall incidence. Additionally, the fall group was slightly older and had a slower average walking speed (Table 3). No significant difference was found in drinking habits between the two groups.

Table 2. Comparison of fall situations by group

	Total	outcome		
	Weighted N (%)	No N(%)	YES N(%)	p-value
Total	7367	5900	1467	
Exposure				
Gender				<0.001
male	3,647 (50%)	3.071(52%)	576(39%)	
female	3,720 (50%)	2,829 (48%)	891 (61%)	
Physical functions				
Adlab_c				<0.001
Normal	5,509 (75%)	4,636 (79%	873 (60%)	
Level1	956 (13%	683 (12%)	273 (19%)	
Level2	429 (5.8%)	289 (4.9%)	140 (9.5%)	
Level3	232 (3.1%)	146 (2.5%)	86 (5.9%)	
Level4	129 (1.8%	83 (1.4%)	46 (3.1%)	
Level5	74 (1.0%)	41 (0.7%)	33 (2.2%)	
Level6	38 (0.5%)	22 (0.4%)	16 (1.1%)	
Chronic disease				
Stroke				<0.001
No	7,056 (96%)	5,677 (96%)	1,379 (94%)	
Yes	311 (4.2%)	223 (3.8%)	88 (6.0%)	
Arthritis				<0.001
No	3,842 (52%)	3,237 (55%)	605 (41%)	
Yes	3,525 (48%)	2,663 (45%)	862 (59%	
Alcohol Drinking				0.13
No	4,980 (68%)	3,964 (67%)	1,016 (69%)	
Yes	2,387 (32%)	1,936 (33%)	451 (31%)	

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Table 3. The name and description of predictor variables

variable	Total sample (N = 7367)	The non-fall group (N=5900)	Fall group (N=1467)	P value
Age (years)	67.0 (63.0, 72.0)	67.0 (63.0, 72.0)	68.0 (64.0, 73.0)	0.003
Average walking speed (meters per second)	0.77 (0.63, 0.92)	67.0 (63.0, 72.0)	0.72 (0.58, 0.87)	<0.001

3.2. Multivariate logistic regression analysis

After adjusting for confounding factors, several factors remained independent predictors of fall risk (Table 4). Female gender was associated with a 62% increased risk of falls (adjusted odds ratio = 1.62, 95% confidence interval: 1.42 - 1.84). There was a clear dose-response relationship between the degree of impairment in activities of daily living and fall risk; even mild impairment (level 1) nearly doubled the risk (adjusted odds ratio = 1.90), and the risk rose sharply with increasing impairment. A history of arthritis and stroke also significantly increased the risk of falls. Conversely, a faster walking speed was a protective factor (adjusted odds ratio = 0.73 for each additional 1 meter/second). After adjustment, age itself was not a significant predictor.

Table 4. Multivariate statistical analysis on the association between physical functions, chronic diseases and falls among elderly people in China

	Crude OR(95%)	Full model Adjusted OR(95%)	Adjusted P-value
Gender	1.68(1.49,1.89)	1.63 (1.43, 1.86)	<0.001
Physical functions			
Adlab_c			
Normal			
Level1	2.13 (1.81,2.49)	1.90 (1.61,2.23)	<0.001
Level2	2.56 (2.06,.3.17)	2.22 (1.78, 2.77)	<0.001
Level3	3.13 (2.36,4.11)	2.59 (1.95, 3.44)	<0.001
Level4	2.94 (2.02, 4.23)	2.38 (1.63, 3.46)	<0.001
Level5	4.27 (2.67, 6.78)	3.37 (2.09, 5.41)	<0.001
Level6	3.86 (1.99, 7.34)	2.84 (1.47, 5.48)	0.002
chronic disease			
Stroke	1.62. (1.25, 2.09)	1.32 (1.01, 1.72)	0.047*
Arthritis	1.73 (1.54, 1.95)	1.43 (1.27, 1.62)	<0.001
Alcohol drinking	0.91 (0.80, 1.03)	1.22 (1.06, 1.40)	0.003
Age	1.01(1.00,1.02)	1.00 (0.99, 1.01)	0.576
Average Walk speed	0.39(0.30,0.51)	0.73 (0.54, 0.98)	<.001

OR = Odds ratio CI = Confidence interval

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3.3. Model for the impact of physical function and musculoskeletal chronic diseases on falls in Chinese older adults

Prior to model interpretation, multicollinearity was assessed and all corrected Generalized Variance Inflation Factor (GVIF) values ranged between 1.01 and 1.11, well below the threshold of 5, indicating no severe multicollinearity. The multivariable logistic regression model demonstrated modest discriminative ability for fall risk, with an area under the ROC curve of 0.647 for the full model (Figure 1).

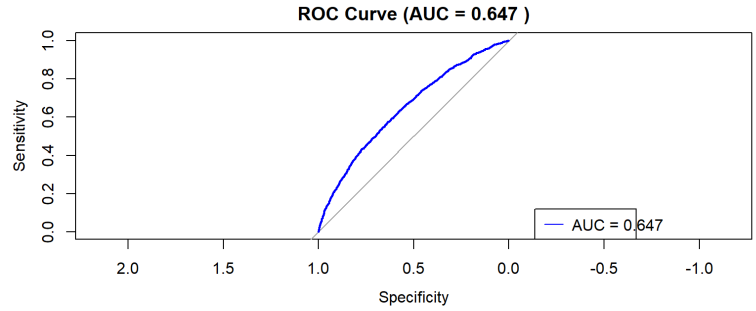


Figure 1. The ROC curve of the full model containing all predictors

3.4. Model for the impact of physical function and musculoskeletal chronic diseases on falls in Chinese older adults stratified by age

To explore the moderating effect of age, we stratified the analysis into three groups (45–64, 65–70, and 71–95 years). The model maintained stable predictive performance across all age strata, with AUC values ranging between 0.63 and 0.66 (Figure 2).A forest plot clearly shows the extent to which each major risk factor affects the risk of falls among elderly people in China (Figure 3). For instance, being female, having a history of arthritis, and all levels of impaired daily living activities significantly increase the risk of falls, while a faster walking speed provides protection in all groups.



Figure 2. The ROC curves of the models after stratification by different age groups

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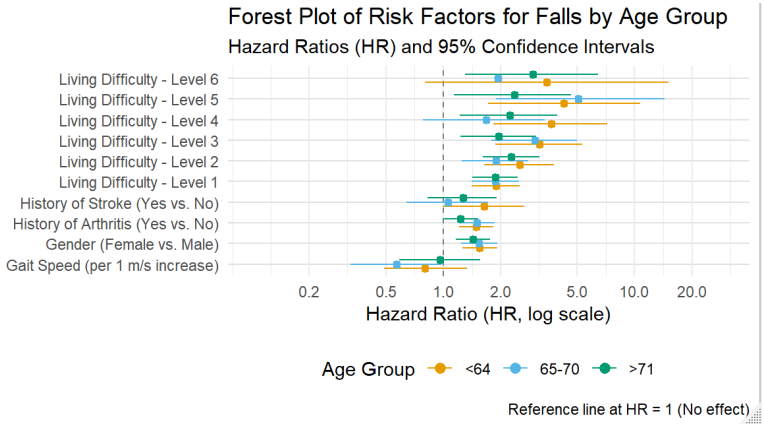


Figure 3. Forest plot of the effect values of the main risk factors in different age subgroups

4. Discussion

4.1. The impact of gender and ADL impairment level on fall risk in middle-aged and older adults

Gender, activities of daily living (ADL) ability, and history of fall-related injuries are considered risk factors for fall-related injuries [5-8]. The data analysis of this study indicates that there is a clear dose-response relationship between the degree of physical function impairment and the risk of falling. As the degree of ADL impairment increases, the risk of falling shows a monotonically upward trend. This finding is similar to the research results of Lin Jinlong et al. [9]. In addition, most studies have reported that the fall rate of elderly women is higher than that of elderly men [10-14].

4.2. The impact of arthritis on fall risk in middle-aged and older adults

This study confirmed arthritis as a significant independent risk factor for falls, which aligns with previous meta-analyses [9]. The underlying mechanism likely involves the core features of arthritis pathology: joint pain, muscle weakness, and impaired balance [15]. These factors can lead to adaptive gait patterns, reduced physical activity, and ultimately, a greater risk of falling [16, 17]. The association appears to be particularly pronounced in women [18].

4.3. The impact of average walking speed on fall risk in middle-aged and older adults

Our finding that faster walking speed is a significant protective factor (aOR=0.73 per m/s) is consistent with existing literature that identifies gait speed as a reliable predictor of fall risk [8, 19]. A slower gait may reflect underlying impairments in strength and balance, making it more difficult to recover from a loss of equilibrium [20, 21].

5. Conclusion

This study identified impairment in Activities of Daily Living (ADL), slower average walking speed, and a history of arthritis as significant, independent risk factors for falls among middle-aged and older Chinese adults. A strong graded dose-response relationship was observed between the degree of ADL impairment and fall risk.

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The main limitations include the cross-sectional design and the use of self-reported data, which preclude causal inference and may be subject to recall bias. Future longitudinal studies are needed to confirm these associations and elucidate the underlying mechanisms. For clinical and public health practice, incorporating simple assessments of walking speed and ADL into routine evaluations could help identify high-risk individuals for targeted interventions.

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