

## Preplanned Studies

## Evaluation of the Effectiveness of “5E” Comprehensive Injury Prevention Strategy for Fall Prevention Among the Rural Elderly — Six Pilot Villages, Yunnan Province and Chongqing Municipality, China, 2018–2023

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### Summary

#### What is already known about this topic?

The mortality rate and disease burden associated with falls among the elderly in China are on the rise. Interventions can play a crucial role in preventing and managing falls.

#### What is added by this report?

The application of the “5E” injury prevention strategy led to a decrease in both the occurrence of falls and the likelihood of subsequent falls. Regular physical activity and maintaining a positive outlook were identified as protective measures against falls, while sleep issues and hearing impairment were found to increase the risk of falling.

#### What are the implications for public health practice?

The group-based comprehensive intervention strategy is crucial as it offers an innovative intervention model and empirical evidence for decreasing fall rates among elderly individuals living in rural areas.

As of 2021, China has entered a phase of moderate aging, with a significant projected increase in the elderly population over the next decade due to a second baby boom starting in 1962. This demographic shift poses significant challenges for national finances, social healthcare services, and home assistance. Falls are the primary cause of fatal injuries and illnesses among Chinese individuals over 65 years old (1). Research indicates that about 1/3 of 65-year-olds and half of 80-year-olds have experienced a fall, with a high likelihood of recurrence for those with a history of falls. Prompt prevention and diagnosis of falls using clear criteria can yield visible results quickly (2). Preventing and managing falls among the elderly is a key priority for facilitating healthy and active aging in China. Domestic researchers have successfully implemented the “5E” strategy — Education, Environmental

modifications, Engineering improvements, Enforcement measures, and Evaluation — to mitigate fall risks among elderly inpatients (3–4). Nonetheless, there is a scarcity of studies evaluating the efficacy of group-based fall prevention interventions for rural older adults.

This study aims the effectiveness of a group-based comprehensive intervention strategy to prevent falls in older adults through a prospective cohort study conducted from October 2022 to September 2023. Using random cluster sampling, six project townships were chosen from Yunnan Province and Chongqing Municipality, with one project village selected from each township. The survey involved 1,536 rural elderly individuals aged 60 and above across 6 project villages. Baseline data from 1,276 rural elderly individuals aged 60 and over from the same villages collected from November to December 2018 was used for self-control. The research was part of the “Community Participation to Promote Rural Elderly Health – Phase II” project by the National Health Commission (NHC). Inclusion criteria included individuals aged 60 and above residing in the project area for at least six months, while exclusion criteria involved severe mental illness, paralysis, and epilepsy.

The research team implemented a detailed, household-level investigation by deploying a specifically designed questionnaire. This questionnaire encompassed a wide array of topics, capturing essential resident demographics, lifestyle choices, daily activity capabilities, overall physical health, and impressions of the intervention project. The multifaceted “5E” strategy for injury prevention was employed, focusing on the following dimensions: 1) Provision of targeted health education, which addressed themes such as fall prevention and awareness, handling falls, the significance of physical activity, and safety measures associated with exercise. 2) Modification of the living environment in an age-sensitive manner, entailing

upgrades such as smoothing out uneven surfaces, enhancing lighting in communal areas, bathroom repairs, handrail installations, and setting up fitness equipment. 3) Dispensation of age-friendly assistive devices that included items like reading glasses for presbyopia, portable commodes, walking sticks, and crutches aimed at reducing the fall risk for the elderly. 4) Oversight of the entire intervention process, from the development and procurement of necessary resources to the actual execution and subsequent assessment of the interventions. 5) Conducting risk evaluations for potential recurrent falls. Evaluation metrics involved measuring the frequency of falls, defined as the percentage of participants who reported experiencing a fall in the preceding year, as well as quantifying re-fall risk. For assessing re-fall risk, we employed the endorsed scoring systems of the Fall Risk For Older People-Community Setting (FROP-Com) (5) and the Falls Risk Assessment Tool (FRAT) (6), resulting in a comprehensive 37-point score with 13 primary factors, comprising: fall history, medications influencing fall risk, medical conditions affecting balance and flexibility, paresthesia occurrences, sleep quality, health literacy, urinary incontinence, nutritional health, environmental safety assessment, level of physical activity, proficiency in everyday activities, engagement in physical exercise, and emotional well-being.

Data analysis was performed using SPSS statistical software (version 27.0, SPSS Inc., Chicago, IL, USA). This study was approved by the Ethics Review Committee of the National Center for Women and Children's Health, China CDC, under the protocol (Ethics Review Number: FY2018-07). Before the intervention, participants were well-informed about the study procedures and provided their informed consent.

The initial data indicated that 159 individuals suffered falls; however, in the subsequent survey, only 33 reported falls. The prevalence of falls decreased from 12.46% to 2.15% following the intervention (Table 1). The mean scores for the reassessment of fall risk decreased from  $9.64 \pm 2.99$  to  $7.79 \pm 2.44$ . Analysis using a regression model revealed that regular physical activity [odds ratio (OR): 0.34, 95% confidence interval (CI): 0.16, 0.72] and a positive attitude (OR: 0.22, 95% CI: 0.07, 0.64) were protective factors, while sleep disturbances (OR: 2.86, 95% CI: 1.21, 6.77) and hearing impairment (Wald  $\chi^2=8.46$ ,  $P=0.037$ ) were identified as risk factors for falls. Visual impairments such as blurred vision can be corrected

with the use of presbyopia glasses (Table 2). The ratio of falls attributed to intrinsic factors versus environmental factors was approximately 1:1. Slippery surfaces or obstacles in the surroundings (33.33%) were identified as the primary causes of falls (Table 3).

## DISCUSSION

The introduction of an intervention led to a decrease in fall incidence from 12.46% to 2.15%. Additionally, re-fall risk assessment scores dropped from an average of  $9.64 \pm 2.99$  to  $7.79 \pm 2.44$ . Both the reduced fall incidence and lower re-fall risk assessment scores were statistically significant, demonstrating that the intervention effectively minimized falls among elderly individuals in the research locations and mitigated the risk of recurring falls. Consequently, the study affirms that a group-based holistic intervention approach notably diminishes fall rates among older adults residing in rural areas.

The initial fall incidence rate of 12.46% aligns with prior research in Chongqing Municipality (10.45%) (7) and Yunnan Province (9.60%) (8), affirming the baseline data's reliability. This study consistently involved participants aged 65 years and older across all sites, excluding those unavailable for follow-up. New local residents joining during the intervention phase maintained the data's comparability. Results demonstrated that physical exercise is an effective fall prevention strategy. According to Li Jinmei (9), balance is a modifiable fall risk factor. Practices such as Tai Chi and Baduanjin — a series of Qigong exercises — can enhance postural stability when walking or standing, and fortify the lower body's strength and endurance in the elderly. A positive mindset also corresponds to a reduced fall occurrence. In our study, 19 individuals (57.58%) experienced a fear of falling (FOF), paralleling Xu Peimei's (10) meta-analysis findings on FOF prevalence. FOF may curtail activity levels and diminish physical activity, leading to a decline in muscle strength and balance, hence raising the fall risk and perpetuating a detrimental cycle. Consequently, organizing recreational events, fostering social interaction, and providing emotional sustenance via caregivers is crucial (9–10). Moreover, the hazard of falls is heightened by the distractions and sluggish reactions stemming from sleep disturbances and sensory degradation. Auditory issues delay the elderly's response to auditory fall-risk warnings, while visual impairments directly disrupt their vision and wayfinding abilities. Improvement in

TABLE 1. Univariate analysis of the impact factors of falls among rural elderly pre- and post-intervention in six pilot villages, Yunnan and Chongqing, China, 2018–2023.

Item	Post-intervention		$\chi^2$	P	Pre-intervention		$\chi^2$	P
	Number	Number of falls (%)			Number	Number of falls (%)		
Sex			2.899	0.089			0.489	0.484
Male	737	11 (1.49)			635	75 (11.81)		
Female	799	22 (2.75)			641	84 (13.10)		
Ethnicity			5.729	0.126			4.903	0.179
Han	426	15 (3.52)			316	46 (14.56)		
Tujia	423	7 (1.65)			453	61 (13.47)		
Lahu	469	6 (1.28)			317	29 (9.15)		
Other	218	5 (2.29)			190	23 (12.11)		
Age (years)			2.981	0.225			6.353	0.042
60–	773	12 (1.55)			698	73 (10.46)		
70–	551	14 (2.54)			417	65 (15.59)		
≥80	212	7 (3.30)			161	21 (13.04)		
Educational level			10.750	0.005			4.871	0.088
Illiterate	969	28 (2.89)			827	112 (13.54)		
Primary school	506	3 (0.59)			327	39 (11.93)		
Junior high school and above	61	2 (3.28)			122	8 (6.56)		
Occupation			7.821	0.020			0.485	0.785
Housework	416	14 (3.37)			513	67 (13.06)		
Farming	1,075	16 (1.49)			721	86 (11.93)		
Other	45	3 (6.67)			42	6 (14.29)		
Alcohol consumption			0.329	0.566			1.456	0.228
Yes	441	8 (1.81)			456	50 (10.96)		
No	1095	25 (2.28)			820	109 (13.29)		
Having sleeping problems			7.498	0.006			3.757	0.053
Yes	169	9 (5.33)			389	59 (15.17)		
No	1,367	24 (1.76)			887	100 (11.27)		
Physical exercise			10.054	0.002			4.661	0.031
Yes	964	12 (1.24)			541	80 (14.79)		
No	572	21 (3.67)			735	79 (10.75)		
Having chronic disease			0.001	0.971			1.322	0.250
Yes	554	12 (2.17)			368	52 (14.13)		
No	982	21 (2.14)			908	107 (11.78)		
Vision			7.845	0.049			14.512	0.002
Normal	504	8 (1.59)			338	29 (8.58)		
Slightly blurred	835	17 (2.04)			609	79 (12.97)		
Often unable to see clearly	176	5 (2.84)			192	22 (11.46)		
Blurred	21	3 (14.29)			137	29 (21.17)		
Hearing			7.894	0.048			11.647	0.009
Normal	672	8 (1.19)			694	68 (9.80)		
Sometimes cannot hear	689	20 (2.90)			367	62 (16.89)		
Often cannot hear	139	5 (3.60)			131	19 (14.50)		
Severe hearing loss	36	0			84	10 (11.90)		
Mentality			6.793	0.009			8.881	0.003
Positive	1,025	4 (0.39)			971	106 (10.92)		
Loneliness, anxiety or depression	511	29 (5.68)			305	53 (17.38)		

TABLE 2. Multivariate logistic regression analysis of the impact factors of falls among rural elderly pre- and post-intervention in six pilot villages in Yunnan and Chongqing, China, 2018–2023.

Impact factors (Reference groups)	$\beta$	S.E.	Wald $\chi^2$	P	OR	95% CI
Pre-intervention						
With exercise (No)	-0.392	0.174	5.100	0.024	0.68	0.48, 0.95
Vision (Blurred vision)			8.417	0.038		
Normal vision	-0.259	0.241	1.159	0.282	0.77	0.48, 1.24
Slightly blurred	-0.829	0.313	7.028	0.008	0.44	0.24, 0.81
Often unable to see clearly	-0.110	0.324	0.116	0.733	0.90	0.48, 1.69
Mentality (Loneliness, anxiety or depression)	-0.466	0.188	6.173	0.013	0.63	0.43, 0.91
Post-intervention						
Having sleeping problems (No)	1.050	0.440	5.686	0.017	2.86	1.21, 6.77
With exercise (No)	-1.089	0.387	7.897	0.005	0.34	0.16, 0.72
Hearing (Normal)			8.464	0.037		
Sometimes cannot hear	1.161	0.750	2.393	0.122	0.31	0.07, 1.36
Often cannot hear	0.527	0.622	0.718	0.397	1.69	0.50, 5.73
Severe hearing loss	18.903	6041.682	-	0.998	-	-
Mentality (Loneliness, anxiety or depression)	-1.534	0.557	7.571	0.006	0.22	0.07, 0.64

Note: “-”: The number of falls due to severe hearing loss is zero.

Abbreviation: S.E.=standard error; OR=odds ratio; CI=confidence interval.

TABLE 3. The comparison of the leading cause of falls among rural elderly, pre- and post-intervention in six pilot villages, Yunnan and Chongqing, China, 2018–2023.

Cause of fall	Post-intervention		Pre-intervention	
	N	%	N	%
Elderly themselves				
Leg weakness	14	16.67	30	8.33
Poor body balance ability	11	13.10	64	17.78
Distraction	11	13.10	30	8.33
Vision problems	6	7.14	25	6.94
Unwell episodes	3	3.57	45	12.50
Surroundings				
Slippery grounds and obstacles	28	33.33	118	32.78
Insufficient or blinding light	8	9.52	26	7.22
Steps with large height difference	2	2.38	13	3.61
Furniture too high or too low	1	1.19	7	1.94
No handrails in bathroom	0	0	2	0.56

visual acuity after prescribing appropriate glasses significantly mitigates the fall risk, underscoring the value of investing in suitable assistive devices for the elderly in fall prevention efforts.

The research sites in Yunnan and Chongqing, situated in mountainous regions with high seasonal rainfall, present challenging environmental conditions that elevate the risk of falls among the elderly, particularly within the Tujia and Lahu ethnic

communities residing in traditional stilt houses. Approximately one-third of older adults experience falls due to slippery surfaces or obstacles, influenced by the unique geography, climate, and living conditions. Prior studies indicate that enhancing the living environment through personalized age-appropriate modifications indoors and outdoors can significantly reduce fall occurrences. Hence, feasible intervention strategies include decluttering and incorporating age-

appropriate adjustments like slope modifications at home.

The comprehensive injury prevention strategies known as the “5E” approach, which involves age-appropriate modifications and aids, demonstrated substantial and swift efficacy in decreasing fall rates. It is essential to tackle root causes like slippery surfaces and obstacles to prevent falls effectively. These findings offer empirical support for health departments in devising future fall prevention initiatives and equipping healthcare workers with efficient strategies for preventing falls in elderly populations.

This study is subject to some limitations, including the absence of a control group due to its prospective cohort design and the omission of socioeconomic factors that may influence falls. Moreover, the study did not assess the long-term effects of the interventions. In summary, a group-based comprehensive intervention strategy demonstrated efficacy in decreasing fall rates and re-fall risks among older individuals.

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