Falls in old age: Research Review of Risk Identification and Intervention

Zongzhen Jin*, Lili Cao, Yonghong Cheng, Qi Liu
China national institute of standardization, Beijing 100191, China
*Corresponding author’s e-mail: jinzzh@cnis.gov.cn

Abstract: Fall injuries in the elderly have become an important risk to the health and safety of the elderly, directly affecting their physical and mental health. This paper analyzes the existing research literature on the fall injuries in the elderly in China and sums up the existing literature on fall injuries in the elderly in China from five aspects, namely risk factor research, intervention research, awareness survey, research on risk assessment tools and research on detection and alarm system, so as to put up the research and development of technologies related to falls in the elderly.

1. Research on risk factors of falls in the elderly

Chinese scholars roughly divide the factors related to falls in the elderly into five categories: physiological factors, disease factors, psychosocial factors, medication factors and environmental factors. For example, Wang Cuixia et al made use of a self-designed questionnaire to retrospectively survey the general records of patients who fell in their ward in the past three years, and collected general information of such patients, and information on the risk factors for falls, related situations when falls occurred, and consequences of falls. The survey found that most of the falls occurred indoors, followed by toilets; and the time of occurrence was scattered, but most of them occurred between 6:00-7:30 in the morning, 11:00-14:00 in the noon and 1:30-2:00 in the night. It was concluded that the causes of falls in the elderly patients were complex, and factors such as age, disease, medication, psychology, and history of falls had important influences.

Among them, the physiological factors mainly refer to the decline of gait coordination, the stability of the balance and muscle strength, as well as the decline of the visual, hearing, vestibular functions, and proprioception of the elderly due to the physiological decline, resulting in gait instability and high risk of falls. For example, Xu Guohui et al. believed that along with aging, the body of the elderly underwent different degrees of degenerative changes in physiological functions and structures, usually showing a certain degree of decline of the central and peripheral nervous system and musculoskeletal system, which increased the risk of falls.

In terms of disease factors, pathological changes resulting from acute and chronic diseases can cause physiological abnormal changes, which can affect sensory input, central nervous system function and skeletal muscle strength and coordination. Consequently, the physical and mental changes and the decrease of functional reserve of the elderly make them more prone to falls. The damage of balance and gait may directly affect the old adults’ ability to conduct physical activities, resulting in the threat of falls. For example, Li Yingjuan pointed out that the more chronic diseases an old adult suffered, the greater the risk of falling. Jiang Xuwen et al. also believed that pathological changes resulting from acute and chronic diseases might affect the coordination of sensory input,
central nervous system and skeletal muscle strength, leading to an increased risk of falls. For example, stroke, Parkinson’s disease, senile arthritis, etc. among the elderly can cause the decline of lower limb muscle strength, limited joint activity, and the decline of balance and coordination, which make them prone to falls; presbyopia, cataract, glaucoma and other common eye diseases in the elderly can cause visual disturbances, which are related to falls; medications and the decrease of vascular nerve reactions can easily cause orthostatic hypotension, which leads to cerebrovascular insufficiency and fainting.

In terms of social psychological factors, living alone and being alone are social factors related to falls. One’s balance confidence and emotion when falling occurs are also important psychological factors related to falls. The psychological factors related to falls are affected by emotions and balance confidence. Falls can occur repeatedly, forming a vicious circle of “falling, loss of confidence, and getting more likely to fall”. Frustration and anxiety can reduce old adults’ attention to themselves, the environment and others, thereby increasing their chances of falling. The research of Li Lintao et al. confirmed that fear of falls might increase the risk of falls. Old adults who have experienced a fall often fear of falling again, which can lead to a decline in daily activities and an increase in demand for medical services.

In terms of medication factors, taking anti-epileptic drugs and antipsychotic drugs can affect the balance function and make the gait unsteady; sedative-hypnotic drugs with muscle relaxant and inhibition effects may lead to adverse reactions such as lethargy, dizziness and fatigue, and reduce muscle coordination and reaction, making falls more likely; the drugs taken by patients with cardiovascular and cerebrovascular diseases are mostly vasodilators, which may lead to orthostatic hypotension and falls; hypoglycemic agents may cause hypoglycemia; diuretics, laxatives cause abnormal excretion and the increase of bathroom visits, enhancing the probability of falling. For example, Huang Tianwen believed that many drugs and alcohol could affect consciousness, spirit, vision, gait, balance, blood pressure, etc., enhancing the incidence of falls.

In terms of environmental factors, studies have reported that 51% of falls in the elderly living at home over the age of 65 are related to environmental factors. There are three types of common environmental risk factors: objects causing trips, slippery floor, poor illumination, carrying heavy items, etc.; wearing slippers or unsuitable shoes and trousers; improperly furnished furniture, chairs that are too soft and/or too low, beds that are too high/low, etc, which make it difficult for the elderly to use them and cause falls.

In terms of research methods, the studies on the risk factors of falls in the elderly were mainly based on qualitative analysis. In addition, some scholars adopted the method of household sample survey. For example, Ji Yanhu adopted this method in his study of the characteristics and laws of the falls in the elderly in the Beijing communities. Firstly, 12 communities under the jurisdiction of a certain sub-district office in Beijing were identified. Among the eligible old adults aged 60 and over in each community, 100 elderly people were selected by systematic sampling for household survey.

2. Research on interventions for preventing falls in the elderly
In the research on interventions to prevent falls in the elderly, Chinese scholars summarized the commonly used interventions as: assessment of hazard factors; rational use of drugs in the treatment of diseases; strengthening physical exercise and health education. For example, Lin Hemei summarized the risk factors of falls in the elderly in communities and the interventions to prevent falls, and emphasized that community nursing staff should identify early the high-risk groups in the elderly and provide effective interventions in time to reduce the incidence of falls in the elderly. Cao Zhijuan et al. evaluated the effects of exercise interventions on community-based fall prevention in the elderly and provided clues for developing more effective fall intervention models for the elderly. Using a before and after study design, they collected information about the occurrence of falls and exercises in the elderly before and after the intervention. The chi-square test and the non-parametric K-S test were used to compare the differences before and after the intervention, and then the effect of the intervention was evaluated. It was concluded that the incidence of falls in the 71-80 year old age group
decreased from 6.8% to 3.4% after the exercise intervention; the incidence of falls in the elderly over 80 years old decreased from 9.3% to 5.8%. The proportion of old adults who could exercise regularly increased compared with that before the intervention. The elderly’s perceptions of exercises and the exercise self-efficacy scores increased compared with those before the intervention. It is concluded that community-based exercise intervention to prevent falls in the elderly was effective to a certain degree, reducing the incidence of falls in the elderly, improving the exercise behavior and related beliefs of the elderly, and was an effective intervention model.

3. Awareness survey of falls in the elderly
Gao Maolong et al. randomly selected 1,000 old adults over the age of 60 from the Xicheng District of Beijing to conduct one-on-one questionnaires on falls. It was found that the incidence of falls in the elderly in Xicheng District of Beijing was 20.2%, and the rate of falls awareness was 37.5%. There was no statistical significance between differences in gender, age, education level, marital status, income, and previous experience of any fall and difference in the rate of falls awareness among the elderly. The study concluded that promotion of the awareness of fall hazards among the elderly should be strengthened to prevent falls in the elderly.

Zhou Liqing et al. used multi-stage random sampling to survey 6 communities and 35 neighborhoods in a sub-district in Shanghai, and a direct household survey was conducted among a total of 3,000 old adults selected. [Results] A total of 3000 questionnaires were sent out, and 2559 valid questionnaires were returned, with an effective rate of 85.30%. It was found that 73.00% of the old adults have not received training and guidance on the knowledge of falls prevention, 98.40% believed that it was necessary to provide the old adults with knowledge of the prevention of fall injuries in communities, 44.20% believed that falls prevention could not play a significant role in preventing falls. After assigning values to the knowledge and behaviors related to falls, the knowledge scores of the males were higher than those of the females (t=2.645, P<0.05), and there was no difference between different ages; old adults below 70 years old had higher behavioral scores than old adults at or over 70 years old (t=2.227, P<0.05); there was no difference between different genders. The conclusion was that it was necessary to strengthen the training and guidance on the professional knowledge of fall injuries among the elderly, to further improve the old adults’ understanding of promoting a safe community, enhance the confidence of old adults in communities in the prevention of fall injuries, and improve and regulate the behaviors of the elderly population.

4. Research on risk assessment tools for falls in the elderly
Hao Yanping et al. evaluated the self-developed fall risk assessment scale for the elderly by adopting a convenient sampling method. They conducted a survey of 459 elderly patients and old adults living in communities aged 60 to 100 (mean age 75.5) with self-evaluation questionnaires to evaluate the reliability, validity and predictive performance of the fall risk assessment scale; they also analyzed the effects of age, residence pattern and body mass index on the incidence of falls in the elderly. It was proved that the fall risk assessment scale had good reliability, could to some extent predict fall risk in the elderly, and had certain practical value.

Wang Liwei et al. used the revised fall risk assessment tool for the elderly living in communities to analyze the falls and the fall risk factors in the elderly in communities, which might serve as a frame of reference for community interventions. It was confirmed that the fall risk assessment tool had high predictive accuracy for fall risk screening among the elderly living in communities. By using this tool to identify the risk factors that can be remedied, the user could conduct targeted interventions in accordance with the specific fall risk factors in the elderly. If old adults had a history of falls, or diseases that affect their own balance and flexibility, were taking medicines that may easily cause falls, or had environmental risk factors at home, even if they were not assessed as at high risk of falls, they should be carefully monitored.
5. Research on detection and alarm system for falls in the elderly

In the research of the detection and alarm system for falls in the elderly, Li Yaping et al designed a mobile phone-based fall detection and alarm system for seniors to provide timely help for seniors who had fallen, and provide emergency first aid as soon as possible. They made use of iPhone’s built-in three-axis accelerometer and gyroscope to collect data on human body acceleration and angular velocity, and calculate the values related to human motion, such as the signal vector magnitude (SVM), the signal magnitude area (SMA), and the tilt angle (TA). Multi-threshold judgment algorithms were used to determine whether the human body had fallen. When a fall occurred, the phone sent a fall alarm to the guardian. RESULTS: The system accuracy test simulated the walking, jogging, sitting down, lying down, bending down and forward falling, lateral falling, and backward falling of the elderly. The accuracy of jogging recognition was 96%, and misstatement occurred; the accuracy of forward fall detection was 98%, and failure to report occurred; the accuracy rates in other situations are 100%, and the overall accuracy of the system was 99.25%. The conclusion was that the system could effectively detect falls by using the built-in sensors of the mobile phone, and had no requirement for the positions of the mobile phone and was an easy-to-accept and more feasible fall detection system.

Guo Xing et al. conducted an experimental study on the effects of applying telemedicine monitoring system to provide medical alerts for falls in the elderly out of hospital. The study selected 322 old adults and had them wear portable telemedicine monitoring equipment for one month. And their falls were recorded and compared with the alert information received by the telemedicine monitoring system platform. The results showed that the monitoring system platform received 18 alerts, while there were 21 actual falls; no alerts for three actual falls; no false alert. The accuracy of the system was 85.71%. It was concluded that the telemedicine monitoring system can accurately and timely report the sudden falls in the elderly out of hospital.

6. Summary

The fall injuries in the elderly have already attracted the attention of all sectors of society. Especially with the increasing aging of China, it is urgent to carry out theoretical and pragmatic research on the fall injuries in the elderly, reduce the incidence of accidental injuries in the elderly and improve the sense of security and satisfaction with the government among the elderly living at home. The health services to the elderly should be improved to encourage old adults to be actively involved in the actions of healthy aging and active aging.

References
[1] Cao Yanjun, Feng Wei, Liu Qingyan, Ning Changqing, Chen Shixuan,. Research Progress on Factors Related to Falls in the Elderly and Functional Exercise Intervention [J]. Shanghai Journal of Traditional Chinese Medicine, 2014, (6).
[2] Chen Xinian, Lin Mei,. Research on Causes for Falls in the Elderly and Nursing Strategies[J]. Science & Technology Information, 2014, (9).
[3] Cheng Qianqiu,. Risk Factors and Nursing Interventions for Falls in the Elderly [J]. Science & Technology Association Forum (the second half of the month), 2009, (8).
[4] Dong Jige, Qiu Yuanyuan, Zhang Li, Zhong Ying,. Research Progress on Assessment and Management of Falls in the Elderly Living in the Community[J]. Chinese Journal of Medicinal Guide, 2011, (5).
[5] Du Mei, Xu Guangxu,. Hazards Control, Rehabilitation and Prevention of Falls in the Elderly [J]. Practical Geriatrics, 2013, (4).
[6] Gong Wei, Lu Pingjing, Liu Lidan,. Study on the Influence of Adverse Drug Reactions on Falls in the Elderly[J]. Chinese Nursing Research, 2010, (36).
[7] Hu Guoping, Yan Wanqiong, Chen Shuping,. Factors Related to Falls in the Elderly and Its Preventive Nursing[J]. Journal of Nursing Science, 2003, (5).

4
[8] Huang Haiyan, Liu Lei, Pan Xuejiao. Clinical Application of the Risk Assessment Form for Falls or Falling from Bed in the Elderly Patients[J]. Journal of Kunming University, 2013, (6).

[9] Huang Tianwen, Luo Xiaomei, Huang Huanxue, Jiang Meixia. Risk Factors and Interventions for Falls in the Elderly[J]. Modern Clinical Nursing, 2004, (1).

[10] Ji Shufeng, Zhu Hui,. Analysis of the Causes of and Prevention for Falls in the Elderly [J]. Chinese Journal of Rehabilitation Theory and Practice,2007,(1).

[11] Jiang Yu, Xia Qinghua, Hu Jia, Zhou Peng, Zhang Bu,. Study on the Epidemiology and Disease Burden of Fall Injuries in the Elderly in Changning District, Shanghai [J]. Chinese Journal of Disease Control & Prevention, 2013, (2).

[12] Li Xinhui, Chen Lili,. Research Progress on Risk Factors and Prevention of Falls in the Elderly[J]. Chinese General Practice Nursing, 2008, (31).

[13] Lin Hemei, Mo Haihua, Zhou Xiangling,. Risk Factors of Falls in the Elderly in Communities and the Progress on Nursing Interventions[J]. Chinese General Practice Nursing, 2014, (15).

[14] Liu Chong, Yan Fen, Cao Bing, Du Jie, Zhao Huanbin,. Research Progress on Delaying the Decline of Balance of in the Elderly Through Exercise [J]. Chinese Journal of Rehabilitation Medicine, 2009, (7).

[15] Liu Yuanbiao, Li Jian'an,. Falls in the Elderly and Balance and Abnormal Gait[J]. Chinese Journal of Rehabilitation Theory and Practice, 2012, (1).

[16] Lu Yan, Du Ning, Zhou Xianjun,. Awareness of Knowledge of the Prevention of Falls in the Elderly in Communities of Jiamusi City[J]. Chinese Journal of Gerontology, 2012, (10).

[17] Lu Yandi,. Factors Related to Falls in the Elderly and Preventive Nursing[J]. Nursing Research of China, 2007, (12).

[18] Xu Wei, Wan Qiuping, Wu Yisheng, Zhou Feng,. Investigation on Risk Factors of Falls in the Elderly in Communities[J]. Journal of Environmental & Occupational Medicine, 2010, (12).

[19] Xu Wei, Wu Yisheng, Wan Qiuping, Zhang Guohui, Long Yixuan, Zhou Feng, Zhou De'ding,. Investigation on Falls in the Elderly in Communities and Relevant Risk Factors[J]. Chinese Journal of Prevention and Control of Chronic Disease, 2010, (5).

[20] Xun Qin,. Risk Factors of Falls in the Elderly Patients with Cerebrovascular Disease and the Progress on Nursing [J]. Chinese and Foreign Medical Research, 2011, (29).

[21] Yang Yi, Wang Jing, Yang Bin,. Analysis of Risk Factors of Falls in the Elderly in a Town in Shanghai[J]. Health Education and Health Promotion, 2010, (1).

[22] Yu Hongyu,. Research on Factors Related to Falls in the Elderly and Preventive Nursing [J]. Chinese Journal of Geriatric Care, 2009, (1).

[23] Zhang Jinglan,Chen Hong,Wang Yan,. Assessment of Risk Factors of Falls in the Elderly and the Progress of Nursing Interventions[J]. Chinese Nursing Management,2012,(8).

[24] Zhang Li, Weng Changshui, Wang Qiuhua, Peng Nan,. Research Progress on the Evaluation of and Intervention Strategies for Falls in the Elderly[J]. Chinese Journal of Rehabilitation Theory and Practice, 2010, (1).

[25] Zhang Yongzhen,. Correlation Graph Analysis of Risk Factors of Falls in the Elderly in Communities[J]. Journal of Community Medicine, 2014, (18).

[26] Zhao Liqun, Wan Qiaoxin,. Research Progress on Risk Assessment Tools for Falls in the Elderly [J]. China Nursing Management, 2012, (11).

[27] Zhou De'ding, Li Yanhong, Lu Wei,. Research Progress on Risk Factors of Falls in the Elderly in Communities[J]. Journal of Environmental & Occupational Medicine, 2007, (1).

[28] Zhou Liqing, Li Jinfeng, Wu Chengrong, Zhu Peifang, Chen Zhihua,. KAP Analysis of Fall Injuries in the Elderly in a Sub-district in Shanghai[J]. Security, 2010, (3).
[29] Zhou Liqing, Li Jinfeng, Wu Chengrong, Zhu Peifang, Chen Zhihua,. KAP Analysis of Fall Injuries in the Elderly in a Sub-district in Shanghai[J]. Journal of Environmental & Occupational Medicine, 2009, (3).