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# Review of Nutrition and Exercise Intervention on Falling in the Elderly Population

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## Abstract

One major cause of death or getting injured among the elderly is falling. falling may lead to accidental injuries, which may in turn cause physical and mental trauma to the individuals and make them lose the ability to live independently and even cause death, resulting in increase of financial burden of the family and community. Although there are numerous risk factors that lead to falling in the elderly, it appears that the diminishing of functions of the vestibular, visual and proprioceptive systems with increases of age is the internal mechanism of falling in the elderly. Regular exercise (balance training, gait exercise and resistance training) and a balanced diet (intake of protein, calcium, iron, folic acid, Vitamin B complex and Vitamin D) can be effective means of prevention of falling and fractures caused by falling. This paper will focus on risk factors of falling in the elderly and suggestions for prevention of falling via exercise and nutrition, providing adequate methods for prevention of falling in the elderly.

## Keywords

Nutrition; the elderly; falling; exercise intervention

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## 1. Introduction

These days, issues of fall-related injuries and death rate have gradually gained concern of scientists around the world. According to reports from World Health Organization, 391,000 people died from falling in 2001 worldwide, where the elderly of 60 or older accounted for more than 50%; 28% - 35% of the elderly over 65 years old occurred falling in one year; 40% - 70 % of falling caused injuries and 5% caused fractures. falling have become the first to cause injuries and death among the elderly [1-2]. A survey for analysis of death among the elderly Americans due to accidents and falling from 1990 to 1998 was conducted by Stevens and Dellinger [Stevens et al.,2002], and results showed that the lethality of falling increased significantly during the experiment, increasing annually by 3.6% among males and 3.2% among females. Schultz [3] pointed out that about 20% of females with hip fractures would die in the first year after fractures; while another 20% of females with hip injured would be unable to get up and walk independently in the absence of external assistance, often resulting in long-term hospitalization.

China is a country of most old-age population in the world; the elderly of 60 or older account for 10% of China's total population, with the estimated absolute number of 132 million; at least 20 million people occur falling (25 million times) every year, incurring direct medical costs of more than RMB 5 billion. Related articles published nearly 10 years in China were searched and results showed that the cross-sectional survey was adopted in most articles involved to study the risk factors. At present, articles about randomized controlled trials of falling in the elderly are from Western countries. Due to differences in economic levels and the lifestyle, related interventions taken by Western countries may

not be effective for the elderly in our country. Therefore, it is also necessary for us to carry out a lot of prospective randomized controlled studies for falling prevention. The fall is in a vicious cycle, which means a fall may cause fractures and long term bedridden situations, resulting in the gradual decline of bodily functions and increase of a variety of chronic morbidity, and eventually causing increase of the lethality. With technological and medical advances, the life span will be longer gradually; adding with the decline of fertility, the global phenomenon of aging occurs; falling in the elderly is bound to become an important topic of the future society. This paper will focus on risk factors of falling in the elderly and suggestions on prevention of falling from exercise and nutrition so as to provide adequate methods for prevention of falling in the elderly.

## 2. Risk Factors Of Falling In The Elderly

Risk factors of falling in the elderly have long become causes for concern of international and domestic scholars, which involve the interactions of many factors. Age increase, decline of cognitive and physical functions, meditation, damage of sensory and nervous systems, musculoskeletal system diseases, other chronic diseases, indoor and outdoor environment, social and behavioral factors, history of falling, etc. are all risk factors of falling in the elderly [6][5]. Han Yufen carried out an analysis on 32 elderly patients hospitalized due to falling and found common causes of falling included aging, disorders of balance and gait, decreased ability of daily life and environmental and medicine factors. Close et al. [6] carried out a study on 110 elderly patients who occurred falling and found that 44 cases were related to external environmental risk factors, 29 to internal environmental risk factors, 26 to the cardiovascular and cerebrovascular diseases and 2 to medication; the reasons of falling in some other elderly patients were not clear. You Liming et al. investigated 415 aged people over 60 years old in some old city of Guangzhou City and found the percentages of falling in the elderly outdoors and indoors are the same, 50% for both cases; 67.5% of falling outdoors are related to environmental factors, while that is 46.2% for falling indoors. They concluded that the major factor of falling in the elderly was the dangerous environment. Qin Zhaohui et al. surveyed 1,536 aged people over 60 years old in Chongwen District, Beijing and found that the incidence of falling was 18%; the incidence of falling in females was higher than that in males; multivariate analysis showed that dementia, depression, blood pressure medicine, glaucoma, high blood pressure, fear of falling, the use of multiple medicine fell within risk factors of falling. Xia Qinghua et al. conducted a questionnaire survey on 2,310 aged people over 60 years old in communities of Changning District, Shanghai and found the incidence of falling was 17.97%; categorized by sites where falling occur, home accounted for 42.2%, inside the community for 19.5%, and outside the community for 35.7%, including the street, the bedroom, stairs, vegetable market, bathroom and the kitchen in sequence. A variety of chronic diseases, diabetes, cataracts, anemia and stroke are within risk factors of falling.

The vestibular system provides the position information in the role of gravity to the perceptual part in the brain; it also provides the sense of speed and sense of direction to the brain; the visual system provides information on the relative position of the body and the environment; the body sensory system provides the brain with information used to distinct positions and movements of different body segments. Aging of the above-mentioned three sensory systems reduces the the ability of the elderly to perceive information on the body and the environment, leading to uncoordinated or imbalanced movement, decline of movement efficiency and other cases; these will increase the risk of falling by 35-40% for the aged over 60 [7]. Compared with the 20-year-old, at the age of 70, the muscle strength will reduce about 30% and the muscle size will lose about 40%. Indications of muscle function decline in the elder include the decline in total muscle fibers, reduction of the size of muscle fibers, the selective atrophy of the second type of muscle fibers, impairments of excitation - contraction coupling mechanism and drop of the motor unit discharge threshold [8]. Teixeira [9] noted the effects of aging on the musculoskeletal system included the decline of oxidant and glycolytic enzyme capacities, decrease of total muscle fibers, decline of the degeneration ability and moisture content of cartilage, structural changes of bones and joints, increase of lateral connections and total volume of collagen, increase of fat and connective tissues

within the muscle, atrophy of second type of muscle fibers, shortening of tendon and ligament and the decline of tissue elasticity; the indications of aging of nervous system included the decrease of dendrite in the central nervous system, decrease of  $\alpha$  motor neurons in the spinal cord, reduction of the number of motor units with increase of the size of remaining motor units, decrease of proprioception, derogation of nerve recruitment, formation of plaques and tangles in nerve fibers of cerebral cortex, slow nerve conduction velocity, longer reaction time, reduction of lens adaptation (presbyopia) and formation of cataract.

In addition, meditations (such as sedatives, hypnotics, antidepressants, anti-hypertensive agents, alcohol) can increase the risk of falling. Campbell et al. [10] pointed out that reducing the use of medicine will help reduce the risk of falling. Some of the irreversible risk factors, such as stroke and traumatic arthritis, can be improved theoretically via rehabilitation therapy for certain impairments (improving muscle strength and proprioception) and disability (improving gait). Therefore, the risk factors of falling can be subject to changes.

### 3. Exercise And Falling in The Elderly

Since the risk factors of falling are diverse and complex, there is still no conclusive prescription for appropriate exercise to prevent falling. However, American College of Sports Medicine (ACSM) pointed out in one statement in 1998 that balance training, resistance exercise, walking and shifting the weight may be taken comprehensively, as exercise-based prescription for reducing the risk of falling. Muscle strength and explosiveness are factors keeping the body in upright posture and disorder of body posture. Therefore, enhancing muscle strength helps to promote the balance. Some scholars have pointed out [11]: resistance training could improve muscle strength, explosiveness, walking mechanism and speed, and these factors were important risk factors associated with falling. Teixeira et al. [12] found: for women using hormone therapy, after one year of resistance training, significant progress was made in their 1-RM muscle strength; the progress ranged from 28% in seated cable row to 77% in lower extremity push-off; whether the hormone therapy was used, resistance training could significantly increase the net body weight.

In most cases, the fatality of falling consists in a series of problems following the fracture. For this purpose, the bone loss in the elderly has also gained attention of related researchers involving falling in the elderly. Nelson et al. [13] carried out a study of 50-70 year-old females and found after intense resistance training, the bone mineral density was increased, while the bone mineral density in the control group declined significantly. However, most related articles showed that the increase percentage of bone mineral density via various forms of exercise training was less than 5%. Some scholars believed that exercise training only played the role of fall prevention rather than the prevention of fractures caused by falling. Mazzeo [14] believed that most of the mechanical training equipment had no movements for standing support, thus the movable training equipment had a better effect for improving the balance; lower extremity resistance training (such as weight lifting exercise and kneebend) and balance training emphasizing one-leg posture (training of plantar flexor muscles, hip flexor muscles, muscle clusters of extending hip, abductors of hip, kneebend muscles and other muscles ) were conducive to the training of the balance system. Therefore, ACSM recommended that the posture of standing on one leg should put emphasis on gradually reducing the upper support in progression, as from holding the chair with two hands to holding it with one hand, and finally to the hands-free and eyes-closed state. Dynamic movements which require to moving the center of gravity are also helpful to improve the balance of the elderly, such as toe walking on pads, heel walking and walking in circles. In addition, it is also believed that training of reducing the input of other sensory signals (visual blocking for example) also contributes to the balance control and adaptation.

Individual interventions mainly include movement and exercise or transformation of hazardous household conditions, where movement and exercise include balance gymnastics and Tai Chi. Wolf et al. [15] provided simplified Tai Chi training to some aged people over 70 years old in communities of Atlanta, American, twice/week. After 15 weeks of training, it was found that the incidence of falling in

the elderly in the intervention group decreased by 50%. Barnett et al. [16] performed exercise training to the aged community people over 67 years old (vulnerable to falling) once a week, one hour each time. The exercise contents include improving balance, muscle strength and ability to respond. After 37 weeks of training, the incidence of falling in the intervention group reduced by 40%. Nikolaus et al. [17] carried out 2-3 times of family visits to the aged community people (vulnerable to falling) over 65 years old, and the contents involved transformation of hazardous household environment and proper use of handrail and walking aid. Compared with the control group, the incidence of falling dropped by 31%. A number of joint interventions have achieved obvious results. Margaret et al. [18] separated 252 aged community people into four groups, A, B, C and D. Group A only received education and was treated as the control group. Group B received strength and balance training, once a month. Group C was added with house safety assessment and intervention on the basis of Group B. Group D was added with physical examination and medicine administration on the basis of Group C. Observations were made for incidences of tripping, slips and falling in the four groups of aged people within 2 years. Comparison between incidences of falling of Group B, C and D and that of Group A was made, and results showed that all incidences decreased, 58%, 64% and 30% respectively. But except for tripping, no superimposed effect of interventions was shown in slips or falling. Day et al. [2002] randomly assigned 1,090 healthy aged people over 70 in the Melbourne Community of Australia into 8 groups for separate or combined interventions (physical function training, house safety management and vision improvement). The follow-up was maintained for 18 months. Results showed that combination based on physical function training had the best intervention effect, highly correlated with improvement of balance of the elderly; while the separate home safety management or improvement of vision of the elderly had no significant effect. Clemson et al. [2004] randomly separated 310 aged community people over 70 years into groups; the intervention group took exercise one a week, with a duration of seven weeks, improving lower extremity strength and body balance, improving internal and external living environment, encouraging regular eye examinations and medication reasonableness checks. The followup lasted for 14 weeks. Results showed that the incidence of falling in the intervention group dropped by 31% compared with that in the control group; and this was particularly effective for males. In addition, Lan et al. [2002] believed that as Tai Chi included the transfer of body weight, body rotation and standing on one leg with various postures, it would contribute to improve balance and motion control of the elderly, thereby reducing the risk of falling in the elderly.

#### **4. Nutrition and Falling in the Elderly**

The adipose tissue in central and visceral parts as well as the body fat mass increase gradually with the increase of age. Vellas et al. [22] believed that the increase of fat in the elderly body was helpful to protect the hip from fracture. The protection mechanisms include: 1) fat tissue can absorb forces when falling so as to provide physical protection; 2) fat increases additional loads to bones, helping to increase bone mineral density of the femoral neck; 3) adipose tissue will increase the secretion of estrogen in the body, helping to increase bone mineral density in the hip. Therefore, appropriate amount of body fat mass has a protective effect on fractures caused by falling. But on the other hand, whether overweight, obesity or moderate obesity is closely related with many diseases, such as type II diabetes, hypertension, coronary artery diseases and cancer. Therefore, keeping "moderate" body fat in the elderly remains to be further studied.

In terms of micronutrients, Lehmann pointed out [23]: the deterioration of the surrounding nerves and spinal nerves was associated with Vitamin B12 deficiency, which may result in the loss of body sensation, thereby causing loss of sense of space by limbs and muscle powerlessness; the lack of iron, folic acid and Vitamin B12 can cause anemia, making movement more difficult. Since features of Vitamin D include increasing absorption of calcium by the gastrointestinal tract, adjusting secretion of calcium ions in kidney and regulating the flow of calcium between blood and bone, Vitamin D supplementation can also help prevent fractures due to falling [24]. In addition to supplement Vitamin D through diet, the Vitamin D in body mainly comes from Vitamin D synthesis occurred in deep-layer

tissue of the skin via ultraviolet (such as sunlight) exposure. It is recommended to take 200 -800 IU of Vitamin D every day. However, long-term supplementation of high-dose Vitamin D will cause nausea, vomiting, mineral imbalance in blood and damage of kidney [24]. In terms of calcium intake, calcium absorption and secretion are affected by many factors, such as age, daily intake of calcium, other nutrients supplemented in company with calcium (such as high doses of protein, sodium and caffeine) and medicine. The calcium absorption rate is the highest at the skeletal development stages, such as in children, adolescents, pregnancy duration and lactating period; and the absorption rate starts to slow down from the middle age; after menopause, the rate will decrease rapidly in female [24].

Daily energy consumption will decrease gradually with the increase of age. The energy of body is consumed mainly by three aspects, namely basal metabolic rate (BMR), thermogenic effect of food and consumption by physical activities. Due to the loss of muscle mass in the elderly, the BMR decreases subsequently; adding with the reduction of physical activities, there is no surprise for reduction of daily energy consumption by the elderly. Roberts [25] estimated that for one 60 years old female, the BMR accounts for two-thirds of the total daily energy consumption, while the thermogenic effect of food accounts for 10 percent only; the remaining 23% is energy consumption for physical activities. When the daily energy consumption decreases, excessively taken nutrition will be stored in the body as fat. Therefore, we recommend a proper diet by the elderly. This is not only helpful to control weight, but also helpful to retain muscle mass; muscle mass loss prevention helps BMR drop prevention and falling prevention. Roberts believed [25] the energy intake by the elderly should depend on their physical activities. For example, for a 68kg female of 55 years old, her BMR is about 1,422 calories. The total energy consumed by the elderly with mild physical activities is about 1,991 calorie, about 2,275 calories for those with moderate physical activities, and about 2,560 calories for those with much amount of physical activities. In addition, inadequate protein intake may be the main reason for the loss of muscle mass. Long-term deficiency of protein intake will result in loss of net weight loss, a compensatory response. ACSM has recommended the elderly to take protein properly, better to take 1.0 to 1.25 grams of high quality protein every day per kilogram of body weight.

## 5. Conclusion

Falling stands at the start of pathogenic and deadly problems of the elderly. Although no adequate exercise prescription could be provided for falling prevention via current studies, the training of balance, gait exercise and improvement or maintenance of muscular fitness are all helpful to reduce the risk of falling in the elderly. Regular exercise habits are also conducive to improvement of health of the elderly, enhancement of functional capabilities, improvement of quality of life and individual independence. For diet prescription of falling prevention, the aged people are recommended to take adequate amount of protein, calcium, iron, folic acid, Vitamin B complex and Vitamin D, adding with keeping the balance between energy consumption and intake. A two-pronged intervention of diet and exercise will help reduce the risk of falling in the elderly, thereby reducing the series of subsequent problems caused.

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