

Sarcopenia and falls in older adults

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Abstract

The biggest social impact of Taiwan's aging population is an increase in the need for geriatric medical care as well as an increase in the burden on social and economic wellbeing. It will have an impact on domestic consumption, domestic demand, and labor supply, as well as changes in the demographic structure. As the workforce decreases and productivity declines, there will be a succession of shifts in consumer demand and infrastructure. Sarcopenia has more detrimental effects in obese or osteoporotic populations than in the general healthy population, and it is additive to the effects of obesity and osteoporosis on metabolism and physical activity. Increased adipose tissue in the aged can also cause an increase in chronic inflammation, insulin resistance, decreased muscle synthesis, and increased muscle breakdown, increasing the prevalence of sarcopenic obesity in the elderly. According to studies, sarcopenia increases the risk of falls in the elderly and causes obese older persons to lose muscle readily on a calorie-restricted diet. As shown above, nutritional supplementation as well as moderate aerobic and resistance exercise can reduce the risk of sarcopenia and falls in the obese elderly. Falls and their associated injuries are a major health care issue among the elderly. Falls are a typical occurrence in the elderly and are related to increased morbidity and disability. It is predicted that in such a community, two-thirds of unintentional injury deaths are caused by a fall. And increase geriatric mobility, so pay attention to sarcopenia and frailty problems in the elderly, and early and active intervention can avoid subsequent disability and the disadvantages of sarcopenia and frailty.

Keywords: Sarcopenia, malnutrition, falls, frailty, geriatric syndrome, osteosarcopenia

Introduction

As aging continues to grow in our society, sarcopenia and associated fall risk are considered a public health problem since falling is the third cause of chronic disability. The numbers predicted by the United Nations indicate that the number of old adults will reach 2 billion by 2050, global aging is bringing new realities to economic, social, and health systems in most countries [1, 2]. Falls in the elderly is an important issue, especially in patients with sarcopenia and osteoporosis, and falls are a major cause of disability and bedridden. Sarcopenia is an age-related chronic inflammation, changes in body composition, and hormon-

al imbalances. Taiwan has entered an aging society. Due to the aging process, motor nerve degeneration, reduced protein synthesis, insufficient nutrient supply, sedentary inactivity or chronic disease bed rest, and inflammatory reactions are all causes of sarcopenia [3]. Frailty is characterized by a diminished response to stress, which triggers a decline in the physiological function of various systems. The cost of treatment of secondary injuries related to falls is high. The frailty typical of older adults is often associated with reduced quality of life and mobility [4]. Falls are often associated with reduced mobility and the ability to perform common functions of daily living, as well as increased hospitalization days. When an elderly person has both obesity and muscle deficiency, it is called sarcopenia obese [5]. In addition, muscle mass loss associated with altered muscle composition increased visceral fat, and altered infiltration and innervation of muscle cells by fat, as well as increased fat mass, have a multiplicative effect on increased cardiovascular risk [6]. The risk of falls in elderly women is about 1.5-2 times that of elderly men. The elderly over the age of 65 will fall about 28-35% every year, and it will increase to 32-42% over the age of

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Received: 8 August 2022 / Revised: 26 August 2022

Accepted: 01 September 2022 / Published: 30 September 2022

70. The incidence of falls is 30-40%, and the incidence of falls can be as high as 50% for the elderly over 80 years old, and the incidence of falls in the elderly in long-term care institutions is even higher, even as high as 50% per year. There is much foreign literature related to the pathophysiology of sarcopenia and frailty and its sarcopenia, osteoporosis, and falls in the elderly. Muscle mass, muscle strength, bone density, and cartilage function may play significant roles in daily activities, resistance training may positively and significantly affect the elderly. Exercise programs focusing on strength may significantly influence muscle mass and muscle strength, minimizing functional decline and the risk of falling.

Frailty and sarcopenia

Sarcopenia is defined as a decrease in muscle mass and strength, a phenomenon that occurs naturally with age [7]. In 1997, American scholar Rosenberg first used the Greek word "Sarcopenia" to name this phenomenon and called it sarcopenia [8]. Sarcopenia is mainly manifested as a decline in muscle strength, which reduces the mobility of the elderly, making it difficult for the elderly to complete daily activities such as walking, sitting, and lifting heavy objects, and even leads to balance disorders and easy falls. In 2001, the scholar Fried proposed five main clinical indicators of frailty (Fried frailty phenotype), and based on this to define frailty; these clinical indicators include unintentional weight loss, self-reported fatigue, decreased muscle strength, walking Slower speed, and lower physical activity [9, 10]. The National Nutrition and Health Status Change Survey from 2014 to 2015 found that the prevalence of frailty among Taiwanese aged 65 and over was 7.8%, and the prevalence of pre-frailty was 50.8%. Compared with normal people, patients with sarcopenia have significantly lower body weight and lean body mass, significantly lower grip strength, and significantly weakened lower extremity flexors, so the elderly fall frequently [11]. Sarcopenia is associated with poor physical fitness, lack of exercise, slowed gait speed, and decreased mobility; these manifestations also represent common features of frailty and together lead to an increased risk of falls. Sarcopenia, obesity, and sarcopenic obesity are associated with many negative health outcomes such as a high risk of falls and low health-related quality of life in older adults [12]. AWGS 2019 retains the previous definition of sarcopenia but revises the diagnostic algorithm, protocols, and some criteria: low muscle strength is defined as hand-grip strength < 28 kg for men and < 18 kg for women; criteria for low physical performance are 6-m walk < 1.0 m/s, Short Physical Performance Battery score \leq 9, or 5-time chair stand test \geq 12 seconds. AWGS 2019 retains the original cutoffs for height-adjusted muscle mass: dual-energy X-ray absorptiometry, < 7.0 kg/m² in men and < 5.4 kg/m² in women; and bioimpedance, < 7.0 kg/m² in men and < 5.7 kg/m² in women. In addition, the AWGS 2019 update proposes separate algorithms for community vs. hospital settings, which both begin by screening either

calf circumference (< 34 cm in men, < 33 cm in women), SARC-F (\geq 4), or SARC-CaF (\geq 11), to facilitate earlier identification of people at risk for sarcopenia. Although skeletal muscle strength and mass are both still considered fundamental to a definitive clinical diagnosis, AWGS 2019 also introduces "possible sarcopenia," defined by either low muscle strength or low physical performance only, specifically for use in primary health care or community-based health promotion, to enable earlier lifestyle interventions. Although defining sarcopenia by body mass index-adjusted muscle mass instead of height-adjusted muscle mass may predict adverse outcomes better, more evidence is needed before changing current recommendations [13]. Low skeletal muscle mass and low physical performance in older persons are both predisposing conditions for disability. These conditions are coming into focus with numerous ongoing clinical trials, such as the SPRINTT study (Sarcopenia and Physical fRailty IN older people: multi-component Treatment strategies) [1, 2, 14].

Falls are highly associated with sarcopenia

Sarcopenia has gradually gained acceptance among the general public, health sports centers, nutrition associations, and geriatric medicine experts in recent years; it has been defined internationally: in 2010, the European Working Group on Sarcopenia (EWGSOP) proposed a "progressive" definition of sarcopenia. Reduced muscle mass and function (muscle strength and physiological activity) may lead to a syndrome of increased disease incidence, decreased quality of life, and even death. [15]. Criteria for Diagnosis and Grading: There are three components to this condition: low muscle mass, low muscle strength, and low physical performance. Many kinds of literature discuss falls in the elderly, however, sarcopenia-related falls are rarely discussed. There are numerous individual reasons for sarcopenia and falls, making it difficult to prove a causal relationship, especially since most research is cross-sectional. A cross-sectional study cannot determine whether sarcopenia is a risk factor for falls, and future prospective studies are required to determine whether sarcopenia causes falls in older adults; in short, sarcopenia is a risk factor for falls. It is connected with falls in older adults and is defined by muscle mass, muscle strength, and physical performance [13, 16]. Interventions to prevent sarcopenia may be useful in preventing falls in the elderly. Sarcopenia is a geriatric syndrome characterized by decreasing muscle mass, strength, and physical function. Sarcopenia may be a significant risk factor for falls. Sarcopenia and frailty are common geriatric syndromes around us. As we get older, muscle and bone mass will gradually lose, and the risk of sarcopenia will gradually increase. After the age of 30, muscle mass decreases by 8% every ten years. After muscle mass declines, weakness, weakness, fatigue, falls, and Symptoms such as weight loss [17]. Whereas medical care in the past focused on prevention, early diagnosis, and long-term care, current trends tend to view age as a background cause of frailty,

interacting with multiple factors including age-related physiological changes, environment, various diseases, and medications [18]. This leads to debilitating symptoms in the elderly, and many factors can be summarized as endocrine system diseases and systemic inflammation. Body composition changes in the skeletal musculature may be nutrient deficiencies, of which sarcopenic obesity has drawn more attention. Many physiological mechanisms are considered to be related to frailty, among which sarcopenia is considered to be highly correlated with frailty, and it can almost be said that sarcopenia and frailty are two sides of the same coin [19]. If obesity is combined at the same time, it will also lead to metabolic deterioration problems such as blood sugar and blood pressure, because muscle is closely related to the storage of human protein and the regulation of blood sugar and another metabolism. If the elderly have both muscle deficiency and obesity, it is called sarcopenic obesity, and sarcopenic obesity may be more likely to cause cardiovascular disease or falls than obesity or sarcopenia alone, and even increase mortality. According to recent research, approximately 6% of all medical expenditures for older Americans are related to falls, and 5% of older adults who fall require hospitalization [20].

Sarcopenic osteoporosis

Sarcopenia and osteoporosis are major contributors to disability and frailty. Age-related chronic inflammation, often indicated as inflammaging, leads to a decrease in both muscle mass and strength and bone loss, such as sex and growth hormone decline. Sarcopenic osteoporosis is also known as osteosarcopenia, which is osteopenia or osteoporosis combined with sarcopenia [21]; sarcopenia and osteoporosis are generally related. Since 2001, some people have studied the relationship between muscle and bone in the elderly; recent studies have found that muscle mass can predict bone density for both elderly men and women, and the evidence for postmenopausal women is that stronger than in men [22]. Therefore, the synergistic relationship between sarcopenia and osteoporosis may be better viewed as an interaction of five indicators of muscle mass, muscle strength, bone mineral density, fractures, and quality of life [23]. After the age of 50, the muscle mass decreases by about 1-2% per year, and the muscle strength decreases by 1.5-3% per year. Some literature believes that it is caused by the decline of estrogen after menopause [24]. In addition to the effects of sex hormones, insulin-like growth factors and growth hormones also affect bones and muscles. Because muscles and bones are mutually reinforcing [25], sarcopenia and osteoporosis are also often combined, resulting in osteopenia syndrome. EWGSOP defines sarcopenia as not only a decrease in muscle mass, but also an impact on muscle strength and physical performance [26]; recent studies have found that people with osteoporosis are often also people with sarcopenia, so sarcopenia is associated with Osteoporosis is co-existing and closely related.

Physiological factors affecting balance

Falls have many different causes, some risk factors that predispose older adults to falls are classified as intrinsic or extrinsic [27]. Intrinsic factors include those related to function and health conditions such as physiological dysfunction and balance disorders. Extrinsic factors include adverse drug reactions, use of restraints, and environmental factors such as poor lighting or lack of safety equipment in bathrooms. Physiological functions include: 1. Degeneration of the nervous system: the nerve conduction speed in the elderly becomes slower, the sensation is slower, and the reaction time is prolonged; the degeneration of the optic nerve affects vision, and lesions of the vestibular nerve, cerebellum, brain stem, and basal ganglia (stroke, Parkinson's disease) Symptoms and so on will affect the balance of the elderly. 2. Degeneration of skeletal joints and muscular systems, such as joint pain, deformation, contracture, *etc.*, caused by lower limb or spondyloarthritis, affects the stability and symmetry of the patient's gait and makes the patient prone to falls. Compared with young people, the total muscle mass and number of muscle fibers of the elderly show a significant decrease, and aging causes muscle atrophy; from the age of 60 to 90, the average muscle strength decreases by 20-30%. All of the above reasons make the elderly unable to cope with the occurrence of falls. 3. Concomitant medical diseases such as arrhythmia, postural hypotension, inappropriate hypoglycemic and hypertensive drugs, antihistamines and sedatives, *etc.*, may affect the sense of balance and make the elderly more prone to falls [28].

Improve diet and regular exercise to prevent falls in older adults

During the process of muscle loss, adipose tissue also slowly accumulates. This phenomenon is a state of excessive fat accumulation and reduced muscle mass, also known as musculoskeletal atrophic obesity. If the elderly population is combined with muscle atrophy and obesity, it will have a multiplicative negative impact on health, and accelerate the physical disability, morbidity, and mortality of the elderly [29]. Sarcopenia, obesity, and sarcopenic obesity are associated with many negative health outcomes such as a higher risk of falls and lower health-related quality of life in older adults. Vitamin D supplementation appears to reduce the risk of falls by more than 20 percent in stable ambulatory or hospitalized older adults [30]. Studies have found that 400 IU of vitamin D did not significantly reduce fracture risk, while trials using 700-800 IU/day of vitamin D did find a significant reduction in observed fractures, and further studies should be considered to examine the effects of alternative types of vitamin D and their dose, calcium. The role of supplements and effects in men [31]. Musculoskeletal aging is a major public health problem and stress in Taiwan due to significant demographic changes with aging, and frailty,

sarcopenia, a high risk of falls, and loss of autonomy in the elderly are associated with institutionalized health outcomes [32]. This pathological state is therefore also associated with high morbidity rates and health care expenditures. Bone mass, muscle mass, and strength increase in late adolescence and early adulthood, but decrease significantly from age 50 and are closely related. It is increasingly accepted that bone and muscle tissue are endocrine organs that interact through paracrine and endocrine signaling [33]. The mineral content of bone is closely related to muscle mass during growth, there is some evidence that osteoporosis and sarcopenia share common pathophysiological factors, and that low bone mineral density (BMD) in both men and women is associated with a correlation exists between sarcopenia [34]. Typical elderly sarcopenia and osteoporosis are often closely related and are also highly related to frailty. These syndromes lead to an increased risk of falls in the elderly; according to research, falls in long-term care institutions are an important factor in disability and death for the elderly, Studies have investigated that “environmental factors” account for the largest proportion of falls in the elderly, as high as 50% [35]. And older people living in the community, due to various internal (age, gender, ethnicity, physical health problems, medical, cognitive impairment, and physical inactivity), and external (vision, polypharmacy, inappropriate shoes, inappropriate accessories furniture and bathrooms, lack of grab bars, poor lighting, uneven stairs or slippery surfaces) risk factors, more than one-third of seniors fall at least once a year, and among seniors living in the community, 30-50% of falls are due to environmental factors caused [36].

Prescriptions for balance-promoting exercise for the elderly

Due to lack of exercise, the walking speed of some elderly people is slower, the pace is smaller, the walking pause time is longer, the swinging time of the hands during walking is shortened, the foot lift is not high, and the range of motion of each joint of the leg is small during walking. Lack of sufficient exercise can cause muscle atrophy and joint stiffness and contracture. Muscle atrophy refers to the reduction of muscle size, tension, and muscle strength. Usually, symptoms of muscle weakness will appear after 1-2 days of bed rest. The more frail, the lower the activity tolerance, the less the amount of exercise, and the more reluctance to move because of the weakness. In this vicious cycle, the muscles begin to atrophy [37]. The gait and balance problems of the elderly are related to the stability of the elderly when walking and standing, and the walking posture is different due to common elderly diseases, which are all factors that cause the elderly to fall. The body needs to be coordinated by 3 systems to maintain balance: 1. Vestibular system: sensory organs that regulate balance force (balance force perception), directional information related to head position (internal gravity, linear

and angular acceleration). 2. Somatosensory system: joint proprioception and kinematic sensation, information from skin and joints (pressure and vibration sensations); spatial position and motion relative to supporting surfaces; motion and position of different body parts relative to each other. 3. Vision system: refer to the verticality of body and head movements, relative to the spatial position of the object [38]. Once the elderly fall, they will be more afraid of walking, staying in bed, or sitting in a wheelchair all day, and the muscles and joints will gradually degenerate, forming a vicious circle [39]. When practicing Tai Chi, you need to focus on muscle control, which can help enhance the strength of the upper and lower limbs and the overall balance and stability, so that the elderly can reduce the risk of falling. Some studies have pointed out that practicing Tai Chi can reduce the risk of falling by as much as 50% within 12 months. Older adults with physical frailty and sarcopenia represent a subset of the older population at risk of adverse health-related events and whose medical needs are currently unmet. A multicomponent intervention with physical activity with technological support and nutritional counseling is associated with a reduction in the incidence of mobility disability of follow-up in older adults with physical frailty and sarcopenia and SPPB scores.

Therefore, such an intervention may be proposed as a strategy to preserve mobility in older adults at risk of disability [40, 41].

Conclusion

Aging is associated with the gradual decline of the body's physiological functions. An important body part affected by aging is muscle tissue [42]. Gait speed also represents a marker of sarcopenia. In the revised recommendation by the European Working Group on Sarcopenia in Older Persons (EWGSOP2), a cutoff score of even 0.8 m/sec is defined as an indicator of severe sarcopenia [43].

The world's population is aging, and increases in life expectancy are often unhealthy. In particular, musculoskeletal aging, which leads to sarcopenia and osteoporosis, has a variety of causes; such as changes in body composition, inflammation, and hormonal imbalances. Sarcopenia, osteoporosis, and sarcopenic obesity are often closely associated with frailty, often leading to the development of geriatric syndromes [44]. Frailty increases the risk of immobility or falls during daily activities, and increases cardiovascular disease, cancer, and death [45]. As the geriatric population continues to increase, it is most important to identify the elderly at risk of frailty early and treat or prevent their poor prognostic factors [46], and develop interventions that can promote successful aging. The complexity and heterogeneity of sarcopenia and frailty require a comprehensive geriatric assessment, such as nutritional interventions, regular physical activity, and psychosocial well-being, and regular review of medication intake, which appears to prevent and affect life expectancy and quality of life, thereby reducing mortality [47, 48]. Falls

and sarcopenia are interrelated. If there is no effective prevention and interventional treatment, the disability of the elderly may come early, which will bring more burdens to patients and caregivers. Of course, more foundations are required. And clinical research to understand the complex physiology of sarcopenia, osteoporosis, and frailty leading to falls in the elderly, and to take effective clinical interventions at a young age to prevent and treat sarcopenia [25, 36].

Declarations

Authors' contributions: Both authors contributed equally.

Availability of data and materials: Not applicable.

Financial support and sponsorship: None.

Conflicts of interest: All authors declared that there are no conflicts of interest.

Ethical approval and consent to participate: Not applicable.

Consent for publication: Not applicable.

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