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The Silent Epidemic: Understanding Osteosarcopenia and Its Impact on Elderly Health

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ABSTRACT

The occurrence of osteoporosis and sarcopenia often increases in the elderly population, yet it frequently does not present clear complaints. Osteoporosis is characterized by low bone mass and damage to the microarchitectural structure of bone, while sarcopenia refers to the loss of muscle mass, strength, and function. When both conditions coinside, the term used is osteosarcopenia. The presence of osteosarcopenia can increase the risk of falls, which may lead to fractures. Falls have a significant impact, both on individuals—including a decline in quality of life, the need for care in nursing homes, and even death—and on society, which faces rising healthcare costs. The purpose of this writing is to raise awareness about osteosarcopenia, which often receives insufficient attention, by providing an overview of this condition. With a better understanding, it is hoped that effective preventive measures can be taken to reduce the negative impacts caused by osteosarcopenia.

Keywords: osteosarcopenia, osteoporosis, sarcopenia, fall risk, quality of life

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INTRODUCTION

The quality of life of healthy older adults is highly dependent on the ability to maintain the reserve capacity of various physiological systems. One crucial system is the musculoskeletal system, which not only allows individuals to mobilize but also serves as a storage site for major metabolites, such as calcium in bones and glucose in muscles (Kirk et al., 2020). Osteosarcopenia is a new term in geriatric syndrome that describes a condition in which osteoporosis or osteopenia occurs together with age-related sarcopenia (Sepúlveda-Loyola & al., 2020).

In the future, it is anticipated that osteosarcopenia will become more common among the elderly, which may raise the likelihood of fragility fractures and lead to considerable morbidity and mortality (Clynes & al., 2020). Research indicates that after middle age, skeletal muscle mass may decrease by as much as

6% every decade, which complicates the management of older adults' health (de Sire & al., 2024).

This geriatric condition has considerable implications due to its significant effects on health, mobility, and overall well-being. Consequently, the purpose of this review is to explore the causes, prevalence, and clinical consequences of osteosarcopenia. Gaining this insight is crucial for designing effective prevention and treatment approaches aimed at enhancing musculoskeletal health and improving the quality of life for elderly individuals in good health.

Osteosarcopenia

Patients with osteoporosis or osteopenia have lower bone density, so they are at higher risk for fractures. On the other hand, patients with sarcopenia experience decreased muscle mass and muscle strength, which significantly increases the risk of falls, hospitalization, disability, or even death. 5 Research shows that osteoporosis and sarcopenia have similar risk factors and often appear and develop simultaneously (Nielsen et al., 2018). As individuals enter their sixties, there is a gradual reduction in bone mineral density (BMD), typically ranging from 1-1.5% annually, along with a decrease in muscle mass and strength, which drop by 1% and 2.5-3% per year, respectively. This deterioration significantly increases the risk of osteosarcopenia.

Epidemiology

Several studies have reported the prevalence of osteosarcopenia among older adults, both in hospitals and in the community. Previous research has shown a wide range of prevalence rates for osteosarcopenia, varying from 5% to 37%. A meta-analysis conducted in 2023 revealed that the global prevalence of osteosarcopenia was 18.5% in a sample of 63,369 elderly individuals. It was found that frailty, female gender, malnutrition and age could be risk factors for osteosarcopenia (Nielsen et al., 2018). A cohort study involving 14,429 participants followed for an average of 6.6 years found that the presence of osteosarcopenia at baseline was associated with a 53% increased risk of mortality, with no influence from any heterogeneity (Veronese & al., 2024). A recent meta-analysis showed that the prevalence of osteosarcopenia ranges from 1.5% to 65.7%, with major risk factors including female gender, advanced age, and history of fracture (Huang et al., 2023). In a cross-sectional study conducted in Finland in 2024 involving 2142 people aged ≥ 55 years, the prevalence of sarcopenia was 3.9% which was associated with factors associated with frailty, including impaired mobility, low body weight, and depression (Blomqvist & al., 2024). Osteosarcopenia significantly increases the risk of falls and fractures, which contribute to morbidity and mortality in the elderly population (B. J. Kim, 2024). Another study revealed that out of 337 participants, 38.3% were considered to have osteosarcopenia. Individuals with osteosarcopenia had more chronic diseases,

disabilities in daily activities, and cognitive impairment compared to those without this condition (Chou & al., 2023).

Pathophysiology of Osteosarcopenia

Many factors contribute to the pathology of osteosarcopenia, including genetic influences on muscle strength and attainment of maximal bone mass. This highlights the importance of understanding these factors in developing effective preventive strategies. Genome-wide association studies have shown that although no single gene is exclusively associated with osteosarcopenia, some genetic variants such as GDF8 may influence an individual's risk of developing the condition (Trajanoska et al., 2019). In addition to genetic factors, environmental factors such as diet, physical activity, and underlying health conditions also play a role in the development of osteosarcopenia.

The mechanostat hypothesis proposed by Frost emphasizes that greater mechanical loading of bones during childhood and adolescence may increase bone strength in adulthood. Conversely, decreased muscle strength with age causes bones to become less used, leading to suboptimal bone remodeling. This process may result in decreased bone mineral density and increased fracture risk, which are hallmarks of osteosarcopenia (Laskou et al., 2022).

Inflamm-aging, which describes the prolonged, low-level activation of the immune system, arises from continuous exposure to antigenic stimuli throughout life. This process is influenced by a complex interplay of genetic, environmental, and age-related factors, including mitochondrial dysfunction. The resulting chronic inflammation can impact bone and muscle metabolism, playing a role in the development of osteosarcopenia (Franceschi et al., 2019).

Prolonged inflammation can lead to increased pro-inflammatory cytokines, which contribute to decreased muscle mass and bone density, and interfere with healthy bone remodeling. Fatty infiltration is a hallmark of sarcopenia and osteoporosis, with high levels of bone marrow adipose tissue associated with bone loss and decreased muscle quality. Changes in hormone levels with aging may contribute to the development of osteosarcopenia. Estrogen receptors are present in both human muscle and bone cells, indicating that hormone replacement therapy in postmenopausal women could aid in preserving bone and muscle mass (Hidayat & Riviati, 2021). After menopause, estrogen levels decline dramatically, leading to increased osteoclast activity and decreased osteoblast activity. These changes contribute to decreased bone density, increasing the risk of osteoporosis and fractures (Yoh & al., 2023). In addition, estrogen also plays an important role in muscle protein synthesis. Decreased estrogen levels can lead to loss of muscle mass, which further worsens osteosarcopenia. Low levels of testosterone in men and estrogen in women contribute to an increased risk of muscle atrophy and bone loss (Tejawati & al., 2023). Decreased levels of these hormones can disrupt the balance between bone formation and resorption, and affect muscle protein synthesis,

ultimately worsening osteosarcopenia. Growth hormone (GH) and insulin-like growth factor-1 (IGF-1) play important roles in the growth and maintenance of muscle and bone tissue (Ahmad & al., 2020). Growth hormone (GH) promotes the production of IGF-1 in the liver, which plays a role in muscle protein synthesis and bone formation. However, as individuals age, levels of GH and IGF-1 typically decrease, leading to a reduction in muscle mass and bone density, thereby raising the risk of osteosarcopenia (Hage & al., 2023).

Nutrisi tertentu, terutama vitamin D, memiliki pengaruh signifikan terhadap kesehatan tulang dan otot. Sebuah studi yang dilakukan di Korea menunjukkan bahwa defisiensi vitamin D berkaitan dengan rendahnya kepadatan mineral tulang (BMD), dengan hubungan yang lebih jelas pada individu yang lebih tua. Penurunan kadar vitamin D dapat mengganggu proses penyerapan kalsium dan mempengaruhi fungsi otot, yang pada gilirannya dapat memperburuk kondisi osteosarkopenia. Oleh karena itu, pendekatan multidimensional yang mempertimbangkan berbagai faktor ini sangat penting dalam memahami dan menangani osteosarkopenia.

Certain nutrients, particularly vitamin D, have a significant impact on bone and muscle health. A study conducted in Korea showed that vitamin D deficiency is associated with lower bone mineral density (BMD), with the association being more pronounced in older individuals. Decreased vitamin D levels may impair calcium absorption and affect muscle function, which in turn may worsen osteosarcopenia. Therefore, a multidimensional approach that takes these factors into account is essential in understanding and managing osteosarcopenia (Laskou et al., 2022).

Risk Factors

Risk factors for osteosarcopenia in older adults include a variety of factors, including decreased muscle mass and bone mineral density associated with aging, physical inactivity, and nutritional deficiencies, especially in protein and vitamin D intake (Silveira & al., 2023). Studies have shown that a variety of underlying health conditions may contribute to the development of osteosarcopenia, including endocrine disorders, such as diabetes and thyroid dysfunction, and low vitamin D levels (Hirschfeld et al., 2017). In addition, abnormalities in sex steroid hormones, decreased levels of growth hormone and insulin-like growth factor 1 (IGF-1), and malnutrition have also been identified as factors associated with osteosarcopenia, as they play an important role in regulating bone and muscle mass metabolism, with decreased levels of GH/IGF-1 associated with osteoporosis and sarcopenia (Chew & al., 2019; Hamad & al., 2019; Hassan & Duque, 2017). These conditions may alter the balance between bone formation and resorption, as well as affect muscle mass, thereby increasing the risk of osteosarcopenia in older adults.

Studies have shown that patients with osteosarcopenia have a significantly lower Body Mass Index (BMI) compared to patients with osteoporosis alone (Okamura & al., 2020). This finding is supported by recent research reporting that

malnutrition is significantly associated with osteoporosis and sarcopenia (Y. Yoshimura & al., 2017). A study involving 700 participants found that patients with osteosarcopenia tended to be older, predominantly female, had a body mass index (BMI) below, and were at higher risk of depression and malnutrition (Huo & al., 2015). Other studies have also confirmed that osteosarcopenic patients tend to be older and more frail, with a low Body Mass Index (BMI), and have decreased muscle mass and handgrip strength (Pourhassan & al., 2021).

Yoshimura et al. melaporkan dalam survei tindak lanjut selama empat tahun bahwa keberadaan osteoporosis secara signifikan meningkatkan risiko perkembangan osteosarkopenia di masa depan (N. Yoshimura & al., 2017). Meskipun demikian, intervensi olahraga dan nutrisi untuk pengobatan sarkopenia dapat berkontribusi dalam meningkatkan kekuatan otot. Pasien dengan osteosarkopenia menunjukkan tingkat kerapuhan dan disabilitas yang lebih tinggi dalam aktivitas sehari-hari, serta mengalami depresi yang lebih parah (Okayama & al., 2022; Park & al., 2021; Reiss & al., 2019). Oleh karena itu, deteksi dini osteosarkopenia dan penerapan strategi intervensi yang tepat sangat penting untuk mencegah perkembangan kondisi ini.

N. Yoshimura & al. (2017) reported in a four-year follow-up survey that the presence of osteoporosis significantly increases the risk of developing osteosarcopenia in the future. However, exercise and nutritional interventions for the treatment of sarcopenia may contribute to improving muscle strength. Patients with osteosarcopenia show higher levels of frailty and disability in daily activities, and have more severe depression. Therefore, early detection of osteosarcopenia and implementation of appropriate intervention strategies are essential to prevent the development of this condition.

Health Impact

Osteosarcopenia, which is a combination of osteoporosis and sarcopenia, has significant health impacts on older individuals. Studies have shown that individuals with osteosarcopenia are at higher risk for fractures, decreased mobility, and functional disability. Osteosarcopenia can worsen pre-existing health conditions, such as diabetes and cardiovascular disease, adding to the overall health burden (A. Lee & al., 2024; Polito & al., 2022). Other studies have shown that sarcopenia worsens the condition of osteoporosis patients, especially in women, by accelerating bone tissue breakdown. This leads to an increased risk of falls and fractures, and significantly impairs daily activities. Individuals with osteosarcopenia experience decreased walking speed and an increased risk of falls, which can reduce their independence (Tu & al., 2025).

Furthermore, osteosarcopenia is also associated with an increased risk of poorer cognitive function, malnutrition, and a higher burden of disease. Studies have shown that individuals with osteosarcopenia have a higher prevalence of cognitive impairment and poor nutritional status compared to those with

osteoporosis or sarcopenia alone. Therefore, osteosarcopenia affects not only physical health but also mental health, contributing to a decrease in overall quality of life. Therefore, early detection, proper management, and preventive measures are essential to reduce these negative impacts in high-risk individuals.

Diagnosis and Assessment

The diagnosis of osteopenia and osteoporosis is based on the criteria set by the World Health Organization (WHO), where bone mineral density (BMD) is measured using the dual X-ray absorptiometry (DXA) method. Osteopenia is defined as a BMD in the range of -1.0 to -2.5 standard deviations (SD) for healthy young adults, while osteoporosis is characterized by a BMD of -2.5 SD or lower.

Sarcopenia is a condition characterized by decreased muscle mass, muscle strength, and/or impaired physical function. In clinical practice, some commonly used diagnostic criteria to assess sarcopenia include the guidelines set by the European Working Group on Sarcopenia in Older People (EWGSOP), the latest version of the criteria, and the criteria issued by the Asian Working Group for Sarcopenia (AWGS 2019). When using DXA, the threshold value for muscle mass in the EWGSOP criteria is 7.0 kg/m² for men and 5.5 kg/m² for women, while the AWGS 2019 criteria are 7.0 kg/m² for men and 5.4 kg/m² for women. Muscle strength is measured by grip strength. Gait speed, 5-fold chair stand test, and the Short Physical Performance Battery (SPPB) are recommended to measure physical function.

Prevention and Treatment Strategies

The treatment and prevention of osteosarcopenia require a multidisciplinary approach that includes appropriate physical and nutritional interventions. Resistance and aerobic exercise have been shown to be effective in increasing muscle mass and bone density, which are essential for managing osteosarcopenia (B. C. Lee & al., 2024). In addition, nutrition plays a crucial role in the treatment and prevention of osteosarcopenia, especially through adequate protein intake (B.-J. Kim & al., 2024). Studies have shown that adequate protein intake can increase muscle synthesis and improve muscle mass in older individuals, which is essential for combating sarcopenia (Franulic & al., 2024). In addition, vitamin D also plays an important role in bone and muscle health, with vitamin D deficiency worsening osteosarcopenia. Vitamin D supplementation has been shown to increase muscle strength and bone density, thereby reducing the risk of falls in older adults. Adequate calcium intake is also essential for maintaining bone health, as calcium contributes to bone mineral density. Studies have shown that a diet rich in calcium can help prevent osteoporosis, which is a major component of osteosarcopenia. Additionally, antioxidants such as vitamins C and E may help reduce oxidative stress that contributes to muscle and bone aging. 40 A balanced diet that includes a variety of nutrients, including healthy fats, complex carbohydrates, and

micronutrients, is also important for supporting overall health and preventing osteosarcopenia.

Pharmacological therapy also plays an important role in the management of osteosarcopenia, especially in improving bone and muscle health in older individuals. One of the most studied drugs is Denosumab, which is used to treat osteoporosis and has been shown to reduce the risk of falls and improve physical function in patients with osteoporosis, which is relevant for osteosarcopenia. In addition, therapy with bisphosphonates has also shown potential in increasing bone mineral density and reducing fracture risk in patients with osteosarcopenia (Kirk et al., 2020). Studies have shown that the combination of pharmacological therapy with non-pharmacological interventions, such as physical exercise and proper nutrition, may provide better outcomes in the management of osteosarcopenia. Drugs such as teriparatide and romosozumab are also being explored as therapeutic options to increase bone and muscle mass and reduce fracture risk in patients with osteosarcopenia. Therefore, a multidisciplinary approach that includes both pharmacological and non-pharmacological therapies is essential to improve the quality of life of patients with osteosarcopenia. reduce the risk of fractures. Other studies have suggested that hormonal therapy, specifically hormone replacement therapy (HRT), has been shown to be effective in the management of osteosarcopenia, especially in postmenopausal women. HRT can help increase bone mineral density and reduce the risk of fractures, which are important components in the management of osteosarcopenia. Studies have shown that estrogen use can reduce bone loss and improve overall bone health. In addition, HRT can also contribute to increased muscle mass, which is important for preventing sarcopenia associated with osteosarcopenia. However, it is important to weigh the risks and benefits of HRT, and to conduct an individualized evaluation of the patient before starting this therapy. Therefore, an integrated approach that includes hormonal therapy, proper nutrition, and exercise is essential in the management of osteosarcopenia.

Antimyostatin antibodies are therapies designed to inhibit myostatin, a protein that regulates muscle growth by inhibiting muscle protein synthesis (Jang & al., 2021). Myostatin plays a key role in regulating muscle mass, and increased myostatin levels can lead to decreased muscle mass, which is one of the main features of osteosarcopenia (Jang & al., 2021). Studies have shown that the use of antimyostatin antibodies can increase muscle mass and strength in individuals with sarcopenia and osteosarcopenia. 45 In addition, this therapy also shows potential in improving the quality of life of patients with osteosarcopenia by improving physical function and mobility.

Creatine is a compound that plays an important role in improving muscle and bone health, especially in aging individuals. Creatine supplementation has been shown to increase muscle mass and strength, and contribute to improved physical performance (Candow et al., 2019). In addition, creatine also plays a role in

improving bone quality by influencing the activity of cells involved in bone formation and resorption. Several studies have shown that creatine supplementation, especially when combined with resistance training, can increase bone mineral density and reduce fracture risk in the elderly population (Dolan et al., 2019). Thus, creatine not only serves as a supplement to increase muscle strength, but also has therapeutic potential in supporting bone health, making it an attractive option in the management of osteosarcopenia. By understanding the relationship between osteosarcopenia and frailty, more integrated interventions can be designed to improve health outcomes in the elderly population. Therefore, a combination of physical exercise, nutritional support, and comprehensive health management is essential to address and prevent osteosarcopenia.

CONCLUSION

Healthy aging is highly dependent on the ability to maintain the reserve capacity of different physiological systems. Osteosarcopenia, characterized by low bone mass density and microarchitectural deterioration of bone, as well as loss of muscle mass and function, increases the risk of falls. The diagnosis of this condition integrates the assessment of osteoporosis and sarcopenia, while its management requires a holistic approach that includes non-pharmacological and pharmacological strategies to effectively manage both conditions.

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