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A review of research progress on the comorbidity of sarcopenia and cardiovascular diseases in the elderly

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Abstract: As the global population ages, age-related diseases, particularly cardiovascular ailments, pose formidable challenges to healthcare systems worldwide. This review highlights the importance of exercise in both the prevention and rehabilitation of cardiovascular disorders, underscoring the pronounced correlation between diminished exercise capacity in the elderly and heightened disease susceptibility. Moreover, sarcopenia, defined by reduced muscle mass and function, is intricately linked to cardiovascular health. The article reviews recent studies on the pathophysiology, interactions, mechanisms, clinical presentations, diagnostic criteria, and treatments of sarcopenia and cardiovascular diseases, with the objective of fostering a nuanced comprehension of these maladies

1. Introduction

Senile sarcopenia and cardiovascular disease represent two important health concerns affecting the elderly population globally. Sarcopenia, characterized by the progressive loss of skeletal muscle mass and function with age, not only reduces quality of life but also increases the risk of falls and fractures. It is estimated that approximately 10 to 24 percent of older adults are affected by sarcopenia, with a higher prevalence observed among those with chronic diseases[1].

Cardiovascular disease, including coronary artery disease, heart failure and high blood pressure, stands as a leading causes of mortality worldwide. The onset of these conditions is often associated with multiple physiological and metabolic changes during aging, especially pronounced in the elderly, where the incidence of cardiovascular disease increases significantly[2]. Besides immediate threats to life safety, cardiovascular disease can engender enduring health ramifications, such as diminished mobility and reduced quality of life.

There is a complex relationship between sarcopenia and cardiovascular disease in the elderly. Studies have shown that people with sarcopenia have a significantly increased risk of cardiovascular events, which may be due in part to a decrease in basal metabolic rate due to reduced muscle mass, as well as the associated inflammatory response and endocrine changes[3]. In addition, cardiovascular disease itself may also accelerate the loss of muscle function by reducing the amount of physical activity and promoting inflammatory pathways. Investigating this interplay not only improves our understanding of the biological mechanism governing the dual afflictions but also holds profound clinical implications. By revealing the mechanism of comorbidity between sarcopenia and

cardiovascular disease, it can help to develop more targeted prevention and treatment strategies to improve the health and quality of life of the elderly. Therefore, thorough exploration of the association between sarcopenia and cardiovascular disease assumes great importance in optimizing geriatric care and shaping public health policies.

2. Overview of sarcopenia

The aging process entails the loss of muscle mass, precipitating a decline in muscle function. In 1989, the term "sarcopenia" was first used to describe age-related muscle mass loss and to identify sarcopenia as a key component of geriatric syndromes. Sarcopenia is defined as a clinical syndrome characterized by progressive systemic reduction of skeletal muscle mass and strength, which can culminate in adverse outcomes including physical disability, reduced quality of life, and increased risk of death [4]. A systematic review revealed that the incidence of sarcopenia ranged from 1% to 29% among community-dwelling elderly, 14% to 33% in long-term care settings, and approximately 10% among elderly patients admitted to the emergency department. Studies indicate that sarcopenia incidence escalates with advancing age, with no significant gender disparities [5].

In Asia, the incidence of sarcopenia varies by region, with rates in Thailand being 35.33% for men and 34.74% for women; In Japan, it is 6.7% to 11.3% and 6.3% to 11.7%; In South Korea, 6.3% to 21.8% and 4.1% to 22.1%; In China, it is 12.3% and 7.6% [6]. The significant differences between these incidence rates are mainly due to differences in diagnostic criteria and methods of disease assessment.

The diagnostic criteria established by the European Working Group on Sarcopenia in Older People (EWGSOP) have gained widespread international acceptance. The diagnostic criteria include:

- Decreased muscle strength.
- Decreased muscle mass or volume.
- Decline in physical performance.

Detection of the first criterion warrants suspicion of sarcopenia; meeting both the first and second criteria allows for a diagnosis of sarcopenia; fulfillment of all three criteria indicates severe sarcopenia [4]. In reference to EWGSOP diagnostic criteria, the Asian Sarcopenia Working Group adjusted the diagnostic threshold values to accommodate Asian populations based on differences in ethnicity, lifestyle, body type, and cultural background [6]. Assessment of muscle strength typically involves a grip strength test, while dual-energy X-ray absorptiometry and bioelectrical impedance analysis are recommended for measuring muscle mass. Physical performance tests include walking speed test, physical fitness scale, standing up - walking timing test and so on. Screening for Sarcopenia is currently recommended in older age groups, particularly those at high risk as identified by the International Working Group on Sarcopenia (IWGS).

3. Overview of cardiovascular diseases

Cardiovascular diseases, encompassing coronary heart disease, heart failure, and hypertension, represent a significant burden on global health [7]. Coronary heart disease stems primarily from coronary artery stenosis, which restricts blood flow to the myocardium, leading to insufficient myocardial perfusion. Heart failure, characterized by the heart’s reduced efficiency in pumping blood, is frequently triggered by conditions such as high blood pressure or cardiac events like myocardial infarctions [8]. Hypertension, a chronic condition marked by elevated arterial pressure, substantially heightens the risk of developing cardiac complications and cerebrovascular events like strokes [9]. Risk factors for cardiovascular diseases are categorized into non-modifiable factors, including age, genetics, and gender, and modifiable ones, which consist of lifestyle choices such as poor dietary habits, lack of physical activity, smoking, and excessive alcohol consumption. Interventions

promoting healthier lifestyle choices can dramatically reduce the prevalence and impact of cardiovascular diseases.

4. Association mechanism between sarcopenia and cardiovascular disease in the elderly

The association between senile sarcopenia and cardiovascular disease is mediated through several complex pathophysiological pathways. Reduced muscle mass can significantly impair cardiovascular function, affecting both cardiac muscle function and vascular health. For instance, heart failure may induce peripheral ischemia and hypoxia, leading to skeletal muscle cell apoptosis, muscle atrophy, and consequently, diminished exercise capacity [10]. Additionally, sarcopenia's impact on reducing exercise capacity can exacerbate obesity, lipid disorders, and inflammatory responses, which, in turn, may accelerate the progression of cardiovascular diseases. This bidirectional relationship underscores the intertwined nature of muscle degradation and cardiovascular health in the elderly.

Common risk factors such as chronic inflammation, endocrine changes, insulin resistance, malnutrition, and reduced physical activity are prevalent in both sarcopenia and cardiovascular diseases in the elderly. Chronic systemic inflammation, in particular, assumes plays a pivotal role throughout the progression of cardiovascular diseases and intricately influences the onset of sarcopenia [11]. For instance, chronic inflammation, notably characterized by elevated levels of interleukin-6 (IL-6), plays a critical role in both atherosclerosis and muscle health. IL-6 contributes to the inflammatory pathway associated with atherosclerosis, fostering plaque formation and vascularconstriction, while also instigating catabolic processes in muscle tissues. This cytokine is implicated in accelerating muscle protein breakdown, leading to muscle weakness and atrophy, which are key characteristics of sarcopenia. Elevated IL-6 levels, therefore, exacerbate both vascular rigidity and muscle wasting, illustrating the interconnected nature of these pathologies in the aging population. These mechanisms not only shed light on the pathological link between sarcopenia and cardiovascular disease, but also emphasize the importance of co-management of the two conditions.

5. Joint intervention of sarcopenia and cardiovascular disease

5.1 Lifestyle adjustment

5.1.1 Exercise

Exercise is a cornerstone intervention for managing and mitigating the effects of both cardiovascular disease and sarcopenia, offering a multitude of benefits that extend beyond simple physical fitness. Regular engagement in exercise routines, particularly those incorporating both resistance and aerobic elements, has been extensively validated through various studies to significantly improve health outcomes in elderly populations, particularly those afflicted with sarcopenia and heart-related conditions [12].

Resistance training, involving activities that challenge muscles to work against a weight or force, emerges as particularly effective in enhancing muscle strength and mass. This modality of exercise stimulates muscle protein synthesis while inhibiting protein degradation, thereby counteracting the muscle wasting and weakness characteristic of sarcopenia. Over medium to long-term periods, resistance training can lead to substantive gains in muscle strength and size, improving physical function and reducing the risk of falls and fractures which are common complications of sarcopenia. Conversely, aerobic exercise primarily bolsters cardiovascular health, albeit also supporting muscle maintenance. Activities such as walking, cycling, and swimming enhance cardiovascular efficiency by elevating heart rate and facilitating improved blood circulation. This type of exercise is essential for retarding the progression of heart failure, a common cardiovascular ailment in the elderly, by

optimizing cardiac function and endurance. Furthermore, regular aerobic exercise reduces arterial stiffness and lowers blood pressure, thereby curtailing the likelihood of developing severe cardiovascular events.

The synergy between resistance training and aerobic exercise cannot be overstated. While resistance training builds muscle mass and strength, aerobic exercise enhances the endurance of these muscles and the efficiency of the cardiovascular system. Together, they provide a comprehensive approach to health maintenance, improving overall quality of life and longevity. Moreover, exercise fosters improved metabolic health, mitigating the prevalence of obesity, diabetes, and other metabolic syndromes that can exacerbate both heart conditions and muscle degradation. It is noteworthy that the benefits of exercise are contingent on dosage, with greater and more sustained benefits accruing from prolonged and consistent exercise regimens. However, exercise programs must be tailored to individual capabilities and health conditions to avoid injuries and ensure the maximum benefit. For older adults, especially those with pre-existing health conditions, consulting healthcare providers to devise a safe and efficacious exercise plan is imperative. Furthermore, the inhibitory effects of regular exercise on skeletal muscle breakdown are a vital area of interest. Through engagement in structured exercise programs, older adults can significantly reduce the rate of muscle loss associated with aging and disease. This not only aids in maintaining independence and mobility but also lessens the burden on healthcare systems by reducing the incidence and severity of falls, hospitalizations, and chronic health conditions.

5.1.2 Proper nutrition

The Mediterranean diet, renowned for its rich and balanced nutritional profile, represents an ideal dietary choice for individuals afflicted with coronary heart disease. Its emphasis on diverse array of nutrient-dense foods not only promotes cardiovascular health but also plays a crucial role in muscle maintenance, potentially delaying muscle atrophy in the elderly and reducing the risk of sarcopenia [13]. Sustained adherence to such a comprehensive diet yields substantial health benefits. However, the efficacy of vitamin D supplementation in averting and managing muscle atrophy remains subject of contention, as studies have yielded disparate findings on its effectiveness. This highlights the importance of a holistic dietary approach rather than reliance on single-nutrient supplementation to combat health issues associated with aging.

Smoking cessation and alcohol restriction are integral components of health management, particularly in the context of aging and associated diseases such as cardiovascular disease and sarcopenia. Smoking stands as a recognized independent risk factor for cardiovascular problems and can further compromise muscle strength in older adults, contributing to faster physical decline [14]. While existing meta-analyses have not directly linked alcohol consumption to sarcopenia, the variability in diagnostic criteria among studies casts some doubt on the reliability of these findings [15]. Hence, reducing alcohol consumption and quitting smoking are advised not only for their direct benefits on cardiovascular and muscle health but also for their broader positive impact on longevity and quality of life. These lifestyle adjustments are part of a comprehensive approach to health maintenance, which also includes proper nutrition, regular physical activity, and management of other modifiable risk factors. Through the adoption of such such holistic health strategies, individuals can significantly mitigate the risks associated with aging, thereby enhancing both their lifespan and healthspan.

5.2 Application of hormone therapy

5.2.1 Testosterone

Testosterone plays a crucial role in maintaining muscle strength and overall physical performance, especially in older adults. Diminished testosterone levels commonly correlate with reduced muscle strength and athletic prowess. Supplementation of testosterone can significantly enhance these physical capabilities. However, caution is warranted in approaching this treatment due to potential side effects, including prostatic hyperplasia, polycythemia, and others. To minimize risks, treatments are generally administered via intramuscular injections, which are considered safer and more effective in controlling dosage and reducing potential complications. This method helps ensure that the benefits of testosterone supplementation are realized while minimizing adverse effects.

5.2.2 GHrelin

Ghrelin, often referred to as the "hunger hormone," also plays a multifaceted protective role in the body, particularly concerning skeletal muscle cells. It regulates critical processes such as autophagy and apoptosis, which are essential for maintaining muscle cell health, and it helps modulate insulin resistance, a common metabolic issue. Apart from its impact on muscle cells, ghrelin is known to enhance cardiac and endothelial functions, which are crucial for cardiovascular health, and it possesses properties that inhibit the progression of atherosclerosis, thereby mitigating the risk of heart disease. However, the clinical application of ghrelin is intricate due to its heightened expression levels in specific tumor tissues, necessitating a cautious approach to its therapeutic utilization to ensure safety and efficacy.

5.2.3 Growth hormone

Growth hormone (GH) plays a critical role in skeletal muscle development, primarily through its regulation of insulin-like growth factor 1 (IGF-1), a key promoter of muscle mass. While the hormone's capacity to enhance muscle size extensively documented, it is imperative to acknowledge that increments in muscle mass may not uniformly correspond to proportional increases in muscle strength. This distinction is crucial for understanding the full implications of GH therapy in clinical settings, especially in treating conditions like sarcopenia and other muscle-wasting disorders.

While GH can effectively increase muscle mass, it does not have a significant impact on muscle strength. This may stem from the mechanisms tunderlying the mediation of muscle strength and mass. Muscle strength is influenced not only by the size of the muscle fibers but also by neuromuscular junction function, motor neuron capabilities, and various other biochemical and physiological factors that are not directly affected by growth hormone. Moreover, GH therapy administration carries potential side effects that necessitate careful management. One primary concerns is fluid retention, which can lead to edema and exacerbate conditions such as congestive heart failure or hypertension. Another significant risk is insulin resistance, a condition that can predispose individuals to diabetes and exacerbate existing metabolic disorders. These side effects pose particular risks to the cardiovascular system, potentially leading to complications that could offset the benefits of increased muscle mass. Given these complexities, the use of GH therapy requires careful consideration and monitoring. Healthcare providers must balance the potential benefits of increased muscle mass against the risks of side effects and potential lack of improvement in muscle strength. This decision-making process should involve a comprehensive evaluation of the patient’s overall health status, potential risk factors, and specific therapeutic goals.

In addition to clinical monitoring, ongoing research is essential to further elucidate the mechanisms by which GH influences muscle properties and to optimize treatment protocols. This endeavor will

facilitate the development of more targeted approaches that maximize the benefits of GH therapy while minimizing adverse effects, thereby ensuring that patients receive the most effective and safest level of care.

5.3 Drugs for the treatment of cardiovascular diseases

Angiotensin-converting enzyme inhibitors (ACEIs) and angiotensin receptor blockers (ARBs) are crucial in managing cardiovascular health due to their expansive protective benefits, which include significant anti-inflammatory and antioxidant properties. These properties not only benefit cardiovascular tissue but also extend to muscle tissue, offering a dual therapeutic potential. While early research indicated that ACEIs might slow the reduction in muscle mass associated with aging and various diseases, subsequent studies have yielded inconsistent results regarding their direct impact on muscle mass and strength. Conversely, ARBs have exhibited promising results in clinical settings, particularly among hemodialysis patients, demonstrating effective enhancement of muscle strength. This distinction underscores the importance of personalized medicine, as the response to these medications may vary based on individual health conditions and treatment contexts, necessitating tailored therapeutic strategies to optimize outcomes in muscle health and cardiovascular disease management.

5.3.1 Diuretics

Recent studies haveshed light on a concerning link between the use of loop diuretics and an increased risk of developing sarcopenia in patients with non-dialysis chronic kidney disease. While these medications effectively regulate fluid balance, their profound diuretic effects may inadvertently exacerbate muscle loss by inducing electrolyte imbalances and potential nutritional deficiencies, known contributors to muscle degradation. Conversely, in the context of heart failure, certain diuretics, such as Antolactone, have been observed to have a protective effect against sarcopenia. This benefit is likely due to the improvement in cardiac function that these diuretics facilitate. By enhancing cardiac output and reducing fluid overload, Antolactone can indirectly support better overall muscle function and strength. This improvement in cardiac function reduces the fatigue and inefficiency of muscle metabolism, which are common contributors to muscle atrophy in heart failure patients. The dual nature of diuretics underscores the complexity of medication management in chronic conditions and highlights the necessity of tailored treatment strategies. Healthcare professionals must judiciously weigh the benefits of diuretics in managing specific conditions against the potential risks these drugs pose to muscle health. Ongoing research and clinical observations are imperative in refining these approaches to optimize patient outcomes and minimize adverse effects, especially in vulnerable populations like those with chronic kidney disease and heart failure.These intervention strategies reflect the importance of integrated management of cardiovascular disease and sarcopenia, emphasizing the role of lifestyle adjustments, hormone therapy, and targeted medications in improving the health of patients with both conditions.

6. Conclusion

In summary, both cardiovascular disease and sarcopenia exhibit a rising incidence trend in the elderly population, with shared pathogenic mechanisms and interactions between them. Effective treatment of one disease can often yield positive outcomes for the other. However, certain treatments may manifest a dual effect. Therefore, adopting a healthy lifestyle and implementing sound medication strategies are pivotal in the prevention and treatment of these two diseases. Future studies are warranted to explore optimal treatment modalities tailored to specific patient populations afflicted

with cardiovascular disease and sarcopenia, aiming to enhance patient care and outcomes.

References

[1] Ken-ichiro Sasaki, Yoshihiro Fukumoto, "Sarcopenia as a comorbidity of cardiovascular disease," Journal of Cardiology 79 (2022) 596–604.

[2] Xinrong Zuo et al., "Sarcopenia and cardiovascular diseases: A systematic review and meta-analysis," Journal of Cachexia, Sarcopenia and Muscle 2023; 14: 1183–1198.

[3] Nana He et al., "Relationship between Sarcopenia and Cardiovascular Diseases in the Elderly: An Overview," Front. Cardiovasc. Med., 09 December 2021.

[4] Cruz-Jentoft AJ et al., "Sarcopenia: revised European consensus on definition and diagnosis," Age Ageing, 2019, 48(1): 16-31. DOI: 10.1093 /ageing /afy169.

[5] Chen L-K et al., "Sarcopenia in Asia: consensus report of the Asian Working Group for Sarcopenia," J Am Med Dir Assoc, 2014, 15(2): 95-101.

[6] Dhillon RJ, Hasni S. "Pathogenesis and management of sarcopenia," Clin Geriatr Med, 2017, 33(1) : 17-26.

[7] Kotseva, K., et al., "Lifestyle and Impact on Cardiovascular Risk Factor Control in Coronary Patients Across 27 Countries: Results from the European Society of Cardiology ESC-EORP EUROASPIRE V Registry." European Journal of Preventive Cardiology, 2019.

[8] Libby, P., et al., "Mechanisms of Acute Coronary Syndromes and Their Implications for Therapy." New England Journal of Medicine, 2019.

[9] Heidenreich, P. A., et al., "Forecasting the Future of Cardiovascular Disease in the United States: A Policy Statement from the American Heart Association." Circulation, 2013.

[10] Zhisheng Tan et al., "The relationship between muscular atrophy/sarcopenia and cardiovascular diseases in the elderly: a bibliometrics study," Ann Palliat Med 2021;10(8):9136-9148 | https://dx.doi.org/10.21037/apm-21-2144.

[11] Liu HW,Chen YJ,Chang YC,et al., "A low-molecular weight polyphenol derived from lychee,alleviates muscle loss in diabetes by suppressing atrogin-1 and MuRF1," Nutrients,2017,9(9) : e1040. DOI: 10.3390 /nu9091040.

[12] Stewart RAH, Held C, Krug-Gourley S, et al., "Cardiovascular and Lifestyle Risk Factors and Cognitive Function in Patients with Stable Coronary Heart Disease.," J Am Heart Assoc 2019;8: e010641.

[13] Yoon MS, "mTOR as a key regulator in maintaining skeletal muscle mass," Front Physiol, 2017, 8 (10) : 788. DOI: 10. 3389 /fphys.2017.00788.

[14] Gueugneau M, Coudy-Gandilhon C,Meunier B,et al., "Lower skeletal muscle capillarization in hypertensive elderly men," Exp Gerontol, 2016, 76(4) : 80-88.

[15] Lin YL, Chen SY, Lai YH, et al., "AngiotensinIIreceptor blockade is associated with preserved muscle strength in chronic hemodialysis patients," BMC Nephrol, 2019, 20(1) : 54.