REVIEW ARTICLE

CONTENTS

The impact of dietary factors on the outcomes of rehabilitation in individuals diagnosed with sarcopenia

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ABSTRACT

This review gives an overview of the current knowledge about the impact of nutrition on sarcopenia treatment effectiveness. We examined the outcomes of 11 individual clinical trials in conjunction with existing literature to assess the effectiveness of nutritional interventions. Our focus encompassed protein nutrition and its components, the provision of vitamin D. Furthermore, we explored the influence of these substances in addressing sarcopenia within the context of concurrent conditions like osteoporosis, fractures, stroke, or chronic kidney disease. Sarcopenia is a disease of the skeletal muscles that causes a decline in muscle function and mass, which affects mainly elderly people. A progressive course leads to multiple serious complications, such as increased mortality, falls, and co-morbidity. Sarcopenia treatment is limited to physical activity, mainly resistance exercise training and nutritional interventions... Our investigation underscores the significant role of proper nutrition in the treatment process. Finally, this review demonstrates the need for further high-quality research on nutrition and its impact on sarcopenia treatment outcomes.

KEY WORDS: sarcopenia, nutrition, nutritional therapy, malnutrition, rehabilitation

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INTRODUCTION

Sarcopenia is a progressive muscle disease strictly connected to the aging process, which is characteristic of muscle function impairment and muscle mass loss. However, the first quality has the primary significance [1, 2]. Since 2016, it has been included in the International Classification of Disease (ICD) as a separate disease entity [2]. The definition of sarcopenia has evolved over the last few years. It was established in 2019 by some consensus groups such as the European Working Group on Sarcopenia in Older People (EWGSOP2), Asian 2019 Asian Working Group for Sarcopenia (AWGS2019), and the American Sarcopenia Definitions and Outcomes Consortium (SDOC) [3-6].

The quintessence of sarcopenia is the reduction of the effectiveness of muscle work, which leads to several various consequences and complications of sarcopenia, the most significant risk of which is increased mortality, impaired cognitive functions, falls, osteopenia, osteoporosis, fractures, non-alcoholic liver disease, depression, and an increased risk of hospitalization [7].

The reason for the loss of muscle cell functions in the aging process is several factors and changes at the molecular level. The factors above influencing muscle cell changes explain the most common causes of sarcopenia. Those factors can be divided into related to: nutrition, inactivity caused by disease, and iatrogenic (Fig. 1) [8].

The prevalence of sarcopenia varies between studies, from 5% to 22% in the global general population, while among older adults in nursing homes, the prevalence is up to 29%, and in people over 80 years of age, from 11% to 50% [9]. Additionally, the incidence of sarcopenia in chronically ill people is higher. The incidence of sarcopenia in patients with type II diabetes is 18%, in esophageal cancer 66%, and is also high in people with kidney and liver disease requiring surgical treatment, as well as with various site-specific cancers [7]. Such a high incidence in elderly and chronically ill people, in the context of an aging society, encourages authors to take a closer look at the topic of sarcopenia in the context of effective treatment, with nutrition as a crucial aspect.

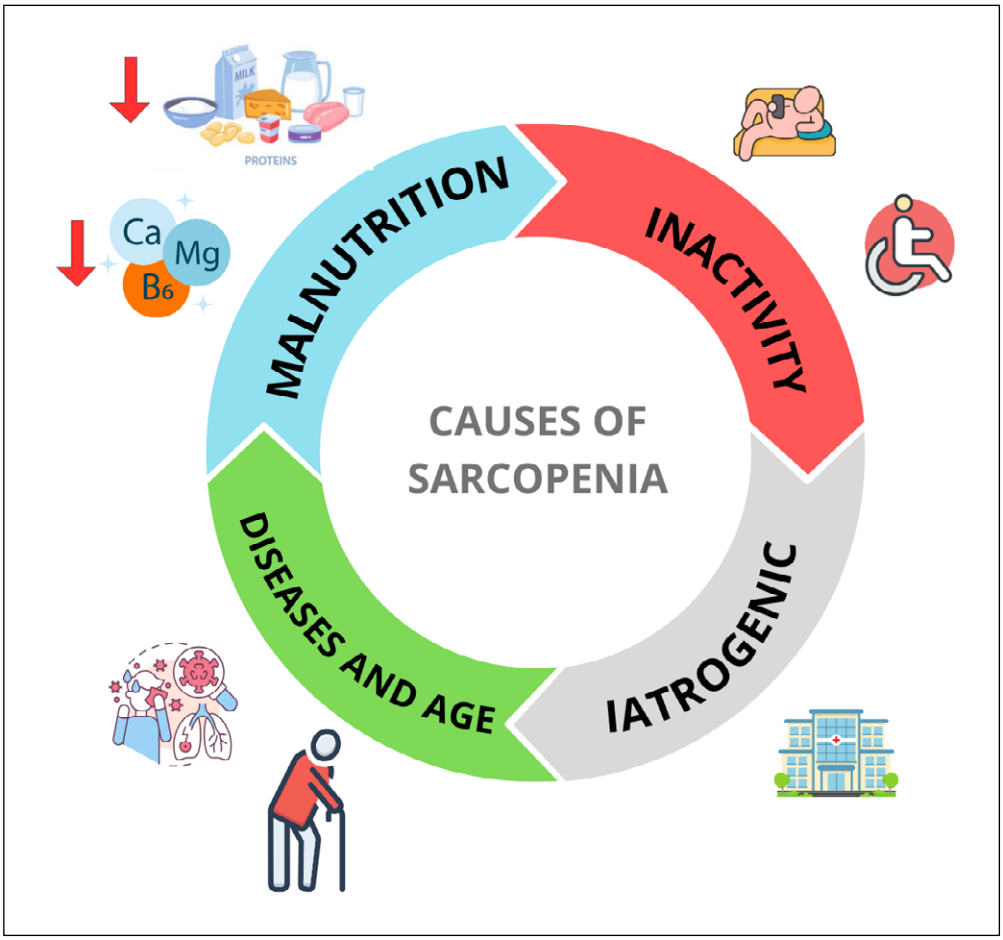

Fig. 1. Causes of sarcopenia [8].

Proper sarcopenia treatment is based on lifestyle changes, namely physical rehabilitation and nutrition. Physical rehabilitation involves performing resistance exercises, and nutrition provides all the necessary nutrients in a daily diet [10]. The current guidelines developed by AWGS2019 or EWGSOP2 for treating sarcopenia propose combining both methods and indicate greater effectiveness than using nutrition and exercise separately. Moreover, there is speculation in the literature as to the validity of the adopted dietary guidelines. Regardless of all ambiguities, proper nutrition, particularly the supply of protein and other necessary dietary elements, is essential to obtaining favorable results in rehabilitating and treating sarcopenia [11].

AIM

The objective of this systematic review is to compile insights from various research studies on the impact of nutrition on the rehabilitation of individuals with sarcopenia and to juxtapose these findings with existing literature. Additionally, this review aims to systematically organize the existing information in this domain, enhance understanding of co-morbidities associated with sarcopenia, and foster further exploration by researchers into the role of nutrition in addressing and preventing complications related to sarcopenia.

MATERIALS AND METHODS

A review of international scientific literature was conducted in January 2024. The study used several databases, including PubMed, Scopus, Web of Science, and Google Scholar. The existence of specific keywords such as "sarcopenia,""nutrition,""nutritional therapy,""malnutrition," "rehabilitation" individually or in combination have been thoroughly checked in these databases. Articles that did not meet the thematic criteria were removed after checking the titles and abstracts because they did not cover the topic of our work, which is based on the assessment of nutritional factors on the effects of rehabilitation. A thorough analysis of the remaining publications was carried out to determine which research and review works are the most important. The review underwent independent evaluation by two individuals. Inclusion criteria comprised scientific papers investigating the correlation between nutritional interventions and the status of sarcopenic patients, as well as systematic and interventional reviews within this field. The search was confined to scientific publications

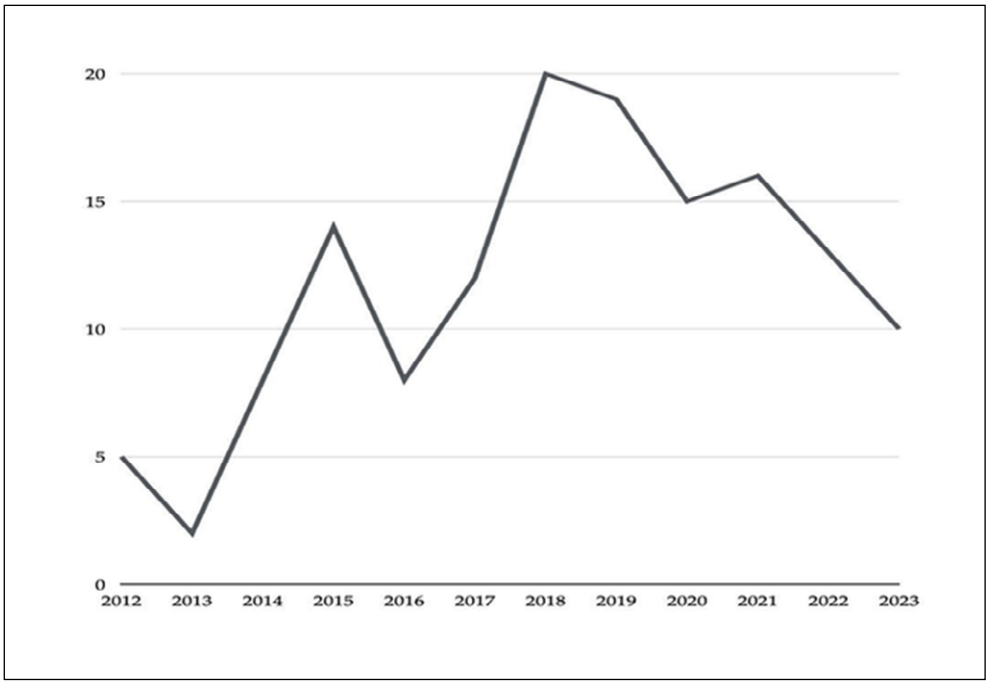

Fig. 2. The PubMed database contains 122 clinical trials conducted between 2012 and 2023, containing the keywords "sarcopenia," "nutritional therapy," and "rehabilitation".

released from 2012 to 2023, with the inclusion of pivotal research papers predating this period.

REVIEW

NUTRITIONAL THERAPY FOR SARCOPENIC PATIENTS – CLINICAL EVIDENCES

NUTRITIONAL TREATMENT IS THE KEY TO EFFECTIVE REHABILITATION

Malnutrition is a significant issue faced by around 30% to 50% of patients who undergo rehabilitation [12]. These patients can benefit from nutritional therapy, which can increase their chances of effective rehabilitation and a faster recovery. In this review, we will focus on the impact of nutrition on the patient's condition, using data from six clinical trials available on PubMed from 2012 to 2023 (Fig. 2).

After analyzing the data, it can be concluded that nutritional therapy can have a positive impact on muscle mass and physical capacity in older people. The results suggest that consuming around 1.5 grams of protein per kilogram of body weight can be beneficial for muscle mass and walking speed. Studies using this amount of protein showed more positive effects than those using lower amounts [13, 14]. In addition, some studies suggest that leucine and vitamin D supplements can further enhance the benefits of protein supplementation [15, 16]. Patients' age and the length of intervention can also affect the results. Studies indicate that the benefits related to walking speed may be more noticeable in people under 75 years of age [17]. Also, the improvements in muscle mass and physical performance were observed in studies lasting 12 to 24 weeks [13, 15-20]. Research shows that different types of protein, such as whey protein, soy protein, and milk protein, can help maintain muscle mass and exercise capacity [13]. These results suggest that protein supplementation, especially at appropriate doses and with additives, can be an effective strategy for maintaining muscle mass and improving exercise capacity in older adults, particularly those affected by problems associated with loss of muscle mass (sarcopenia) and frailty.

DISEASES ASSOCIATED WITH SARCOPENIA

Sarcopenia can be classified as "primary" if it is associated with a natural sign of aging in the body, or as "secondary" if it is related to activity, disease, or diet [21]. Malnutrition and nutrient deficiencies can increase the risk of chronic diseases such as osteoporosis, fractures, stroke, chronic kidney disease, and dementia [22]. Rehabilitation nutrition is of particular importance in the care of patients with disabilities, as both primary and secondary sarcopenia are common among them [21].

Osteoporosis and fractures

Sarcopenia and osteoporosis are two diseases that are closely related. They share several risk factors, such as aging, poor nutrition, and chronic inflammation. These diseases can also interact with each other. For example, sarcopenia can lead to a decrease in bone load due to loss of muscle mass and strength, leading to poor mineralization and impaired bone remodeling. This can result in further worsening of osteoporosis. On the other hand,

fractures occurring in osteoporosis can lead to limited muscle activity and immobilization, leading to further muscle atrophy [23]. In 2019, a study conducted on malnourished people aged 65 and over compared the effects of supplementation containing protein, vitamin D, calcium, and other ingredients with a control group receiving a placebo. The supplementation group showed significant improvements, such as an increase in vitamin D3 levels, a reduction in parathyroid hormone, an increase in the concentration of insulin-like growth factor, a reduction in bone resorption markers, and an improvement in total bone mineral density [24]. Another study conducted in Stockholm in 2015 involved 79 patients with hip fractures. The study compared the effectiveness of three therapies: a high-protein diet with bisphosphonates, bisphosphonates alone, and calcium and vitamin D3 supplementation. The results showed no significant differences in body composition after 6 and 12 months of follow-up. However, the group receiving the high-protein diet with bisphosphonates showed improvement in handgrip strength after six months, and the quality of life index decreased the least in this group. The study concluded that a high-protein diet with bisphosphonates may improve grip strength and quality of life, but further research is needed to confirm the effectiveness of this therapy [25].

Stroke

In the world, stroke continues to be the second-leading cause of death and the third-leading cause of death and disability combined (measured in disability-adjusted life-years lost, or DALYs) [26]. Because stroke disorders have a significant social impact, multi-track rehabilitation is needed to enable patients to recover as rapidly as possible. Sarcopenia affects a large number of these patients, which seems to be contributing to the difficulty of the rehabilitation process [27]. In a 2022 study by Mariacristina Siotto et al. regarding stroke patients, it was found that sarcopenia in these people is associated with poorer nutritional status, more significant food waste, and poorer functional recovery. There are reports of a better prognosis for overweight and moderately obese patients compared to undernourished patients, whose tissue atrophy delays rehabilitation progress [28]. A 2018 study conducted by Yoshihiro Yoshimura MD et al. on elderly patients with sarcopenic stroke showed the effectiveness of therapy based on a leucine-enriched supplement. After eight weeks of using the supplement and rehabilitation program, patients noticed an increase in muscle mass and strength and improved physical fitness [27, 29].

Chronic kidney disease

Chronic Kidney Disease (CKD) often coexists with the aforementioned illnesses. People with kidney diseases are usually advised against consuming a high-protein diet, which makes it impossible to use the above-mentioned nutritional strategies in people with CKD [30]. Unfortunately, muscle loss is a common issue among people with chronic kidney disease, especially in patients with advanced disease. The dialysis process, kidney disease, and the typical chronic low-grade inflammation experienced by CKD patients are among the many factors that collectively increase protein degradation, reduce protein synthesis, and create a negative protein balance. As a result, there is a loss of muscle tissue and a reduction in strength [31,32]. In a study involving 148 CKD patients with stages 3-5, a correlation was found between a decline in glomerular filtration rate (GFR) and a decrease in muscle mass [33]. Nutritional interventions are essential for preventing and treating muscle loss and sarcopenia in CKD patients. Low-protein diets (LPD) in CKD should be supplemented with essential amino acids and ketoacids (KA) to help maintain muscle mass and strength [34]. Zemchenkov et al. (2016) studied 96 CKD patients with a low-protein diet and ketoanalog therapy, finding a reduction in CKD progression, especially in older patients with lower phosphate levels and higher proteinuria [35]. A 2018 study by Milovanova et al. on 79 CKD patients compared LPD + KA to LPD alone, revealing that LPD + KA maintains nutritional status, nitrogen balance, and may delay CKD progression, while low protein diet alone does not slow CKD progression and leads to malnutrition [36]

DISCUSSION

This article delves into existing literature to evaluate how nutritional interventions affect the rehabilitation outcomes of individuals with sarcopenia, encompassing both primary and secondary sarcopenia. The majority of studies exploring the influence of nutritional therapy on sarcopenia suggest that a heightened protein intake proves beneficial. This position is supported by the studies we have analyzed, which have demonstrated that increased protein intake can lead to increased muscle mass, which is an important predictor of successful rehabilitation [13,14,17].The addition of supplements such as leucine and vitamin D to protein intake can also be beneficial for patients with sarcopenia [15,16]. Previous research has suggested that leucine is beneficial when used in combination with other substances, such as BCAA or protein [37]. However, one of the studies we have analyzed demonstrated a beneficial effect of leucine alone, which is a new finding in the area of amino acid supplementation in sarcopenia [19]. Nevertheless, further research is required to confirm this. Studies have

shown that an increased intake of proteins, vitamin D, and calcium, in combination with bisphosphonates, can be beneficial [24,25]. These supplements help improve bone tissue quality, decrease osteolytic factors, and increase muscle mass. This increased load on bone tissue results in better mineralization and bone remodeling. Therefore, nutritional therapy is a suitable strategy for tackling osteoporosis. Nutritional interventions have also shown measurable effects in enhancing rehabilitation for post-stroke patients. By adding essential amino acids like leucine to their diet and combining it with physical activity, better rehabilitation outcomes, including increased strength and muscle mass, were observed [27,29]. Hence, a high-protein diet is fundamental in nutritional intervention for sarcopenia patients. However, this may not be feasible for all patients. Patients with chronic kidney disease are often required to follow a low-protein diet due to their condition. Unfortunately, this can result in malnutrition and sarcopenia. In such cases, it is necessary to choose a safe amount of protein and supplement it with keto analogs of amino acids. This approach can prevent the worsening of kidney function while ensuring proper nutrition for the patient [35,36]. While our review primarily focuses on nutritional therapy, we cannot disregard the fact that the most significant benefits in treating sarcopenia come from a dualistic approach that combines proper nutrition with physical activity in the form of resistance exercises [11,38,39,40]. The evidence currently available does not support the effectiveness of any pharmacological therapy for sarcopenia, so it is crucial for researchers to focus more on the aforementioned therapeutic methods. This is particularly important because most research regarding nutritional treatment in sarcopenia is conducted in small research groups, which makes the results difficult to generalize.

CONCLUSIONS

Most studies addressing sarcopenia have primarily concentrated on integrating nutritional treatment with physical exercise. Nevertheless, this approach may not always be feasible for the elderly population. Consequently, we conducted a literature review to address the gap in scientific publications specifically dedicated to nutritional interventions. A more holistic approach that places greater emphasis on nutritional therapy may enable a lower incidence of sarcopenia in future generations, better treatment of currently affected patients, and an improved prognosis of their rehabilitation progress. Our review also highlighted the need to update nutritional guidelines for older people. Current guidelines do not consider the therapeutic impact of certain nutrients, such as protein, on the performance of patients with sarcopenia. This is particularly evident in the recommended dose of grams of protein per kilogram of body weight. Additional research is required to enhance our comprehension of the impact of nutrition on the rehabilitation of sarcopenic patients. This effort is essential for generating improved recommendations and updating existing guidelines.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest.

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