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Literature review

Is there a benefit in unifying the concepts of sarcopenia and dynapenia in patients with sarcopenic obesity elective for bariatric surgery? A conceptual review

Existe vantagem na unificação dos conceitos de sarcopenia e dinapenia em pacientes com obesidade sarcopênica eletivos à cirurgia bariátrica? Uma revisão conceitual

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ABSTRACT

Introduction: Sarcopenic obesity is a growing condition globally, which can affect not only the elderly population but also the young population, leading to a reduction in quality of life and predisposing the development of other comorbidities. **Methods:** The present literature review revisited the conceptual formation of sarcopenia and dynapenia, investigated the physiological mechanisms of sarcopenic obesity, exploring the benefits of bariatric surgery in this context. **Results:** The available evidence of improvement in muscle strength even with a decrease in the amount of lean mass in patients undergoing bariatric surgery exposes the scarcity of studies regarding the association of metabolic factors with decreased muscle strength. **Conclusion:** The reliability of the use of the terms dynapenia and sarcopenia as a cause-effect relationship is questioned and further studies are needed.

Keywords: obesity; dynapenia; sarcopenia; bariatric, surgery.

RESUMO

Introdução: A obesidade sarcopênica é uma condição crescente globalmente, podendo acometer não somente a população idosa como também a população jovem, gerando redução da qualidade de vida e predispondo o desenvolvimento de outras comorbidades. **Métodos:** A presente revisão de literatura revisitou a formação conceitual da sarcopenia e dinapenia, investigou os mecanismos fisiológicos da obesidade sarcopênica e explorou os benefícios da cirurgia bariátrica nesse contexto. **Resultados:** As evidências disponíveis de melhoria na força muscular, mesmo tendo diminuição da quantidade de massa muscular em pacientes submetidos à cirurgia bariátrica, expõe a escassez de estudos referentes a associação de fatores metabólicos com a diminuição de força muscular. **Conclusão:** Dessa forma, a confiabilidade do uso dos termos dinapenia e sarcopenia enquanto relação de causa-efeito é questionada e mais estudos são necessários para investigar essa relação.

Palavras-chave: obesidade; dinapenia; sarcopenia; bariátrica, cirurgia.

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Introduction

Sarcopenic obesity is a condition determined by the decrease in the amount of lean mass and muscle strength associated with the increase in fat mass [1,2] and is defined by the existence of diagnoses of sarcopenia and obesity.

The currently used concept of sarcopenia comprises the decrease in muscle strength as an intrinsic process to the loss of lean mass and is related to the aging process [2]. However, in the context of sarcopenic obesity, this may not apply [3,4]. Studies with patients that undergo bariatric surgery have demonstrated that despite the decrease in lean mass, it is possible to obtain gains in muscle strength [5,6].

Bariatric surgery has been successful in the treatment of obesity, being able to prevent the emergence of other comorbidities, also improving quality of life and functional capacity. Although the literature is wide on the causes of loss of lean mass and muscle strength associated with aging, there is not much evidence regarding the influence of metabolic syndrome on this same process [1].

The present study aims to revisit the construction of the concepts of sarcopenia and dynapenia, investigate the physiological mechanisms of sarcopenic obesity and explore what benefits can be promoted by bariatric surgery.

Methods

To meet the purposes of this literature review, a search for studies on sarcopenic obesity, and its association with bariatric surgery, sarcopenia, and dynapenia was performed in the databases: PubMed/Medline and Periódicos CAPES. The minimum limit of the publication date of the studies was not proposed. The search was completed in September 2022. The heterogeneity of the studies was significant to the characteristics of the population, the study design, and the analysis of the variables.

Results

In the studies of this review, a divergence of concepts about sarcopenia was identified with that being used with comparative purpose. Some risk factors for sarcopenia and dynapenia were found and analyzed as part of a unique system.

Sarcopenia and dynapenia concepts

Table I describes the primitive concepts of sarcopenia and dynapenia and compares them to the actual ones.

Table I - Sarcopenia and dynapenia concepts

Concept	Primitive	Actual
Sarcopenia	Age-related process of the reduction in muscle mass	Process related to the decline of muscle mass and muscle strength, age-related, with physical reduction of high magnitude
Dynapenia	Age-related process of decline in muscle strength	Not used anymore

Muscular, neuromuscular, and metabolic factors

Figure 1 presents some of the main risk factors related to elderly obese patients as part of a unique system.

Discussion

Sarcopenia and dynapenia concepts

Sarcopenia

The term sarcopenia, since its first use in the literature, has undergone several changes in its concept and has not yet been established [2]. Although it was previously associated with the process related to aging [2,7], the most used concept today for sarcopenia is the association of the processes of loss of lean mass and consequent loss of strength, with loss of physical performance being the parameter of severity of this condition [2].

The most commonly used diagnostic criteria for sarcopenia are defined by the European Working Group on Sarcopenia in Older People (EWGSOP) [2]. Due to the change in the concept of sarcopenia - in which the loss of strength was considered an essential parameter for the diagnosis - there was also an update of the diagnostic criteria used by the EWGSOP, resulting in the EWGSOP2 [2]. The parameters for diagnosing sarcopenia according to the EWGSOP2 are evaluated based on a priority order, with the first parameter being muscle strength, the second being the amount of lean mass and the third being physical performance [2]. Each of these has specific tests and cutoff values that define sarcopenia [2].

The reduction of the first two parameters – muscular strength and amount of lean mass below the cut-off values – indicate sarcopenia, while the reduction of the third parameter – loss of physical performance – suggests severe sarcopenia [2].

Dynapenia

The concept of dynapenia was initially defined by Clark & Manini [8] as the age-related process of the loss of muscular strength [7,9]. With the inclusion of loss of strength as a parameter for sarcopenia, the term dynapenia was no longer used [8].

Authors began to opt for the intuitive use of sarcopenia as a term that describes the aging-related loss of both muscle strength and strength of lean mass [10]. This unifying of concepts refers to the existence of causality between sarcopenia and dynapenia, influencing researchers to describe sarcopenia as responsible for the occurrence of dynapenia [8]. Dynapenia, however, can have several causes, not only related to loss of lean mass [9].

Sarcopenia vs dynapenia: prognosis and physiological mechanisms

Although not predisposing to a direct risk to life, sarcopenia is a comorbidity for other conditions of considerable morbidity and mortality, such as falls from standing height, cardiovascular and respiratory diseases, mobility restriction, and reduced quality of life [2]. For this reason, it is of significant importance for an early screening of sarcopenia to initiate treatment soon.

The scientific literature is wide regarding the influences of neuromuscular factors on the occurrence of sarcopenia and dynapenia. Some studies, for example, have shown that, at the beginning of resistance exercise, gains related to muscle strength were not due to intrinsic muscular physical capacity, but due to factors such as increased activation and discharge of motor units [11,12]. Clark & Manini showed that the decrease in load impacted a greater loss of muscle strength than a decrease in lean mass [13]. In addition, neurological factors such as excitation-contraction uncoupling in skeletal musculature and changes in central command explained most of the loss of muscle strength [13].

Aging, in this sense, reduces the number of motor units, in addition to influencing their reorganization, with the replacement of type 2 motor units for type 1 motor units [14] and a decrease in the maximum rate of action potential triggers of the motor units [12]. It also influences the hyporeflexia of upper and lower motor neurons, as well as the decrease in the conduction velocity of the nervous stimulus [15]. All these changes are responsible for the muscular atrophy characteristic of the elderly [16]. For this reason, sarcopenia is commonly associated with aging [8].

Thus, several factors that influence muscle strength are emphasized, whether intrinsic to the muscle, such as the amount of lean mass, or neuromuscular, associated with the activation capacity of the motor plate, rate of triggering of action potentials, motor learning, and contraction-excitatory synergy. However, there is little emphasis on the influence of metabolic factors that can determine the decrease in muscle strength.

Sarcopenic obesity and dynamic obesity: health consequences

Sarcopenic obesity is a condition that describes the decline in muscle strength and lean mass in obese individuals, defined by the coexistence of two diagnoses: obesity and sarcopenia [3,4,17]. The sum of the two comorbidities leads to greater severity in the development of other diseases than just one of them alone [3,4]. In addition, one condition can be a precursor of the other. For example, obesity can be related to sedentary behavior as it is a risk factor for the development of sarcopenia and vice-versa [18]. The criteria for the coexistence of the diagnoses of obesity and sarcopenia in sarcopenic obesity have been questioned [3,4,18] concerning its efficiency, since the diagnostic criteria for sarcopenia used are aimed at the elderly patient, as described by the EWGSOP2, for example.

Some studies in the literature used the term “dynamic obesity” to refer to sarcopenic obesity, using the same concept [19-21]. Dynamic obesity, however, refers to the initial idea of dynapenia - the loss of muscle strength in obese patients - and perhaps it would be more effective to define obesity as leading to decreased muscle strength [19]. While sarcopenic obesity would be defined as obesity only with a decrease in lean mass, without negative repercussions on strength or even with improvement, as seen in studies [5,6].

A current limitation of studies on sarcopenic obesity is the lack of diagnostic criteria that aims at the young population since sarcopenic obesity is not restricted to the elderly [4], not properly isolating neuromuscular factors from metabolic factors.

Physiological mechanisms of sarcopenic obesity

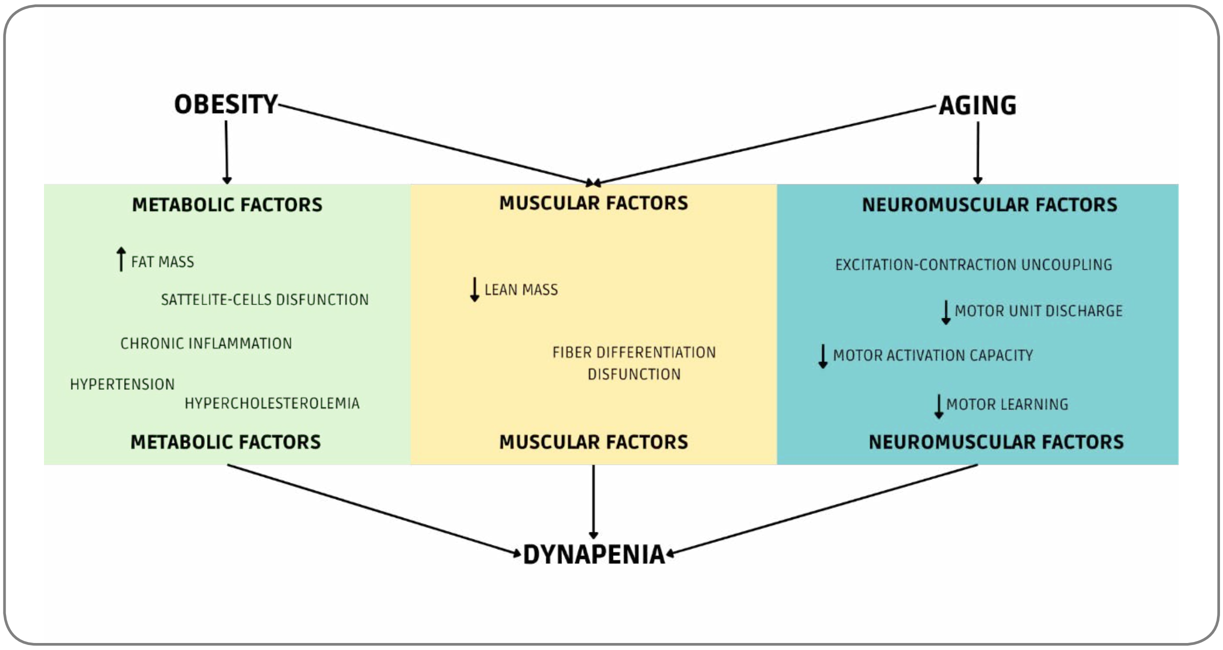
In obese individuals, there is an increase in the deposit of lipids in the intramuscular environment due to the increase in insulin resistance [22]. Sarcopenia, in this scenario, develops due to chronic and systemic conditions of mild inflammation and increased body load [23].

Obesity is also a risk factor for systemic arterial hypertension and hypercholesterolemia, conditions that can also influence musculoskeletal function [1]. Hypertension can contribute to tissue damage since it makes it difficult to exchange substrates necessary for its survival [24], while hypercholesterolemia, in addition to being able to deregulate lipid metabolism, which influences endothelial dysfunction, can be related to tissue damage in tendons, the decrease in bone mineral density, and osteoarthritis [25-27].

Muscle fibers are in a constant process of degeneration and regeneration, resulting from the mechanism of inflammation and tissue repair, respectively, being this behavior responsible for muscle growth and remodeling [22]. Obesity also leads to metabolic complications that impair angiogenesis and the formation of new muscle fibers [1]. This deregulation leads to the deposition of fibrous tissue - from the tissue repair process - and of adipose tissue, leading to structural and, consequently, functional loss [28].

Obesity can also be related to a quantitative imbalance in oxidative and glycolytic muscle fibers [29]. Oxidative muscle fibers are endowed with a greater number of satellite cells, and as obesity makes the activation of these cells difficult, the glycolytic muscle fibers replace the functions of the oxidative fibers [1]. This change is an effect of low-level chronic inflammation and negatively influences muscle regeneration [1].

Obesity establishes an unfavorable environment for the activation of satellite cells, preventing their proliferation and differentiation into muscle fibers [30,31]. Macrophages attracted by the chronic inflammatory process resulting from obesity can also inhibit satellite cell activity [32]. Fibroadipogenic Progenitor Cells or FAPs are cells that act in muscle repair, but in the absence of satellite cell activity, they differentiate into fibroblasts and adipocytes, characterizing the intramuscular lipid deposition [33] that sustains the inflammatory condition of obesity. Figure 1 presents a proposal for a single system associating muscular, neuromuscular, and metabolic factors.



Source: Author himself
Figure 1 - Multifactorial system of dynapenia in elderly obese patients

Bariatric surgery: associations with sarcopenia and dynapenia

Bariatric surgery is the most used method and it has shown the best results for the treatment of severe obesity in terms of weight and body fat reduction, in addition to showing significant improvements in the individual's morbidity and mortality [5,6,34-36]. Bariatric surgery sets the patient to a phase of rapid weight loss after the intervention and a subsequent phase of weight stability [6].

Due to the greater amount of total corporal mass, the obese patient also has a greater amount of lean mass in comparison to a non-obese individual [6]. During the phase of rapid weight loss, there is a significant reduction in the amount of lean mass that can lead the individual to develop sarcopenia [6].

Strategies for the prevention of sarcopenia and dynapenia in bariatric surgery

Some studies showed that individuals who underwent bariatric surgery showed improvements in muscle strength, even with a decrease in lean mass [5,6]. When comparing women with sarcopenic obesity two years after bariatric surgery to women with sarcopenic obesity who did not undergo the same surgery [6], it was identified that the performance of the five times-sit-to-stand-test was superior in the intervention group, even when both groups were diagnosed with sarcopenic obesity. The result of this test for the intervention group was still compatible with sarcopenia, according to the EWGSOP2 criteria, but a significant improvement was demonstrated with the compared group.

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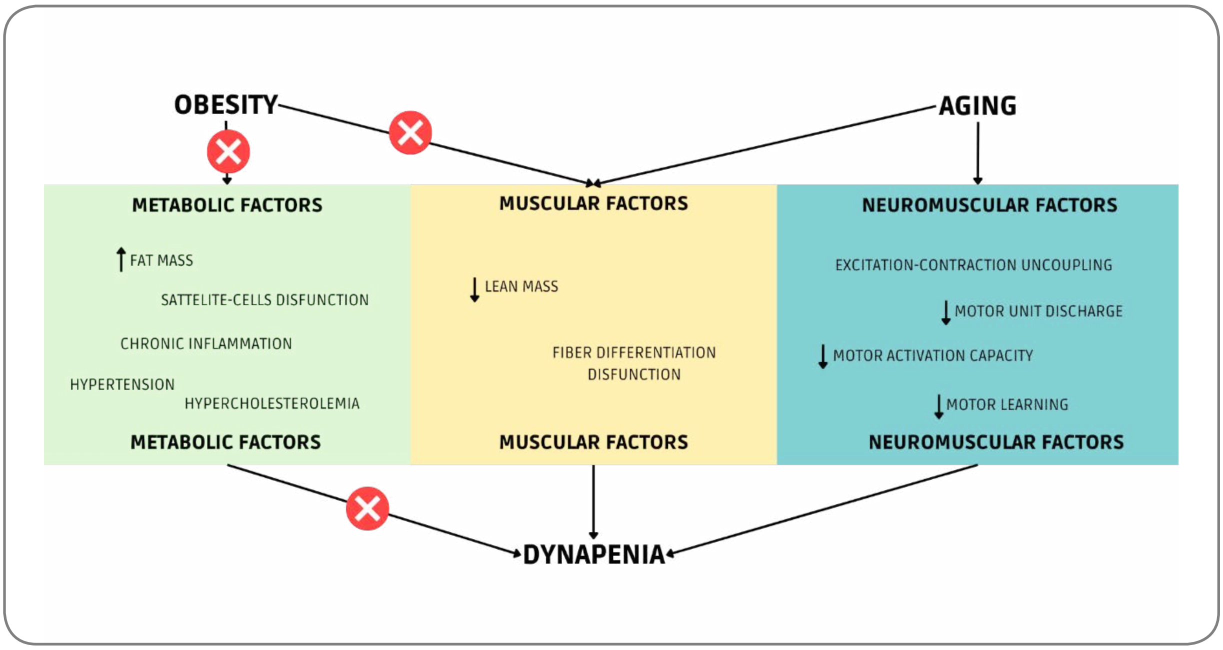

Source: Author himself
Figure 2 - Multifactorial system of dynapenia in elderly obese patients after bariatric surgery

In the Coral et al. study [5], individuals were evaluated before bariatric surgery and compared six months after surgery. Despite the significant reduction in lean mass, there were important improvements in muscle performance, evaluated with gait speed and the "get up and go test".

Assuming that strength loss is linked to lean mass loss is intuitive, but there are other factors, as seen in Figure 2, that can more effectively impact – positively or negatively – muscle strength. In the case of obesity, the rapid weight loss provided by surgery can reverse metabolic factors that influence the occurrence of sarcopenia and dynapenia and may weigh even more than muscle factors and neuromuscular factors.

Conclusion

The state of the art in sarcopenia demonstrates that authors often assume that there is a causal relationship between sarcopenia and dynapenia. The neglect of the use of the term dynapenia highlights this fact and restricts the impressions about the existence of an intrinsic nature between the two terms. For this reason, the better performance found in patients undergoing bariatric surgery associated with higher muscle strength, despite the decrease in lean mass, leads to a counterintuitive conclusion. There are several factors - muscular, neuromuscular, and metabolic - for muscular performance, in addition to different weights to be considered for each of these influences that can unbalance negatively or positively. Thus, further studies are needed to investigate the nature of the sarcopenia-dynapenia relationship and the weight of the influence of other factors on these conditions.

Potential conflict of interest
No conflicts of interests have been reported for this article.

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Authors' contributions
Research conception and design: Takenami LI, Santos CPC, Bomfim ES, Filha AMSG; **Literature review:** Takenami LI, Lagares LS, Almeida LAB; **Manuscript writing:** Takenami LI, Lagares LS, Macedo RC; **Critical review of the manuscript for important intellectual content:** Santos CPC, Filha AMSG, Bomfim ES, Almeida LAB

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