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EARLY-ONSET SARCOPENIA IN YOUNG ADULTS: MECHANISMS, RISK FACTORS AND PREVENTION STRATEGIES

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ABSTRACT

Sarcopenia, traditionally associated with aging, has been increasingly recognized in younger populations. Early-onset muscle loss may have significant long-term metabolic and functional consequences. This review aims to summarize current evidence on the epidemiology, pathophysiology, risk factors, and preventive strategies of sarcopenia in young adults. A structured literature search was conducted using the PubMed database, prioritizing studies published between 2010 and 2025, including systematic reviews, meta-analyses, and narrative reviews. Current evidence suggests that the prevalence of sarcopenia in adult populations ranges from approximately 10% to over 20%, although data specific to younger individuals remain limited. In this group, sarcopenia is primarily associated with physical inactivity, inadequate nutrition, obesity, and metabolic dysfunction. Chronic low-grade inflammation and insulin resistance contribute to impaired muscle protein synthesis and increased catabolism, while early impairments in muscle function may remain clinically underrecognized. Resistance training and adequate protein intake remain the most effective preventive strategies, particularly when applied in combination. Early identification of at-risk individuals and targeted lifestyle interventions may play a crucial role in preventing long-term adverse health outcomes. Sarcopenia should therefore not be considered exclusively an age-related condition but rather a multifactorial process that may begin early in adulthood.

KEYWORDS

Sarcopenia, Young Adults, Sarcopenic Obesity, Resistance Training, Protein Intake

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1. Introduction

Sarcopenia is characterized by a progressive decline in skeletal muscle mass, strength, and function. Although it has traditionally been associated with aging, emerging evidence indicates that muscle deterioration may develop in early adulthood. This early onset may predispose individuals to long-term metabolic disturbances, reduced physical performance, and increased risk of chronic disease. (Cruz-Jentoft et al., 2019; Mitchell et al., 2012)

The recognition of sarcopenia in young adults is of growing clinical importance, particularly in the context of modern sedentary lifestyles and suboptimal nutritional habits. This review aims to summarize current evidence on the epidemiology, underlying mechanisms, risk factors, and preventive strategies for sarcopenia in younger populations. (Petermann-Rocha et al., 2022; El Ghoch et al., 2022)

2. Methods

A structured literature review was conducted using the PubMed database to identify relevant studies on sarcopenia in young adults. The search focused on articles published between 2010 and 2025 to ensure the inclusion of recent and high-quality evidence.

The search strategy included combinations of the following keywords: “sarcopenia,” “young adults,” “muscle loss,” “resistance training,” “protein intake,” and “sarcopenic obesity.” These terms were used individually and in combination to capture studies addressing epidemiology, pathophysiology, risk factors, clinical implications, and preventive strategies related to early-onset sarcopenia.

Articles were selected based on their relevance to the topic and included systematic reviews, meta-analyses, and narrative reviews, as well as key original studies where appropriate. Priority was given to publications with a strong methodological background and clear clinical relevance. Studies focusing exclusively on older populations without addressing mechanisms applicable to younger individuals were considered less relevant unless they provided important insights into underlying biological processes.

Studies were excluded if they lacked scientific rigor, were not available in full text, or did not directly address sarcopenia or related aspects of muscle health. Non-English publications were also excluded.

The selected literature was analyzed qualitatively, with a focus on identifying consistent patterns across studies, including common risk factors, underlying mechanisms, and evidence-based intervention strategies. Particular attention was given to studies examining the interaction between physical activity, nutrition, and metabolic health.

Due to the narrative nature of this review, no formal statistical analysis or meta-analysis was performed. Instead, findings were synthesized descriptively to provide a comprehensive overview of current knowledge on early-onset sarcopenia.

3. Results

3.1 Definition and Diagnostic Criteria

According to Cruz-Jentoft et al. (2019), sarcopenia is defined as a progressive and generalized loss of skeletal muscle mass and function characterized by low muscle strength, low muscle quantity or quality, and reduced physical performance. Although these criteria were originally developed for older populations, emerging evidence suggests their applicability in younger individuals at increased metabolic risk.

3.2 Epidemiology in Young Adults

Petermann-Rocha et al. (2022) demonstrated that the prevalence of sarcopenia varies substantially depending on diagnostic criteria and population characteristics, with global estimates in adult populations typically ranging from approximately 10% to over 20%. In some subgroups, particularly when more sensitive diagnostic thresholds are applied, prevalence may exceed these values, highlighting the impact of methodological differences on reported rates. Although data specifically focusing on young adults remain limited, emerging evidence suggests that early manifestations of sarcopenia may be increasingly observed in individuals with sedentary lifestyles and poor nutritional habits. In younger populations, physical inactivity and inadequate dietary intake appear to be key contributing factors.

Furthermore, the growing prevalence of sarcopenic obesity, particularly in individuals with excess adiposity and reduced muscle quality, represents an emerging clinical concern in this age group. El Ghoch et al. (2022) emphasized that this condition may be underrecognized in younger individuals and is associated with increased metabolic risk, including insulin resistance and chronic inflammation. The coexistence of reduced muscle mass and increased adiposity therefore represents a particularly important clinical phenotype that may complicate both diagnosis and management of early-onset sarcopenia.

3.3 Pathophysiology

The development of sarcopenia in young adults is multifactorial and reflects the interaction of metabolic, inflammatory, and lifestyle-related factors (Figure 1). Although classically associated with aging, similar mechanisms may contribute to early impairments in muscle health in younger individuals exposed to unfavorable lifestyle conditions.

Chronic low-grade inflammation plays a central role in this process. Persistent elevation of pro-inflammatory mediators may promote muscle protein breakdown and impair regenerative capacity. As highlighted by Murton (2015), alterations in muscle protein turnover represent a key mechanism underlying sarcopenia, with an imbalance between protein synthesis and degradation contributing to progressive muscle loss. Even in younger populations, exposure to adverse metabolic conditions may shift this balance toward a more catabolic state.

In parallel, insulin resistance represents another critical factor influencing muscle metabolism. Impaired insulin signaling disrupts anabolic pathways and reduces the efficiency of muscle protein synthesis. Deutz et al. (2014) emphasized the importance of metabolic regulation in maintaining muscle function, noting that disturbances in anabolic signaling may contribute to muscle loss even when nutritional intake is sufficient.

Physical inactivity further exacerbates these processes. Adequate mechanical loading is essential for maintaining muscle mass, as it stimulates anabolic signaling and supports neuromuscular function. In the absence of sufficient physical activity, reduced stimulation leads to progressive declines in muscle strength and mass, particularly in populations characterized by prolonged sedentary behavior.

Nutritional factors also play a crucial role in regulating muscle metabolism. Insufficient protein intake limits substrate availability for muscle protein synthesis, thereby impairing the adaptive response of skeletal muscle. Deutz et al. (2014) highlighted the importance of adequate protein intake in preserving muscle function, while Morton et al. (2018) demonstrated that higher protein intake enhances resistance training–induced gains in muscle mass and strength.

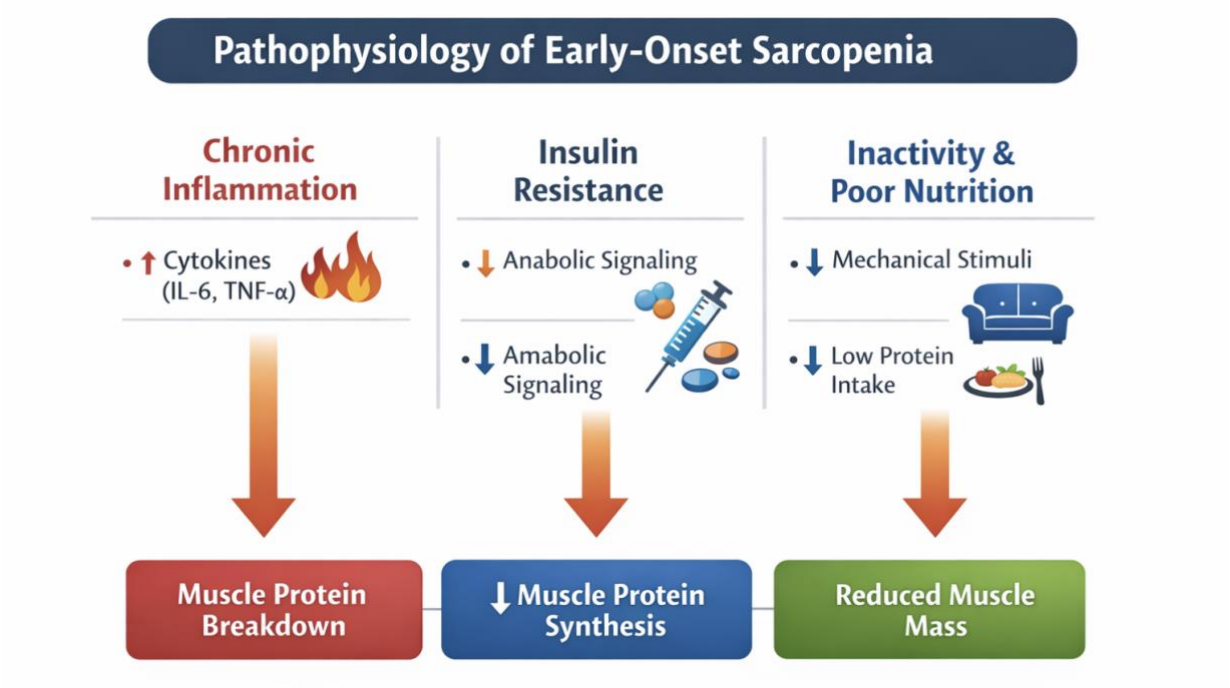

Fig. 1. *Pathophysiology of early-onset sarcopenia in young adults.*

An additional mechanism contributing to sarcopenia is anabolic resistance, defined as a reduced sensitivity of skeletal muscle to anabolic stimuli such as dietary protein intake and resistance exercise. This phenomenon has been described in the literature and may result in a diminished muscle protein synthesis response despite adequate nutritional intake. Combined nutritional and exercise interventions are therefore considered essential to overcome this effect (Deutz et al., 2014; Morton et al., 2018).

Importantly, these mechanisms do not act in isolation. Instead, they interact and reinforce one another, leading to progressive impairments in muscle mass, strength, and function. The coexistence of metabolic dysfunction, reduced physical activity, and suboptimal nutrition may therefore create a cumulative effect that accelerates the development of early-onset sarcopenia in young adults.

3.4 Risk Factors

Key risk factors for early-onset sarcopenia include physical inactivity, obesity, inadequate protein intake, poor sleep quality, and metabolic dysfunction. Physical inactivity is one of the most significant contributors, as it reduces mechanical stimuli required for maintaining muscle mass and function. In modern populations, prolonged sedentary behavior has become increasingly prevalent, particularly among younger individuals.

Obesity, particularly in the form of sarcopenic obesity, represents another important risk factor. Excess adiposity is associated with chronic low-grade inflammation and insulin resistance, both of which negatively impact muscle metabolism (El Ghoch et al., 2022). In addition, inadequate protein intake may limit the availability of essential amino acids required for muscle protein synthesis, further contributing to muscle loss.

Table 1. Risk factors and mechanisms of sarcopenia in young adults

Risk Factor	Mechanism	Clinical Impact
Physical inactivity	Reduced anabolic signaling	Muscle atrophy
Low protein intake	Decreased muscle protein synthesis	Impaired regeneration
Obesity	Chronic inflammation	Insulin resistance
Poor sleep	Hormonal dysregulation	Reduced recovery
Metabolic dysfunction	Impaired insulin signaling	Increased catabolism

Lifestyle-related factors such as poor sleep quality and irregular dietary patterns may also influence muscle health through hormonal and metabolic pathways. As highlighted by Westerterp (2018), changes in physical activity and lifestyle behaviors across the lifespan play a significant role in body composition and the development of sarcopenic obesity. Early identification of these risk factors is therefore essential for implementing effective preventive strategies.

3.5 Clinical Consequences

Early-onset sarcopenia may lead to reduced muscle strength, impaired metabolic health, and increased susceptibility to injury. Sarcopenic obesity is associated with insulin resistance, cardiovascular risk, and decreased functional capacity even in young adults. (Tomlinson et al., 2016)

In addition to reduced muscle strength, early-onset sarcopenia may have broader metabolic consequences. Impaired muscle function is associated with decreased glucose uptake and altered energy metabolism, which may contribute to the development of insulin resistance. Over time, these changes may increase the risk of metabolic disorders, including type 2 diabetes and cardiovascular disease.

Sarcopenic obesity further amplifies these risks. As described by Tomlinson et al. (2016), excess adiposity combined with reduced muscle quality is associated with decreased functional capacity and increased cardiovascular risk. Even in younger individuals, this phenotype may lead to reduced physical performance and increased susceptibility to injury.

These findings highlight that early-onset sarcopenia is not only a musculoskeletal condition but also a systemic issue with significant long-term health implications.

Beyond metabolic and functional consequences, early-onset sarcopenia may also influence overall physical resilience and adaptability. Reduced muscle strength and quality may impair the ability to respond to physiological stressors, including acute illness, injury, or increased physical demands. In younger individuals, this may not be immediately clinically apparent, but over time it may contribute to reduced exercise tolerance and decreased capacity for physical performance.

In addition, early impairments in muscle function may negatively affect long-term engagement in physical activity. Individuals experiencing reduced strength or increased fatigue may be less likely to participate in regular exercise, which may further accelerate muscle deterioration. This creates a self-reinforcing cycle in which declining muscle function leads to reduced activity levels, further exacerbating both metabolic dysfunction and muscle loss.

These observations suggest that early-onset sarcopenia may have broader implications than previously recognized, extending beyond musculoskeletal health to influence overall physical capacity and long-term health trajectories.

3.6 Role of Resistance Training

Resistance training represents one of the most effective strategies for preserving and improving muscle mass and function. It provides a mechanical stimulus necessary to promote muscle protein synthesis and neuromuscular adaptations. Evidence suggests that resistance training performed at least 2–3 times per week is effective in improving muscle strength and hypertrophy in both untrained and trained individuals (Grgic et al., 2018). Furthermore, meta-analytical data indicate that progressive overload and sufficient training volume are key determinants of muscular adaptations. These findings highlight the importance of structured and consistent training programs in the prevention and management of sarcopenia.

Phillips and Winett (2010) emphasized the importance of resistance training as a key component of public health strategies aimed at improving overall health outcomes. Regular participation in resistance-based exercise has been associated with improvements in muscle strength, body composition, and metabolic health, which are particularly relevant in the context of early-onset sarcopenia.

From a physiological perspective, resistance training promotes adaptations at both the muscular and neural levels. Early improvements in strength are largely attributed to enhanced neuromuscular efficiency, whereas longer-term adaptations involve increases in muscle cross-sectional area. These changes are driven by repeated exposure to mechanical loading, which stimulates anabolic processes and enhances muscle protein synthesis.

The concept of progressive overload is fundamental to resistance training. It refers to the gradual increase in training stimulus over time and is necessary to sustain muscle adaptation. Without progressive increases in load, volume, or intensity, the adaptive response may plateau. Training programs should therefore be structured to ensure a continuous but controlled increase in stimulus.

Training frequency also influences the effectiveness of resistance training. Grgic et al. (2018) demonstrated that frequency affects gains in muscular strength, although the optimal approach depends on factors such as training status and total training volume. In practice, resistance training programs typically involve regular sessions targeting major muscle groups with sufficient recovery between sessions.

Resistance training additionally exerts important metabolic effects. Regular exercise improves insulin sensitivity, which may help counteract metabolic disturbances associated with sarcopenia. This is particularly relevant in individuals with sedentary lifestyles or increased adiposity, where impaired metabolic regulation contributes to reduced muscle quality.

The interaction between resistance training and nutrition further enhances its effectiveness. Adequate protein intake is essential for maximizing the adaptive response to training. Morton et al. (2018) demonstrated that protein supplementation enhances resistance training–induced gains in muscle mass and strength, with optimal daily intake generally around 1.6 g/kg body weight, and potential benefits up to approximately 2.2 g/kg. Deutz et al. (2014) similarly emphasized the importance of sufficient protein intake in maintaining muscle function and supporting muscle adaptation.

Taken together, these findings highlight the importance of an integrated approach. Resistance training alone may be insufficient if nutritional intake is inadequate, while dietary interventions without mechanical stimulation may not fully activate anabolic pathways. Therefore, the combination of structured resistance training and appropriate nutritional strategies represents the most effective approach to preserving muscle mass and function in young adults.

3.7 Role of Nutrition

Adequate nutrition, particularly sufficient protein intake, plays a crucial role in maintaining muscle mass and function. Protein provides essential amino acids required for muscle protein synthesis and recovery. Morton et al. (2018) demonstrated that protein intakes of approximately 1.6 g/kg/day are sufficient to maximize muscle protein synthesis in individuals engaged in resistance training, with higher intakes providing no additional benefit in most cases. Inadequate protein intake may contribute to negative nitrogen balance and impaired muscle maintenance, particularly in individuals with low physical activity levels. These findings emphasize the importance of combining nutritional strategies with resistance training to optimize muscle health.

Beyond protein intake, overall nutritional adequacy also plays an important role in maintaining muscle health. Insufficient protein intake and inadequate nutritional support may contribute to impaired muscle maintenance, particularly in individuals with sedentary lifestyles (Deutz et al., 2014). Taken together, these findings underscore the importance of nutrition as a key component of strategies aimed at preventing early-onset sarcopenia. Adequate protein intake, in combination with regular resistance training, represents a cornerstone of interventions designed to preserve muscle mass and function in young adults.

3.8 Prevention and Management

Effective prevention of early-onset sarcopenia is primarily based on lifestyle interventions targeting modifiable risk factors. Among these, regular resistance training and adequate protein intake represent the most consistently supported strategies for maintaining muscle mass and function. Resistance training provides the mechanical stimulus necessary to promote muscle protein synthesis and preserve neuromuscular function, while sufficient dietary protein ensures the availability of essential amino acids required for muscle adaptation (Deutz et al., 2014; Morton et al., 2018).

In addition to structured exercise, reducing sedentary behavior plays an important role in prevention. Even in individuals who engage in regular physical activity, prolonged periods of inactivity may negatively affect muscle metabolism. Modern lifestyle patterns, characterized by extended sitting time and reduced daily movement, may therefore contribute to the development of early impairments in muscle health. Addressing these behaviors through increased daily activity and reduced sedentary time may represent a simple yet effective preventive strategy.

Nutritional strategies should extend beyond total protein intake and include overall dietary quality and energy balance. Inadequate energy intake may impair muscle maintenance, while imbalanced dietary patterns may contribute to metabolic dysfunction. In this context, a balanced diet combined with sufficient protein intake is essential for supporting both muscle health and metabolic regulation. The interaction between nutrition and exercise is particularly important, as the effectiveness of resistance training may be limited in the absence of adequate dietary support. Preventive strategies should also be individualized, taking into account differences in physical activity levels, body composition, and metabolic status. Individuals with obesity, low physical activity, or poor dietary habits may require more targeted interventions. As highlighted by El Ghoch et al. (2022), the presence of sarcopenic obesity further complicates management and requires a combined approach addressing both adiposity and muscle function.

Table 2. Mechanisms of early-onset sarcopenia and evidence-based interventions

Mechanism	Description	Evidence-based intervention	Supporting reference
Chronic low-grade inflammation	Promotes muscle protein breakdown and impairs regeneration	Resistance training; lifestyle modification	Murton, 2015
Insulin resistance	Impairs anabolic signaling and reduces muscle protein synthesis	Resistance training; metabolic control	Deutz et al., 2014
Physical inactivity	Reduces mechanical stimuli required for muscle maintenance	Regular resistance training	Phillips and Winett, 2010
Anabolic resistance	Reduced responsiveness of muscle to protein intake and exercise	Higher protein intake; combined exercise and nutrition strategies	Deutz et al., 2014; Morton et al., 2018
Inadequate protein intake	Limits substrate availability for muscle protein synthesis	Protein intake ~1.6–2.2 g/kg/day	Morton et al., 2018
Sarcopenic obesity	Combination of excess fat mass and reduced muscle quality	Combined exercise and dietary interventions	El Ghoch et al., 2022
Suboptimal training frequency	May limit strength and hypertrophic adaptations	Structured resistance training programs (frequency-dependent effects)	Grgic et al., 2018

Early implementation of preventive strategies is particularly important in young adults. Lifestyle habits established during this period often persist into later life, suggesting that early interventions may have long-term benefits. Rather than focusing solely on treatment after the onset of muscle loss, a proactive approach aimed at maintaining muscle health may be more effective in reducing future health risks.

Overall, prevention and management of early-onset sarcopenia should be based on a comprehensive approach that integrates resistance training, adequate nutrition, and lifestyle modification. Such strategies not only support muscle mass and function but may also contribute to improved metabolic health and long-term disease prevention.

3.9 Clinical Assessment and Implications

The clinical assessment of sarcopenia in young adults remains a significant challenge, primarily due to the lack of age-specific diagnostic criteria. Current approaches are largely based on guidelines developed for older populations, which emphasize the assessment of muscle strength, muscle mass, and physical performance (Cruz-Jentoft et al., 2019). In this framework, muscle strength—commonly evaluated using handgrip strength—is considered a primary parameter, while measures of muscle quantity or quality and physical performance are used to confirm diagnosis and determine severity. Although these criteria provide a useful foundation, their direct application to younger individuals may be limited, particularly in cases of early or subclinical muscle impairment.

One of the main difficulties in younger populations is the absence of clearly defined cut-off values that would allow for accurate classification of sarcopenia. In older adults, diagnostic thresholds are based on population-specific reference values; however, similar standards are not well established for younger age groups. As a result, early changes in muscle mass or function may go unrecognized, especially when they do not yet meet conventional diagnostic criteria. Conversely, there is also a potential risk of overinterpretation of mild deviations in physically inactive individuals, highlighting the need for careful clinical judgment. These challenges underscore the importance of interpreting assessment results within a broader clinical and lifestyle context rather than relying solely on isolated measurements.

From a practical perspective, early identification of individuals at risk may be more relevant than formal diagnosis in this population. Screening strategies should therefore focus on modifiable risk factors, including physical inactivity, obesity, and inadequate nutritional intake, which have been identified as key contributors to impaired muscle health in younger individuals (Petermann-Rocha et al., 2022; El Ghoch et al., 2022). Simple functional assessments, combined with evaluation of lifestyle behaviors, may provide a pragmatic approach to identifying individuals who could benefit from early intervention.

Another important consideration is the distinction between clinical and subclinical manifestations of sarcopenia. In younger individuals, early impairments may present as subtle reductions in strength or physical performance rather than overt functional limitations. These changes may not be detected through routine clinical evaluation but may still have long-term implications for metabolic health and physical capacity. This highlights the need for increased awareness among clinicians and the potential value of incorporating muscle health assessment into broader preventive healthcare strategies.

The integration of clinical assessment with preventive strategies is particularly important in the context of early-onset sarcopenia. Rather than focusing solely on diagnosis, a proactive approach aimed at identifying at-risk individuals and implementing targeted lifestyle interventions may be more effective. Early recognition of unfavorable patterns in physical activity and nutrition may allow for timely modifications that can prevent the progression of muscle deterioration. In this sense, clinical assessment should be viewed not only as a diagnostic tool but also as an integral component of preventive medicine in young adults.

4. Discussion

This review highlights that sarcopenia should not be considered exclusively a condition of aging but may develop as early as young adulthood. Increasing evidence suggests that early impairments in muscle health are closely linked to modifiable lifestyle factors, including physical inactivity, suboptimal nutrition, and metabolic dysfunction. Although diagnostic criteria have been well established for older populations, their applicability to younger individuals remains limited, which may contribute to underrecognition of early-onset sarcopenia (Cruz-Jentoft et al., 2019). In addition, variability in diagnostic approaches and assessment methods contributes to inconsistent prevalence estimates across studies (Petermann-Rocha et al., 2022).

A key observation emerging from the literature is the central role of lifestyle-related and metabolic factors in the development of early sarcopenia. Modern behavioral patterns, characterized by prolonged sedentary behavior, may significantly impair muscle metabolism even in otherwise healthy individuals. As highlighted by Westerterp (2018), changes in physical activity across the lifespan have a substantial impact on body composition, while reduced energy expenditure may contribute to the development of sarcopenic obesity. The interaction between chronic low-grade inflammation and insulin resistance further exacerbates these effects, leading to impaired muscle protein synthesis and increased protein breakdown (Murton, 2015; Deutz et al., 2014). The concept of sarcopenic obesity, described by El Ghoch et al. (2022), emphasizes the coexistence of excess adiposity and reduced muscle quality, representing a phenotype associated with increased metabolic risk even in younger populations.

Resistance training and adequate nutrition remain the most consistently supported strategies for preventing and mitigating sarcopenia. Evidence from Phillips and Winett (2010) and Grgic et al. (2018) highlights the effectiveness of resistance training in improving muscle strength and function, while Morton et al. (2018) and Deutz et al. (2014) emphasize the importance of sufficient protein intake in supporting muscle protein synthesis. However, despite strong evidence supporting these interventions, optimal implementation strategies remain unclear, and further research is needed to define individualized approaches. From a clinical perspective, early identification of individuals at risk represents a critical step in prevention, although the lack of age-specific diagnostic thresholds for younger populations complicates clinical decision-making. Importantly, young adulthood may represent a critical window for intervention, as lifestyle habits established during this period often persist later in life.

An important aspect that emerges from the current evidence is the potential underestimation of early-onset sarcopenia in clinical practice. In younger individuals, subtle impairments in muscle strength or quality may not be routinely assessed, particularly in the absence of overt functional limitations. This may result in delayed recognition and missed opportunities for early intervention. In addition, the increasing prevalence of sedentary behavior in modern societies may have a profound impact on muscle health across the lifespan. Prolonged sitting time reduced daily movement, and insufficient engagement in resistance-based activities may collectively contribute to gradual declines in muscle mass and function. These changes may occur even in individuals who do not meet traditional criteria for physical inactivity, suggesting that current definitions of an “active lifestyle” may not fully capture the requirements for maintaining optimal muscle health.

The interaction between behavioral, metabolic, and environmental factors further complicates the understanding of early-onset sarcopenia. While individual risk factors such as obesity, poor nutrition, and low physical activity have been well described, their combined effects may be greater than the sum of their individual contributions. This highlights the importance of adopting a multidimensional approach when evaluating muscle health in younger populations. From a preventive standpoint, these findings reinforce the need for early lifestyle interventions that extend beyond traditional recommendations. Incorporating resistance training as a routine component of physical activity, optimizing dietary habits, and reducing sedentary time may collectively play a critical role in preserving muscle function. Overall, early-onset sarcopenia should be viewed not only as an emerging clinical entity but also as a marker of broader lifestyle-related health risks, with implications extending beyond musculoskeletal health to long-term metabolic outcomes.

5. Limitations

This review is subject to several limitations that should be considered when interpreting the findings. First, the available literature on sarcopenia in young adults remains limited, and much of the existing evidence is derived from studies conducted in older populations. As a result, the applicability of current diagnostic criteria and mechanistic insights to younger individuals may be restricted.

In addition, considerable heterogeneity exists across studies in terms of diagnostic definitions, assessment methods, and population characteristics. This variability contributes to inconsistent estimates of sarcopenia prevalence and limits the comparability of findings across different studies.

Another important limitation is that a large proportion of the available data is based on observational and cross-sectional studies. While such studies provide valuable insights into associations between risk factors and muscle health, they do not allow for the establishment of causal relationships.

Furthermore, lifestyle-related factors such as physical activity and dietary intake are often assessed using self-reported measures, which may introduce bias and affect the accuracy of the findings. These limitations highlight the need for more standardized and methodologically robust research in this field.

6. Future Directions

Future research should focus on addressing the current gaps in knowledge regarding early-onset sarcopenia in young adults. One of the key priorities is the development of age-specific diagnostic criteria that would allow for more accurate identification of sarcopenia in younger populations. Establishing appropriate reference values for muscle strength and mass is essential for improving both clinical assessment and research consistency.

There is also a need for well-designed longitudinal studies to better understand the progression of sarcopenia from early adulthood and its long-term health consequences. Such studies would provide valuable insights into the temporal relationship between lifestyle factors, metabolic dysfunction, and muscle deterioration.

In addition, future research should explore the effectiveness of combined intervention strategies, including resistance training and nutritional optimization, in preventing and reversing early impairments in muscle health. A better understanding of how these interventions can be tailored to individual characteristics, such as baseline physical activity and metabolic status, may further enhance their effectiveness.

Finally, greater emphasis should be placed on the role of public health strategies aimed at promoting physical activity and healthy dietary habits in younger populations. Increasing awareness of muscle health as a component of long-term disease prevention may play an important role in reducing the future burden of metabolic and musculoskeletal disorders.

7. Public Health Implications

Early-onset sarcopenia may represent an underrecognized public health concern, particularly in the context of modern lifestyle patterns characterized by reduced physical activity and suboptimal dietary habits. While traditionally associated with aging, the presence of early impairments in muscle health among younger individuals suggests that preventive strategies should be implemented much earlier in life.

Increasing levels of sedentary behavior, combined with inadequate nutrition, may contribute to the gradual decline in muscle mass and function, potentially leading to long-term metabolic consequences. As such, public health initiatives aimed at promoting regular physical activity and healthy dietary patterns may play a critical role in preserving muscle health across the lifespan.

In addition, raising awareness of sarcopenia as a condition that can develop early in adulthood may encourage both clinicians and individuals to adopt a more proactive approach to prevention. Integrating muscle health assessment into routine health evaluations could further support early identification and intervention.

Overall, addressing early-onset sarcopenia from a public health perspective may contribute to reducing the long-term burden of metabolic and musculoskeletal diseases.

8. Emerging Perspectives

Recent literature increasingly suggests that sarcopenia should be understood as a condition influenced by multiple interacting factors rather than a process limited to aging alone. As described by Deutz et al. (2014) and Murton (2015), disturbances in muscle protein metabolism, including impaired anabolic signaling and increased protein breakdown, may occur in the presence of metabolic dysfunction and inadequate nutritional support. These mechanisms are not exclusive to older populations and may also be present in younger individuals exposed to unfavorable lifestyle conditions.

The concept of sarcopenic obesity further supports a more integrated understanding of muscle health. El Ghoch et al. (2022) emphasized that the coexistence of excess adiposity and reduced muscle quality is associated with increased metabolic risk, including insulin resistance and chronic inflammation. This highlights the complex interaction between muscle and metabolic regulation, suggesting that muscle health should be considered within a broader physiological context.

In addition, lifestyle-related factors such as physical inactivity and inadequate dietary intake, as described by Petermann-Rocha et al. (2022) and Westerterp (2018), play a central role in the development of early impairments in muscle health. These factors may contribute to gradual changes in muscle mass and function over time, even in individuals without overt clinical symptoms.

Taken together, these findings indicate that early-onset sarcopenia may represent a multifactorial condition influenced by metabolic, behavioral, and nutritional factors. A better understanding of these interactions may contribute to improved prevention strategies and more effective clinical management.

9. Conclusions

Sarcopenia should no longer be viewed exclusively as a condition of older age. The evidence summarized in this review indicates that early impairments in muscle health may develop in young adults and are closely linked to modifiable lifestyle factors, including physical inactivity, suboptimal nutrition, obesity, and metabolic dysfunction. These factors contribute to disturbances in muscle protein turnover and may initiate a trajectory leading to progressive declines in muscle mass and function over time. Importantly, early manifestations of sarcopenia are often subtle and may remain unrecognized in clinical practice, particularly in the absence of age-specific diagnostic criteria.

From a practical perspective, the most effective approach to addressing early-onset sarcopenia appears to be prevention rather than treatment. Resistance training and adequate protein intake represent the most consistently supported strategies for preserving muscle health, while reducing sedentary behavior and

improving overall lifestyle habits may further enhance their effectiveness. In this context, muscle health should be considered an integral component of metabolic health, as early alterations in muscle function may reflect broader disturbances in energy metabolism and insulin sensitivity.

Taken together, these findings highlight the need for greater clinical awareness and a more proactive approach to muscle health in younger populations. Early identification of at-risk individuals, combined with targeted lifestyle interventions, may play a crucial role in preventing long-term adverse outcomes. Further research is required to establish age-specific diagnostic criteria and to better define effective intervention strategies; however, current evidence already supports the importance of early prevention as a key element of long-term health promotion.

Author Contribution:

Conceptualization, Kamil Wójcik; methodology, Kamil Wójcik; writing—original draft preparation, Kamil Wójcik; literature search, Irmina Grygutis, Julia Kępska, Weronika Olech, Wiktor Kowalczyk; data curation, Irmina Grygutis, Julia Kępska, Weronika Olech; visualization (figure and tables), Wiktor Kowalczyk, Arina Drobashko; investigation, Aneta Synakiewicz, Natalia Lewińska, Nikola Murawska, Aleksandra Pociej, Milena Dziedzina; writing—review and editing, all authors; supervision, Kamil Wójcik. All authors have read and agreed to the published version of the manuscript.

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