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PREVALENCE, NUTRITIONAL CORRELATES, DIAGNOSIS, AND MANAGEMENT STRATEGIES FOR SARCOPENIA AMONG MIDDLE-AGED ADULTS: A LITERATURE REVIEW

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ABSTRACT

Background: *Sarcopenia is a disorder that progressively reduces muscle mass, function, and strength. It is a serious health issue for the elderly that can affect everyday tasks, raise the risk of falls, and cause disability. However, emerging evidence highlights its prevalence among middle-aged adults, underscoring the need for early identification and intervention.* ***Aim:*** *This literature review explores the multifaceted aspects of sarcopenia in middle-aged adults, including its prevalence, nutritional correlates, diagnostic criteria, and management strategies.* ***Methods:*** *A comprehensive literature search was conducted using databases such as Google Scholar, Research Gate, PubMed, and Medline. Inclusion criteria encompassed research articles, systematic reviews, clinical trials, observational studies, and case studies focusing on Sarcopenia.* ***Results:*** *Sarcopenia, a multifactorial geriatric condition, is increasingly recognized as a global health concern. Management combines resistance training, protein-rich diets, and emerging pharmacological agents, but challenges like inconsistent diagnostic criteria, financial barriers, and limited research necessitate region-specific guidelines and multidisciplinary strategies to support healthy aging worldwide.* ***Conclusion:*** *Treating sarcopenia includes specialized exercise routines, dietary plans, pharmacological therapy, and management. Addressing current obstacles requires creating region-specific recommendations. Multidisciplinary cooperation and ongoing research can improve management and prevention.*

KEYWORDS: *Sarcopenia, Middle-Aged Adults, Muscle Mass Loss, Prevalence, Nutrition, Diagnosis, Management Strategies.*

INTRODUCTION

Sarcopenia is a progressive condition characterized by the widespread decline of skeletal muscle mass and function, which leads to a higher risk of adverse outcomes such as falls, reduced functionality, frailty, and increased mortality. (1) The term was initially coined to describe the decline in muscle mass and function linked to the aging process. (2) In 1989, Rosenberg introduced the term "sarcopenia" (derived from the Greek words 'sarx' meaning flesh, and 'penia' meaning loss) to refer to the age-related reduction in muscle mass. (3)

The pathophysiology of sarcopenia is intricate, encompassing muscle function as well as neural and hormonal regulation. As part of the natural aging process, muscle fiber quality gradually deteriorates, and there is a slow decline in peak power, shortening speed, and elasticity. (4) The prevalence of sarcopenia varies depending on the location and definition used. However, it is estimated that up to 29% of older individuals in community healthcare settings are affected, while the rate ranges from 14% to 33% in those residing in long-term care facilities. (5) A decline of 10-15% in leg strength per decade is observed until the age of 70, after which the loss accelerates, ranging from 25% to 40% per decade. (6) Sarcopenia is more commonly observed in older populations, although the decline in muscle mass typically begins around the age of 40. As a result, the negative impact of sarcopenia on quality of life, healthcare needs, morbidity, and mortality can affect both middle-aged and older adults. (7)

With advancing age, skeletal muscle undergoes physiological and morphological changes, including a general reduction in the size and number of muscle fibers, particularly type 2 (fast-twitch) fibers. Additionally, there is significant infiltration of fibrous and adipose tissue into the muscle. (8) Current known causes of sarcopenia include chronic diseases, a sedentary lifestyle, reduced mobility, and malnutrition. Sarcopenia arises from a variety of interconnected and complex pathophysiological mechanisms, such as aging, physical inactivity, neuromuscular dysfunction, impaired postprandial muscle building, insulin resistance, lipotoxicity, hormonal imbalances, oxidative stress, mitochondrial dysfunction, and inflammation. (9) In sarcopenia, initial changes occur selectively in the muscular system, but eventually, they affect the entire skeletal muscle system. This progression results in the loss of muscle mass, decreased functional ability, and the inability to perform essential daily tasks independently, leading to dependence. (10)

Sarcopenia is often undiagnosed, as there are no universally reliable screening tools to detect the condition (1). The diagnosis of sarcopenia is based on measurements of muscle mass and functional tests that assess muscle strength or physical performance. (11) As people age, muscle mass decreases and fat increases. Anthropometry estimates fat and muscle, but is less precise. Bioelectrical impedance analysis (BIA) estimates muscle mass but doesn't differentiate fat types. Dual-energy X-ray absorptiometry (DEXA) is accurate and provides a body

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model with minimal radiation. CT and MRI scans assess muscle volume and visceral fat. Ultrasound is cost-effective for clinical use but depends on operator skill and doesn't measure muscle mass. [12] The SARC-F test evaluates five areas: strength (difficulty lifting heavy objects), walking assistance (challenges moving across a room), chair rise (struggling to stand without hands), stair climbing (difficulty with stairs), and falls (whether the person has fallen in the past year). Each component is scored yes or no, with a higher score indicating greater sarcopenia risk. The test helped assess the severity of the patient's symptoms and guide their treatment. [13] Management of sarcopenia can be effective in primary care when the physician, plays an active role in nutrition and physical activity. [14]

Nutrition is regarded as an important contributing factor in the complex etiology of sarcopenia. Associations between several nutritional factors and muscle mass, strength, function, and physical performance were reported in a growing number of studies in recent years [15]. . Severe vitamin D deficiency is linked to sarcopenia, particularly in men. [16] Dietary protein ingestion indicates that older adults require protein intakes 50%-100% higher than the daily allowance to preserve muscle mass.[17] Optimizing the potential for muscle protein anabolism by consuming an adequate amount of high-quality protein at each meal, in combination with physical activity, appears as a promising strategy to prevent or delay the onset of sarcopenia[18]

When developing Resistance Exercise Training (RET) programs for older adults, it is important to consider all of the various training-related variables such as frequency, duration, exercises, sets, intensity, repetitions, and progression.[19] Progressive resistance training (PRT) is recommended to include 8–10 exercises for the major muscle groups using a resistance that allows 10–15 repetitions for each exercise [20] Additionally, Aerobic training, land- or water-based exercises in which muscle contractions are sustained for long periods, has long been known for its beneficial effects on cardiorespiratory health. Aerobic exercise induces various adaptations and improvements in skeletal muscle, including increased satellite cell content, resulting in increased myonuclear number per fiber. It also leads to gene expression changes, mitochondrial volume/density alterations, increased mitochondrial enzyme activity, and enhanced lipid oxidation in the muscles [21-22]

Several different drugs have been tested with various scientific evidence levels to impact skeletal muscle maintenance among diseased patients. They can alter the sarcopenia's metabolic parameters, protect against cardiovascular diseases and outcomes while protecting muscles, or even act directly on them. Some of these drugs are sodium-glucose cotransporter 2 (SGLT2) inhibitors, metformin, growth hormone, glucagon-like peptide-1 receptor agonists (GLP-1A), statins, losartan, peptidyl peptidase 4 (DPP-4) inhibitors [23]. Puerarin is an effective monomer isolated from the traditional Chinese medicine Pueraria lobata (Willd.) Ohwi, which has various pharmacological activities, such as anti-inflammatory, anti-oxidant, vasodilation, and apoptosis-regulating effects. It has the potential to treat sarcopenia through the regulation of the cell cycle, apoptosis, and protein homeostasis [24]

The research focuses on identifying which age group is most affected by sarcopenia and how early signs can be detected. The study aimed to develop effective intervention strategies to manage and prevent its progression. It also includes the development of exercise-based protocols and lifestyle recommendations to help improve strength, mobility, and overall quality of life in individuals at risk.

ARTICLE REVIEWS

Article No.	Source Title	Year of publication	Author(s)	Method used	Major findings
1.	**Obstacles to the Early Diagnosis and Management of Sarcopenia: Current Perspectives[25]**	**2024**	Hoyli Ooi and Carly Welch	- Reviews sarcopenia literature and EWGSOP2 (2019) guidelines. -Covers diagnostic tools: grip strength, chair stand, SARC-F, muscle mass (DXA, CT, MRI, BIA, ultrasound). - Discusses clinical challenges of these tools. - Highlights importance of objective tests: gait speed, SPPB, TUG.	- Sarcopenia diagnosis focuses on muscle strength; EWGSOP2 cut-offs guide screening. -Confirmation requires muscle mass measurement (imaging or alternatives). -Challenges: individual variability, limited tools (e.g., SARC-F), low awareness, equipment, and time constraints. -Emphasizes performance tests and urges better awareness, routine screening, and clinical use.
2.	**Prevalence and factors associated with sarcopenia among urban and rural Indian adults in middle age: A cross-**	2024	Gauri Bhat, Alex Ireland, Nikhil Shah, Ketan Gondhalekar, Rubina Mandlik, Neha Kajale, Tarun Katapally, Jasmin	- Participants: 745 adults (400 women), urban and rural -Data: Demographics, diet, activity (GPAQ), anthropometry	- Mean age: 53 ± 7.6 years -Sarcopenia: 10% overall; 4.2% severe -Higher in: Rural areas (14.8%) and men (12.5%) *($p<0.05$)*

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	sectional study from Western India[26]		Bhawra, Rahul Damle, and Anuradha Khadilkar	-Tests: Muscle mass (DXA), strength, function (SPPB) -Sarcopenia: AWGS 2019 criteria -Included: Healthy adults >40 -Excluded: Illness, chronic conditions, pregnancy, implants	-Urban adults: Better muscle mass, strength, function *(p<0.05)* -Risks: Age, rural living, low protein, low SES -Implication: Early detection needed, especially in rural India
3.	**Diagnostic Criteria and Measurement Techniques of Sarcopenia: A Critical Evaluation of the Up-to-Date Evidence [27]**	2024	Gavriela Voulgaridou, Maria Tolia, Eleni Spanoudaki, Vasileios Kouloukoussa, Maria Tzavara, and Maria G. Grammatikopoulou	-Assessed strengths and limits of screening tools (SARC-F, MSRA), muscle mass methods (DXA, MRI, CT, BIA, ultrasound), strength tests (grip, knee extensor, chair stand), and performance measures (SPPB, gait speed, TUG). -Compared methods by sensitivity, specificity, practicality, and clinical utility.	-Screening: SARC-F simple, cost-effective, moderate sensitivity; MSRA-5 more sensitive. -Muscle mass: DXA accurate, affordable; MRI/CT gold standard but costly; ultrasound practical and cheap; BIA portable but indirect. -Muscle strength: Handgrip most reliable; knee extensor and chair stand for lower limbs. -Performance: SPPB, gait speed, TUG assess function; SPPB also estimates biological age.
4.	**Diet for the prevention and management of sarcopenia[34]**	2023	Calvani R, Picca A, Coelho-Júnior HJ, Tosato M, Marzetti E, Landi F.	- Reviewed diet and nutrition's role in sarcopenia. -Covered diet impact on muscle mass and intervention challenges. -Highlighted personalized nutrition potential. -Explored tech tools: EHRs, wearables, multi-omics, digital diet apps for tailored care.	-Protein, leucine, vitamin D, antioxidants plus exercise support muscle health. -Diet boosts protein synthesis, lowers inflammation, fights oxidative stress. -Tech (EHRs, sensors, apps) can personalize nutrition but have cost/usability limits. -Challenges: optimizing intervention timing and content. -Future: integrate tech and nutrition for tailored sarcopenia care.
5.	**Engagement in Aerobic Exercise Is Associated with a Reduced Prevalence of Sarcopenia and Severe Sarcopenia in Italian Older Adults [21]**	2023	Hélio J. Coelho-Júnior, Riccardo Calvani, Anna Picca, Matteo Tosato, Francesco Landi ,Emanuele Marzett	-Data from Lookup 7+ study: 13,515 Italians aged 65+ (BMI ≥18.5). -Lifestyle and exercise data via interviews. -Sarcopenia defined by dynapenia and low ASM. -Muscle strength measured by handgrip and sit-to-stand tests. -Physical activity: inactive, aerobic, or resistance training. -Analyzed exercise type's link to sarcopenia by sex and strength test.	-Aerobic exercise (running/swimming) was linked to lower sarcopenia and severe sarcopenia rates in both sexes. -In women, it reduced sarcopenia (STS test); in men, severe sarcopenia (IHG test). - Resistance training showed no significant effect. - Effects varied by sex and strength assessment method. -Highlights aerobic exercise's potential and the need for sex-specific approaches.
6.	**Insights into Pathogenesis, Nutritional and Drug Approach in**	2023	Rodrigo Haber Mellen, et al.	-Review on sarcopenia causes and treatments.	-Supplements (leucine/BCAAs, creatine, omega-3, vitamin D, calcium) improve muscle mass, strength, function.

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	Sarcopenia: A Systematic Review[23]			-Nutrition: amino acids, creatine, omega-3, vitamin D, calcium. -Drugs: metformin, GLP-1 agonists, statins, growth hormone, DPP-4 inhibitors. -Included resistance exercise. -Outcomes: muscle mass, strength, performance, metabolism, quality of life.	-No approved drugs; metformin and GLP-1 agonists show potential but need research. -Resistance training most effective; combined exercise and nutrition best. -Recommend early detection and personalized lifestyle; supplements supported, drugs under study.
7.	**Sarcopenia definition, diagnosis and treatment: consensus is growing[13]**	2022	Avan Aihie Sayer, Alfonso Cruz-Jentoft	Narrative review of recent research, guidelines, and consensus statements	- Global focus is shifting to muscle strength over mass in sarcopenia diagnosis. - Resistance training is strongly supported but underused clinically. -The Global Leadership Initiative on Sarcopenia aims to unify international diagnostic criteria.
8.	**Sarcopenia: how to measure, when and why[28]**	2022	Tagliafico AS, Bignotti B, Torri L, Rossi F	-Comprehensive review of sarcopenia diagnostic criteria, measurement methods, and guidelines. -Critical analysis of strengths, limitations, and clinical use of muscle mass (DXA, MRI, CT), strength (handgrip), and performance tests (SPPB, TUG).	- Muscle Mass: DXA, MRI, CT are accurate but costly. -Strength: Handgrip is simple and reliable. -Performance: SPPB and TUG assess function. -Diagnosis: Combines mass, strength, performance. -Screening: Needed early in older adults. -Impact: Supports timely treatment. -Care: Requires multidisciplinary approach.
9.	**Lifestyle approaches to prevent and retard sarcopenia: A narrative review[16]**	2022	Oliver Bruyère, Jean-Yves Reginster, Charlotte Beaudart	-Reviewed literature (2011–2021) on sarcopenia, nutrition, physical activity, and lifestyle. -Focused on meta-analyses, systematic reviews, trials, and key epidemiological studies. -Studies are categorized into: physical activity, nutrition, combined approaches, and other lifestyle factors.	-Physical Activity: Exercise prevents sarcopenia; inactivity raises risk. -Nutrition: Healthy diets support muscle; malnutrition increases risk. -Combined: Exercise plus supplements show mixed results; more research needed. -Other: Limited evidence on alcohol/tobacco impact.
10.	**Network Pharmacology-Based Analysis of the Effects of Puerarin on Sarcopenia[24]**	2022	Xufeng Chen, Yan Wang, Meige Liu, Xiaodong Song, Dong Wang, Jun Zhang	-Identified puerarin and sarcopenia targets via multiple databases. -Found 206 overlapping core targets using PPI network. -GO and KEGG analyses revealed key biological processes and pathways.	- Puerarin targets sarcopenia-related proteins and pathways. -Key pathways: PI3K-Akt, mTOR, FOXO, MAPK, NF-κB (muscle protein balance, cell survival). -Key processes: Protein synthesis, apoptosis, telomere maintenance—crucial for muscle health.

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11.	**Global prevalence of sarcopenia and severe sarcopenia: a systematic review and meta-analysis[7]**	2022	Fanny Petermann-Rocha, Viktoria Balntzi, Stuart R. Gray, Jose Lara, Frederick K. Ho, Jill P. Pell, Carlos Celis-Morales	**-Systematic Review and Meta-Analysis** -263 studies included for narrative synthesis; 151 for meta-analysis (n = 692,056, mean age 68.5 years	- Sarcopenia prevalence varies by criteria: 10%–27% in meta-analyses. - Highest in Oceania, lowest in Europe (EWGSOP/EWGSOP2). -Age <60: 8%–36%; age ≥60: 10%–27%. - EWGSOP2: higher in men (11% vs. 2%); IWGS: higher in women (17% vs. 12%). -Severe sarcopenia: 2%–9%
12.	**Roles of nutrition in muscle health of community-dwelling older adults: evidence-based expert consensus from Asian Working Group for Sarcopenia[33]**	2022	Ling-Wei Chen, Hiroyuki Arai, Patama Assantachai, Masahiro Akishita, See-Tarn Chew, Liza C. Dumlao, Gustavo Duque, and Jean Woo	-A panel of eight Asia-Pacific experts formed a Special Interest Group (SIG) to develop consensus. -Conducted a systematic review of studies on adults 60+ in Asia, including RCTs, meta-analyses, and observational research on nutrition and muscle health	-Panel created 14 consensus statements on sarcopenia covering screening, assessment, diet, supplements, exercise, and COVID 19 -Emphasized protein, vitamin D, and key nutrients for muscle health. -Provided practical guidance for Asian healthcare providers. -Promoted global understanding and multidisciplinary nutrition-exercise approach.
13.	**Patterns of Nutrient Intake in Relation to Sarcopenia and Its Components[30]**	2021	Bagheri A., et al.	-Cross-sectional study: 300 Iranians (55+, equal men/women). -Diet via FFQ; patterns by PCA. -Sarcopenia by DXA, handgrip, gait speed (EWGSOP). -Analysis adjusted for key demographics and lifestyle factors.	- Three nutrient patterns identified: Pro-vit, Anti-inflammatory, and Carbo-vit. -Anti-inflammatory pattern linked to lower sarcopenia and muscle weakness. -The Carbo-vit pattern is associated with better gait speed. -Highlights the importance of overall nutrient patterns in sarcopenia prevention
14.	**Prevalence of sarcopenia and relationships between muscle and bone in Indian men and women[29]**	2021	Ayse Zengin, Bharati Kulkarni, Anuradha V Khadilkar, et al.	- Study Design: Pooled cross-sectional analysis from multiple Indian cohort studies. Participants: 1009 young adults (20–35 years) and 1755 older adults (>40 years), both sexes. Measurements: 1. Areal bone mineral density (hip/spine, DXA) 2. Fat and lean mass (DXA) 3. Hand grip strength (HGS, dynamometer)	-Indian cut-points for ALM, ALMI, and HGS are lower than global standards. -Sarcopenia prevalence in Indian adults varies by definition. -EWGSOP2 cut-point best predicted low grip strength. -Muscle-bone links were stronger in women, indicating sex differences.
15.	**Resistance exercise to prevent and manage sarcopenia and dynapenia[19]**	2016	Brian C. Clark, Laura A. Clark, Timothy D. Law	- Reviewed resistance exercise training (RET) for sarcopenia/dynapenia in older adults. -Covered key prescription factors: intensity, volume,	-RET prevents and manages sarcopenia/dynapenia effectively. -Key: moderate-high intensity, progressive overload, 2–3 sessions/week.

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				frequency, sets, reps, progression. -Included functional and home-based exercises using household items. -Highlighted safety and proper technique to prevent injuries.	-Functional exercises support daily tasks, useful without gyms. -Home-based RET uses bands, dumbbells, and household items. -Safe technique vital, especially unsupervised. -Individualized plans are needed based on health.
16.	**Prevention and optimal management of sarcopenia: a review of combined exercise and nutrition interventions to improve muscle outcomes in older people[31]**	2015	Helen J. Denison, Cyrus Cooper, Avan A. Sayer, and Sarah M. Robinson	-Reviewed 133 papers; 17 met criteria (exercise + nutrition interventions). -Studies ranged 17–217 participants, 8 weeks–18 months duration. -Designs: two- and four-group comparisons. -Outcomes: muscle strength, size, physical performance.	-Combined exercise and nutrition improved strength and function in some trials. -Results varied by participants and protocols. -Protein and vitamin D plus training boosted grip strength and gait speed; muscle mass results mixed. -More large, quality trials needed. -Future studies should test more nutrients.
17.	**Nutrition and Sarcopenia: Evidence for an Interaction [20]**	2012	D. Joe Millward	-Reviews nutrition's role in sarcopenia, dynapenia, frailty, and related factors(inactivity, anabolic resistance, inflammation, acidosis, vitamin D deficiency). -Analyzes observational and intervention studies, including UK protein intake. -Uses causal framework to integrate factors and stresses clinical importance of dynapenia distinct from sarcopenia.	-Sarcopenia is multifactorial; nutrition alone isn't key. -Older adults face anabolic resistance; protein intake (~1.24 g/kg/day) usually adequate. -Protein needs rise with age; low energy and inactivity increase risk. -Supplements add limited benefit with resistance training in frail elderly. -Fish oil may help; antioxidants have little effect. -Vitamin D deficiency linked to sarcopenia; extra supplementation unclear.

METHODOLOGY

Aim: - This literature review, titled "Prevalence, Nutritional Correlates, Diagnosis, and Management Strategies for Sarcopenia among Middle-Aged Adults: - A Literature Review," aimed to explore the prevalence of sarcopenia in middle-aged adults, assess their dietary habits and physical activity levels, identify common symptoms, and evaluate their awareness of the condition. The review also focused on how existing research supports effective management and prevention strategies for this age group.

Selection criteria:- A total of 17 full-text articles were reviewed, sourced from databases such as Google Scholar, PubMed, and Pedro. These articles covered topics including the definition of sarcopenia, its prevalence, diagnosis, nutritional factors, and management strategies. Special attention was given to interventions such as exercise, dietary changes, and other approaches aimed at maintaining or improving muscle health in middle-aged adults.

Articles were included if they were published in English, available as full texts, and specifically addressed prevalence, risk factors, diagnosis, or management of sarcopenia. Selection was based on relevance and adherence to these inclusion criteria. Among the reviewed topics, management emerged as a key area of focus, with many studies highlighting the benefits of physical activity and nutritional support in addressing muscle decline.

Problem statement:- A research gap was also identified sarcopenia was not widely acknowledged as a specific medical condition until recent years. Previously considered a normal part of aging, it received limited attention in both clinical practice and research, particularly for middle-aged individuals. The growing recognition of sarcopenia now calls for more awareness, early screening, and tailored intervention strategies.

In summary, this review highlights the importance of early identification and appropriate management of sarcopenia in

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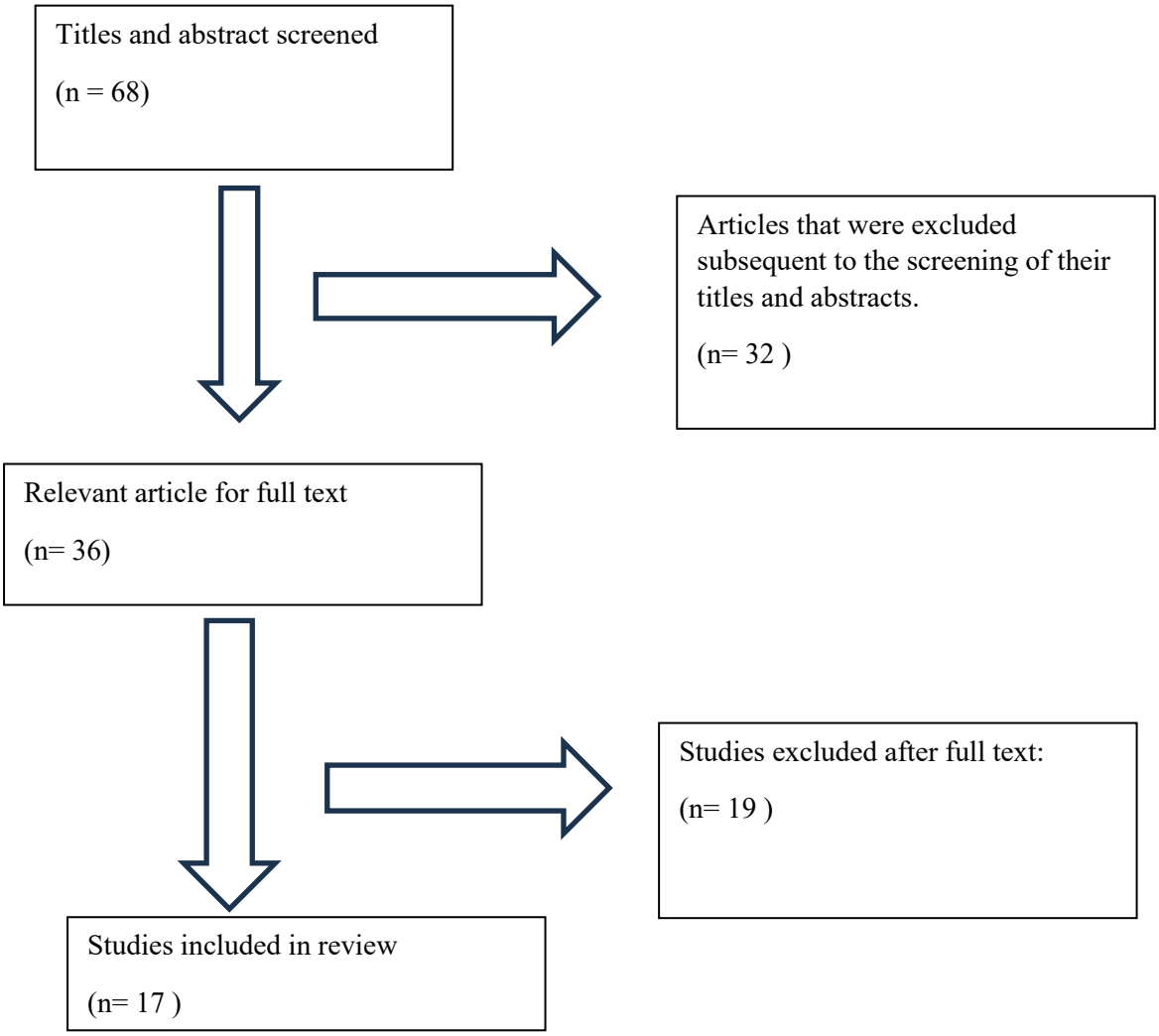
middle-aged adults, emphasizing the need for continued research and practical strategies to support healthy aging.



RESULTS

According to recent studies, sarcopenia is becoming more widely acknowledged as a serious health concern, especially the low- and middle-income nations. Because of inconsistent diagnostic criteria, low awareness, and logistical difficulties in implementing therapies, sarcopenia is still not fully integrated into clinical care, even after being officially recognized as a condition in 2016. Evidence from multiple studies emphasizes the effectiveness of resistance training and nutritional optimization, although widespread application is hampered by financial and infrastructural barriers. Meta-analyses and cross-sectional studies reveal significant variability in sarcopenia prevalence, influenced by geographic location, measurement techniques, and population characteristics, with rural and male populations often showing higher rates. Indian-specific research further demonstrates the necessity for ethnicity-adjusted diagnostic thresholds, as international standards may underestimate prevalence in non-Caucasian populations. Collectively, the findings underscore the urgent need for standardized, universally accepted diagnostic criteria, region-specific guidelines, and expanded research efforts, particularly in underrepresented areas to facilitate early detection and effective management of sarcopenia worldwide.

The prevention and management of sarcopenia in older persons is greatly aided by integrated nutritional and exercise therapy, according to a recent study. With data demonstrating the value of diets high in protein and certain supplements in preserving muscle mass and function, nutrition plays a fundamental role. Though their expense and limited use among older populations present obstacles to their implementation, technological innovations like wearable sensors, electronic health records, and multi-omics platforms offer intriguing pathways for tailored nutritional regimens. The expert consensus from the Asian Working Group for Sarcopenia underscores the need for region-specific, evidence-based nutritional guidelines tailored to community-dwelling older adults. Moreover, a review of intervention studies demonstrates that combining resistance training with dietary supplementation significantly enhances muscle strength and performance. Observational data from a large cohort of Italian older adults further suggest that engagement in aerobic activities such as running and swimming is associated with a reduced prevalence of sarcopenia, with variations observed based on sex and assessment tools.

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Resistance training, particularly when adapted for home use with simple equipment, offers a practical and effective strategy for older adults, provided exercises are performed safely. Collectively, these findings advocate for a comprehensive, individualized approach that incorporates both nutritional and physical activity components to effectively address sarcopenia and support healthy aging. There have also been recent advancements in the pharmacological approach toward Sarcopenia, which includes agents such as GLP-1 agonists, losartan, and Puerarin.

All of the evaluated publications emphasize how crucial lifestyle changes, especially those related to nutrition and physical exercise, are to managing and preventing sarcopenia in older persons. While sedentary behavior is known to be a risk factor for muscle degradation, resistance exercise has repeatedly been found to be a critical component in enhancing muscle development, strength, and functional capacity. Positive results in muscle preservation are linked to nutritional tactics, such as consuming enough protein and following dietary patterns like the Mediterranean and Baltic Sea diets. The effectiveness of particular nutritional supplements or calorie intakes in reversing or stopping the progression of sarcopenia, however, is still up for debate. Millward, in particular, cautions against attributing sarcopenia primarily to nutritional deficiencies, suggesting instead that it results from a complex interaction of factors including anabolic resistance, inflammation, acidosis, and reduced physical activity. This study emphasizes that most healthy older adults consume sufficient protein and that current data do not support precise nutritional recommendations beyond general healthy dietary practices. Additionally, other lifestyle factors such as alcohol and tobacco cessation remain insufficiently studied. Overall, the findings reinforce the potential of combined exercise and nutritional approaches as non-pharmacological tools to combat sarcopenia, while highlighting the need for further high-quality research to develop targeted and individualized intervention strategies.

The reviewed literature collectively underscores sarcopenia as a progressive and multifactorial geriatric condition marked by the decline of skeletal muscle mass, strength, and physical performance. The consensus across the articles supports the integration of diagnostic strategies involving muscle strength assessments, such as handgrip strength and chair stand tests, alongside muscle mass evaluation through imaging methods like DXA, MRI, and CT. Despite their diagnostic precision, these imaging modalities are often constrained by cost and accessibility, prompting reliance on more feasible alternatives like ultrasound and BIA in clinical settings. Screening tools such as the SARC-F and MSRA questionnaires are highlighted for their simplicity and effectiveness in early identification. Furthermore, the studies emphasize the value of physical performance assessments, including the SPPB and TUG tests, as integral components in determining functional status. While resistance-based exercise and optimized nutrition are consistently recommended as first-line, non-pharmacological interventions, the literature reveals limited progress in developing effective pharmacological treatments. The findings advocate for a multidisciplinary approach, involving clinicians, nutritionists, and physical therapists, to facilitate early detection and individualized care. Overall, the articles point to the critical need for increased awareness, standardized diagnostic criteria, and further research to enhance prevention and management strategies for sarcopenia in aging populations.

DISCUSSION

Sarcopenia, characterized by age-related declines in muscle mass, strength, and function, poses a significant public health challenge, particularly in aging populations. Emerging research highlights the multifactorial nature of sarcopenia, with chronic diseases (e.g., stroke, diabetes) and lifestyle factors (e.g., alcohol use, physical inactivity) significantly modulating risk. For instance, longitudinal studies reveal that chronic inflammation and oxidative stress from conditions like obesity or cardiovascular disease exacerbate muscle degradation.

There have been recent advancements in diagnostic criteria, such as the revised European Working Group on Sarcopenia in Older People (EWGSOP2) recommends a diagnostic framework that includes low muscle strength as the principal determinant, supported by low muscle quantity/quality and poor physical performance. Tools such as grip strength dynamometry, dual-energy X-ray absorptiometry (DEXA), bioelectrical impedance analysis (BIA), and gait speed assessments are commonly used for evaluation. However, clinical implementation remains inconsistent due to limited access to such tools, underscoring the need for standardized diagnostic protocols. In addition, clinical tools like the SARC-F questionnaire and the Ishii test have shown utility in community and clinical settings. The Use of physical performance assessments, such as the Short Physical Performance Battery (SPPB) and the Timed Up and Go (TUG) test, are suggested to evaluate functional capacity and mobility in individuals with suspected sarcopenia. Radiological examinations using MRI, CT, and ultrasound can also play an important part in diagnosing Sarcopenia and help the radiologist play a pivotal role in muscle mass and sarcopenia assessment by monitoring muscle changes in size and architecture.

Sarcopenia management focuses on exercise (resistance and aerobic) and diet, both shown to improve muscle mass and strength. A high-quality, nutrient-rich diet is a key strategy in combating sarcopenia. Adequate protein intake along with essential micronutrients is vital for muscle health. The Asian Working Group for Sarcopenia (AWGS) recommends 1–1.2 g/kg BW of protein daily for healthy older adults, and 1.2–1.5 g/kg BW for those with sarcopenia or frailty, emphasizing high-quality proteins like whey and amino acids such as leucine and beta-hydroxy-beta-methyl butyrate (HMB). Diets like the Mediterranean diet, rich in antioxidants, polyunsaturated fats, and plant proteins, are also beneficial. Key micronutrients include creatine, omega-3 fatty acids, and vitamin D. Proper hydration is equally important, as water makes up about 75% of muscle mass and is crucial for physiological, structural, and mechanical functions. [25].

Development and personalization of dietary strategies can be implemented to manage sarcopenia using Nobel technologies such as electronic health records, wearable and ambient

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sensors, and multi-omics platforms. The use of these technologies could assist in characterizing metabolic response to foods and supplements in older adults at risk of sarcopenia at the individual level, devising tailored nutritional interventions, and monitoring their effects over time. However, there are limitations in implementing such techniques, such as cost, low acceptability of these devices by older adults, due to negative attitudes toward technologies, and difficulties in handling these sophisticated devices[26].

Exercise plays a key role in managing sarcopenia, serving as one of the most effective ways to improve muscle mass, strength, and physical performance. Regular physical activity, especially resistance training (RT), is central to sarcopenia treatment. Resistance exercises using weights or bands stimulate muscle protein synthesis, increase strength, and enhance physical performance. Variables such as frequency, duration, type of exercise, sets, intensity, repetitions, progressions, and existing health conditions (e.g., orthopedic or cardiovascular issues) must be considered when designing RET programs for older adults. Guidelines recommend progressive resistance training 2–3 times per week, targeting major muscle groups for best results. Additionally, Aerobic exercises like walking, cycling, or swimming improve cardiovascular health, fat metabolism, and overall function. Balance and flexibility exercises are also crucial for frail older adults, helping reduce fall risk and improve mobility.

Pharmacological therapies for sarcopenia remain experimental. Agents like SGLT2 inhibitors and GLP-1 agonists improve metabolic parameters and muscle health, while drugs such as losartan reduce inflammation-driven muscle atrophy. Myostatin inhibitors and selective androgen receptor modulators are also under investigation. Another agent-Puerarin, a traditional Chinese medicine compound, shows potential in modulating sarcopenia via network pharmacology by targeting cell cycle regulation, apoptosis inhibition, and protein homeostasis, potentially countering muscle loss from inflammation and oxidative stress. However, current treatments are limited by variable efficacy and safety concerns, highlighting the need to repurpose existing drugs like Puerarin using computational approaches.

Given the complex etiology involving hormonal, neural, inflammatory, and metabolic pathways, a multidisciplinary approach is essential for management. Future studies should prioritize randomized controlled trials (RCTs) to evaluate multimodal interventions combining nutrition, exercise, and pharmacotherapy. Solutions for cost-effective methods to implement Nobel technologies such as electronic health records, wearable and ambient sensors, and multi-omics platforms for forming dietary strategies, must be researched. Future research should also prioritize large-scale clinical trials to explore the potential of emerging pharmacological agents and their efficacy and safety in humans, alongside mechanistic studies to clarify their role in muscle protein synthesis and mitochondrial function. Additionally, Studies should also prioritize standardization of diagnostic criteria across diverse populations with consistency and availability. The article has been drafted following the TAILMRDCR model proposed by Kumar[35]. The findings are useful for the practitioners and medical tourism scope[36,37].

CONCLUSION

The literature under review lists progress and gaps that should be addressed moving forward in improving outcomes for individuals suffering from sarcopenia.

The diagnostic criteria for sarcopenia differ greatly among investigators, depending on the suggestions put forth by either the European Working Group on Sarcopenia in Older People (EWGSOP), the Asian Working Group for Sarcopenia (AWGS), or the Foundation for the National Institutes of Health (FNIH). This, along with differences in measurement techniques, study population, and geographic differences, leads to a significant variation in estimates of global prevalence rates. The studies suggest that standardizing the diagnosis may enhance the interpretation and application of research in clinical settings. Research from India shows a comparatively higher prevalence in rural than urban areas owing to differences in nutrition, lifestyle, and health-seeking behavior. This implies the need for region-specific intervention plans. Very few studies about sarcopenia have been carried out in developing countries like LMICs, especially in Africa and South Asia, thereby pointing out the need for further research with respect to poorly represented populations. Therefore, some region-based diagnostic criteria must be prepared to account for variations in lean mass, fat mass, height, and muscle strength in different populations regarding ethnicity.

Resistance exercise and optimized nutrition are always pointed out as effective strategies in sarcopenia management. Evidence indicates that improvement in muscle strength, size, or physical performance came primarily through these interventions. Integration of exercises along with nutritional modalities looks very promising; however, implementation has been hard due to logistic and financial hindrances. Recent technologies, with the use of wearable sensors, electronic health records, and multi-omics platforms, provide more personalized solutions for sarcopenia diagnosis or management; however, the costs associated with these technologies and acceptance by the end-user present challenges. These researchers propose the systematization of artificial intelligence (AI) in healthcare in order to facilitate early sarcopenia identification. Upcoming studies should focus on diagnostic criteria, try to fill the data void in middle-aged adults, and suggest an intervention relevant to the region. Followed by intervention costing for exercise programs and nutritional ones so it would be accessible to individuals across a varied socio-economic spectrum.

There is a need for early diagnosis and interventions to reduce the health burden of sarcopenia. Resistance exercise programs should be tailored to the individual and must overcome barriers of affordability and accessibility. Nutritional strategies must consider optimizing both protein intake and supplementation with micronutrients while definitely avoiding counterproductive excesses.

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STEPS FOR RESEARCH

- Choose a subject area of interest for your research or review.
- Each team member gathers five relevant articles.
- Group the collected articles according to specific subtopics or interest areas.
- Review and summarize the main points, findings, and significance of each article.
- Describe the approach used for collecting, reviewing, and analyzing the articles.
- Set the context, define the scope, and highlight the objective of the paper.
- Compile a Review Table summarizing the articles.
- Discuss the findings in a Discussion section.
- Wrap up the insights in a Conclusion