NATIONAL ACADEMY OF SPORTS MEDICINE

THE NASM GUIDE TO

SARCOPENIA: AN EVIDENCE-BASED REVIEW

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Contents

Contributors

Dr. Scott Cheatham, PhD, DPT, OCS, ATC, is a professor and associate chair in the Department of Kinesiology at California State University at Dominguez Hills in Carson, California. He is the owner of the Sports Medicine Alliance, a concierge sports and orthopedic physical therapy company. Dr. Cheatham is a national presenter for various organizations and has authored over 140 peer-reviewed publications, textbook chapters, and home-study courses on the topics of sports medicine, orthopedics, and health and fitness. In addition to being a subject matter expert for NASM, Dr. Cheatham is an education and research consultant for various health and fitness organizations and the managing board member of the NASM Scientific Advisory Board. He received a Doctor of Physical Therapy (DPT) and a Doctor of Philosophy (PhD) in Physical Therapy. He is a board-certified orthopedic physical therapist (OCS), certified athletic trainer (ATC), and certified ergonomic specialist. Certifications: NASM-CPT, CES, PES, CNC; NSCA-CSCS, CPT

Dr. Edwin Davila, DO, MS, CISSN, is a senior resident physician of internal medicine at the Texas Institute for Graduate Medical Education and Research. He was raised in a farming community along the Texas–Mexico border, where he saw the value and benefits of physical activity on general health and the significant, debilitating impact obesity can have on a population. He obtained his medical degree from the University of the Incarnate Word School of Medicine in San Antonio, an MS in Exercise Physiology from Baylor University, and a BS in Biology from Baylor University. He is a Certified Sports Nutritionist with the International Society of Sports Nutrition, a member of the Texas American College of Sports Medicine board of directors, a board member of the American Medical Society for Sports Medicine, and a former U.S. naval officer. His primary interest is in obesity medicine and developing methods of incorporating lifestyle medicine and exercise science as primary care modalities to prevent the progression of debilitating and preventable diseases for his patients.

Dr. Brad Dieter, PhD, MS, is a scientist and entrepreneur whose goal is to bring science and industry together to improve human health and well-being. He is a leader in the fields of health, wellness, and applied biotechnology. He has experience in the areas of metabolism, nutrition, diabetes, and molecular biology and has led businesses from startups to mature companies. He has authored peer-reviewed publications and has been a contributing author and editor to textbooks, certification courses, and the development of industry guidelines and standards. He currently serves as the chief operating officer of Macros, Inc. and as the chief executive officer of Outplay, Inc., and also sits on the scientific advisory board for the National Academy of Sports Medicine.

Erik Bustillo, MS, RD, FISSN, has been in healthcare and fitness for well over a decade and is a registered dietitian, an International Society of Sports Nutrition fellow and certified sports nutritionist, a certified strength coach, a certified CrossFit Level 2 coach, and a certified personal trainer. He earned his BS in Dietetics and Nutrition and his MS in Applied Exercise Science and Sports Nutrition. He specializes in reading blood and lab values that directly affect health and performance. Several of his fields of expertise are energy improvement, performance recovery, weight loss, working with professional and elite athletes, and stress management. Erik has experience in medical nutrition therapy and lifestyle and health coaching. He is a published author in several scientific journals. He is a world-renowned speaker and works closely with military groups, including forces such as the US Navy and the US Army. One of his passions is educating, and he does this on many levels, from lecturing for sports teams to guest lecturing at universities, presenting to tactical athlete and corporate wellness groups, and helping other dietitians and coaches grow in their careers. His social media handle is @erikbustillo.

Brian Sutton MS, MA, NASM-CPT, PES, CES, CSCS, is a 20-year veteran in the health and fitness industry, working as a personal trainer, author, instructional designer, and professor, and has overseen the development of several NASM publications, including Certified Personal Trainer, Certified Nutrition Coach, Certified Sports Nutrition Coach, Physique and Bodybuilding Coach, and Weight Loss Specialization. He earned an MA in Sport and Fitness Management from the University of San Francisco, an MS in Exercise Science from PennWest University, and several certifications from NASM, ACSM, and NSCA. He served as an adjunct faculty member for PennWest University (2010–2018), teaching graduate-level courses in corrective exercise, performance enhancement, and health and fitness. Brian is also a fourth-year doctoral candidate earning an EdD in Kinesiology from the University of North Carolina-Greensboro.

Abstract

Sarcopenia, or age-related muscle loss, is a growing concern among healthcare and fitness professionals. Sarcopenia is linked to a decline in muscle strength, muscle quantity and quality, and performance. Sarcopenia is also associated with different chronic conditions (e.g., diabetes, cardiovascular disease), worsening quality of life, and increased mortality. Researchers have recently updated and expanded the classification of sarcopenia, including diagnosis and management strategies. Even with these research advancements, sarcopenia remains under-recognized and under-diagnosed, and the application of proven treatment modalities remains low.

This evidence-based review explores important issues regarding sarcopenia as they relate to the fitness professional and wellness coach. This discussion details the definition of sarcopenia and associated risk factors, related consequences, suspected causes, and related conditions. The role of the fitness professional and wellness coach is discussed, along with suggested management strategies for individuals experiencing sarcopenia.

Introduction

Sarcopenia, or age-related muscle loss, is a condition resulting from adverse muscle changes that accumulate over a lifetime (Ardeljan & Hurezeanu, 2023). Researchers have estimated the prevalence of sarcopenia among adults 60 years and older worldwide to be between 10–27% and between 8–36% among individuals 60 years and younger (Petermann-Rocha et al., 2022). Among individuals diagnosed with sarcopenia, 2–9% are classified as having severe sarcopenia (Petermann-Rocha et al., 2022; Yuan & Larsson, 2023). The annual sarcopenia-related medical costs in the United States (US) in 2000 were estimated at $18.5 billion (Janssen et al., 2004). Furthermore, sarcopenia increases the risk of many chronic diseases, such as diabetes and cardiovascular disease, and raises the risk of fall-related fractures among older adults.

In typical aging individuals, lean muscle mass declines approximately 3–8% each decade after 30 years and faster after 60 years, with up to 15% muscle loss per decade after 70 years (Volpi et al., 2004; Yu et al., 2016). Sarcopenia results in more severe, accelerated loss of muscle mass, muscle strength, and muscle performance among aging individuals who are relatively inactive (Ackermans et al., 2022). Sarcopenia remains an important topic in the scientific community, and several research groups worldwide continue to study sarcopenia and provide working definitions, suggest management strategies, and research objectives for the disease (Bhasin et al., 2020; Chen et al., 2020; Cruz-Jentoft et al., 2018). Due to the growing prevalence of sarcopenia among aging individuals, there is a need for greater awareness among healthcare and fitness professionals.

The fitness professional and wellness coach are uniquely qualified to help individuals with sarcopenia through healthy lifestyle interventions. This evidence-based review will provide the latest information on the definition of sarcopenia, its risk factors, consequences, related conditions, and the role of the professional in ameliorating its effects.

GETTING TECHNICAL

The professional should consider that different research groups worldwide study sarcopenia and have published their own definitions of the condition. There are some similarities and differences among these definitions. The differences may be reflected in the published prevalence statistics (Petermann-Rocha et al., 2022). For example, a scientific study may document sarcopenia statistics on a client population based on one research group's definition. Another study may document different statistics on the same population using another research group's definition. The subsequent sections will discuss the different definitions of sarcopenia and which research group's definition is used most among researchers and professionals.

Defining Sarcopenia

Irwin H. Rosenberg first recognized sarcopenia in 1989, and the condition was named "sarcopenia," which has Greek roots ("sarx" or *flesh* and "penia" or *loss*) (Rosenberg, 1997). Initially, the primary focus on understanding this condition was centered on the loss in lean body mass; however, over the last few decades, the understanding of sarcopenia has extended beyond just the loss in lean body mass. In 2010, the European Working Group on Sarcopenia in Older People (EWGSOP1) expanded on the original definition by publishing more comprehensive guidelines to identify sarcopenia. This definition was expanded by identifying the significance of impaired function, mobility, and strength that came along with loss of muscle mass. Since then, other research groups have formed worldwide to study and provide guidelines for sarcopenia. The most notable include the Asian Working Group for Sarcopenia (AWGS) and the American Sarcopenia Definitions and Outcomes Consortium (SDOC). From 2018 to 2020, the EWGSOP2, AWGS, and SDOC all provided updates to their sarcopenia definitions and guidelines, which will be discussed in the subsequent sections (Bhasin et al., 2020; Chen et al., 2020; Cruz-Jentoft et al., 2018) (**Figure 1**). In 2016, the US Centers for Disease Control (CDC) formally recognized sarcopenia in the International Classification of Disease, 10th Revision (ICD-10: M62.84) (Falcon & Harris-Love, 2017). Healthcare professionals use this diagnostic code to document sarcopenia-related treatment and to bill health insurance for provided services.

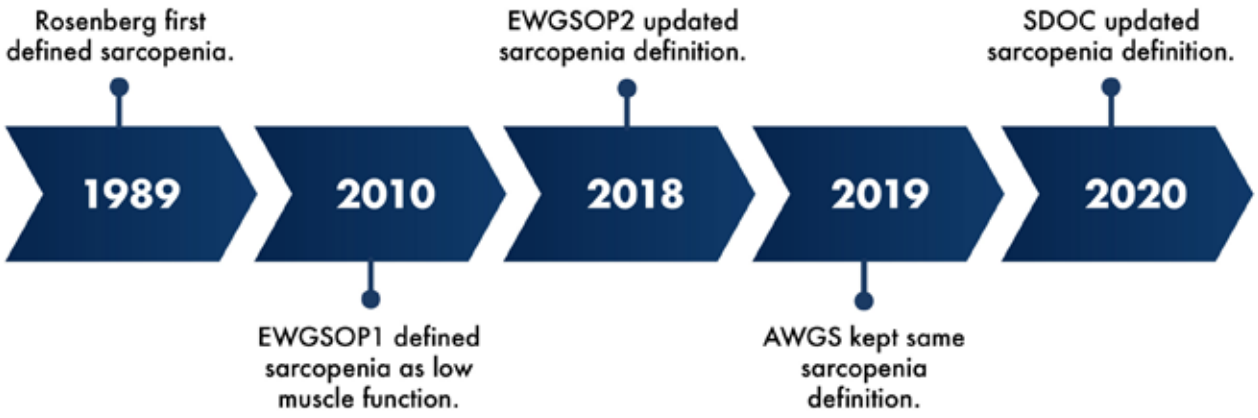


Figure 1. Timeline for Research Groups Defining Sarcopenia

The most recent guidelines from the EWGSOP2 and AWGS expanded the definition of sarcopenia to include three specific criteria: low muscle strength, low muscle quantity and quality, and low physical performance. The SDOC guidelines only include low muscle strength and low physical performance (gait speed) (Bhasin et al., 2020; Chen et al., 2020; Cruz-Jentoft et al., 2018). **Table 1**. summarizes the different research groups' most recent working definitions of sarcopenia with related criteria.

Research Groups	Criteria 1: Low Muscle Strength	Criteria 2: Low Muscle Quality & Quantity	Criteria 3: Low Physical Performance
EWGSOP2	✔	✔	✔
AWGS	✔	✔	✔
***SDOC**	✔		✔

*SDOC: Physical Performance = Gait Speed; EWGSOP2 = Low physical performance indicates severe sarcopenia

Table 1. Research Groups' Definition of Sarcopenia

The EWGSOP2 definition and guidelines are the most comprehensive and widely used for sarcopenia (Cruz-Jentoft et al., 2018). The researchers developed a diagnostic scoring system to accompany the three defining criteria. The scores are as follows: 1) *criteria 1* = probable sarcopenia, 2) *criteria 1 and 2* = diagnosis of sarcopenia, and 3) *criteria 1, 2, and 3* = severe sarcopenia (Cruz-Jentoft et al., 2018). Thus, an individual identified as having both *criteria 1* and *criteria 2* would be classified as having sarcopenia. An individual identified as having criteria 1, 2, and 3 would be classified as having severe sarcopenia. These guidelines will be referred to in subsequent sections.

Sarcopenia Criteria

The EWGSOP2 defining criteria help guide healthcare professionals in diagnosing sarcopenia among older individuals. The suggested criteria include a combined clinical assessment and diagnostic testing. The proposed algorithm for assessment, testing, and diagnosis contains four steps: *find, assess, confirm*, and *severity* (Cruz-Jentoft et al., 2018; Lian et al., 2023). The *find* step includes a screening questionnaire called the SARC-F (strength, assistance with walking, rising from a chair, climbing stairs, and falls). Diligence when screening clients is imperative because identifying sarcopenia in the early stages provides a greater possibility of improvement and avoidance of progression to more advanced stages. The *assess* step consists of a hand-grip strength test and a chair sit-to-stand test, testing the client's maximum reps in 30 seconds. The *confirm* step includes the use of dual x-ray absorptiometry (DXA), bioelectrical impedance analysis (BIA), computer tomography (CT), or magnetic resonance imaging (MRI) to assess the quantity and quality of appendicular (e.g., arms and legs) and/or skeletal muscle quality and quantity. The *severity* step includes physical performance assessments such as gait speed, a Timed Up and Go (TUG) test, and the 400-meter walk test (**Table 2**) (Cruz-Jentoft et al., 2018; Lian et al., 2023). These criteria are general guidelines that can be modified based on the individual's health status, functional abilities, and available resources.

Find	Screen	SARC-F questionnaire
Assess	Muscle strength	Hand grip strength & chair sit-to-stand test
Confirm	Muscle quantity and quality	DXA, BIA, CT, MRI
Severity	Physical performance	Gait speed, TUG, 400m walk

Table 2. EWGSOP2 Algorithm for the Diagnosis of Sarcopenia in Older Individuals

HELPFUL HINT

Researchers consider sarcopenia to occur in individuals 60 years and older, who are regarded as older individuals. Older individuals diagnosed by a qualified healthcare provider often meet the EWGSOP2 definition and criteria for sarcopenia (Cruz-Jentoft et al., 2018). The fitness professional and wellness coach should consider that using the sarcopenia diagnostic criteria to assess clients may exceed their scope of practice. Those assessments should only be conducted by a qualified healthcare provider. However, fitness professionals and wellness coaches must understand how sarcopenia is diagnosed and managed to effectively collaborate with healthcare professionals in the care of their clients with this condition.

Sarcopenia Subcategories

The EWGSOP2 has further subcategorized sarcopenia as acute, chronic, primary, and secondary. *Acute* sarcopenia is when the condition lasts for 6 months or fewer and may be related to acute illness or injury. *Chronic* sarcopenia is 6 months or longer and may be associated with a chronic or progressive condition and an increased mortality risk (Cruz-Jentoft et al., 2018). *Primary* sarcopenia is considered to be age-related when no other identifiable causes are present. *Secondary* sarcopenia is when a specific cause is identified with or without the addition of aging, such as disease, inactivity, and poor nutrition. These subcategories were introduced in the latest EWGSOP2 guidelines to better describe the disease's clinical course for healthcare professionals and researchers (Cruz-Jentoft et al., 2018). To date, these subcategories have not been fully studied or utilized among research groups, nor have they been included in the latest International Classification of Disease, 10th Revision (ICD-10) (Anker et al., 2016; Cao & Morley, 2016).

Sarcopenia Risk Factors

Although sarcopenia is technically defined as an age-related disease, there are additional factors that are independent of age that can modify an individual's risk. Several of these risk factors, such as obesity, physical inactivity, and malnutrition, are modifiable and fall within the scope and expertise of the fitness professional and wellness coach. **Figure 2**. provides a summary of common risk factors for sarcopenia.

There are also several chronic diseases that are associated with sarcopenia. They include but are not limited to, chronic obstructive pulmonary disorder (COPD), cardiovascular disease (CVD), chronic heart failure (CHF), chronic kidney disease (CKD), type II diabetes mellitus (T2DM), human immunodeficiency virus (HIV), and cancer (Ardeljan & Hurezeanu, 2023; Xu et al., 2022).

Figure 2. Sarcopenia Risk Factors

Sarcopenia-Related Consequences

Sarcopenia is a progressive condition that results in reduced muscle mass, muscle health, and muscle function, all of which can have different consequences if not managed properly. Common functional consequences of sarcopenia include but are not limited to, low muscle strength (e.g., grip strength), slow movement (e.g., slow gait speed), poor mobility, fatigue, low physical activity, poor balance, and an increased risk of falls and fractures (Yuan & Larsson, 2023). Consequential medical conditions of sarcopenia include, but are not limited to, mortality, malnutrition, osteoporosis, metabolic syndrome (which is comprised of the presence of at least three or more of the following: low HDL cholesterol, high triglycerides, obesity [BMI > 30], and elevated blood glucose levels), elevated blood pressure, T2DM, nonalcoholic liver disease, liver fibrosis, hypertension, depression, dysphagia (swallowing difficulties),

hospitalization, and cognitive impairments (**Table 3**) (Yuan & Larsson, 2023). The fitness professional should consider that many of the functional and medical consequences may not occur with every client but are commonly reported among individuals initially identified with sarcopenia. Researchers are still studying the link between sarcopenia and these related consequences, with no consensus to date (Yuan & Larsson, 2023).

Consequences	Description
Functional	Low muscle strength (e.g., grip strength), slow movement (e.g., slow gait speed), poor mobility, fatigue, low physical activity, poor balance, falls, and fractures
Medical	Mortality, malnutrition, osteoporosis, metabolic syndrome, T2DM, nonalcoholic liver disease, liver fibrosis, hypertension, depression, dysphagia, hospitalization, and cognitive impairments

Table 3. Consequences of Sarcopenia

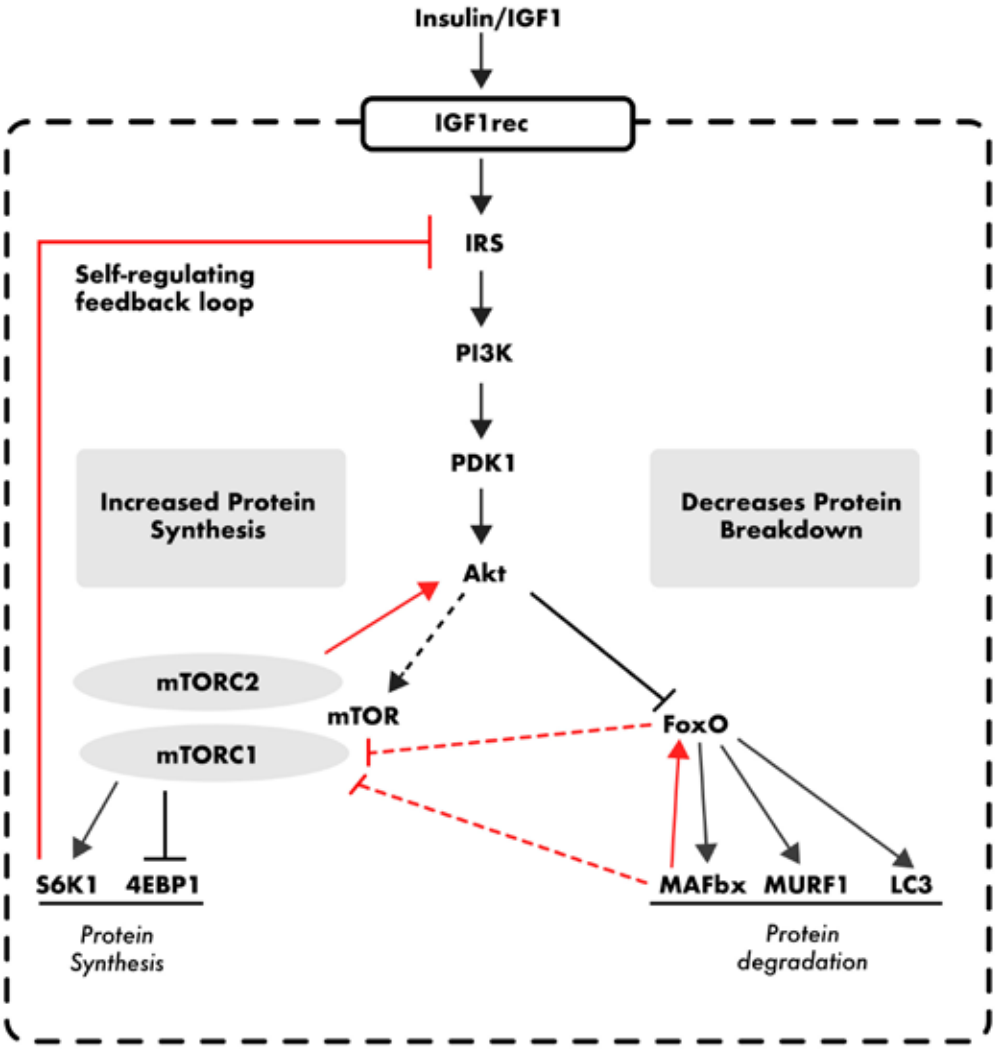
GETTING TECHNICAL

Sarcopenia is becoming a growing concern among health professionals due to its relationship with mortality. Researchers have documented a high prevalence of premature mortality among community-dwelling older adults with sarcopenia (Batsis et al., 2014; Brown et al., 2016). Similarly, researchers have also found that a healthy amount of muscle mass and adequate muscle performance are predictors of longevity among healthy older adults (Wang et al., 2019; Srikanthan & Karlamangla, 2014). This data supports the idea that resistance training, high-intensity interval training (HIIT) strategies, and adequate protein intake can be used as interventions to help improve or maintain muscle health and make daily living activities easier for older adults with or without sarcopenia. These interventions will be discussed in the upcoming sections.

Suspected Causes of Sarcopenia

While researchers have not agreed upon definite causes of sarcopenia, several physiological conditions or changes have been theorized to explain the decline in muscle strength, quality, quantity, and performance for older adults (Yu et al., 2016).

First, age-related cellular derangement or disorientation is among the factors that govern the balance between anabolic and catabolic signal transduction cascades. Stimulation of anabolic signal transduction can manifest via numerous agents, including anabolic hormones (e.g., testosterone, insulin, IGF-1), skeletal muscle contraction, and branched-chain amino acids such as leucine (Schiaffino et al., 2021). Mechanisms operate via either a direct induction of anabolic signaling via the Akt/mTOR and mitogen-activated protein kinase cell signaling cascades or indirectly via inhibiting catabolic signaling, such as Fox-O, and/or anabolic inhibiting myokines, such as myostatin (Lee & Neppl, 2021) (**Figure 3**). The age-related "anabolic resistance" leads to an attenuated effect of these anabolic stimuli, leading to lessened Akt/mTOR signaling and an improper increase in catabolic processes. Second, aging has been associated with changes in the motor neurons, particularly in the glycolytic, fast-twitch, type II muscle fibers (Cannataro et al., 2021; Shaw et al., 2017). While the exact mechanisms causing this are not fully understood, research from both animal and human studies postulate several causes, including axon thinning, a decrease in the density of postsynaptic acetylcholine receptor, and motor unit remodeling (Moreira-Pais et al., 2022). Third, researchers have also theorized that sarcopenia could be caused by age-related mitochondrial dysfunction, reduced muscle satellite cells (e.g., somatic stem cells), changes in muscle fiber quality, and an increase in inflammatory markers (Cannataro et al., 2021; Shaw et al., 2017). The resulting chronic, low-grade inflammatory state produced by proinflammatory cytokines such as TNF-alpha, IL-6, IL-1, and CRP perpetuates mitochondrial dysfunction, leading to increased oxidative stress and reactive oxygen species accumulation (Gomes et al., 2017). Fitness professionals should consider that researchers are still investigating these theories, with no consensus to date.



IGF1 = Insulin-like Growth Factor 1
PI3K = Phosphoinositide 3-kinases
PDK1: = Pyruvate Dehydrogenase Kinase 1
Akt = Protein Kinase B
mTOR = Mammalian Target of Rapamycin
mTORC1 = Mammalian Target of Rapamycin Complex 1
mTORC2 = Mammalian Target of Rapamycin Complex 2
FoxO = Forkhead Box O
MAFbx = Muscle Atrophy F-box
MURF1 = Muscle RING-finger Protein-1
LC3 = Microtubule-associated Protein 1 Light Chain 3
RS6K1 = Ribosomal Protein S6 Kinase Beta-1
4EBP1 = Eukaryotic Translation Initiation Factor 4E-binding Protein 1

Adapted from Schiaffino & Mammucari 2011.

Figure 3. Signaling Pathways Downstream of Insulin/IGF01 Receptor Activation and Cross-Talk with Catabolic Signaling Pathways

IMPORTANT INFORMATION

The fitness professional and wellness coach should consider that secondary sarcopenia may be more prevalent than primary sarcopenia (Supriya et al., 2021). Professionals can play an important role in helping reduce risk factors and related consequences by adding healthy lifestyle interventions. For example, teaching and coaching a middle-aged client about regular exercise, healthy eating, and wellness practices may help reduce risk factors such as physical inactivity, malnutrition, and poor sleep. Furthermore, it may help to avoid future sarcopenia consequences such as functional decline, falls, fractures, and diabetes. Thus, healthy lifestyle interventions may have the potential to reduce risks for sarcopenia in these individuals.

Sarcopenia-Related Conditions

Sarcopenia-related conditions include but are not limited to, frailty, cachexia, sarcopenic obesity, and malnutrition-associated sarcopenia. *Frailty* is a progressive, age-related decline in the body's physiological systems, resulting in an extreme vulnerability to stressors and increased risk of adverse health conditions (e.g., physical, cognitive). Frailty has many overlapping consequences with sarcopenia, such as low grip strength, low muscle performance, low muscle mass, slow movement, poor mobility, fatigue, poor balance, malnutrition, and low physical activity (Ali & Garcia, 2014; Gingrich et al., 2019). Weight loss, cognitive impairment, and social isolation are other diagnostic criteria of frailty (Chu et al., 2021). Researchers have documented that a weight loss of 5% and greater among individuals 60 years and older was a significant risk factor for frailty, and weight loss over a lifespan was strongly associated with frailty (Crow et al., 2020). Frailty has been linked to increased disability, falls, fractures, hospitalization, and mortality among adults 75 years and older (Chu et al., 2021; Middleton et al., 2021). Low muscle mass and low strength are associated with the risk of falls and fall-related fractures, which have high mortality rates, further highlighting the importance of maintaining muscle mass throughout adulthood.

Cachexia is a complex metabolic syndrome associated with chronic illnesses such as COPD, heart failure, and chronic kidney disease. Cachexia also has similar consequences to sarcopenia and frailty, such as severe weight loss, low strength, low muscle performance, low muscle mass, slow movement, poor mobility, fatigue, poor balance, and malnutrition (Ali & Garcia, 2014; Gingrich et al., 2019). Cachexia can also lead to anorexia. Overall, researchers consider sarcopenia, frailty, and cachexia to have overlapping consequences and are often studied together in different populations (**Figure 4**) (Ali & Garcia, 2014; Gingrich et al., 2019; Jeejeebhoy, 2012).

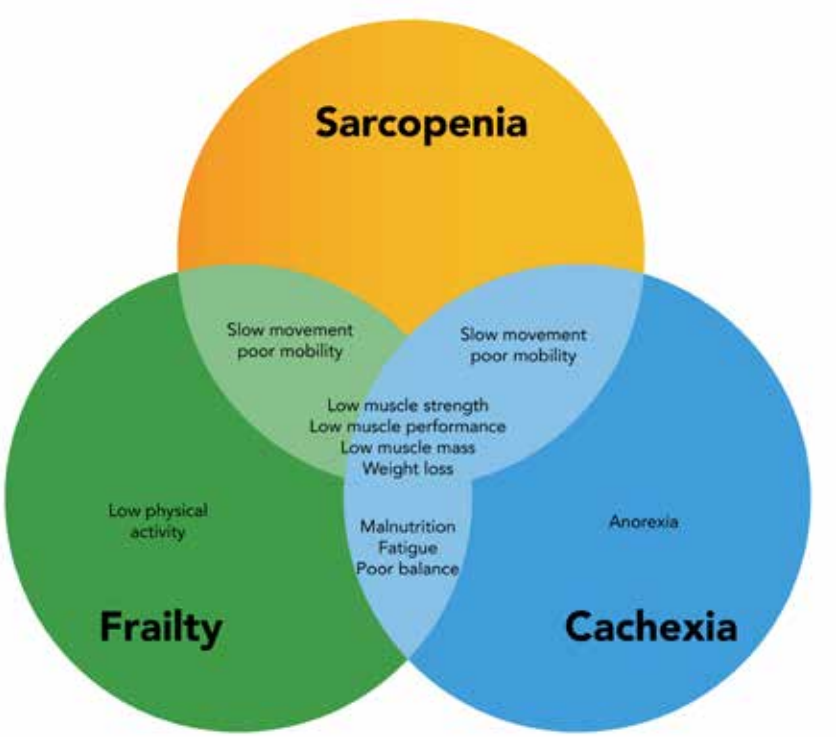


Figure 4. Overlapping Consequences of Sarcopenia, Frailty, and Cachexia

Sarcopenic obesity is another related condition characterized by reduced lean muscle mass with excess adiposity (Donini et al., 2022). Sarcopenic obesity is most common in older individuals as both risk and prevalence increase with adults 65 years and older (Batsis et al., 2014). Obesity has been linked with increased infiltration of fat into muscle, which can impair muscle function and contractility, lower physical function, and increase mortality risk (Cruz-Jentoft et al., 2018; Donini et al., 2022). Sarcopenic obesity may not be as prevalent as frailty. Further investigation is needed to fully define and understand the connection between obesity and sarcopenia (Donini et al., 2022). Researchers often use the individual definitions of sarcopenia and obesity (e.g., Obesity: BMI ≥ 30.0 kg/m2) to define sarcopenic obesity (Wei et al., 2023). To date, researchers support sarcopenic obesity being identified as two distinct phenotypical traits versus acting as a single definition of the condition (Donini et al., 2022). It is important for the fitness professional not to rely on generalized weight assessments, such as BMI, for screening in older populations because the loss of skeletal muscle may be offset by the gain of body fat.

The European Society for Clinical Nutrition and Metabolism (ESPEN) and the European Association for the Study of Obesity (EASO) developed a consensus on the definition of sarcopenic obesity as being the coexistence of obesity and sarcopenia (Donini et al., 2022). They have further developed diagnostic guidelines, which include screening, diagnosis, and staging (**Figure 5**).

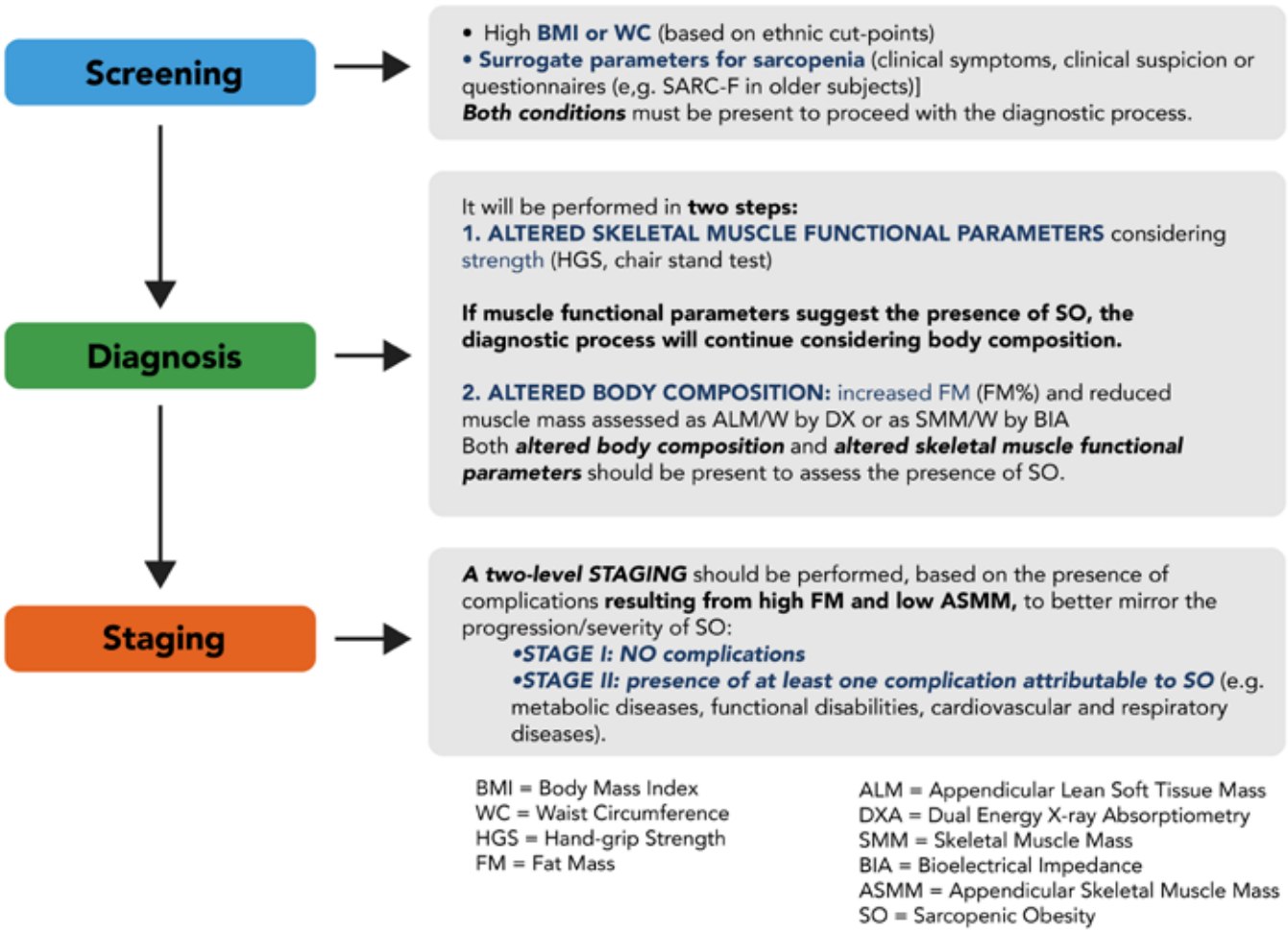


Figure 5. ESPEN and EASO Diagnostic Guidelines for Sarcopenic Obesity

Sarcopenia has also been linked to malnutrition among aging individuals. Several factors, such as low dietary (energy) intake, reduced nutrient bioavailability, or high nutrient requirements, can lead to malnutrition and, eventually, sarcopenia (Cruz-Jentoft et al., 2018; Sieber, 2019). Protein malnutrition is often observed in sarcopenia and frailty, both of which can contribute to the declining health of the individual (Gingrich et al., 2019; Sieber, 2019). The fitness professional and wellness coach should consider that sarcopenia may be related to other comorbid conditions. Individuals with these related comorbidities may need further medical care.

HELPFUL HINT

The fitness professional and wellness coach must consider the growing popularity of glucagon-like peptide-1 (GLP-1) medications (e.g., Ozempic) for cosmetic or medical weight loss. Middle-aged or older Individuals who have comorbid conditions, such as obesity and T2DM, may be prescribed these medications. These individuals may already have secondary sarcopenia or be at risk due to inactivity and lack of healthy lifestyle behaviors. The NASM GLP-1 evidence-based review contains further recommendations and management strategies.

The Fitness Professional and Wellness Coach

The fitness professional and wellness coach can play a significant role in helping individuals with sarcopenia and sarcopenia-related conditions. Coaching these clients using healthy lifestyle modification may help them improve their overall muscle health. Recommended healthy lifestyle strategies that fall within the scope of the professional include physical activity, healthy eating, and wellness (Rippe, 2018). These strategies will be discussed in the subsequent sections.

Physical Activity

Physical activity is an important healthy lifestyle behavior for individuals with sarcopenia and reduces the risk of developing metabolic syndrome and losing bone mass. More specifically, resistance exercise (RE) and HIIT are first-line interventions for sarcopenia (Kumar et al., 2022). Both forms of exercise can produce positive benefits for muscle health and can help prevent and address sarcopenia (Atakan et al., 2021; Yasuda, 2022).

Resistance Exercise

RE has emerged as an important intervention to reduce the risks and consequences of sarcopenia. Researchers have documented several positive effects of RE, which include, but are not limited to, improved muscle strength, muscle performance (e.g., gait speed, sit-to-stand), mitochondrial function, and reduced fat mass (Chen et al., 2021; Hurst et al., 2022; Law et al., 2016). Other potential effects from RE that are being investigated include improved appendicular (extremity) and skeletal muscle mass and reversal of lost type II muscle fibers and motor units among individuals with sarcopenia (Law et al., 2016; Long et al., 2023; Nilwik et al. 2013; Shen et al., 2023). Evidence-based guidelines suggest that RE programming should be based on the linear and systematic overload of the musculoskeletal system using exercise progression to promote muscle health (Yasuda, 2022). An RE load of 65% or greater of the one repetition maximum (1RM) is recommended to stimulate muscle growth (Yasuda, 2022).

The research has proposed different progressive RE programs for individuals with sarcopenia (Chen et al., 2021; Hurst et al., 2022; Law et al., 2016). These programs range from two to three sessions per week, an intensity range of 40–85% 1RM, 1–3 sets, and 6–15 repetitions per exercise (**Table 4)** (Chen et al., 2021; Hurst et al., 2022; Law et al., 2016). The fitness professional should consider that the suggested RE programs reflect the SAID principle (specific adaptations to imposed demands) through a linear periodization programming approach (Yasuda, 2022). Linear periodization is a model designed to progressively increase the intensity of the training load while concurrently decreasing volume over a set period (Evans, 2019). This will allow time for the individual to adapt to the progressive overload or to regress if the exercise is too difficult.

Programming Variables	Hurst et al., 2022	Chen et al., 2021	Law et al., 2016
Frequency	2 sessions/week	3 sessions/week	2–4 sessions/week
Intensity	40–60% *1RM, progress to 70–85% 1RM	> 60% 1RM, progress to > 70–75% 1RM	3 phases: begin 50–60% 1RM, progress to ≥ 80% 1RM
***RPE (CR10) scale**	3–5, progress to 6–8		
Sets	1–3	2–3	1–3
Reps	6–12	8–12	6–18
Rest	60–120 sec		30–60 sec
Duration	TBD	TBD	TBD
Body Region	Upper/lower body	Upper/lower body	Upper/lower body
*1RM = repetition maximum; RPE = rate of perceived exertion			

Table 4. RE Programming Variables

RE programming for sarcopenia can also be categorized into the following: high-load, low-load, low-load with slow movement, and low-load exercising to failure (Yasuda, 2022). Low-load RE can be enhanced by adding blood flow restriction training (BFRT), which shows promise as a type of RE (Zhang et al., 2022). BFRT involves applying a pneumatic cuff on the proximal end of the exercising limb, blocking venous return, and partially occluding arterial blood flow. This reduces blood flow and increases metabolic stress, potentially augmenting RE-induced muscle hypertrophy (Cognetti et al., 2022). This approach allows individuals with sarcopenia to participate in RE and BFRT at lower loads and promotes muscle growth, similar to higher loading strategies (Cognetti et al., 2022). It is important to note, however, that this approach is based on data collected in otherwise healthy persons, as there are no research studies on BFRT among individuals with sarcopenia (Baker et al., 2020; Centner et al., 2019; Labata-Lezaun et al., 2022). Researchers see the potential of low-load BFRT to improve muscle strength and performance and have proposed preliminary recommendations (Zhang et al., 2022). **Table 5** summarizes different types of categorical RE programming strategies identified in the research.

Training Variables	High-Load	Low-Load BFRT	Low-Load + SM (Slow Movement)	Low-Load to Failure (Fatigue)
Intensity (Load)	70–85% *1RM	10–50% 1RM	*BW, 30–50% 1RM	20% 1RM
Frequency	2–3 days/week	2–3 days/week	2–7 days/week	3 days/week
Sets	1–3	1–4	1–3	1
Reps	8 to 15	15 to 30	5 to 15	80 to 100
Rest	30–120 sec	30–120 sec	30–120 sec	TBD
Duration	TBD	TBD	TBD	TBD
Body Region	Upper/lower body	Upper/lower body	Upper/lower body	Upper/lower body
*1RM = One repetition maximum; BW = body weight				

Table 5. RE Categorical Programming for Sarcopenia

IMPORTANT REMINDER

The fitness professional should consider that it may be unrealistic for some individuals with sarcopenia to begin exercising at the levels suggested in Tables 4 and 5. These individuals may be experiencing the negative consequences of sarcopenia and will need time to adapt. This may require light exercise initially (e.g., BW or 10–20% 1RM, 10 reps, 1–2 sets per exercise, 1–2 days per week) with a slow exercise progression over time to allow them to progress their muscle strength and performance to meet or exceed the ≥ 65% 1RM recommended threshold for muscle growth (Yasuda, 2022).

Integrated Exercise

Integrated exercise programming is also recommended to help combat some of the negative consequences of sarcopenia, such as poor balance, slow movement and mobility, and risk of falls (Yuan & Larsson, 2023). Integrated exercise for older adults often includes different types of exercises such as aerobic, RE, and balance exercises. The US Physical Activity Guidelines (PAG) recommend the following integrated exercises for older adults (Piercy et al., 2018):

- At least 150 minutes a week of moderate-intensity, 75 minutes a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity aerobic activity
- Muscle-strengthening activities two or more days a week
- Activities to improve balance such as dancing, single-leg stance exercises, and backward walking

The fitness professional and wellness coach should consider using integrated exercise programming with clients needing such training. Using the NASM Optimum Performance Training® (OPT™) model is a great strategy for these individuals. However, it's important to keep RE as the focus of integrated exercise because it is the first-line intervention for sarcopenia (Kumar et al., 2022).

High-Intensity Interval Training (HIIT)

HIIT may effectively combat the functional (e.g., low muscle strength, fatigue, low physical activity) and medical (e.g., metabolic syndrome, T2DM) consequences of sarcopenia and improve muscle health among individuals who can safely participate. HIIT is characterized by repeated short to long bouts of high-intensity exercise followed by alternate recovery periods of low-intensity exercise or rest (Atakan et al., 2021). Individuals may use their body weight, weighted objects, resistance bands, or unstable objects to enhance the effects of the exercise.

There are well-documented benefits of HIIT among individuals with sarcopenia. They include but are not limited to improved muscle strength, muscle performance, and mitochondrial function (Hayes et al., 2021; Zhu et al., 2023). To date, no research directly links HIIT to increased human skeletal muscle mass (Hayes et al., 2021). Preliminary research has documented positive lower extremity muscle mass changes in humans and skeletal muscle mass changes in rodent models; however, this has yet to be observed to any meaningful degree in humans (Hayes et al., 2021; Seldeen et al., 2018). Thus, the main improvements observed with HIIT are muscle strength and performance among individuals with sarcopenia (Hayes et al., 2021). HIIT has also been shown to improve metabolic parameters associated with sarcopenia, such as insulin resistance, blood pressure, and blood lipids (Du, Oh & No, 2018; Su et al., 2019).

Suggested HIIT programming for healthy individuals includes an exercise intensity ≥ 90% VO_{2max} for an average time range of 6 seconds to 4 minutes, with a recovery period of low-intensity exercise of 20–40% of VO_{2max} for 10 seconds to 5 minutes. The volume (exercising minutes) can be classified as low (≤ 15 minutes) or high (≥ 15 minutes) (Atakan et al., 2021). The time ranges for healthy individuals will vary based on the client's exercise goals, fitness level, and physical ability.

IMPORTANT REMINDER

The intensity, duration, and frequency of the work intervals and the length of the recovery intervals are important considerations when designing a HIIT program. Exercisers can use various work-to-recovery ratios to improve cardiorespiratory fitness.

For example, a work-to-recovery ratio of 1:1 could be 4 minutes of high-intensity work followed by a 4-minute recovery period. The work interval is performed at a subjective intensity that feels "challenging" to "hard," generally lasting between 3–5 minutes, with equal recovery periods. These intervals are repeated several times based on the exerciser's fitness level and goals.

Another popular HIIT training protocol is sprint interval training (SIT), which will be discussed in the next section. With a SIT program, the exerciser completes a short sprint (lasting ~30 seconds) followed by several minutes of recovery (e.g., ~4 minutes). This process is repeated several times.

HIIT programming for individuals with sarcopenia is similar and can be categorized as short, moderate, or long exercise intervals with similar training variables and the use of different equipment (**Table 6**) (Liu et al., 2022). The fitness professional and wellness coach may want to start clients with a short-interval program and progress the client (e.g., linear programming) to moderate and longer intervals as their fitness improves.

Training Variables	Short Intervals	Moderate Intervals	Long Intervals
Intervals (Work/Rest)	Exercise: 15–60 sec Recover: 15–120 sec	Exercise: 1–2 min Recover: 1–4 min	Exercise: 3–4 min Recover: 3–4 min
Exercise Intensity	85–100% *VO_{2max}	85–100% VO_{2max}	85–100% VO_{2max}
Total Time	15–60 min	15–60 min	15–60 min
Equipment	Body weight, bands, medicine balls, kettlebells, unstable objects, etc.		
*VO_{2max} = maximum volume of oxygen consumed			

Table 6. HIIT Programming for Sarcopenia

HELPFUL HINT

The traditional gold standard measurement for cardiorespiratory fitness is VO_{2max}, often expressed as the maximal volume of oxygen consumed per kilogram of body weight per minute (mL/kg per min). In other words, VO_{2max} is the maximum amount of oxygen an individual can use during intense exercise. Once VO_{2max} is determined, a common method to establish exercise training intensity is to have individuals exercise at a percentage of their VO_{2max}. However, accurately measuring VO_{2max} is frequently impractical for fitness professionals because it requires clients to perform cardiorespiratory exercise at maximal effort and sophisticated equipment to monitor the client's ventilation response (oxygen consumed and carbon dioxide expired). Thus, submaximal aerobic tests have become popular for fitness professionals to estimate VO_{2max}.

Types of HIIT

Beyond the traditional HIIT method noted in the prior section, two other types of training may be appropriate for some individuals with sarcopenia. Sprint interval training (SIT) is another form of HIIT that includes repeated bouts of high-intensity exercise followed by alternate recovery periods on cardio equipment such as a stationary or outdoor bike. Suggested SIT programming includes 4–6 sprint intervals at 100% intensity. Each exercise interval lasts 30 seconds, with a recovery period of up to four minutes (Liu et al., 2022; Vollaard & Metcalfe, 2017). Another form of HIIT is repeated sprint training (RST), which also includes repeated bouts of high-intensity exercise followed by alternate recovery periods. RST can be done on an outdoor track, street, elliptical, or treadmill (if safe). Suggested RST programming includes 10–20 maximum sprint intervals. Each exercise interval lasts 10 seconds, with a recovery period of up to 60 seconds (Atakan et al., 2021; Liu et al., 2022). **Table 7** summarizes the different types of HIIT for individuals with sarcopenia.

Type of Interval	General Guidelines
High intensity interval training (HIIT)	Intervals are 85–100% effort exercise bouts lasting 15 seconds to 4 minutes, with a recovery period of 15 seconds to 4 minutes. The total exercise time is 15–60 minutes.
Sprint Interval training (SIT) (bike or running)	Intervals include 4–6 sprints at 100% effort, with 30-second exercise bouts and a recovery period of up to 4 minutes.
Repeated sprint training (RST)	Intervals include 10–20 sprints at 100% effort for a ≤ 10-second exercise bout and a recovery period of < 60 seconds.

Table 7. Different Types of HIIT for Sarcopenia

HIIT is generally considered an advanced form of training and may not be appropriate for some

individuals with sarcopenia. The fitness professional needs to make sure the client has an acceptable level of fitness and health status to participate due to the high demands this type of exercise places on the body. The different types of HIIT provide options for various clients that may fit their exercise setting and/or available resources, such as equipment.

TRAINING TIPS

Fitness professionals and wellness coaches should consider that RE and HIIT are first-line interventions to combat sarcopenia in older adults (Kumar et al., 2022). Other forms of exercise, such as cardiorespiratory and balance, are not recommended as key interventions but should be included in the client's exercise programming as needed to help improve their overall health and function. Mixed or integrated training provides options to include other forms of exercise along with RE and HIIT.

Healthy Eating

Another healthy lifestyle strategy that may benefit individuals with sarcopenia is healthy eating. One nutritional aspect of the older populations who are primarily at risk for sarcopenia is the increased rates of decreased appetite. Depending on the population, the rates of decreased appetite and even anorexia can be as high as 20–30% (de Souto Barreto et al., 2022; Malafarina et al., 2013). Age-related declines in appetite can occur from factors such as changes in the digestive system, hormones, and senses of smell, taste, and vision; reduced energy needs; disease and pain; psychosocial status; and certain medications (**Figure 6**) (Giezenaar et al., 2016; Pilgrim et al., 2015). Older individuals with sarcopenia may be malnourished, lack energy balance and essential nutrients, and have a reduced appetite that can result in poor muscle health (Sieber, 2019; van Dronkelaar et al., 2019). Protein malnutrition is often observed in sarcopenia, frailty, and cachexia, which can contribute to the declining health of these individuals and can specifically accelerate the loss of muscle mass (Gingrich et al., 2019; Sieber, 2019).

Digestive System	•Reduced saliva production •Poor dentition (chewing difficulties and dentures) •Slower gastic emptying and constipation
Hormones	• Reduced levels of fasting ghrelin • Increased levels of cholecystokinin and leptin
Taste, smell, and vision	• Age-related decline in taste, smell, and vision which reduce appetite and enjoyment of eating
Disease and pain	• Acute illness, chronic disease, or pain can impair appetite along with medication (if taken)
Reduced energy needs	• Older adults have lower energy requirements which contribute to reduced appetite
Psychosocial	• Depression, living alone, eating alone, retirement, and finances are related to reduced appetite
Medications	•Medications can reduced appetite by affecting sense of taste, smell, or cause nausea

Figure 6. Factors Related to Reduced Appetite in Older Individuals

Research on nutritional strategies for sarcopenia is emerging, and some strategies may help reduce the risk of sarcopenia and slow its progression. The subsequent sections will focus on protein intake, branched-chain amino acid (BCAA), vitamin D, omega-3 polyunsaturated fatty acid (PUFA), and flavonoids—all of which have research supporting their potential for improving muscle health among individuals with sarcopenia (Cochet et al., 2023; Coelho-Junior et al., 2022; Wu & Suzuki, 2023).

Protein Requirements and Supplementation

The fitness professional and wellness coach must consider protein intake recommendations when working with individuals diagnosed with sarcopenia. The current recommended daily allowance for protein per day is 0.8 g/kg (0.36 g/lb) of body weight for adults, and the optimal protein intake for exercising adults is roughly 1.4–2.0 g/kg (0.64–0.91 g/lb.) of body weight per day (Jang, 2023; Kerksick et al., 2018). Emerging research suggests that the protein requirements for older individuals may be higher than current guidelines due to anabolic resistance that appears as people age (Breen & Phillips, 2011). Protein intake recommendations for healthy older adults include 1.0–1.2 g/kg (0.45–0.54 g/lb) of body weight per day and 1.2–1.5 g/kg (0.45–0.68 g/lb) of body weight per day for older malnourished older individuals (**Table 8**) (Deutz et al., 2014; Liu et al., 2023). Currently, there is no consensus among researchers regarding protein intake guidelines for individuals with sarcopenia.

In addition to total daily protein intake, there is some evidence that older individuals may require a larger bolus of protein at each meal to stimulate muscle protein synthesis to the same extent as younger individuals. For example, one study found that older adults require 0.6 g/kg in a single meal to elicit the same muscle protein synthesis as 0.4 g/kg for younger adults (Moore et al. 2014). The exact optimal protein intake per meal for older adults is not currently defined, but there does appear to be an increased requirement for single-meal protein intake to elicit muscle protein synthesis.

Population	Daily Recommendation
General adults	0.8 g/kg (0.36 g/lb) BW
Exercising adults	1.4–2.0 g/kg (0.64–0.91 g/lb.) of BW
Healthy older adults	1.0–1.2 g/kg (0.45–0.54 g/lb) of BW
Malnourished older adults	1.2–1.5 g/kg (0.45–0.68 g/lb) of BW

Table 8. Protein Intake Recommendation for Different Adult Populations

Protein Supplementation and RE

When coaching individuals with sarcopenia about protein supplementation and RE, it is important to understand the effects of those interventions on healthy, aging individuals. Researchers have documented the favorable association between protein supplementation and appendicular lean muscle mass and strength among healthy middle-aged and older adults (Gielen et al., 2021; Jun et al., 2021). Researchers have also documented the positive synergistic effects of protein supplementation and RE among healthy, aging individuals. They found improvements in lean appendicular muscle mass and strength (e.g., hand grip, leg extension, leg press) from the combined intervention (Hou et al., 2019; Kirwan et al., 2022; Morton et al., 2018). Researchers have also studied the effects of the combined intervention among individuals with sarcopenia and documented favorable results, which will be discussed in this section (Cheah & Cheah, 2023).

Older individuals with sarcopenia appear to consume less protein and be less active than healthy individuals, which may lead to malnutrition and poor muscle health (Coelho-Junior et al., 2022). Researchers have postulated that the same improvements from protein supplementation and RE observed in healthy individuals can be seen among individuals with sarcopenia (Cheah & Cheah, 2023). This has stimulated an emerging body of research that has produced mixed results and debate among researchers (Murphy et al., 2023). The most relevant research is summarized in the next section.

Among available studies, two systematic reviews documented favorable results of protein supplementation and RE among individuals with primary sarcopenia and sarcopenic obesity. First, one research group appraised 14 clinical studies that used a milk protein or protein-based dairy as the intervention, with seven studies including a 3- to 5-day RE intervention. The protein intake ranged from 14–40 g/day for a 12- to 24-week intervention period. The researchers found that protein intake only improved appendicular muscle mass among middle-aged and older adults with and without sarcopenia. The combined protein supplementation and RE intervention produced no benefits for muscle strength (e.g., hand grip, leg) or performance. One limitation cited by the authors is that most studies reported just the daily amounts of protein supplementation and did not report the amounts based on body weight (Hanach et al., 2019). Second, another research group examined seven clinical studies on the effects of protein supplementation and RE among individuals with sarcopenic obesity. The clinical studies appraised used a whey, leucine, or essential amino acid (EAA)–enriched protein supplement as the main intervention. The protein intake ranged from 1.0–1.8 g/kg/BW/day (0.45–0.82 g/lb) for the intervention group, with the RE duration ranging from 2 to 3 times per week for 60 minutes per session (one study combined RE and aerobic exercise). The researchers found that protein supplementation alone, and when combined with RE, improved both muscle mass (not specific to skeletal or limb) and strength for individuals with sarcopenia obesity. The combined intervention also demonstrated additional benefits such as improved inflammation markers, blood lipid profiles, fasting glucose levels, and enhanced weight loss while preserving lean muscle mass (Cheah & Cheah, 2023).

The fitness professional and wellness coach should consider that the research investigating protein supplementation to improve muscle health among individuals with sarcopenia is still under study. The available evidence suggests that milk, dairy, whey, leucine, or EAA-enriched protein supplementation alone may benefit muscle health (Hanach et al., 2019). The combination of protein supplementation and RE may provide additional benefits for individuals with sarcopenia (Cheah & Cheah, 2023). The current gaps in the research include the lack of studies directly investigating individuals diagnosed with sarcopenia, determining the ideal amount and type of protein supplementation, and the optimal combination of protein and RE intervention.

FOOD FOR THOUGHT

Older individuals with sarcopenia may find it difficult to meet protein requirements to sustain lean body mass due to reduced appetite. Some strategies can be used to help these individuals meet protein requirements more efficiently.

1. **Drink liquid forms for protein**. Liquids tend to be less satiating than solid forms of protein. This means that protein shakes and other liquid forms of protein like kefir can provide higher protein food sources while not being overly satiating.
2. **Choose more protein-dense options**. For example, if individuals are consuming cheese, they can consume hard cheeses like parmesan, which has ~30 grams of protein per 100 grams.
3. **Be selective with protein sources.** Proteins like chicken, turkey, or pork loin have a much higher protein density than beef or fish. Other protein-rich food sources that individuals can utilize are egg whites compared to whole eggs, Greek yogurt instead of regular yogurt, or other easily exchangeable foods.
4. **Opt for complete protein sources**. Most animal-based proteins are complete, meaning they contain all amino acids. Examples of these proteins include meat, poultry, fish, eggs, and dairy. Some plant-based sources also provide complete protein, including soy, quinoa, and buckwheat.
5. **Mix incomplete protein sources to make a complete protein**. Two incomplete proteins can be mixed to obtain all essential amino acids. For example, grains, cereals, nuts, or seeds can be eaten with beans, peas, and lentils. A popular combination is rice and beans.

BCAA, Whey Protein, and Vitamin D

There is evidence regarding the positive nutritional effects of combining branched-chain amino acids (BCAA) (e.g., leucine), whey protein, and vitamin D. One recent systematic review appraised 12 clinical studies that investigated the effects of these nutrients (Cochet et al., 2023). The researchers found that BCAA (leucine), combined with whey protein and vitamin D significantly improved appendicular muscle mass, strength (e.g., hand grip strength), performance (e.g., gait speed, chair sit-to-stand), and mitochondrial function among individuals with sarcopenia. The studies used doses of total leucine higher than 3 g/day combined with 20–40 g of whey proteins/day and used vitamin D doses ranging between 100–1000 IU per day (Cochet et al., 2023). BCAA alone did not improve muscle health, but BCAA did improve mitochondrial function. It is important to note that four appraised studies also included RE intervention, which may have influenced the reported outcomes (Cochet et al., 2023).

Besides the benefits protein supplementation and BCAA have on protein synthesis and muscle health, vitamin D plays a key role in regulating cellular processes related to sarcopenic muscle atrophy. Vitamin D deficiency may lead to increased protein breakdown, impaired mitochondrial function, and increased

muscle adiposity (Cochet et al., 2023; Liu et al., 2023). The available evidence suggests that BCCA, combined with whey protein and vitamin D may improve muscle health among individuals with sarcopenia, and when combined with RE, the effects may be enhanced (Cochet et al., 2023).

Whey Protein, Resistance Exercise, and Vitamin D

Researchers have also reported that whey protein alone may have minimal positive effects on improving muscle strength and physical performance in individuals with sarcopenia (Nasimi et al., 2023). However, greater positive effects in muscle strength and performance have been documented when whey protein (> 20 g of whey protein/day) is combined with RE among these individuals (Kamińska et al., 2023; Nasimi et al., 2023; Cuyul-Vásquez et al. 2023). Other researchers have found that whey protein combined with vitamin D can also improve muscle strength and physical performance without RE among individuals with sarcopenia (Nasimi et al., 2023). The available evidence supports the use of protein and vitamin D supplementation for individuals with sarcopenia. RE is also an important part of restoring or maintaining muscle strength and performance among these individuals and should also be considered.

Flavonoids

Flavonoids may also provide some benefits for individuals with sarcopenia by regulating metabolism in skeletal muscle and preserving muscle structure and function directly through physiological mechanisms or indirectly through molecular signaling within the muscle (Y. Li et al., 2022). Flavonoids are compounds found in plants that may have medicinal properties such as antioxidant, anti-inflammation, and anti-cancer (Wu & Suzuki, 2023). They are widely present in different plants, fruits, and vegetables (Y. Li et al., 2022; Wu & Suzuki, 2023). **Table 9** provides a summary of common flavonoids and the types of food that contain the compounds.

Common Flavonoid	Type of Food
Anthocyanidins (cyandin, delphinidin, and malvidin)	Colored berries and red wine
Flavan-3-ols (catechin, epicatechin, theaflavin)	Cocoa, apples, and grapes
Flavanones (eriodictyol, hesperidin, and naringenin)	Citrus fruits
Flavones (apigenin and luteolin)	Celery, parsley, and chamomile tea
Flavonols (kaempferol, quercetin, and myricetin)	Tea, broccoli, and various fruits

Table 9. Flavonoids and Foods that Contain Them

Two systematic reviews appraised 26 different clinical studies on the effects of flavonoids on muscle health. The researchers found that flavonoids combined with RE improved skeletal muscle mass, muscle strength (e.g., hand grip, knee extension, leg press), and physical performance (e.g., gait speed, TUG, 6-minute walk, step test, and sit-up test) among individuals with sarcopenia (Y. Li et al., 2022; Wu & Suzuki, 2023). One systematic review documented specific flavonoids and doses used among 20 evaluated studies. They include, but are not limited to, catechins supplement powder or fortified tea (540 mg/day), cocoa (179 mg/ day), epicatechin capsules (1 mg/kg BW/day), soy (27–30 g/day), soy peptide (4 g/day), licorice oil (300 mg/day), curcumin and rutin (500 mg/day), and isoflavones capsules (50–135 mg/day) (Y. Li et al., 2022). Based on the current evidence, flavonoids may have the potential as a natural intervention for improving muscle health when combined with RE among individuals with sarcopenia. Further high-quality investigations are needed on this topic.

Creatine

Creatine supplementation may also be a viable strategy for improving muscle health in individuals with sarcopenia when combined with resistance training. Creatine combined with RE increases muscle mass and physical performance among older adults by influencing high-energy phosphate metabolism and calcium uptake, and muscle protein kinetics, as well as by reducing inflammation (Candow et al., 2022; Candow et al., 2021). Creatine without the addition of RE seems to have no muscle health benefits and may not be effective for individuals with sarcopenia (Candow et al., 2022). The current research on creatine supplementation among individuals with sarcopenia is still emerging. Researchers have provided preliminary recommendations for these individuals based on studies among older adults. These studies used the following creatine dosages in their investigations: 20–22 g/day for 5-7 days followed by 3–5 g/day thereafter, or just 5 g/day or 0.5–0.1 g/kg/day (Candow et al., 2022; Candow et al., 2019; Candow et al., 2021; Dolan et al., 2019). The fitness professional and wellness coach should consider that creatine intake among individuals with sarcopenia is still being studied. Further investigations are needed to determine more evidence-based guidelines, such as dosing and timing (Dolan et al., 2019).

COACHING TIP

The research on nutritional interventions for sarcopenia is still emerging. The available evidence suggests that healthy eating of essential nutrients may positively affect muscle health among individuals with sarcopenia (Cochet et al., 2023). The fitness professional and wellness coach can use different coaching strategies to help individuals with sarcopenia adopt healthy eating behaviors. These may include, but are not limited to, food choices (e.g., culturally accepted options), dietary strategies (e.g., Mediterranean diet), meal consumption timing, meal cost, and realistic nutritional goal setting (Clegg & Williams, 2018; Fekete et al., 2022). Due to the complexity of nutrition and potential loss of appetite among these individuals, the professional may need to refer them to a registered dietitian for more nutritional counseling (Giezenaar et al., 2016).

Nutritional Strategy Summary

The fitness professional and wellness coach should consider that nutritional intervention research for individuals with sarcopenia is still emerging. There are still many unknown questions regarding the optimal diet and nutrient supplementation for these individuals. The existing research supports increased protein intake and supplementation with BCAA in combination with whey protein, vitamin D, and flavonoids. Creatine is a promising supplement but is still under study. Professionals should consider that nutritional supplementation may be more effective in conjunction with RE for individuals with sarcopenia.

Clients with sarcopenia may need more advanced nutritional counseling and should be referred to a registered dietician, if needed. The fitness professional and wellness coach are reminded to stay within their scope of practice when educating these clients about nutritional strategies for sarcopenia. **Table 10** provides a summary of nutrient and supplement intake recommendations (Candow et al., 2022; Cheah & Cheah, 2023; Cochet et al., 2023; Dolan et al., 2019; Y. Li et al., 2022; Liu et al., 2023; Morley et al., 2010; Wu & Suzuki, 2023).

Nutrient	Recommendation
Protein	1.0–1.8 g/kg/BW/day (0.45 g/lb–0.82 g/lb)
BCAA + whey protein + Vitamin D	Whey protein (20–40 g) BCAA (Leucine) (3 g/day) Vitamin D (100 – 1000 IU per day)
Flavonoids	Catechins powder/tea (540 mg/day), cocoa (179 mg/ day), epicatechin capsules (1 mg/kg BW/day), soy (27–30 g/day), soy peptide (4 g/day), licorice oil (300 mg/ day), curcumin and rutin (500 mg/day), isoflavones capsules (50–135 mg/day)
Creatine	20-22 g/day for 5–7 days, followed by 3–5 g/day thereafter, or just 5 g/day or 0.5–0.1 g/kg/day

Table 10. Summary of Nutrient and Supplement Intake Recommendations

Wellness

The fitness professional and wellness coach can also promote specific wellness practices to individuals with sarcopenia as part of a healthy lifestyle strategy. Specific strategies that impact sarcopenia may include, but are not limited to, sleep and social support (Hu et al., 2023; Piovezan et al., 2015).

Sleep

Age-related sleep changes are common among older individuals. Factors such as medication, sleep disorders (e.g., sleep apnea), and insomnia can affect sleep quality (Piovezan et al., 2015). Poor sleep quality has a strong relationship with sarcopenia. Short sleep duration (< 6 hours) and long sleep duration (> 8 hours) are strongly correlated with sarcopenia in older individuals (Han et al., 2022; Li et al., 2023; Rubio-Arias et al., 2019; Yang et al., 2022). It is hypothesized that poor sleep may produce negative effects by enhancing catabolic pathways, reducing protein synthesis, increasing cortisol levels, disrupting neuroendocrine hormonal pathways, and stimulating insulin resistance mechanisms. Hormonal and muscle metabolism imbalances derived from poor sleep can complicate the health status of individuals with sarcopenia (**Figure 7**) (Piovezan et al., 2015).

The relationship between poor sleep and sarcopenia has prompted healthcare providers to encourage older individuals with sarcopenia to try to get the recommended average range of 6–9 hours of sleep per night, which may have positive effects on muscle health (Hu et al., 2&017; Watson et al., 2015). It is theorized that adequate sleep within the recommended range can facilitate protein synthesis and anabolic hormone pathways (e.g., growth hormone, insulin-like growth factor 1, testosterone) among individuals diagnosed with sarcopenia (Piovezan et al., 2015).

Fitness professionals and wellness coaches can encourage these individuals to get the recommended amount of sleep per night, which may positively affect their muscle health (Hu et al., 2017; Watson et al., 2015). In some cases, the client may have complications from sarcopenia or other related issues (e.g., medication or sleep disorder) that warrant referral to a qualified healthcare provider to explore possible sleep interventions.

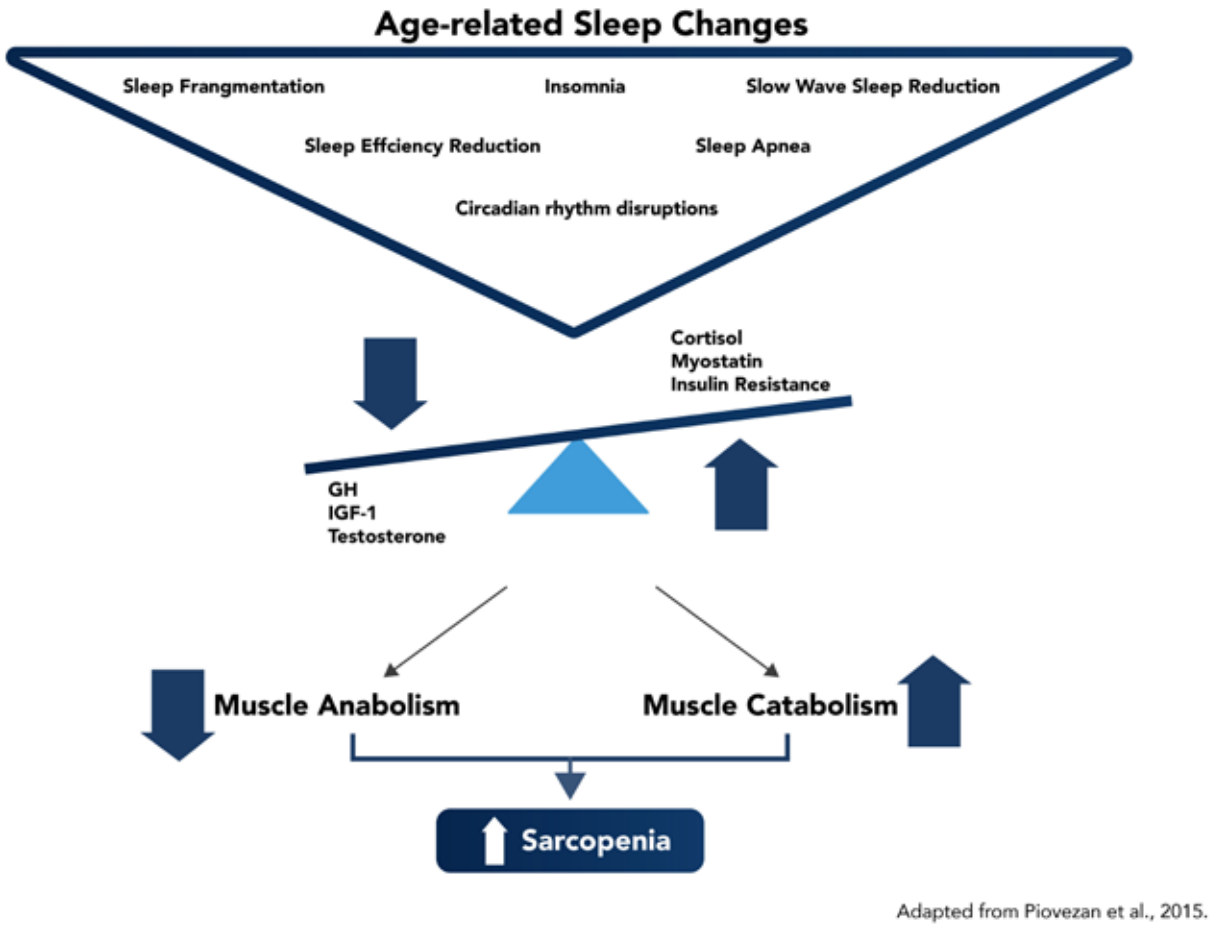


Figure 7. Effects of Age-Related Sleep Changes on Sarcopenia Due to Hormonal and Muscle Metabolism Imbalances

Social Support

Social support is another factor that should be considered by the fitness professional, because it may have a positive effect on individuals with sarcopenia or on those who are at risk for the condition (Bian et al., 2023). Researchers have found that older adults with high levels of social support had a lower risk of cognitive impairments, mortality, and sarcopenia (Bian et al., 2023; Czaja et al., 2021). Furthermore, a lack of support could be a risk factor for mental health issues such as depression among older individuals with sarcopenia (Z. Li et al., 2022; Zhang & Dong, 2023). Other factors such as social isolation, loneliness, living alone, low self-esteem, lack of physical activity, and lack of resources (e.g., financial, health insurance) have been linked to depression among older adults with and without sarcopenia (Hu et al., 2023; Yuenyongchaiwat & Boonsinsukh, 2020; Zenebe et al., 2021).

Social support may help with many of these risk factors by bringing individuals together in a social group format (Czaja et al., 2021). Social support groups via an app, social media, or in person may be beneficial and may be an effective adjunct to a healthy lifestyle program focusing on muscle health (Rayland & Andrews, 2023). The main benefit of social support groups may be accountability among individuals with the same goals, which can improve adherence to their healthy lifestyle program.

The fitness professional and wellness coach should consider that older individuals with sarcopenia may have complications and comorbid conditions that may challenge these wellness practices. Other factors, such as available resources like smartphones and internet connections, may challenge the integration of technology into their healthy lifestyle program. The professional may need to be creative with their coaching to provide healthy lifestyle recommendations that the client can successfully accomplish with available resources.

GETTING TECHNICAL

Currently, there is no US Federal Drug Administration–approved pharmacological treatment for sarcopenia (De Spiegeleer et al., 2018). The use of steroid hormones such as testosterone, anabolic steroids, and dehydroepiandrosterone (DHEA) have been studied as potential treatments for sarcopenia. Researchers have found some positive effects on muscle health, but some of these interventions have adverse effects on the individual's overall health (Jang et al., 2023). Also, several novel sarcopenia treatments are being developed and undergoing clinical trials (Jang et al., 2023). Thus, the best first-line treatment for sarcopenia appears to be healthy lifestyle interventions of RE, nutrition (protein intake), and wellness.

Conclusion

Sarcopenia is an increasingly common muscle health condition that affects older individuals. Researchers have documented risk factors, causative theories, and consequences of sarcopenia. Many of these issues can be prevented or mitigated through a healthy lifestyle, which includes physical activity, healthy eating, and wellness practices. For example, resistance training and HIIT are considered to be first-line interventions for individuals with sarcopenia and those at risk for the condition. The recommendations provided in this review are based on the most current evidence on sarcopenia. The research on sarcopenia is still emerging, with many unanswered questions and no consensus on the optimal healthy lifestyle strategy for these individuals. NASM hopes you have enjoyed this evidence-based review of sarcopenia and encourages all fitness professionals and wellness coaches to study this topic further and stay current with the related research.

Key Takeaways

- Understanding Sarcopenia: Sarcopenia, or age-related muscle loss, is a condition stemming from adverse muscle changes that accumulate over a lifetime. Older adults, 60 years and older, are considered to be the most at ris k for sarcopenia. Researchers have estimated the worldwide prevalence of sarcopenia among older adults to be between 10% to 27%.
- Defining Sarcopenia: Sarcopenia has been defined by several research groups. The general definition of sarcopenia includes three criteria: low muscle strength, low muscle quality and quantity, and low physical performance. The EWGSOP2 definition is the most recognized guideline, which uses a four-step algorithm (find, assess, confirm, and severity) to further diagnose sarcopenia.
- Sarcopenia Subcategories: Researchers have further subcategorized sarcopenia as acute, chronic, primary, and secondary. Secondary may be the most common due to the relationship of sarcopenia with other comorbid conditions.
- Suspected Causes of Sarcopenia: Researchers have postulated several causes of sarcopenia, such as age-related decline in anabolic hormones, neurodegeneration in primarily type II muscle fibers, age-related mitochondrial dysfunction, reduced muscle satellite cells (e.g., stem cells), changes in muscle fiber quality, and an increase in inflammatory markers.
- Sarcopenia Risk Factors: There are several risk factors for sarcopenia, such as obesity, physical inactivity, and malnutrition, which are modifiable and fall within the scope and expertise of the fitness professional and wellness coach.
- Sarcopenia-Related Conditions: Sarcopenia is a progressive condition resulting in functional consequences such as low muscle strength (e.g., grip strength), slow movement (e.g., slow gait speed), poor mobility, fatigue, low physical activity, poor balance, falls, and fractures. Sarcopenia can also lead to other medical conditions such as mortality, malnutrition, osteoporosis, metabolic syndrome, T2DM, nonalcoholic liver disease, liver fibrosis, hypertension, depression, dysphagia (swallowing difficulties), hospitalization, and cognitive impairments.
- The Role of the Fitness Professional and Wellness Coach: The fitness professional and wellness coach can play a significant role in helping individuals with sarcopenia and sarcopenia-related conditions. Coaching these clients using healthy lifestyle strategies such as physical activity, healthy eating, and wellness may help them improve their overall muscle health.
- Role of Physical Activity: Physical activity is an important healthy lifestyle behavior for individuals with sarcopenia. Resistance exercise (RE) and high-intensity interval training (HIIT) are first-line interventions for sarcopenia.
- Healthy Eating: Research on nutritional strategies for sarcopenia is emerging, and there are some strategies that may help reduce the risk of sarcopenia and slow its progression. Intake of protein, branched-chain amino acid (BCAA), vitamin D, omega-3 polyunsaturated fatty acid (PUFA), and flavonoids all have research supporting their potential for improving muscle health among individuals with sarcopenia.
- Wellness: The fitness professional and wellness coach can also promote specific wellness practices to individuals with sarcopenia as part of a healthy lifestyle strategy. Specific strategies that impact sarcopenia may include, but are not limited to, sleep and social support.

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