Developing a Public-Friendly Sarcopenia Guideline Framework: A model integrating ChatGPT, human experts, and Google

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Abstract

Background: The highly academic and complex nature of the current expert consensus on sarcopenia may limit public awareness and understanding of this disease.

Objective: This study aims to develop a more public-friendly framework for future sarcopenia guidelines by utilizing a model that incorporates Google, the Chat Generative Pre-Trained Transformer 4.0 (ChatGPT 4.0), and sarcopenia experts.

Methods: The first step of this human-centered model involved identifying the most popular questions on sarcopenia using the “People Also Ask” feature on Google. In the second step, these questions were input into ChatGPT 4.0 to generate answers, while sarcopenia experts reviewed existing consensus to provide answers. In the third step, sarcopenia experts assessed the relevance of current consensus to the questions. They compared and analyzed the responses from ChatGPT 4.0 and the expert reviews, offering suggestions for future guidelines. Finally, the results from the expert analysis were used as prompts for ChatGPT 4.0 to develop a framework for future sarcopenia guidelines.

Results: We scored and identified the 9 most popular questions. The current sarcopenia consensus was inadequate in answering these questions. In the existing consensus, diagnostic criteria received the highest emphasis, scoring 25.5 points (out of 40 points), followed by exercise and nutrition, each with 13 points. In contrast, topics such as prognosis and symptoms were addressed less, with a score of only 5.5 points and 4.5, respectively. This human-centered model that integrates ChatGPT 4.0, human experts, and Google created a framework for more public-friendly sarcopenia guidelines, addressing the inadequately covered topics.

Conclusions: The human-centered model that combines ChatGPT 4.0, human experts, and Google has great potential in creating more accessible and public-friendly clinical guidelines for sarcopenia Clinical Trial: none

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Abstract

Background: The highly academic and complex nature of the current expert consensus on sarcopenia may limit public awareness and understanding of this disease. This study aims to develop a more public-friendly framework for future sarcopenia guidelines by utilizing a model that incorporates Google, the Chat Generative Pre-Trained Transformer 4.0 (ChatGPT 4.0), and sarcopenia experts.

Methods: The first step of this human-centered model involved identifying the most popular questions on sarcopenia using the “People Also Ask” feature on Google. In the second step, these questions were input into ChatGPT 4.0 to generate answers, while sarcopenia experts reviewed existing consensus to provide answers. In the third step, sarcopenia experts assessed the relevance of current consensus to the questions. They compared and analyzed the responses from ChatGPT 4.0 and the expert reviews, offering suggestions for future guidelines. Finally, the results from the expert analysis were used as prompts for ChatGPT 4.0 to develop a framework for future sarcopenia guidelines.

Results: We scored and identified the 9 most popular questions. The current sarcopenia consensus was inadequate in answering these questions. In the existing consensus, diagnostic criteria received the highest emphasis, scoring 25.5 points (out of 40 points), followed by exercise and nutrition, each with 13 points. In contrast, topics such as prognosis and symptoms were addressed less, with a score of only 5.5 points and 4.5, respectively. This human-centered model that integrates ChatGPT 4.0, human experts, and Google created a framework for more public-friendly sarcopenia guidelines, addressing the inadequately covered topics.

Conclusions: The human-centered model that combines ChatGPT 4.0, human experts, and Google has great potential in creating more accessible and public-friendly clinical guidelines for sarcopenia.

Keywords: Sarcopenia, ChatGPT 4.0, Artificial Intelligence, Search Engine, Clinical Consensus, Health Guidelines, Public Awareness

Introduction

Sarcopenia was first introduced by Irwin Rosenberg in 1989, but it wasn't officially classified as a muscle disease by the WHO until 2016 [1]. The new classification reflects the global trend of an aging population, as the WHO predicts that the proportion of people over-60s worldwide will increase from 12% to 22% by 2050 [2]. This highlights the need for better medical care for older adults with sarcopenia, who are at higher risk of frailty, disability, death, and a lower quality of life [3].

A variety of experts consensus have been established since 2010 for sarcopenia [4-10]. The European Working Group on Sarcopenia in Older People (EWGSOP) introduced the first European consensus on sarcopenia in 2010 [4]. The International Working Group on Sarcopenia (IWGS) followed with their consensus in 2011 [5], and the Asian Working Group for Sarcopenia (AWGS) established the Asian consensus in 2014 [6]. After the WHO reclassified sarcopenia as a specific muscle disease in 2016, both EWGSOP and AWGS updated their guidelines in 2019 and 2020, respectively [7, 8]. Additionally, organizations such as the Sarcopenia Definition and Outcomes Consortium (SDOC) in the US, the Australian and New Zealand Society for Sarcopenia and Frailty Research (ANZSSFR), and the Global Leadership Initiative in Sarcopenia (GLIS) have also developed their own sarcopenia consensus [9-13].

However, despite the development of multiple consensus statements, Hardee and Lynch wrote "Debate and many (not-so-helpful) publications regarding nuances around specific definitions have restricted progress in accepting, understanding and treating sarcopenia" [14]. William J. Evans et al. in 2024 wrote that there is "no consensus, no diagnostic criteria, and no approved indication" for sarcopenia [15]. The lack of consensus on the diagnosis of sarcopenia may explain its neglect in medical practice and hinder its integration into comprehensive clinical care for older adults [15, 16]. A survey of 253 practicing US physicians showed that less than 20% of them reported being familiar with the term sarcopenia, 75% used no criteria for a diagnosis of sarcopenia, and 38% lacked understanding that sarcopenia is treatable [17]. Compared to geriatricians, dietitians and orthopedic professionals were also found to have insufficient or limited knowledge of sarcopenia [18, 19]. Additionally, public awareness of sarcopenia remains quite low [15, 20]. Increasing awareness of sarcopenia among both the public and healthcare providers is essential to enhance patient advocacy and stimulate the development of new drug therapies [15]. Therefore, it is critical to establish more clear, accessible consensus or guidelines for sarcopenia.

Chat Generative Pre-Trained Transformer (ChatGPT) is an AI model designed to generate text-based responses by analyzing vast amounts of data, including both written content and images sourced from the internet. It generates answers or responses based on the input or prompts it receives from users. ChatGPT is gradually being applied in the medical field to assist medical professionals in generating lists of differential diagnoses [21], clinical decision-making [22], cancer screening [23], diagnosis of common cases [24], and medical documentation [25]. ChatGPT's answers were compared with standard medical sources evaluated by experts [26], expert panels [27]the Google search engine [24]or the clinical guidelines [28]. It is suggested that while ChatGPT is increasingly used by patients to access health information, its responses must align more closely with established clinical guidelines to ensure clarity, reliability, and usability [28]. However, if clinical sarcopenia consensus cannot address public questions, or are too complex or inaccessible, can ChatGPT help in developing future user-friendly guidelines?

In this study, we established a human-centered model by collecting popular public questions related to sarcopenia from Google and compared the responses of ChatGPT 4.0 to existing consensus on these questions. Additionally, we explored the potential assistance of ChatGPT in developing a public-friendly framework for sarcopenia guidelines.

Methods

Identification of the most frequently searched questions on sarcopenia using Google Search

We used the Google Search engine to identify the most frequently searched questions on sarcopenia by the public. Google Search offers a feature called "People Also Ask" that displays common questions related to a given query [29]. Different search queries may yield different sets of "People Also Ask" questions. Two geriatric experts suggested a range of search queries, including "sarcopenia", "sarcopenia symptoms", "sarcopenia causes", "sarcopenia treatment", "sarcopenia and aging", "sarcopenia diagnosis", "sarcopenia and health", "sarcopenia and exercise", "sarcopenia and doctor", and "sarcopenia and hospital" to uncover the most frequently asked questions on Google (English version). The first most frequently asked question receives a score of 10, the second most frequently asked question a score of 9, and so on. The cumulative scores from these queries generated a list of the top questions asked by the public regarding sarcopenia. (Step 1, Figure 1)

Generation of ChatGPT 4.0 responses to the top 9 popular sarcopenia questions

We used top 9 frequently asked questions as prompts for ChatGPT 4.0 to generate responses. To maintain brevity, we added the prompt that each answer should be limited to a maximum of three sentences. The answers were collected and later send to the geriatric experts for further evaluation (Step 2a, Figure 1)

Generate the summary of answers from the current consensus

We used the commonly accepted sarcopenia consensus to answer the top 9 popular questions by manually searching the related contents in all selected sarcopenia consensus by the sarcopenia team (two geriatric experts and several general medical doctors). The current consensus included EWGSOP, IWGS, AWGS, EWGSOP2, AWGS2, SDOC, ANZSSFR, and GLIS [4-10, 30]. Additional English literatures from PubMed were cited if the questions could not be answered by the current consensus [9, 30]. (Step 2b, Figure 1)

Comparative Analysis of the responses and suggestion for future guidelines

The top 9 questions on sarcopenia were categorized into specific topics by sarcopenia experts. Two sarcopenia experts first evaluated how well the current consensus addressed each topic represented by these popular questions. A 5-point Likert scale was developed for this evaluation, with the following criteria: 0 = Not addressed at all; 1 = Minimally addressed (mentioned only, with no in-depth discussion); 2 = Partially addressed (covered in some sections, but not a main focus); 3 = Moderately addressed (covered with moderate detail); 4 = Thoroughly addressed (covered in significant detail); and 5 = Fully addressed (comprehensively covered as a central focus of the consensus). The scores for specific topics from various consensus were then summed. The responses from ChatGPT 4.0 and the summary of consensus answers were also compared by two sarcopenia experts. Based on those analyses, the experts provided suggestions for future sarcopenia guidelines. (Step 3, Figure 1)

Generate a framework for future sarcopenia guideline by ChatGPT

We provided the comparative analysis and “suggestions for future guidelines” as input to ChatGPT and asked it to “generate a framework for future sarcopenia guidelines”. Finally, ChatGPT 4.0 generated a detailed flowchart for future sarcopenia guidelines along with a flowchart of the framework. (Step 4, Figure 1)

Results

Top 9 Most Searched questions on sarcopenia from Google

We collected 13 popular questions from Google's "People Also Ask" feature. Similar or related questions were grouped together, and their scores were combined into the selected questions. For example, the search question "Can sarcopenia be reversed?" had its score cumulated with the alternative questions "Can you reverse muscle wasting?" and "Can you recover from sarcopenia?". Based on this approach, the top 9 questions were selected according to the cumulated scores for further evaluation. (Table 1)

Comparison of the answers from ChatGPT and expert reviews

After excluding general advice such as "ask the professionals", the concise answers generated instantly by ChatGPT are listed in Table 2. Simultaneously, two sarcopenia experts and their team reviewed the current sarcopenia consensus in a time-consuming manner and provided concise answers to the nine questions. Once two sets of answers were available, two sarcopenia experts compared them and offered suggestions for developing a future clinical guideline framework on sarcopenia. The details are provided below.

Question 1: Can sarcopenia be reversed? (Prognosis)

ChatGPT 4.0: Sarcopenia can often be improved, though not completely reversed, if the right measures are taken.

Consensus: About 84.1% of GLIS experts agreed that "sarcopenia should be a potentially reversible disease" [12]. AWGS2 indicated that the outcome indicators for intervention should be "a reversal from sarcopenic to nonsarcopenic" [8]. This question is equal to "Can an aged regain muscle mass?" A study found that older adults (around 70 years old) who have exercised regularly for 30 years have muscles similar in quality to young adults (around 27 years old) [31]. However, a study of people aged 65 years and older has shown that physical activity probably helps prevent frailty, but it is unclear whether it can prevent sarcopenia [32].

Comparative Analysis and suggestion for future guidelines: This raises the public interests of whether sarcopenia is a natural part of aging or a treatable disease such as high blood pressure or diabetes. ChatGPT's response aligns with the views of some sarcopenia experts. Future guidelines should address this frequently asked question to reassure the public that sarcopenia can be a treatable

condition that can be partially or potentially fully reversed with appropriate interventions.

Question 2: What is the best exercise for sarcopenia? (Treatment)

ChatGPT 4.0: The best exercises for sarcopenia are resistance training activities such as weightlifting, which can increase muscle mass and strength, along with balance and flexibility exercises to improve functional performance. It's important to tailor the exercise program to individual capabilities and progress gradually.

Consensus: EWGSOP asked the question: "What exercises are best suited and most effective for older people" [4]. However, EWGSOP2 did not answer the question [7]. AWGS suggested focusing on developing appropriate exercise prescriptions and recommended aerobic, endurance and resistance training [33]. AWGS2 examined clinical sarcopenia research on exercise and exercise in combination with different nutrition; however, the suitable type of exercise for sarcopenia was not specified [8]. ANZSSFR recommended a multicomponent exercise program incorporating elements of resistance, challenging balance, and functional mobility training, combined with high-protein, multi-nutrient nutritional support for sarcopenia [11]. GLIS acknowledged that while resistance exercise can improve muscle strength and multicomponent exercises can reduce mobility disability in even the oldest adults [12].

Comparative Analysis and suggestion for future guidelines: Both ChatGPT and the consensus emphasize the importance of resistance training and multicomponent exercises that include balance and flexibility in sarcopenia. The current consensus recommends a broader range of physical activities. Future guidelines could consider proving practical exercise prescriptions for sarcopenia.

Question 3: At what age does sarcopenia generally begin? (Development)

ChatGPT 4.0*:* Sarcopenia generally begins to manifest around the age of 30, with a progressive decline in muscle mass and function accelerating after the age of 60.

Consensus: EWGSOP2 demonstrated that maximal levels of muscles reached in young adulthood (up to 40 years of age) and development of sarcopenia begins earlier in life [7]. The citation in EWGSOP2 was a review in 2008 using a figure of "A life course model of sarcopenia" from Modified WHO/HPS Geneva 2000 [34]. However, that figure depicted "functional capacity", rather

than “muscle mass or strength”, that increases during childhood, peak in early adulthood, and then generally declines with age [34-36] . Therefore, the evidence of peak mass in 40 years of age in EWGSOP2 may not be correct. However, EWGSOP2 also cited a UK study, in which males and females reached a peak median grip up to 40 years of age [37]. EWGSOP2 also cited a literature showed that leg muscle mass lost 1–2% per year and strength 1.5–5% per year from the age of 50 years [38]. AWGS indicated that most previous studies supported the idea that loss of muscle mass and muscle strength becomes pronounced around the age of 50, progresses faster after the age of 60, and accelerate even faster after the age of 75 [33].

Comparative Analysis and suggestion for future guidelines: Both ChatGPT and the consensus agree that sarcopenia involves a gradual loss of muscle mass and strength that accelerates with age. ChatGPT suggests that sarcopenia begins around age 30 and worsens after age 60, while the current consensus indicates that muscle strength peaks around age 40, starts to decline around age 50, worsens after 60, and accelerates after 75. Future guidelines could enhance clarity by introducing a life-course model of sarcopenia that incorporates muscle mass, strength, and physical performance across different stages of life.

Question 4: What type of doctor treats sarcopenia?

ChatGPT 4.0: A geriatrician, who specializes in the care of older adults, is typically involved in treating sarcopenia, often in collaboration with a team that may include physical therapists, nutritionists, and primary care physicians. In some cases, endocrinologists or physiatrists may also be involved in the treatment process.

Consensus: We conducted a review of the authors of EWGSOP2, AWGS2, ANZSSFR Expert Group, and SDOC and find that in a total of 86 authors, 53.5% of them are geriatricians, 14.0% are epidemiologists or public health specialists, 11.6% are nutritionists. The others included internal medicine specialists, rehabilitation medicine specialists, and exercise or nutrition scientists [7-9, 11].

Comparative Analysis and suggestion for future guidelines: The consensus doesn’t directly answer the question. ChatGPT provides a general overview of the treatment team, while the consensus gives a detailed breakdown of the professionals involved, highlighting geriatricians and other specialists.

Question 5: What is the quickest way for elderly to regain muscle mass? (Treatment)

ChatGPT 4.0*:* The quickest way for the elderly to regain muscle mass is through a combination of resistance training exercises and adequate protein intake, tailored to their individual health status and abilities, and supervised by healthcare professionals. This approach should be complemented by overall good nutrition and, if necessary, targeted supplementation as recommended by a doctor.

Consensus: EWGSOP2 did not contain specific recommendation for elderly to regain muscle mass [7]. AWGS2 suggested that the combination of exercise and nutrition—especially resistance-based exercise and supplements like branched-chain amino acids (BCAAs), whey protein, and hydroxy methyl butyrate (HMB) [8]. ICFSR strongly recommends resistance-based physical activity and conditionally recommends protein supplementation or a protein-rich diet but does not recommend Vitamin D supplementation or anabolic hormone use [33]. ANZSSFR emphasizes the importance of nutritional support, multicomponent exercise programs, and early intervention for elderly individuals with sarcopenia or frailty, particularly those who are hospitalized [11].

Comparative Analysis and suggestion for future guidelines: Both ChatGPT and the consensus agree that the quickest way for the elderly to regain muscle mass is through resistance training and adequate protein intake. ChatGPT provides a general approach, whereas current consensus offers specific recommendations and emphasizes the importance of early and combined interventions. Future guidelines could focus on a more systematic explanation of treatment strategies for elderly individuals with sarcopenia.

Question 6: How do I know if I have sarcopenia? (Diagnosis)

ChatGPT 4.0: Sarcopenia is diagnosed through a combination of assessments, including a physical examination, measurement of muscle mass via imaging or bioelectrical impedance analysis, and tests of muscle strength and function, such as grip strength or walking speed.

Consensus*:* EWGSOP suggests diagnosing sarcopenia through a combination of assessments that typically includes evaluating muscle mass, muscle strength, and physical performance [4]. AWGS2 defines sarcopenia as having low muscle mass combined with either low muscle strength or low physical performance[8]. Recent trends in sarcopenia criteria emphasize muscle strength rather than

muscle mass. EWGSOP2 prioritizes low muscle strength before considering muscle quantity or quality in its sequential criteria [7]. SDOC focus exclusively on muscle strength and physical performance, excluding muscle mass from their primary criteria [10]. However, the prevalence of sarcopenia varies significantly depending on the criteria used, ranging from as low as 0.7% with the EWGSOP2 or AWGS2 definitions, to as high as 16.8% when defined solely by low muscle mass [39].

Comparative Analysis and suggestion for future guidelines: Both ChatGPT and the consensus agree that diagnosing sarcopenia involves assessing muscle mass, strength, and physical performance. ChatGPT provides a general overview, while current consensus differs greatly in parameters and cut-off points. Future guidelines should aim to standardize these criteria to provide more consistency in diagnosis and improve comparability across studies and clinical practices.

Question 7: What causes you to lose muscle mass? (Etiology)

ChatGPT 4.0: Loss of muscle mass can be caused by aging, physical inactivity, malnutrition, certain medical conditions such as chronic illness or hormonal imbalances, and it can also result from medications that affect muscle metabolism. It’s a natural part of aging, but lifestyle factors play a significant role in the rate of muscle loss.

Consensus*:* EWGSOP identifies a range of causes for sarcopenia, categorizing it into primary sarcopenia, which is primarily caused by aging, and secondary sarcopenia, resulting from factors such as physical inactivity, chronic diseases, and malnutrition [4]. EWGSOP also identifies primary actor of ageing and secondary factor of disease, inactivity, and poor nutrition [7]. In addition, AWGS identifies a broader range of causes for sarcopenia including aging, multimorbidity, cigarette smoking, low body mass index (BMI), underweight status, physical inactivity, and low testosterone levels in men [6]. Additionally, the AWGS2 links the likelihood of developing sarcopenia to the presence of cardiometabolic risk factors such as diabetes, hypertension, and dyslipidemia [8].

Comparative Analysis and suggestion for future guidelines: Both ChatGPT and the consensus agree that muscle loss is caused by aging, inactivity, malnutrition, and certain health conditions. The current consensus provides a more detailed view than ChatGPT. Future guidelines should emphasize how modifiable factors like nutrition and physical activity can help delay or reduce sarcopenia, while also clarifying how smoking, underweight status, and low testosterone contribute to its onset and

progression.

Question 8: What are 4 symptoms of sarcopenia? (Symptoms)

ChatGPT: Reduced muscle mass without obvious weight loss. Decreased strength, particularly in the hands and legs. Difficulty performing everyday physical tasks. Increased susceptibility to falls and fatigue during activities.

Consensus*:* Although the WHO reclassified sarcopenia as a specific disease in 2016, the symptoms of sarcopenia were not specifically described in all consensus. When the EWGSOP originally proposed the consensus on the definition of sarcopenia, sarcopenia itself was referred to as a "geriatric syndrome" rather than a disease [4]. The EWGSOP2 recommends the use of the SARC-F questionnaire or clinical suspicion to identify "sarcopenia-associated symptoms" such as falls, feeling weak, slow walking speed, difficulty rising from a chair or weight loss/muscle wasting [7]. The description of sarcopenia symptoms is not included in consensus of AWGS, AWGS2, SDOC, ANZSSFR, ICFSR, and GLIS [6, 8, 10, 12, 33].

Comparative Analysis and suggestion for future guidelines: Current consensus lack a systematic description of sarcopenia symptoms, although sarcopenia is a specific disease. Future guidelines should include a clearer and more comprehensive description of the symptoms of sarcopenia. This could include detailed descriptions of physical and functional signs to raise public awareness and facilitate diagnosis.

Question 9: What foods build muscle in seniors? (Treatment)

ChatGPT 4.0: Foods that can help build muscle in seniors include those high in protein such as lean meats, fish, eggs, dairy products, legumes, and nuts, as well as foods rich in vitamins and minerals like fruits, vegetables, and whole grains to support overall health. It's also important for seniors to ensure adequate calorie intake to fuel muscle growth.

Consensus: Consensus guidelines generally do not contain specific information on foods that support muscle gain in seniors or are beneficial in sarcopenia [4, 6-8]. AWGS2 indicated that protein supplements, especially BCAAs, leucine, vitamin D, and whey protein, significantly improve muscle

mass, strength, and function [8]. ANZSSFR recommends 1.2–2.0g of protein per kg of body weight daily for older hospitalized patients to promote muscle protein synthesis, essential for maintaining or building muscle, through high-protein foods or supplements [11]. ICFSR conditionally recommends protein supplements or a protein-rich diet for older adults with sarcopenia to support muscle protein synthesis, which is essential for building and maintaining muscle mass. It also suggests research into nutrients with anti-inflammatory properties like Omega-3, phytochemicals, certain vitamins and minerals, and promotes dietary patterns such as the Mediterranean diet. Healthy fats, hydration, and the quality of calories (processed vs. non-processed foods) should also be considered [33]. ICFSR and Singapore consensus also suggest protein-rich diets or supplements for older adults who cannot meet protein needs through diet [11, 13].

Comparative Analysis and suggestion for future guidelines: ChatGPT provides a direct recommendation for muscle-building foods in seniors, suggesting high-protein foods such as lean meats, fish, eggs, dairy, and nutrient-rich fruits and vegetables, with an emphasis on adequate calorie intake. In contrast, the consensus focuses more on protein supplements, particularly BCAAs, leucine, vitamin D, and whey protein, for improving muscle mass and strength in older adults. While ChatGPT gives practical food options, the consensus concentrates on the need for supplements and dietary patterns without offering specific food examples. Future guidelines could provide a more detailed explanation of practical food choices for seniors, not only in clinical environments but also in day-to-day settings, to ensure clear guidance for both healthcare providers and the public.

Content Emphasis and Variability Across Sarcopenia Consensus

The content coverage of key topics such as etiology, development, symptoms, diagnostic criteria, exercise, nutrition, and prognosis across different sarcopenia consensus was evaluated by two sarcopenia experts using a 5-point Likert scale. This scale was defined as follows: 0 for not addressed at all, 1 for minimally addressed (mention only, no in-depth discussion), 2 for partially addressed (discussed in some sections but not a main focus), 3 for moderately addressed (covered with moderate detail), 4 for thoroughly addressed (covered in significant detail), and 5 for fully addressed (comprehensive coverage, likely a central focus of the consensus). Among these, diagnosis criteria are significantly emphasized by most of the consensus, such as EWGSOP, AWGS, EWGSOP2, and AWGS2, which show a broader and denser focus on the subject, scoring 25.5 points (out of 40 points). Exercise and nutrition also received considerable emphasis, each scoring 13 points (out of 40 points), particularly in ANZSSFR and ICFSR, where multicomponent interventions and

protein-rich diets are emphasized. On the other hand, content areas like etiology, prognosis, and symptoms are less discussed across most consensus. Some consensus such as SDOC focus more on diagnosis criteria but include limited discussion on other topics. (Table 3) In summary, diagnostic criteria receive the most emphasis across sarcopenia guidelines, while exercise and nutrition are moderately covered. However, etiology, prognosis, and symptoms are generally less discussed. (Figure 2)

Generation of a Future Sarcopenia Guidelines Framework by ChatGPT

Based on the popular questions, responses, and the experts' comparative analysis and suggestions for future guidelines, ChatGPT generated a detailed framework (Supplementary Document 1) and a flowchart of the future sarcopenia guideline (Figure 3), designed to be more accessible and public-friendly.

Discussion

The first step in this model involved actively discovering public preferences by posing questions about sarcopenia on Google. Studies have shown that public or patient involvement is beneficial in the development of clinical guidelines [40-42]. Patient involvement can provide patient-relevant topics and popular public questions for development of patient-centered guidelines [40]. The frequently asked questions reflect real-world feedback, ensuring the development of more practical, accessible, and well-received guidelines [41]. Evidence-based guidelines emphasize the scientific data and encourage patients, the public, and healthcare providers to actively participate in guideline development [42]. However, the guideline authors tend to believe they understand the patients' best interests on their behalf, which may not always align with the patients' actual needs [43]. Therefore, it was not surprising that current sarcopenia consensus inadequately responds to these popular questions. To summarize, addressing the concerns of the public and patients on sarcopenia is a crucial step in developing future public-friendly sarcopenia guidelines.

The second step of the model consisted of entering the questions separately into ChatGPT 4.0 to obtain instant responses and engaging professionals for a more time-consuming review of the current sarcopenia consensus. We found that current sarcopenia consensus primarily focuses on diagnostic criteria, provide moderate emphasis on exercise and nutrition, and offer limited attention to etiology, prognosis, and symptoms. Although WHO reclassified sarcopenia as a specific muscle disease in 2016 [1], the current consensus do not include a section to describe the main symptoms [7, 8].

ChatGPT displayed four symptoms for sarcopenia: reduced muscle mass, decreased strength, difficulty performing everyday physical tasks, and increased susceptibility to falls and fatigue during activities. After reviewing current consensus, we found that most of these symptoms are included as parameters in the diagnostic criteria, but the complex cut-off points make them hard to interpret [7, 8]. In the framework for sarcopenia guidelines generated by ChatGPT, a section of “Symptoms and Early Warning Signs” was included, offering a clearer demonstration of sarcopenia as a disease by outlining physical indicators, functional impacts, and screening tools. The question of “Can sarcopenia be reversed?” emerged as one of the top popular questions. ChatGPT responded with, “Sarcopenia can often be improved, though not completely reversed, if the right measures are taken”. Although most of GLIS experts considered sarcopenia as a “potentially reversible disease” [12], the coverage of this question in current consensus was relatively low. In summary, current sarcopenia guidelines heavily focus on diagnostic criteria [4, 6-10] but overlook other important aspects such as symptoms and prognosis.

The third step involved human expert reasoning: sarcopenia experts compared ChatGPT’s responses with key points from current sarcopenia consensus and suggested a future framework for sarcopenia guidelines. The sarcopenia experts proposed several approaches for future sarcopenia guidelines after integrating their clinical knowledge with insights derived from ChatGPT. First, the future guidelines should reassure the public that sarcopenia is a treatable condition that can be partially or fully reversed with appropriate interventions. The guidelines should also include clearer exercise prescriptions, particularly for resistance and multi-component exercise, and introduce a life-course model of sarcopenia that illustrates the development of muscle mass, strength and physical performance at different stages of life. In addition, diagnostic criteria should be standardized to ensure consistency and improve comparability between studies. Finally, future guidelines should include a systematic description of sarcopenia symptoms and provide practical advice on diet and exercise for seniors, including specific food recommendations. However, the third step was the most crucial in the model, although it was time-consuming and required several weeks of work from our sarcopenia experts.

The fourth step involved entering the comparative analysis and suggestions for future guidelines into ChatGPT 4.0, instantly generating a framework for future sarcopenia guidelines (Supplementary Document 1 and Figure 3). ChatGPT are proving to be more essential in medical practice than expected. Currently, ChatGPT can help with medical education [44, 45], create medical

documentation [25], support clinical decisions or optimize clinical workflows [46]. The framework explored Etiology and Risk Factors and provides a section of Symptoms and Early Warning Signs section. Additionally, the framework emphasizes the Management of Comorbidities, Preventive Strategies, and Monitoring and Follow-Up sections. Lastly, the Future Research Directions call for the standardization of diagnostic criteria and the exploration of combined interventions to enhance long-term outcomes. In summary, one of the most significant contributions of this model is that ChatGPT can generate a framework for future sarcopenia guidelines by integrating insights from both AI and expert consensus.

Public preferences on specific clinical condition can arise in different ways. In addition to using Google's "People also ask" feature [47, 48], Google AdWords [49-51], and Google Trends [52-54] have also been used to identify public preferences. Searching for and sharing health information via social media is the most common activity among the public [55]. This includes searching for health advice [56], tracking and sharing news about current health issues [56], expressing public attitudes about disease prevention [57, 58], and discussing controversial health topics [59]. In this model, we used Google's public questions about sarcopenia to incorporate the public's interests into the development of the final sarcopenia guideline.

Researchers complained that ChatGPT model like other AI systems functions as a "black box", i.e. the underlying decision-making process is not transparent [60]. ChatGPT is trained on a variety of data to improve its ability to understand and generate language, including publicly available internet data, third-party partnerships, and user and human trainer contributions [61]. The training dataset for GPT-4 consisted of five primary datasets: Common Crawl, WebText2, Books1, Books2, and Wikipedia [62]. ChatGPT 4 cannot perform live Google searches or access real-time information, as its answers are based on data up to its last update in September 2021. In brief, ChatGPT in this model will generate answers based on resources other than real-time Google searches.

In this model, the human reasoning process is controllable and verifiable. Although the process is time-consuming, our findings highlight the importance of placing human reasoning at the core of the model (Figure 1). For example, in question 3, our sarcopenia experts discovered that the evidence suggesting a peak muscle mass at 40 years of age in EWGSOP2 may be incorrect. Tracing the citation chain, we found that the original figure depicted "functional capacity", which was misrepresented as "muscle mass or strength" [34-36]. As a result, all subsequent references,

including EWGSOP2, carried this error forward. This issue could only be identified through human expertise, as the misrepresentation in the original evidence was deeply embedded within the citation chain. However, in the future, AI should assist human experts by reducing the time-consuming aspects of the model and identifying errors in the citation chain more efficiently.

Limitations

This study has several limitations. First, Google's "People Also Ask" feature for identifying public questions may not comprehensively represent public search queries. The search queries on google suggested by sarcopenia experts may not represent the public's interests. Search behavior and regional differences may influence the types of questions asked. In addition, the panel of experts involved in the evaluation of ChatGPT responses consisted primarily of geriatricians, limiting the perspective of other relevant specialties such as physical therapists and nutritionists. Future studies should include a more diverse group of experts to ensure that the guidelines reflect a broader range of expertise and clinical experience.

Conclusions

Current sarcopenia expert consensus primarily focuses on diagnostic criteria, provide moderate emphasis on exercise and nutrition, and offer limited attention to etiology, prognosis, and symptoms. The human-centered model that combines Google, ChatGPT, and human expertise has great potential in creating more accessible and public-friendly framework of future sarcopenia guidelines.

Author contributions

J.C. was responsible for data collection, data analysis, and writing the first draft. P.B. and C.C., as sarcopenia experts, guided C.X., F.L., and W.Z. in data analysis. Y.H. conducted the ChatGPT 4.0 analysis and crafted Figures 1. P.B. and C.C. also performed the comparative analysis. T.T. revised the manuscript, and D.H. conceptualized the study and made additional revisions to the manuscript.

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Ethics Statement

Our study focuses exclusively on artificial intelligence and does not include direct patient participants. Therefore, the requirements set out in Article 35 of the World Medical Association's Declaration of Helsinki 2013 for the registration of the research study in the above-mentioned databases are not applicable to our research context. Therefore, there is no Unique Identifying Number (UIN) associated with this study.

Conflicts of Interest

The authors declare no conflicts of interest.

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Figure legend

Figure 1: The figure illustrates a model for developing a framework for future sarcopenia guidelines by integrating public inquiries, AI (ChatGPT), and expert reasoning. The process begins with sarcopenia experts inputting search keywords into Google to generate popular questions related to sarcopenia (Step 1). These questions are used as prompts (green arrows) for ChatGPT to generate responses (black arrows) (Step 2a). Sarcopenia experts then review the existing sarcopenia consensus to provide answers to these questions (blue arrows) (Step 2b). The AI-generated responses are compared with the expert-reviewed consensus through human reasoning (clock icon) (Step 3). Finally, the expert insights are input into ChatGPT to generate the framework for future sarcopenia guidelines (Step 4). The dotted arrow represents the ongoing process of updating current guidelines into more public-friendly versions. The time-consuming nature of expert reasoning is symbolized by the clock icon.

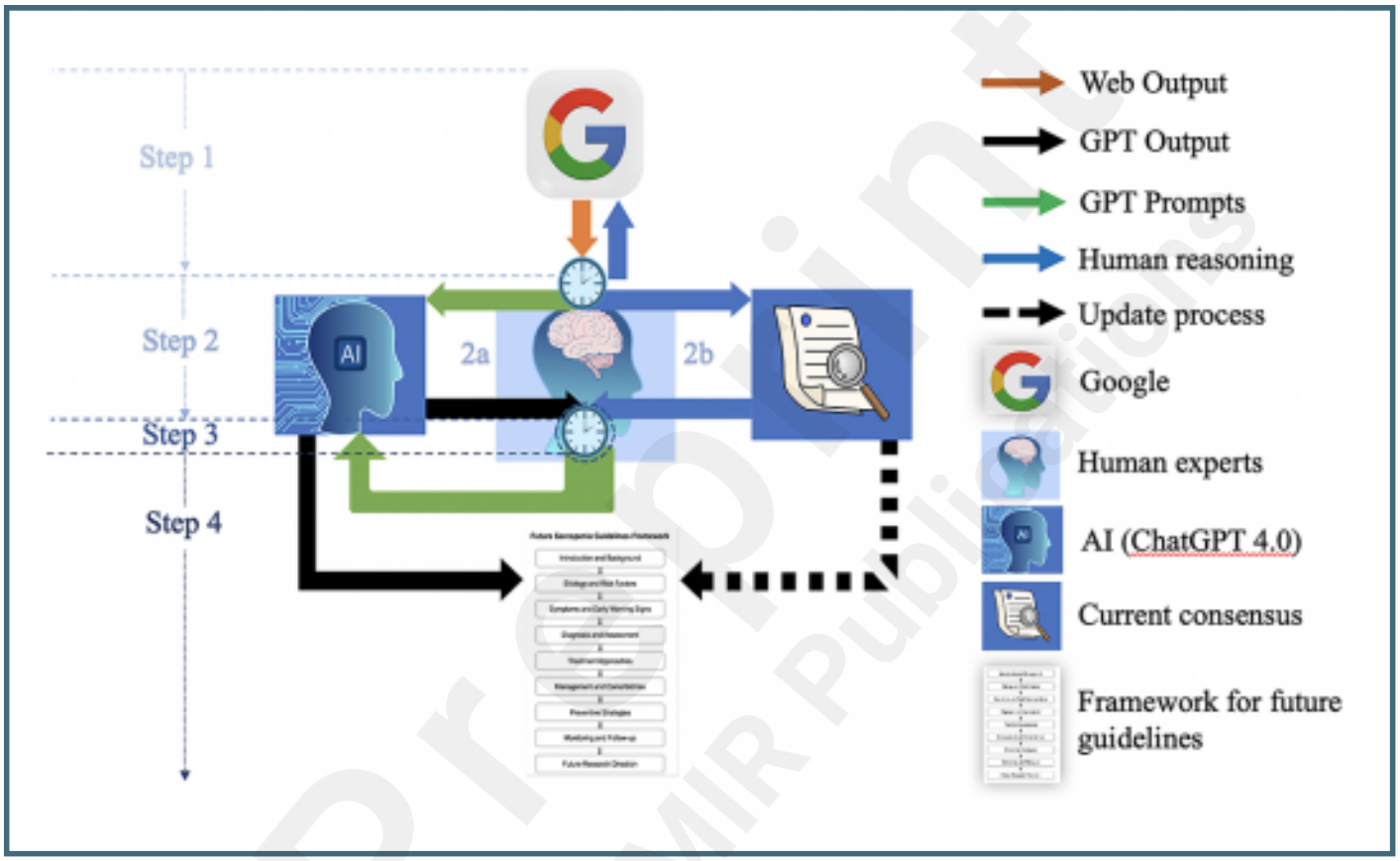
Figure 2: The figure illustrates the varying coverage of key topics (left side) across the main consensus on sarcopenia (right side). Wider arrows indicate a stronger emphasis on the corresponding topics, while narrower arrows indicate limited concern.

Figure 3: A flowchart generated by ChatGPT for a framework of future public-friendly sarcopenia guidelines, integrating insights from ChatGPT, human experts, and public interests.

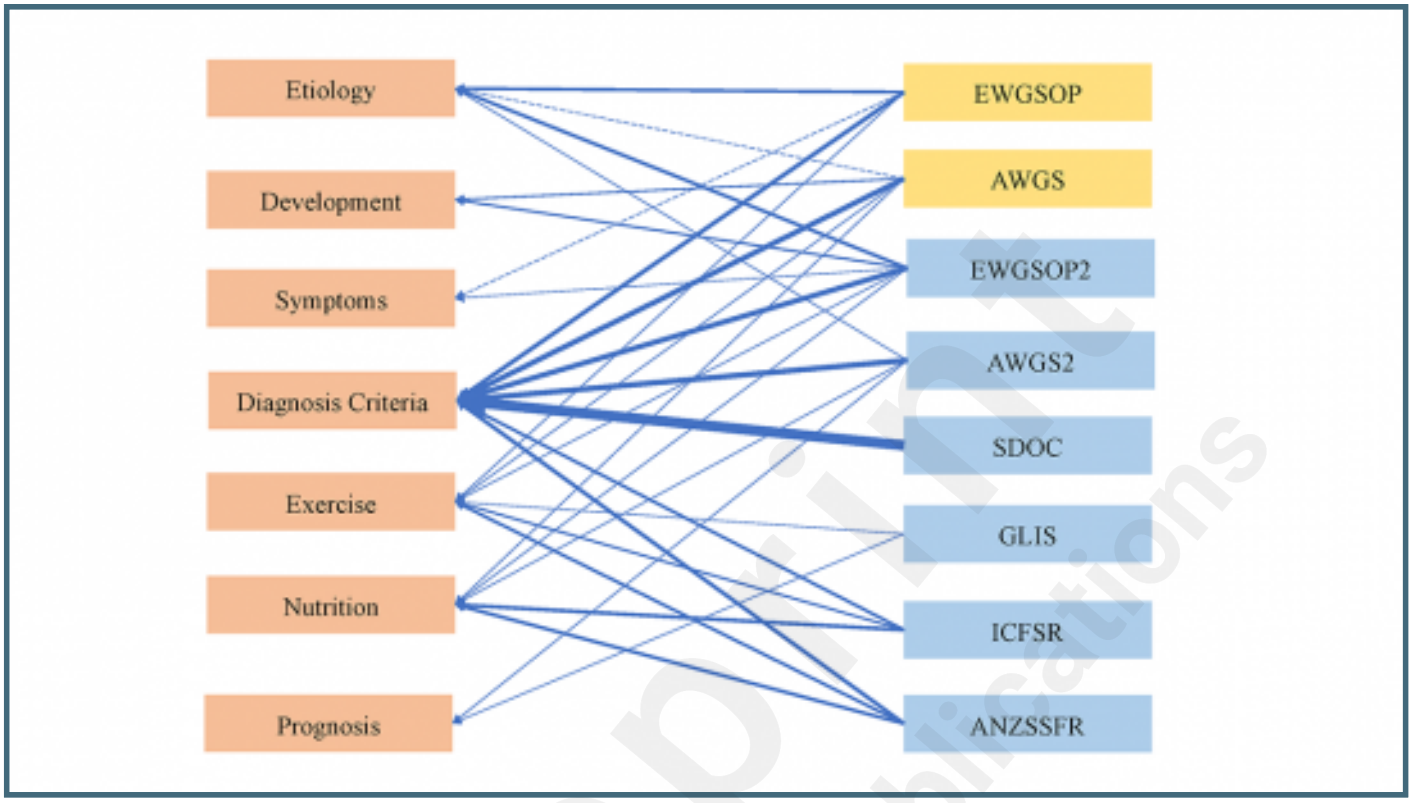
Supplementary Files

Figures

The figure illustrates a model for developing a framework for future sarcopenia guidelines by integrating public inquiries, AI (ChatGPT), and expert reasoning. The process begins with sarcopenia experts inputting search keywords into Google to generate popular questions related to sarcopenia (Step 1). These questions are used as prompts (green arrows) for ChatGPT to generate responses (black arrows) (Step 2a). Sarcopenia experts then review the existing sarcopenia consensus to provide answers to these questions (blue arrows) (Step 2b). The AI-generated responses are compared with the expert-reviewed consensus through human reasoning (clock icon) (Step 3). Finally, the expert insights are input into ChatGPT to generate the framework for future sarcopenia guidelines (Step 4). The dotted arrow represents the ongoing process of updating current guidelines into more public-friendly versions. The time-consuming nature of expert reasoning is symbolized by the clock icon.



The figure illustrates the varying coverage of key topics (left side) across the main consensus on sarcopenia (right side). Wider arrows indicate a stronger emphasis on the corresponding topics, while narrower arrows indicate limited concern.



A flowchart generated by ChatGPT for a framework of future public-friendly sarcopenia guidelines, integrating insights from ChatGPT, human experts, and public interests.