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Prevalence of sarcopenia and its connection with nutritional and functional status in Asian countries: a scoping review

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Abstract

Muscle impairment is a common condition in elderly and a powerful risk factor for disability and mortality. Therefore, this study presents available evidence on the prevalence and its association with nutritional and functional status. An electronic database search on academic journals published from 2015 to 2020 was conducted using PubMed, Google Scholar, and Medscape. A total of 20 studies with 36,739 participants were identified and included in this review. The age range was 55 years and older. The overall prevalence of sarcopenia is in a range of 5.4% to 80.1%. The prevalence among Asian populations is in the range of 6.8% to 80.1%. Prevalence of sarcopenia was reported to be the highest in health care centre (5.4% to 80.1%), followed by nursing homes (28.8% to 41.4%) and community-dwelling (6.8% to 30%). Most studies reported that low body mass index (<18.5kg/m2) was significantly associated with sarcopenia and a positive association was found between inadequate protein intake (<0.8g/kg BW/day) and sarcopenia. However, sarcopenia was not associated with functional status (ADL). It can be concluded that sarcopenia is highly prevalent in older adults, especially with a low BMI and insufficient protein intake. Decline in functional status was an independent indicator for the presence of sarcopenia.

Keywords: sarcopenia, nutritional status, functional status

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Introduction

Sarcopenia, the age-related loss of skeletal muscle mass and function, is prevalent among older adult, and represents a significant risk factor of disability, falls, mortality, and various other adverse health outcomes in elderly [1]. Sarcopenia is a condition characterized by progressive and generalized loss of skeletal muscle mass and strength [2]. In ageing society, sarcopenia has been valued in countries all over the world.

The prevalence of sarcopenia is rising, which is because of population aging all over the world. Worldwide, the overall estimates of prevalence were 10% in men and 10% in women, respectively. According to World Health Organization (WHO), the number of people around the world aged ≥60 years was estimated at 600 million in the year 2000, a figure that is expected to rise to 1.4 billion by 2030 and 2.1 billion by 2050. Even with a conservative estimate of prevalence, sarcopenia affects >50 million people today and will affect >200 million in the next 40 years [2]. Sarcopenia is both common and associated with serious health consequences in terms of frailty, disability, morbidity, and mortality [3].

An individual's nutritional status is usually a result of multiple factors that interact with each other at various levels. The consumption of adequate amount of food both in terms of quantity and quality is one of the key determinants, which has a significant impact on the nutritional status [4]. Nutritional status represents meeting of human body needs for nutritive and protective substances and the reflection of these in physical, physiological, and biochemical characteristics, functional capability, and health status [5,6].

Functional status is measured by the ability to perform basic and instrumental activities of daily living (ADLs). Basic activities of daily living (BADLs) consist of self-care task, while instrumental activities of daily living (IADLs) allow a person to live independently in a community. Preservation of function and independence is one of the goals of successful aging. Functional decline in and of itself should not be considered a geriatric syndrome but rather an indicator of the negative impact that geriatric syndromes and acute or chronic medical conditions may have on an individual [7].

This review comprehensively focuses on evidence on prevalence of sarcopenia and its association with nutritional status (focuses on body mass index (BMI) and protein intake) and functional status identified in Asian countries (Malaysia, Thailand, Korea, China, Japan, Taiwan, Turkey, and Iran) and other multiple countries (i.e., Africa, Europe, Netherlands, America, and Australia).

Materials and Methods

The present study was design as a scoping review, with the aim of determining the prevalence of sarcopenia, as well as describing the association between body mass index (BMI), protein intake and functional status with the risk of developing sarcopenia. The methodological framework proposed by Arksey and O'Malley (2005) [8] was used to conduct this scoping review, which consists of five stages; (1) identifying the research question; (2) identifying relevant studies; (3) study selection; (4) charting the data; and (5) collating, summarizing, and reporting the results. A flow diagram according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2009) [9] showed the flow of articles from search to its final selection.

Identifying the research questions

The review questions were: (i) What is the prevalence of sarcopenia among elderly in different countries? (ii) What is the nutritional status and functional status of elderly in different countries? (iii) What is the association between nutritional status and functional status with the risk of developing sarcopenia among elderly?

Identifying relevant studies

An electronic search was conducted on the following databases: PubMed, Medscape, and Google Scholar. Relevant research websites such as World Health Organization (WHO) and Centers for disease Control and Prevention (CDC) were considered. This search was limited to academic journals published in the English language, from 2015 to 2020. All types of studies, except systematic reviews or review papers, were included in the research. Titles, abstracts, and keywords for eligibility were examined independently by the researcher. Key terms used in the search for articles are listed in Table 1.

Table 1. Key search terms in scoping review

Key Search Terms
Sarcopenia OR lean mass loss AND prevalence OR incidence AND underweight OR low body mass index AND elderly OR aged people
Sarcopenia OR lean mass loss AND occurrence OR epidemiology AND protein intake OR protein supplementation AND elderly OR older people
Progressive muscle loss OR low muscle quality AND prevalence OR incidence AND overweight OR high body mass index AND elderly OR older people
Progressive muscle loss OR low muscle quality AND occurrence OR epidemiology AND functional status OR physical ability AND elderly OR older people

Study selection

After careful consideration, the reviewed studies were selected if the information about: (i) profile of participants; (ii) prevalence of sarcopenia, or components of sarcopenia; (iii) risk factors or, the association between body mass index or protein intake or functional status with sarcopenia; and (iv) diagnostic algorithm of European Working Group on Sarcopenia (EWGSOP) or Asian Working Group on Sarcopenia (AWGS), were provided.

Charting the data

The country(ies), author(s), year of publication, type(s) and purpose(s) of study, number and age of participants, and findings on prevalence, or association between nutritional status (BMI and protein intake) and functional status with sarcopenia or its components (muscle mass,

muscle strength or muscle performance) are summarized in Table 2.

Collating, summarizing, and reporting the results

Evaluations of the review on prevalence of sarcopenia or its components and their association between nutritional status and functional status are illustrated in Table 2.

Results

A total of 36, 739 titles were identified during the search and 107 abstracts were identified for possible inclusion. As shown in Figure 1, 20 studies were selected and included in this review. Most of the research are cross-sectional studies (15 studies, 80%) with three longitudinal cohort studies (15%) and 1 case control study (5%). The sample size in the studies ranged from 102 to 2,581 participants, aged 55 to 91 years old. This study summarized the prevalence of sarcopenia, nutritional status, functional status, and the association between these variables with sarcopenia as outlined in Table 2.

Prevalence of Sarcopenia

Fourteen (14) studies in this review investigate the prevalence of sarcopenia. The overall prevalence of sarcopenia is in the range of 5.4% to 80.1% [10,11,12,13,14,15,16,17,18,19,20,21,22,25,26]. The sarcopenia prevalence is shown to be in the range of 6.8% to 80.1% among Asian populations, and 5.4% to 41.4% among non-Asian population. Sarcopenia is more prevalent in males than females, where the rate of incidence of sarcopenia in males is in the range of 19.1% to 67.6%, while females within the range of 19.1% to 32.4% [12, 17,21,22].

Healthcare centers recorded the highest rate of sarcopenia incidence, which is in the range of 5.4% to 80.1% [10,12,27,18,19] followed by nursing homes elderly (28.8% to 41.4%) [11,14,20,21,22] and lastly is community dwelling elders, which have shown to be in the range of 6.8% to 30% [13,15,16,17].

Nutritional Status

a) Underweight

Most studies in this review explained the association between body mass index (BMI) and risk of sarcopenia. These studies reported that low BMI or underweight was a predictive of sarcopenia while overweight or high BMI was a protective factor of sarcopenia. The mean BMI of sarcopenic participants was 18.7±2.6kg/m^2 to 24.8±1.9kg/m^2 [11,12,13,14,18,20,22], and the median BMI is 23.3kg/m^2 [16].

b) Protein Intake

Five studies examined the association between protein intake with sarcopenia and its components. Three studies reported that protein intake was positively associated with sarcopenia. Nonetheless, a significant association in both genders was found in only one study [24]. The median protein intake of 15% of total protein density or more than 0.8g/kg body weight/day was associated with decreased risk of having low muscle mass among participants.

c) Functional Status

The association between functional status and risk of sarcopenia was observed in three of the reviewed studies. Study by Maeda *et al*. showed that mobility limitation was an independent indicator of sarcopenia and a decrease in appendicular muscle mass, which is one of the components of sarcopenia [27]. The prevalence of sarcopenia in independent walk, walk with help, wheelchair and immobile groups were 57.9%, 76.1%, 89.4% and 91.7%, respectively. Otherwise, Kamo *et al*. concluded that sarcopenia was not associated with activities of daily living (ADL). The Barthel Index score was not significantly lower in participants with sarcopenia compared with those without sarcopenia. The mean Barthel Index score of participants with sarcopenia and without sarcopenia is 38.0 ± 29.7 and 42.8 ± 30.3, respectively [14].

Discussion

Sarcopenia has been one of the most common problems in the elderly population. It is indicative of one of the most important public health issues, as it can worsen the frailty syndrome in older people and result in adverse clinical effects and health status. This scoping review gathered studies on sarcopenia prevalence and examined the relationship between nutritional status and functional status with sarcopenia.

This review uses the Asian Working Group of Sarcopenia (AWGS) and European Working Group for Sarcopenia in Older People (EWGSOP) diagnostic algorithm. It is important to state that the prevalence of sarcopenia differs across different studies due to the differences in diagnostic criteria, measuring instruments used, ethnic characteristics, research populations, and elderly's age groups, genders, dietary regimens, and quality of life [18]. Most of the studies in this review followed the methodology proposed by Asian Working Group of Sarcopenia (AWGS), where muscle mass is measured using Bioelectrical Impedance Analysis (BIA), muscle strength using dynamometer, and muscle performance with a gait speed test.

The latest meta-analysis indicated that the prevalence of sarcopenia was lower in Asian countries compared to non-Asian ones [29]. Nutritional status may have a major impact on the onset and development of sarcopenia. One study finding showed that sarcopenia was associated with poor nutritional status (i.e., low BMI and undesirable MNA results). Low BMI was a major predictor of low skeletal muscle mass index (SMI) and low gait speed (GS), as well as sarcopenia development [18]. This finding was supported by study form Bravo-José et al. (2018) who reported that sarcopenia was inversely associated with BMI [11]. These results were in line with other 11 studies. A study conducted in community-dwelling Chilean elders also found that BMI is negatively associated with sarcopenia. A dose-response was observed in the prevalence of sarcopenia according to nutritional status, exhibiting a negative gradient from underweight to obesity [17].

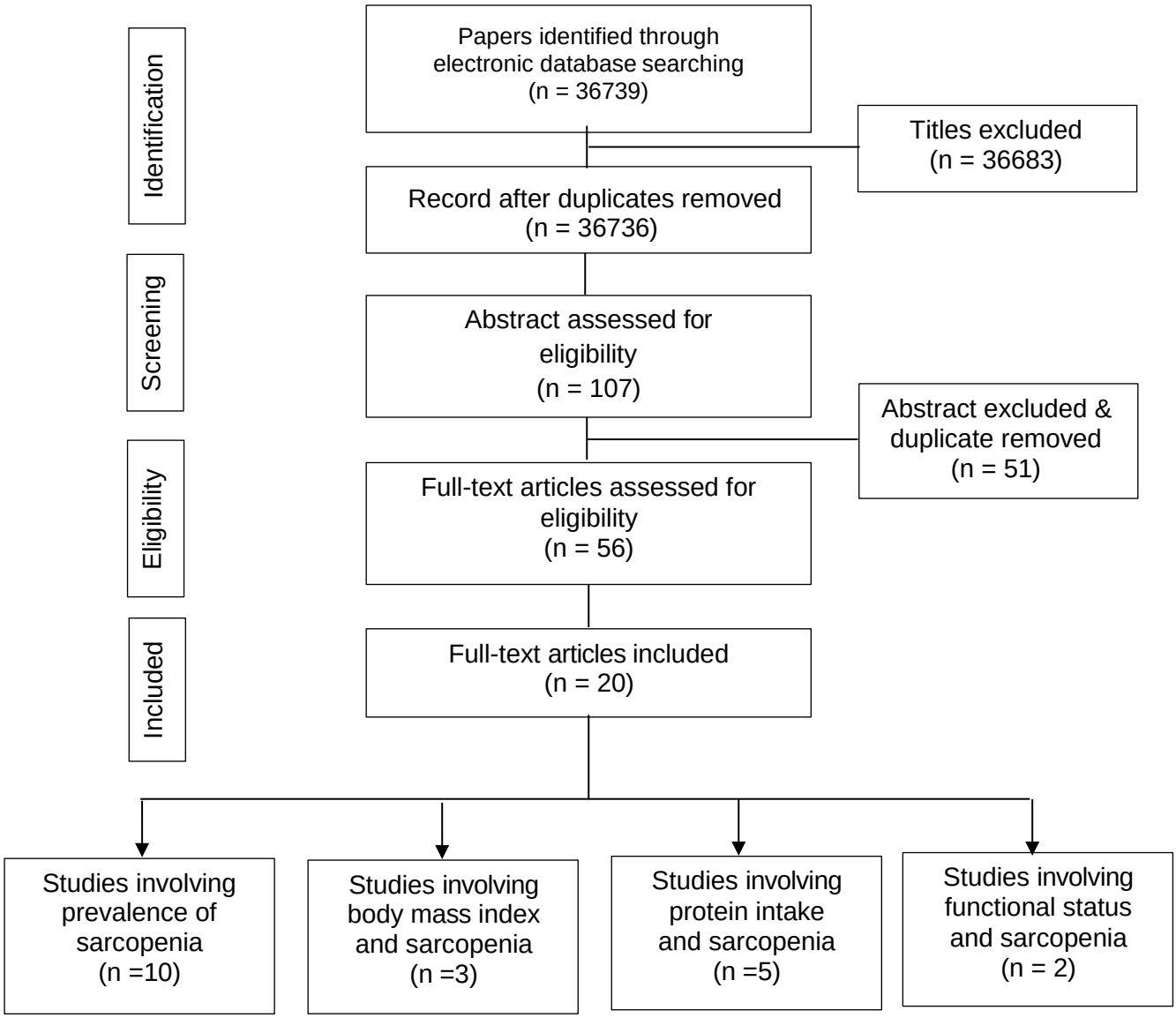

Figure 1. Flow chart of scoping review (based on framework by Arksey & O'Malley, 2005)

Table 2. Prevalence of sarcopenia and its association with nutritional status and functional status

No	Country	Study	Types and Purpose of Study	Participant Characteristics	Diagnostic Algorithm	Prevalence	Nutritional Status/ Functional Status	Results/Findings
1	Malaysia (Asian)	Sazlina *et al* (2020)	Cross-sectional study • To determine the prevalence of sarcopenia and its associated factors among the elderly in public primary care clinics.	Participants; n=506 Aged: ≥ 60 years Mean age: 67.6±6.8 years	Asian Working Group for Sarcopenia (AWGS)	Proportion of elderly with sarcopenia was 28.5%. • Underweight: 91.7% • Normal: 73.1% • Overweight: 30.3% • Obese: 7.3%	Mean BMI: 27.5±8.1 kg/m^2	• Those aged ≥70 years, men and low BMI were associated with sarcopenia. • Lower BMI increased the risk of sarcopenia.
2	China (Asian)	Zhang *et al* (2020)	Longitudinal study • To evaluate risk factors leading to a loss of grip strength, gait speed and skeletal muscle mass index in sarcopenia patients.	Participants; n=560 Aged: ≥60 years	Asian Working Group for Sarcopenia (AWGS)	No findings	Mean BMI; Male: 24.30±3.12 kg/m^2 Female: 24.32±2.85 kg/m^2	• Rates of decreased ASMI, grip strength and gait speed in the sarcopenia patients increased. • A high BMI was a risk factor for a low gait speed but was protective for loss of skeletal muscle mass and sarcopenia.
3	China (Asian)	Cui M *et al* (2020)	Cross-sectional study • To explore metabolic factors sarcopenia.	Participants; n=132 Aged: ≥65 years	Asian Working Group for Sarcopenia (AWGS)	28.8% of participants with sarcopenia • Normal: 53.5% • Overweight: 19.3% • Obese: 3.4%	Mean BMI; Sarcopenia: 22.86±2.71 kg/m^2 Non-sarcopenia: 26.34±3.35 kg/m^2	• BMI and female gender were protective factors for sarcopenia. • With BMI increasing, the prevalence of sarcopenia decreased significantly.

Table 2 continued

No	Country	Study	Types and Purpose of Study	Participant Characteristics	Diagnostic Algorithm	Prevalence	Nutritional Status/ Functional Status	Results/Findings
4	Indonesia (Asian)	Ratmawati *et al* (2020)	Cross-sectional study ● To analyze the intake of leucine as a determinant of muscle strength and gait speed.	Participants; n=132 Aged: 60 – 69 years Men: 25.8% Women: 74.2%	European Working Group on Sarcopenia in Older People (EWGSOP)	No findings	Mean protein intake: 48.2±1.4 g Mean leucine intake: 3,820±1,092 mg	● Intake of leucine was positively correlated with muscle strength and gait speed. ● Protein intake was positively correlated with muscle mass index, muscle strength, and gait speed.
5	Iran (Asian)	Nasimi *et al* (2019)	Cross-sectional study ● To investigate the prevalence of sarcopenia and its factors in older adults	Participants; n=501 Aged: ≥65 years Mean age: 70.35±4.60 years	Asian Working Group for Sarcopenia (AWGS)	Prevalence of sarcopenia • Sarcopenia: 23.6% (male) & 11.8% (female) • Severe sarcopenia: 3.9% (male) and 2% (female)	Mean BMI; Total: 27.2±4.7 kg/m^2 Sarcopenic: 23.1±3.4 kg/m^2 Non-sarcopenic: 28.3±4.4 kg/m^2	● Older age and low BMI were associated with higher risk of low SMI. ● Old age and low BMI were the risk factors of low GS. ● Older age, male gender and low BMI were associated with a higher risk of sarcopenia.
6	Taiwan (Asian)	Kuo *et al* (2019)	Cross-sectional study • To determine the prevalence of sarcopenia and factors associated with it.	Sarcopenic: 76.7±5.3 years Non-sarcopenic: 73.1±5.4 years	Asian Working Group for Sarcopenia (AWGS)	Prevalence of sarcopenia among subjects was 6.8% • Men: 72% • Women: 51.4%	Median BMI; Sarcopenic: 3.3 kg/m^2 Non-sarcopenic: 24.7 kg/m^2	• Sarcopenic subject were significantly more likely to be men, with lower body weight, BMI and lean body mass.

Table 2 continued

No	Country	Study	Types and Purpose of Study	Participant Characteristics	Diagnostic Algorithm	Prevalence	Nutritional Status/ Functional Status	Results/Findings
7	Korean (Asian)	Kwak *et al* (2019)	Cross-sectional study • To identify sex-specific factors associated with handgrip strength in elderly individuals	Participants; n=2581 Aged: ≥ 65 years	No findings	No findings	Mean BMI (male); Low: 22.9±0.2 kg/m^2 Normal HGS: 23.8±0.1 kg/m^2 Mean BMI (female); Low: 24.0±0.2 kg/m^2 Normal : 24.5±0.1 kg/m^2	• Higher likelihood of low handgrip strength in men and women of older age and lower BMI
8	Japan (Asian)	Otsuka *et al* (2019)	Prospective cohort study • To examine association between protein intake per day and at different meals and skeletal muscle mass declines	Participants; n=655 Aged: 60 – 87 years	Asian Working Group for Sarcopenia (AWGS)	Skeletal muscle mass decline after approximately 2 years was 7.2% in men and 5.8% in women.	Mean protein intake; Men:86.7±17.4 g/day Women:71.0±13.4 g/day	• Greater total protein intake was associated with lower prevalence of skeletal muscle mass decline among men at follow-up. • No significant association between total protein intake and prevalence of skeletal muscle mass decline was found among women.

Table 2 continued

No	Country	Study	Types & Purpose of Study	Participant Characteristic	Diagnostic Algorithm	Prevalence	Nutritional Status/ Functional Status	Results/Findings
9	China (Asian)	Yang *et al* (2019)	Case-control study • To investigate the factors associated with sarcopenia and the association with nutrition physical exercise	Participants; n=316 from three nursing homes Aged: ≥ 60 years	Asian Working Group for Sarcopenia (AWGS)	Prevalence of sarcopenia was 28.8% • 30.4% for men • 27.9% for women	Mean BMI; Control: 24.28±3.72 kg/m^2 Sarcopenia: 22.23±3.48 kg/m^2	• There is a positive correlation with the prevalence of sarcopenia and age, and a negative correlation between BMI and consumption of meat, eggs and milk.
10	Nigeria (Africa)	Adebusoye *et al* (2018)	Cross-sectional study • To determine the prevalence and factors associated with sarcopenia at a geriatric centre.	Respondents; n=642 Aged: ≥ 60 years Mean age: 69.1±7.2 Male: 39.4% Female: 60.6%	European Working Group on Sarcopenia in Older People (EWGSOP)	Point prevalence of sarcopenia was 5.4%	No findings	• Prevalence of sarcopenia was significantly higher among females compared with males (7.1% vs 2.8%). • Age, having no formal education and female gender to be predictors of sarcopenia.
11	Spain (Europe)	Bravo- José *et al* (2018)	Cross-sectional study • To establish the prevalence of sarcopenia using EWGSOP defined criteria in institutionalized older adult patients	Participants; n=285 Aged: ≥ 80 years Male: 30.2% Female: 69.8%	European Working Group on Sarcopenia in Older People (EWGSOP)	• 41.4% with sarcopenia • 27% moderate sarcopenia • 66% severe sarcopenia patients <22 kg/m^2: 35.6% >22 kg/m^2: 64.4%	Mean BMI; Sarcopenic: 23.57±4.15 kg/m^2 Non-sarcopenic: 27.61±4.91 kg/m^2 Mean ADL (BI score)*; Sarcopenic40.93±35.9 Non-sarcopenic: 49.22±32.68	• Sarcopenic patients tended to be more functionally impaired and had more unfavorable BMI. • Those older than 85 years old, female gender and low BMI appeared to be associated with sarcopenia.

Table 2 continued

No	Country	Study	Types & Purpose of Study	Participant Characteristic	Diagnostic Algorithm	Prevalence	Nutritional Status/ Functional Status	Results/Findings
12	Amsterdam (Netherland)	Hoekman *et al* (2018)	Cross-sectional study • To determine whether the amount of dietary protein and its distribution throughout the day is associated with muscle mass and muscle strength	Participants; n=220 Aged: 55 – 91 years Mean age: 72.1±6.5 years	No findings	No findings	Mean relative protein intake: 1.7±0.3 g/kg BW Mean absolute protein intake: 77.1±20.8 g	• Association of dietary protein intake (g/kg BW) and protein distribution with skeletal muscle mass index and handgrip strength were found, but they are not significant. • Appendicular lean mass (ALM), body mass index (BMI) and were important confounders that influence these associations.
13	Japan (Asian)	Kamo *et al* (2018)	Cross-sectional study • To investigate the association between sarcopenia and ADL in nursing home residents	Participants; n=276 Mean age: 86.4±7.7 years	Asian Working Group for Sarcopenia (AWGS)	Prevalence of sarcopenia was 45.2%	Mean BI* score; Sarcopenic: 38.0±29.7 Non-sarcopenic: 42.8±30.3 Mean BMI; Sarcopenia: 18.7±2.6 kg/m^2 Non-sarcopenia: 19.1±3.1 kg/m^2	• ADL score was not significantly different between participants with and without sarcopenia. • Sarcopenia was not associated with ADL. Sex and BMI were associated with sarcopenia.

Table 2 continued

No	Country	Study	Types & Purpose of Study	Participant Characteristic	Diagnostic Algorithm	Prevalence	Nutritional Status/ Functional Status	Results/Findings
14	Thailand (Asian)	Khongsri *et al* (2016)	Cross-sectional study • To determine the prevalence of sarcopenia and related factors.	Subjects; n=243 Aged: ≥ 60 years Mean age: 69.7±6.9 Male: 25.5% Female: 74.5 %	Asian Working Group for Sarcopenia (AWGS)	Prevalence of sarcopenia was 30% • Underweight: 18.9% • Normal: 48.7% • Overweight: 32.4%	Body mass index; Underweight (<18.5 kg/m^2): 8.6% Normal (18.5-23.0 kg/m^2): 31.7% Overweight (>23.0 kg/m^2): 59.7%	• Higher prevalence with increasing age among both genders. • Age and BMI were significantly related to sarcopenia.
15	Chile (America)	Lera *et al* (2016)	Cross-sectional study • To determine the prevalence of sarcopenia and its relationship with age, gender, and BMI	Participants; n=1006 Mean age; Men: 67.7±5.7 years Women:67.6±6.0 years	European Working Group on Sarcopenia in Older People (EWGSOP)	Prevalence of sarcopenia was 19.1%, similar in men (19.4%) and women (18.9%)	Mean BMI: 28.7±5.1 kg/m^2 Men: 27.8±4.5 kg/m^2 Women: 29.2±5.4 kg/m^2	• Sarcopenia was negatively associated with overweight and obesity. • Underweight was associated with higher risk of sarcopenia.
16	China (Asian)	Han *et al* (2016)	Prospective cohort study • To examine the incidence of sarcopenia and its associated factors.	Participants; n=356 Aged: ≥60 years Mean age;	Asian Working Group for Sarcopenia (AWGS)	Prevalence of sarcopenia was 10.4% after one year • Male: 7.7% • Female: 92.3%	Mean BMI; Sarcopenia: 23.37±3.93 kg/m^2 Non-sarcopenic: 25.99±3.39 kg/m^2	• It was found that the • Incidence of sarcopenia increased with age, and high BMI is associated with less incidence of sarcopenia.

Table 2 continued

No	Country	Study	Types & Purpose of Study	Participant Characteristic	Diagnostic Algorithm	Prevalence	Nutritional Status/ Functional Status	Results/Findings
17	Taiwan (Asian)	Huang *et al* (2016)	Cross-sectional study • To investigate whether pre- sarcopenia was associated with low protein intake	Participants; n=327 community-dwelling elderly people	European Working Group on Sarcopenia in Older People (EWGSOP)	No findings	Total protein density; Low MM:14.5±2.9 % Normal MM: 15.5±3.1 %	• Estimated skeletal muscle mass index increased significantly across the quartiles of total protein density.
18	Japan (Asian)	Maeda *et al* (2016)	Cross-sectional study • To explore the prevalence of sarcopenia and the impact of ambulatory status on sarcopenia	Participants; n=778 Aged: ≥65 years Mean age: 83.2±8.3 years	Asian Working Group for Sarcopenia (AWGS)	The prevalence of sarcopenia was 80.1%. Independent walk, walk with help, wheelchair and immobile groups was 57.9%, 76.1%, 89.4% and 91.7%	Mean BMI; Independent: 21.6±3.5 kg/m^2 Walk with help: 21.1±3.6 kg/m^2 Wheelchair: 20.5±3.3 kg/m^2 Immobile: 19.8±3.7 kg/m^2	• Mobility limitation was associated with higher age and underweight body mass index. • Appendicular muscle mass index (AMI) and handgrip strength (HGS) gradually decreased with declining ambulatory status.
19	Australia	Senior *et al* (2015)	Cross-sectional study • To evaluate the prevalence and risk factors of sarcopenia among older residential aged care adults	Participants; n=102 older people in 11 long-term nursing homes Mean age: 84.5±8.2	European Working Group on Sarcopenia in Older People (EWGSOP)	42% participants were sarcopenic, 95% of whom were categorized as having severe sarcopenia • Male: 48.4% • Female: 36.6%	Mean BMI; Male: 26±4.4 kg/m^2 Female:28±6.1kg/m^2 Mean BMI; Sarcopenic: 24.8±1.9kg/m^2 Non-sarcopenic: 29.0±4.8kg/m^2	• Univariate logistic regression found that BMI, low physical performance, and nutritional status were predictive of sarcopenia. • With multivariate logistic regression, only low BMI remained predictive.

Table 2 continued

No	Country	Study	Types & Purpose of Study	Participant Characteristic	Diagnostic Algorithm	Prevalence	Nutritional Status/ Functional Status	Results/Findings
20	Turkey (Asian)	Tasar *et al* (2015)	Cross-sectional study • To investigate the prevalence of sarcopenia and its influencing factors in the local elderly nursing home residents	Participants; n=211 Men: 41.2% Women: 58.8%	European Working Group on Sarcopenia in Older People (EWGSOP)	Prevalence of sarcopenia was 33.6%. Severely dependent: 1.4% Moderately: 9.9% Slightly dependent: 21.1% Completely independent: 67.6%	Mean Barthel Index* score: 95.47±10.60 Functional status by Barthel Index category; Completely independent: 63.5% Slightly dependent: 23.7% Moderately: 10% Severely: 2.8%	• The relationship between gender and walking speed was statistically significant. • Sarcopenia was more prevalent in men and young-old and seen less in obese patient. • No relationship was found between the BI and sarcopenia.

*Barthel Index is a scale that measures functional independence in the domain of personal care and mobility, especially in rehabilitation setting. Higher scores indicating higher levels of independency [32].

Abbreviations:
ADL: Activities of daily living
ASMI: Appendicular skeletal muscle mass index
BMI: Body mass index
BI: Barthel Index
GS: Gait speed
HGS: Handgrip strength
MM: Muscle mass
SMI: Skeletal muscle mass index

In the study of Zhang *et al*. (2020), it is stated that there is a significant positive association between BMI and appendicular skeletal muscle mass index (ASMI), and BMI is inversely associated with the incidence of sarcopenia in Asians and Caucasians. This finding is in agreement with previous study performed in the elderly population of China. It was pointed out that fat mass may have several age-related effects on lean mass, and people with higher fat mass may have a higher protein intake, which is a protective factor against sarcopenia. Thus, this study postulated that higher BMI may serve as a protective buffer which help in mitigating declines in muscle performance of older adults [13,34].

Protein intake is a major risk factor of sarcopenia. To counter sarcopenia, strategies focused on providing adequate high-quality dietary protein are required [31]. Nutritional replenishment of protein (raw material for muscle mass) and sufficient energy intake (source of muscle strength) are essential for preventing sarcopenia. In other words, the daily intake of adequate amounts of nutrients is important for maintaining and increasing skeletal muscle [28]. The Society for Sarcopenia, Cachexia and Wasting Disease recommend that the level of protein intake be 1.0 to 1.5 g protein/kg body weight/day to prevent and mitigate sarcopenia [24]. In addition, the International PROT-AGE study group recommended the same amount of protein for individuals older than 65 years with or without disease. In order to help older adults, sustain muscle strength and function into older age, the European Society for Clinical Nutrition and Metabolism (ESPEN) has come out with the protein recommendations by Cruz-Jentoft et al. (2010), where for healthy older adult, the diet should provide at least 1.0 to 1.2 g protein/kg body weight/day [2,23].

A study conducted in Taiwan demonstrated that the healthy elderly participants with the lowest mean intake of total protein density had a threefold risk of low muscle mass compared with those with the highest mean intake of total protein density. Participants who took larger protein intake had a greater skeletal muscle mass. Few interventional studies have shown that a sufficient intake of protein could prevent lean mass loss [24].

The same results were also reported by Ratmawati *et al*. (2020), where they found that protein intake was positively correlated with muscle mass index, muscle strength and gait speed in the community-dwelling elderly. These findings were supported by Deutz *et al*. (2014), who stated that if the daily protein intake unable to meet the increase in protein requirement of older adult to maintain muscle function, negative nitrogen balance will occur, and protein levels, particularly skeletal muscle protein, decrease. Thus, the habit of eating the right amount of protein will help in minimizing muscle loss and prevent sarcopenia in elderly [23,33].

Sarcopenia was associated with activities of daily living (ADL) in people with disability and in patients in geriatric outpatient and geriatric health services facilities, although the association of sarcopenia with ADLs in rehabilitation settings remains unclear [30]. According to one study in Japan, appendicular muscle mass index (AMI) and handgrip strength (HGS) slowly decreased with declining ambulatory status in both genders. Sarcopenia was increased significantly in dependent ambulatory status. This study demonstrated that dependent ambulatory status constitutes an independent risk factor for sarcopenia [27].

However, a cross-sectional study on the prevalence of sarcopenia and its association with activities of daily living (ADL) showed that sarcopenia was not associated with the overall ability to engage in ADL in nursing homes residents and hospitalized geriatric patients [14]. This presents study stated that a decrease in muscle mass does not impede individual's ability to perform ADL. Conversely, a study that is conducted in Japan found that ADLs and dysphagia were independently associated with sarcopenia in both genders, nevertheless these association were weak [30]. Therefore, sarcopenia appears to be a major cause of ADL limitations in patients with musculoskeletal diseases and hospitalized-associated conditioning. A study carried out in Spain supported this finding. They found that activities of daily living (Barthel score) were significantly lower in patients with sarcopenia [11].

Finally, the shortcoming of this scoping review is there was scarce study conducted in Asian countries on the prevalence rates of sarcopenia and the association between nutritional status and functional status with risk of sarcopenia. Therefore, it is necessary for future collaborative research to give attention to the overall prevalence rates of sarcopenia and proper intervention to combat the issues.

Conclusion

In conclusion, this scoping review study provides a subjective summary of the association between nutritional status and functional status with the risk of developing sarcopenia. Overall findings from this review suggests that being underweight, lack of adequate protein intake and gender differences were strongly associated with the development of sarcopenia. Modifiable risk factors such as body mass index and protein intake should be addressed in elderly. Due to the dire health consequences of sarcopenia and future outcomes in the elderly population, appropriate nutritional assessment and interventions may be the key strategies for the prevention and management of this disorder in aged population.

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