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PREVALENCE AND RISK FACTORS ASSOCIATED WITH SARCOPENIA IN ELDERLY PATIENTS: A SYSTEMATIC REVIEW

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ABSTRACT

Sarcopenia is a prevalent disease in the elderly population and is associated with numerous adverse clinical outcomes, directly influencing on the individual's quality of life. This systematic review describes the prevalence and risk factors associated with sarcopenia in elderly patients. The review was made from a search in the databases LILACS, SciELO, CINAHL, and PubMed. We included articles published in Portuguese, English, Spanish and French, of any period of time, consideringcross-sectional or longitudinal research method, which had included more than 50 elderly subjects,and could be found in full version; as well as made use of association measures based on ratio (Odds Ratio or Relative Risk).The search resulted in 669 articles, of which 49met the inclusion criteria. The studies dated from 2003 to 2018 and the European Working Group on Sarcopenia in Older People was the most widely used assessment measure. Most of them were cross-sectional studies. The total sample consisted of 109,601 individuals, and the prevalence of sarcopenia ranged from 9.3% to 68.9%.In conclusion, the main risk factors for sarcopenia refer to aging (longevity), low body mass index, comorbidities, vitamin D deficiency, and low bone density, as well as falls.

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INTRODUCTION

Sarcopenia is a Greek term that means loss of flesh. The word was first used in 1988, referring to the loss of muscle mass and to the adverse outcomes that it could cause, such as changes in mobility, general nutrient intake, independence, and breathing[1]. In the last ten years, the number of publications on this subject has increased exponentially. The prevalence of sarcopenia varies directly with the increase of age and is heterogeneous across countries. In Brazil, for example, it varies from 5.3%[2]to 16.1%[3]; in Japan, from 13.4% to 14.9%[4]; in Belgium, it is of 13.6%[5]; and, in The United States, it varies from35.4% to 75.5%[6].Sarcopenia is associated with several negative clinical outcomes and has a direct influence on the individual's quality of life. It is globally recognized by definition proposed in the last consensus of the European Working Group on Sarcopenia in Older People (EWGSOP), which conceptualizes sarcopenia as a muscular disease due to adverse muscular changes that accrue over a lifetime[7]. It is characterized by the mandatory criterion of reduction of strength and muscular mass, considered severe when there is poor physical performance[7].Among the risk factors that involve the syndrome, the following stand out: elderly people[8,9], lower body mass index (BMI)[8,10], smokers[8], lowerbone mineral density parameters[8,10], low level of physical activity[8]. Besides, malnutrition, especially in women[9]; insulin resistance[10]; decreased glomerular filtration rate, and grade 3 chronic renal injury[10].We highlight protective factors that are

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related to the lower occurrence of sarcopenia in old age, such as black race[8]; high levels of triglycerides in men[9]; increased 1ng/ml IGF-1 (insulin-like growth factor-1) associated with 1% decline in sarcopenia in women in multiple regression models[9]; increase of 1kg/m^2 in unit of BMI related to risk reduction of 0.46, measured in *odds ratio*[10].The consequences of sarcopenia are already well known and refer to functional decline, physical incapacity[5,11,12], falls, fracture, hospitalization, increased length of hospital stay[11], institutionalization[5,12], and mortality[5,11,12].Prevalence is considered the first step in planning health strategies for the elderly population[13]. Thus, knowledge about the associated risk factors is essential to avoid negative health outcomes, such as decline and functional disability, institutionalization, and death[11]. Therefore, the emphasis on the value of performing this review aims to describe the prevalence and risk factors associated with sarcopenia in the elderly.

MATERIALS AND METHODS

This is a systematic review whose protocol is registered in the International Prospective Register of Systematic Reviews (PROSPERO) under the number CRD42019112813. This review answered the following guiding question: What is the prevalence and risk factors associated with sarcopenia in the elderly? The review followed eight stages of elaboration and construction[14].

Elaboration of the research question: The question is related to the PICOS anagram and is the basis for the success of the other steps[14]. In the case of this study: P (Population- aged> 60 years); I (Intervention- risk factors for sarcopenia); C (Comparison- no comparison); O (Outcomes- contribute to possible clinical interventions with this public and to prevent this outcome); S (Type of study- cohort and cross-sectional).

Literature search: The articles selection occurred in the databases LILACS, SciELO, CINAHL, PubMed. Descriptors were defined using DeCS (Health Sciences Descriptors) and MeSH (Medical Subject Heading Term). For the CINAHL database, the titles of the database were used to choose the search terms. Keywords have also been used, i.e., terms not standardized by existing lexis. The collection period was July 2018. In total, 669 references were retrieved. In LILACS, using the descriptor Sarcopenia [Subject descriptor], on 09/17/2018 at 21:51, 46 references were retrieved. In SciELO, with the descriptor #1 Sarcopenia, on 09/17/2018, at 22:07, 151 references were retrieved. In CINAHL, with the search strategy "sarcopenia AND risk factors AND prevalence", on September 22, 2018, at 12:30, 71 references were found. In PubMed, with the search strategy ("Risk Factors" OR "Epidemiologic Factors" OR "Prevalence" AND "sarcopenia") AND "sarcopenic", on 09/22/2018 at 15:06, we found 401 references.

Articles Selection: Two different people made the selection independently; and, when necessary, a third person was involved, in order to avoid selection bias[15].The inclusion criteria were: articles published in Portuguese, English, Spanish and French, cross-sectional or longitudinal research method articles, articles that had included more than 50 elderly subjects, full articles portraying the theme: risk factors associated with sarcopenia in the elderly, papers that used association measures based on ratio (Odds Ratio or Relative Risk), and articles published and indexed in the referred databases at any period of time. We did not include thesis or dissertations, review articles, case studies, reflection and experiences, annals, surveys that were conducted directly and only with professionals, managers or institutions, studies that used clinical trial, case-control or experimental study with animals as a research method. In addition, we excluded research with hospitalized elderly or residents of long-term institutions, with sarcopenic obesity, osteosarcopenia, and sarcopenic dysphagia, as well as those framed in specific groups of diseases, for example: elderly people with sexually transmitted infections, neurological, renal, endocrine, malignant, inflammatory, autoimmune and multisystem diseases. The reason for the exclusion of the elderly patients with multiple comorbidities refers to complications of the clinical condition itself, which may interfere with sarcopenia, and vice versa. The entire process of inclusion and exclusion of articles was recorded in a Microsoft Excel software version 2010 worksheet, in which it was possible to perform a quantitative analysis of the study selection criteria and to remove duplicates. In case there was still doubt about the inclusion of evidence, the evaluation was done together and, the authors would decide through consensus.

Data collection: In this study, data were collected in the database, author's name, article title, year of publication, objective, type of study, sarcopenia classification, data on risk factors and protection, and regression models.

Evaluation of methodological quality: To evaluate the quality of cross-sectional studies, we used an adaptation of the Newcastle-Ottawa Scale, which contains three domains that refer to selection (with four items), comparability (with one item) and results (with two items)[16]. This scale has its own classification, which is represented by stars; being at most five stars in the first domain, two stars in the second domain, and three in the third domain. Very good studies are considered those that contemplate of 9 to 10 points, good from 7 to 8 points, satisfactory from 5 to 6 points; and unsatisfactory from 0 to 4 points[17]. To evaluate the cohort studies, we also used the Newcastle-Ottawa Scale[16], which consists of three main domains: selection (four items), comparability (one item) and evaluation of the result (three items). The classification includes four stars in the first domain; two stars in the second domain; and three in the third domain. In the case of Newcastle-Ottawa Scale for cohort studies, good quality is considered when presenting 3 or 4 stars in the selection domain and 1 or 2 stars in the comparability domain and 2 or 3 stars in the outcome/exposure domain; reasonable quality when stars in the domain of selection and 1 or 2 stars in the domain of comparability and 2 or 3 stars in the domain of outcome/exposure; and poor quality when 0 or 1 star in the selection domain or 0 stars in the comparability domain or 0 or 1 star in the result/exposure domain[16].The studies were classified regarding quality; however, this factor was not an exclusion factor. We developed another spreadsheet in Excel to organize the data on the quality of the studies and charts/tables separating the cohort and cross-sectional studies.

Data synthesis: We detailed each evidence that compiled the review, identifying their main characteristics. Results and statistical analyses of the studies were exposed and compared.

Evaluation of the quality of evidence: The evaluation of the quality of this review was performed by the AMSTAR (a Measurement Tool to Assess Systematic Reviews), which contains questions about search adequacy, selection, extraction, data analysis, and other procedures[18].

Drafting and Results publication: We used the PRISMA tool was used (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) to develop the review. This tool consists of a flowchart to organize the steps that were followed to select the studies and a checklist with 27 questions about items that should be included in systematic reviews or meta-analyzes[19]. We organized the results in tables, based on the primary information extracted from the articles.

RESULTS

We found a total of 669 references, of which 620 were not included for the explicit reasons in Figure 1. Thus, 49 studies remained. We did not retrieve any study from the LILACS database. In the Scielo database, there were seven studies. In the CINAHL, we found 11. In PubMed, there were 31. We emphasize that a study of the CINAHL database met the inclusion criteria, but it was related to data precise to the Korean culture[20], which is beyond the scope of this review; therefore it was excluded.

Characteristics of the studies included: We selected seven studies in the SciELO database and eleven in the CINAHL, which occurred between 2003 and 2018; of those, 71.4% (five) were carried out in Brazil (Table 1). The majority of studies were cross-sectional (88.8%). It is noteworthy that one study was performed at an outpatient clinic[27]. The most widely used measurement (50%) for sarcopenia classification was the EWGSOP (European algorithm of the European Working Group on Sarcopenia in Older People), launched in 2010, which considered muscle mass as the main factor for sarcopenia classification[21]. We know, nowadays, that the first criterion to be considered in the evaluation of sarcopenia is muscle strength[7].At the PubMed database, 26 (83.8%) cross-sectional studies and five (16.2%) cohort or longitudinal studies were found; the highest publication years were 2017 (26.9%) and 2015 (26.9%) (Table 2). The main measure used to classify sarcopenia was the European algorithm (35.5%)[21], followed by the Asian group criterion (16.2%)[42]. Two studies, among the 31 read, are Brazilian[8,44]. Three studies were performed in an outpatient clinic[45-47].Regarding the studies found in the Scielo database, the prevalence of sarcopenia ranged from 9.3% to 41.1%. The main risk factors were male, age ≥75 years, low weight, dependence, physical inactivity, hospital admission. The only finding of a protective factor for sarcopenia was related to the caloric loss resulting from the weekly practice of walking. The total sample consisted of 2,917 individuals (Table 3), with the majority of researches being carried out with elderly men and women (57.2%).In the CINAHL database, the prevalence of sarcopenia ranged from 5.7% to 39.6%, with the participation of 15,110 individuals (Table 3); prevailing studies with elderly men and women (90.9%). The main risk factors for the onset of sarcopenia were: age (≥75 years old), disability, malnutrition, low BMI, lower calf circumference, vitamin D deficiency, smoking, daily alcohol consumption, lack of regular physical activity, worse physical performance, falls and fear of falling. Regarding the protection factors, it is worth noting being black, BMI ≥28kg/m^2, and regular physical activity with energy expenditure ≥1,500 kcal/week (Table 3). One of the studies showed an increased risk of hospitalization (OR: 1.63, 95% CI, 1.08-2.44) and death (OR: 2.12, CI 95%, 1.05% 4.30) due to sarcopenia[31].Table 4 shows that the total sample of the subjects, involved in the surveys of the Pubmed portal, amounted to 91,574. The majority (87.1%) was performed with men and women, with prevalence ranging from 6.6% to 68.9%. Among the risk factors found, those that appeared in more than one article were: aging (longevity), low level of physical activity, diabetes mellitus, dyslipidemia, comorbidities, deficit in self-care and daily life activities, malnutrition, insulin resistance, vitamin D insufficiency, low bone mineral density. Among the protective factors, the most prevalent were: regular physical activity, BMI ≥ 25 kg/m^2, overweight/obesity, balanced diet, higher calf, waist, arm, and pulse circumference values. Curiously, the consumption of one cup of coffee per day was considered a protective factor of sarcopenia in men[54] (Table 4).

Quality assessment: Regarding the quality assessment of the cross-sectional studies (HERZOG *et al.*, 2013) of the Scielo and CINAHL databases, 62.5% obtained a satisfactory concept (that is, 5 to 6 points) and 25% obtained a good concept (i.e., 7 to 8 points). Regarding the PubMed base studies, 46.2% were considered good and 30.8% satisfactory. Only two studies, one from the Scielo database and one from PubMed, were classified as unsatisfactory (that is, from 0 to 4 points). We emphasize that in some studies, the methods were often not adequately described; however, it does not mean that the researches had problems in their designs. Regarding the quality of the cohort studies, all of them classified as good quality, according to the Newcastle-Ottawa tool classification[16]. Finally, the quality of this review complied with 7 of the 11 items advocated by the AMSTAR guide[18]. Among the components, we emphasize we did not contemplate the gray literature; the surveys were not excluded by quality; no homogeneity tests were used (e.g., chi-square test for homogeneity, I²); and there was no combination of graphs and/or statistical tests to evaluate publication bias.

DISCUSSION

Regular aging is associated with a 30% to 50% decline in muscle mass among older men and women of ages 40 to 80 years old due to loss of muscle protein storage and relative increases in body fat[80,81]. This corroborates to a 9% increase in the risk of developing sarcopenia every year after the age of 60.[81].In older people younger than 75 years old, the prevalence of sarcopenia is usually higher in women (OR: 4.81) than in men[37].On the other hand, those who are over 80 years old are the men[37,82]. In the literature, in general, the older man has a higher risk of sarcopenia than the woman[9,38]. In addition, a four-year cohort found that age (OR: 0.90, 95% CI: 0.84-0.96) was the only significant, consistent predictor associated with reversibility of sarcopenia among the different study periods.[75]. The same cohort showed that women were more likely to return to the non-sarcopenia level since they were more health conscious and practiced more physical activity[75].Some researches indicate that women have more sarcopenia than men[4,81,83]. The risk of increased sarcopenia in women is believed to relate to a reduction in the number of neuromuscular junctions and type II muscle fibers, which play an essential role in age-related muscle decline[81]. Also, there is a decrease in hormones necessary for the maintenance of muscle mass, besides the activation of the inflammatory

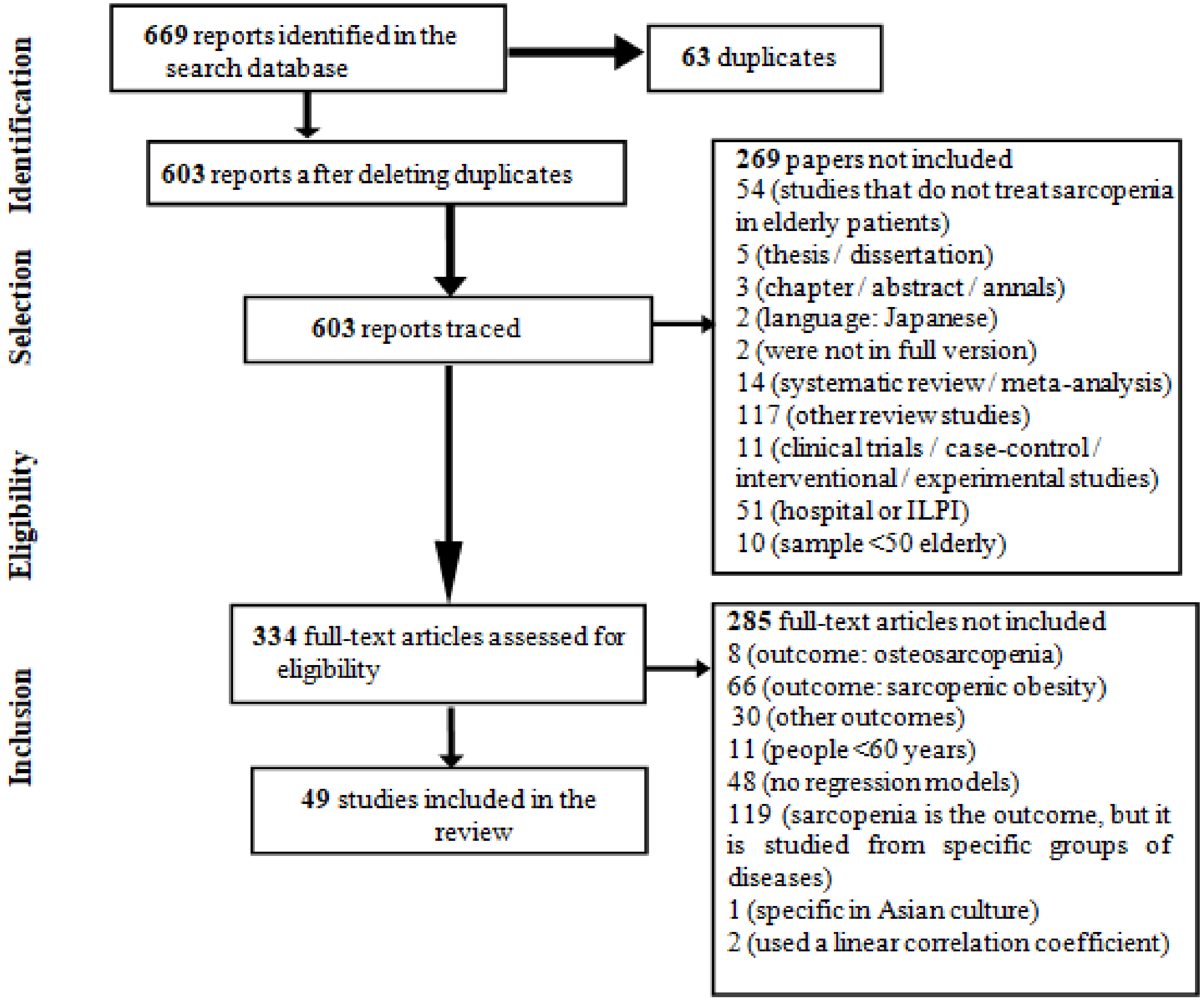

Figure 1. Flowchart showing how the revised articles were identified and selected through the PRISMA strategy (2018)

Table 1. Description of the studies included in the systematic review in the SciELO and CINAHL database, according to authors, year, objective, classification of sarcopenia, type of study, and base/portal. Fortaleza-CE. Brazil. 2018

Authors/Year	Objective	Classification of sarcopenia	Type of study	Base
PELEGRINI *et al*., 2017[22]	To estimate the prevalence and factors associated with sarcopenia in the elderly from a Brazilian capital.	Skeletal muscle mass index (JANSSEN *et al*., 2004)[39]	Cross-sectional	Scielo
CONFORTIN*et al*., 2017[23]	To determine the cutoff points of the anthropometric indicators to track sarcopenia and the association between sarcopenia and these indicators.	Appendicular muscle mass index (BAUMGARTNER *et al*., 1998)[40]	Cross-sectional	Scielo
SANTOS *et al*., 2017[2]	To analyze the association of insufficient physical activity, in different domains, with sarcopenia or sarcopenic obesity in patients aged 50 years and over.	EWGSOPalgorithm(CRUZ-JENTOFT *et al*., 2010)[21] Sarcopenic obesity:BMI ≥25kg/ m^2 + sarcopenia	Cross-sectional	Scielo
PITANGA *et al*., 2015[24]	To analyze the association and discriminatory influence of physical activity to prevent sarcopenia in postmenopausal women.	Skeletal muscle mass index(JANSSEN; HEYMSFIELD; ROSS, 2002)[41]	Cross-sectional	Scielo
DUTRA *et al*., 2015[25]	To identify the prevalence of sarcopenia and associated factors in a population of elderly women living inNortheast Brazil.	EWGSOPalgorithm(CRUZ-JENTOFT *et al*., 2010)[21]	Cross-sectional	Scielo
SANTOS *et al*., 2015[26]	To analyze whether sarcopenia is associated with sociodemographic factors and chronic noncommunicable diseases in adults aged 80 years and over.	Appendicular muscle mass index(BAUMGARTNER *et al*., 1998)[40]	Cross-sectional	Scielo
VELÁZQUEZ ALVA *et al*., 2013[27]	To identify the prevalence of sarcopenia and malnutrition and to evaluate the association between sarcopenia, mobility, and activities of daily living in a group of elderly women.	Skeletal muscle mass index(BAUMGARTNER *et al*., 1998)[40]	Cross-sectional	Scielo
ÖZTÜRK *et al*., 2018[28]	To demonstrate the differences in risk of falls and health-related quality of life among sarcopenic obese, sarcopenic, and obese in the geriatric population.	EWGSOPalgorithm(CRUZ-JENTOFT *et al*., 2010)[21] Sarcopenic obesity:BMI ≥30kg/ m^2 + sarcopenia	Cross-sectional	Cinahl
HASHEMI *et al*., 2016[29]	To investigate the prevalence and factors associated with sarcopenia and severe sarcopenia among the elderly in Iran.	EWGSOPalgorithm(CRUZ-JENTOFT *et al*., 2010)[21]	Cross-sectional	Cinahl
HAN *et al*., 2016a [30]	To estimate the prevalence and factors associated with sarcopenia in China, specifically in peripheric elderly populations.	Asian Working Group for Sarcopenia algorithm (AWGS) (CHEN *et al*., 2014)[42]	Cross-sectional	Cinahl
BIANCHI *et al*., 2016[31]	To explore the predictive value of the diagnostic algorithm of the European Working Group on Sarcopenia in Elderly People (EWGSOP) in terms of disability, hospitalization, and mortality and to analyze the specific role of grip strength and gait speed as diagnostic criteria for sarcopenia.	EWGSOPalgorithm(CRUZ-JENTOFT *et al*., 2010)[21]	Longitudinal	Cinahl
GAO *et al*., 2015[32]	To compare the prevalence of sarcopenia among Chinese urban and rural older people and to identify the risk factors related to sarcopenia.	Asian Working Group for Sarcopeniaalgorithm (AWGS) (CHEN *et al*., 2014)[42]	Cross-sectional	Cinahl
MENG *et al*., 2015[33]	To identify the prevalence and factors associated with sarcopenia in communities in Taichung, Taiwan.	EWGSOPalgorithm(CRUZ-JENTOFT *et al*., 2010)[21] Sarcopenic obesity: BMI ≥25kg/ m^2 + sarcopenia	Cross-sectional	Cinahl
KIM *et al*., 2015[34]	To determine the incidence and predictors of the onset of sarcopenia over four years in older women in the community.	EWGSOPalgorithm(CRUZ-JENTOFT *et al*., 2010)[21]	Cohort	Cinahl
PARK; HAM; LEE, 2014a [35]	To examine whether vitamin D deficiency was positively associated with sarcopenia in adults aged ≥50 years.	Appendicular muscle mass index (JANSSEN *et al*., 2000)[43]	Cross-sectional	Cinahl
VOLPATO *et al*., 2014[36]	To estimate the prevalence and to investigate the clinical correlates of sarcopenia in a sample of Italian elderly living in the community.	EWGSOPalgorithm(CRUZ-JENTOFT *et al*., 2010)[21]	Cross-sectional	Cinahl
YAMADA *et al*., 2013[37]	To assess the prevalence of sarcopenia and examine the association with falls and fear of falling in elderly Japanese residents in the community.	EWGSOPalgorithm(CRUZ-JENTOFT *et al*., 2010)[21]	Cross-sectional	Cinahl
NEWMAN *et al*., 2003[38]	Compare and examine the relationship of two definitions of sarcopenia, physical functioning, and other health-related factors using data from the Health Aging and Body Composition (Health ABC) Study.	Appendicular muscle mass index(BAUMGARTNER *et al*., 1998)[40]	Cross-sectional	Cinahl

Source: designed by the author (2018).

Table 2. Description of the studies included in the systematic review in the Pubmed portal, according to authors, year, objective, sarcopenia classification, study type. Fortaleza-CE Brazil. 2018

Authors/Year	Objective	Sarcopenia classification	Study type
KWON; YOON; LEE., 2018[48]	To evaluate the prevalence of sarcopenic obesity and sarcopenia in healthy Korean women.	Asian Working Group for Sarcopenia algorithm (AWGS) (CHEN *et al*., 2014)[42]	Cross-sectional
DAVIES *et al*., 2018[49]	To assess the coexistence of sarcopenia and frailty in a cohort of older people in the community.	Three criteria:EWGSOP algorithm (CRUZ-JENTOFT *et al*., 2010)[21] Foundation for the National Institutes of Health definition (FNIH) (STUDENSKI *et al*., 2014)[63] Standard FNIH (sFNIH) (WOO; LEUNG, 2016)[64]	Cross-sectional

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KÖNIG *et al*., 2018[50]	To investigate the association of polypharmacy and sarcopenia in a large cohort of elderly residents of the community.	Foundation for the National Institutes of Health definition (FNIH) (STUDENSKI *et al*., 2014)[63]	Cross-sectional
LIM *et al*., 2018[51]	To assess the prevalence of sarcopenia and sarcopenic obesity in elderly Koreans and to analyze the relationship with chronic diseases.	Fourth Korea National Health and Nutrition Examination Survey definition (RYU *et al*., 2013)[65]	Cross-sectional
SUN *et al*., 2017[52]	To investigate the associations between sarcopenia and health-related quality of life of older men and women in Korea.	Appendicular muscle mass index (BAUMGARTNER *et al*., 1998)[40]	Cross-sectional
ROSSI *et al*., 2017[53]	To validate the MSRA (Mini Sarcopenia Risk Assessment) questionnaire as a pre-screening tool for sarcopenia in a population of elderly people in the community.	EWGSOPalgorithm(CRUZ-JENTOFT *et al*., 2010)[21] Mini Sarcopenia Risk Assessment	Cross-sectional
KIM; PARK, 2017[54]	To evaluate the relation between coffee consumption and body composition measurements in Korean adults aged 40 years and over.	Asian Working Group for Sarcopenia algorithm (AWGS) (CHEN *et al*., 2014)[42]	Cross-sectional
LERA *et al*., 2017[55]	To determine the prevalence of sarcopenia in Chilean elderly and its relation with age, gender, and BMI.	EWGSOPalgorithm (CRUZ-JENTOFT *et al*., 2010)[21]	Cross-sectional
TRAMONTANO *et al*., 2017[56]	To evaluate the prevalence of sarcopenia and associated factors in a population of elderly people living in a rural area of the Peruvian Andes.	International Working Group on Sarcopenia definition (IWGS) (FIELDING *et al*., 2011)[66]	Cross-sectional
KILIC *et al*., 2017[45]	Investigate the value of phase angle in the diagnosis of sarcopenia.	EWGSOPalgorithm(CRUZ-JENTOFT *et al*., 2010)[21]	Cross-sectional
BROWN; HARHAY; HARHAY, 2017[57]	To examine whether physical activity and good quality of diet modify the risk of poor outcomes, such as mortality, among elderly patients with sarcopenia.	EWGSOPalgorithm(CRUZ-JENTOFT *et al*., 2010)[21]	Cohort
TYROVOLAS *et al*., 2016[58]	To evaluate the factors associated with low skeletal muscle mass, sarcopenia, and sarcopenic obesity using nationally representative samples of people aged ≥65 years from different geographic regions of the world.	Foundation for the National Institutes of Health definition (FNIH) (STUDENSKI *et al*., 2014)[63]	Cross-sectional
BYEON *et al*., 2016[59]	To assess the relationship between sarcopenia and depression in the Korean population by age group and obesity status.	Special Interest Group definition (SIG) (MUSCARITOLI *et al*., 2010)[67]	Cross-sectional
CHAN; LEUNG; WOO, 2016[60]	To examine the association of eating patterns with sarcopenia in elderly Chinese residents of the community.	Asian Working Group for Sarcopenia algorithm (AWGS) (CHEN *et al*., 2014)[42]	Cohort
BUCHMANN *et al*., 2016[61]	To identify the most appropriate method to diagnose sarcopenia in a cohort of elderly residents in a community of high prevalence of metabolic risk factors and metabolic syndrome.	Two definitions: 1) Appendicular muscle mass index (BAUMGARTNER *et al*., 1998)[40] 2) Sarcopenia parameters by NEWMAN *et al*., 2003[38]	Cross-sectional
BEAUDART *et al*., 2015a [62]	To evaluate the prevalence of sarcopenia and the clinical components related to this geriatric syndrome.	EWGSOPalgorithm(CRUZ-JENTOFT *et al*., 2010)[21]	Cross-sectional
TAY *et al*., 2015[9]	To identify clinical and biological correlates of sarcopenia in a representative cohort of functionally independent elderly in the community with an emphasis on the role of anabolic hormones - insulin-like growth factor-1 (IGF-1) and free testosterone (in men) – and catabolic stimuli(inflammation and myostatin), with particular reference to sexual specificity.	Asian Working Group for Sarcopeniaalgorithm (AWGS)(CHEN *et al*., 2014)[42]	Cohort
BATSIS *et al*., 2015[69]	To apply definitions of the Foundation for the National Institutes of Health in a representative cohort of elderly to verify the prevalence of sarcopenia and sarcopenic obesity.	Foundation for the National Institutes of Health definition (FNIH) (STUDENSKI *et al*., 2014)[63] They used two ways to measure sarcopenia: 1) Appendicular lean mass (men <19.75 kg, women <15.02 kg) 2) Appendicular lean mass divided by BMI (men <0.789kg / m^2, women <0.512kg / m^2)	Cross-sectional
HONG; LEE; KIM, 2015[70]	To study whether gamma-glutamyl transferase is associated with sarcopenia and sarcopenic obesity in the elderly in the community.	Appendicular muscle mass index (JANSSEN; HEYMSFIELD; ROSS, 2002)[41]	Cross-sectional
HUH *et al*., 2015[71]	To determine whether an estimated 24-hour urine sodium excretion values using the Tanaka equation are associated with sarcopenia, obesity, and/or metabolic syndrome in a relatively healthy elderly population of the community.	Definition of sarcopenia as appendicular skeletal muscle mass/weight < 1 mean standard deviation (KIM; CHOI, 2013)[68]	Cross-sectional
WEN *et al*., 2015[72]	To describe the prevalence of sarcopenia and discuss the applicability of different diagnostic criteria in Chinese elderly.	Three definitions: 1) EWGSOPalgorithm(CRUZ-JENTOFT *et al*., 2010)[21] 2) International Working Group on Sarcopenia definition (IWGS) (FIELDING *et al*., 2011)[66] 3) Asian Working Group for Sarcopenia algorithm (AWGS) (CHEN *et al*., 2014)[42]	Cross-sectional
BEAUDART *et al*., 2015b[45]	To evaluate the impact of the use of different diagnostic tools on the estimated prevalence of sarcopenia.	EWGSOPalgorithm(CRUZ-JENTOFT *et al*., 2010)[21]	Cross-sectional
PARK; HAM; LEE, 2014b[73]	To examine whether sarcopenia is positively associated with the prevalence of cardiovascular diseases, including angina pectoris, myocardial infarction, and stroke, in adults of both genders aged ≥50 years.	Appendicular muscle mass index (JANSSEN *et al*., 2000)[43]	Cross-sectional

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BAEK *et al.*, 2014[74]	To investigate the prevalence of sarcopenia and sarcopenic obesity and their association with the risk of dyslipidemia in elderly Koreans.	1) Appendicular skeletal muscle mass / height^2 2) Appendicular skeletal muscle mass/weight x 100 (JANSSEN; HEYMSFIELD; ROSS, 2002)[41]	Cross-sectional
YU *et al.*, 2014[75]	To examine the incidence and reversibility of sarcopenia and its associated factors over 4 years using the criteria of the European Working Group on Sarcopenia in Old People (EWGSOP).	EWGSOPalgorithm (CRUZ-JENTOFT *et al.*, 2010)[21]	Cohort
CHERIN *et al.*, 2014[47]	To evaluate the prevalence of sarcopenia and its association with functional and clinical status in a population of healthy individuals, attended at an outpatient clinic,older than 45 years, in Paris.	EWGSOPalgorithm (CRUZ-JENTOFT *et al.*, 2010)[21]	Cross-sectional
FIGUEIREDO *et al.*, 2014[8]	To analyze the prevalence of sarcopenia and associated risk factors using appendicular skeletal mass (MEA) and height^2 and adjusted MEA for total fat mass criteria in elderly men of the community.	1) Sarcopenia parameters by BAUMGARTNER *et al.*, 1998[40] 2) Sarcopenia parameters by NEWMAN *et al.*, 2003[38]	Longitudinal
RYU *et al.*, 2014[65]	To examine the association of physical activity with sarcopenia and sarcopenic obesity among elderly Korean residents of the community.	Sarcopenia definition by JANSSEN; HEYMSFIELD; ROSS, 2002[41]; KIM *et al.*, 2012[78]	Cross-sectional
LEE *et al.*, 2013[76]	To compare the clinical characteristics of sarcopenia defined by the criteria of the International Working Group on Sarcopenia (IWGS) and the European Working Group on Sarcopenia in Elderly People (EWGSOP) among older people in Taiwan.	1) EWGSOPalgorithm(CRUZ-JENTOFT *et al.*, 2010)[21] 2) International Working Group on Sarcopenia definition (IWGS) (FIELDING *et al.*, 2011)[66] Using two measurement types: Appendicular muscle massindex (BAUMGARTNER *et al.*, 1998)[40] Total skeletal muscle mass (KIM *et al.*, 2002)[79]	Cross-sectional
DOMICIANO *et al.*, 2013[44]	To evaluate the prevalence and risk factors associated with sarcopenia, based on the criterion of appendicular skeletal thin mass / height^2, and lean mass concerning height and total fat mass, among elderly women.	1) Sarcopenia parameters by BAUMGARTNER *et al.*, 1998[40] 2) Sarcopenia parameters by NEWMAN *et al.*, 2003[38]	Cross-sectional
KIM *et al.*, 2011[77]	To investigate whether the vitamin D level is associated with sarcopenia in elderly Koreans.	Special Interest Group definition (SIG) (MUSCARITOLI *et al.*, 2010)[67]	Cross-sectional

Table 3 Relationship between sarcopenia and risk/protection factors, according to the regression models of the included studies of the Scielo and CINAHL database in the systematic review. Fortaleza-CE Brazil. 2018

Authors/Year	n	Gender/Prevalence	Regression model adjusted by	Variable	OR (CI 95%)
PELEGRINI *et al.*, 2017[22]	438	Male and female 33.3%	Adjustment for gender, age group, and nutritional status	Gender (male) Age (≥ 75 years old) Low weight	196.33 (40.05-962.54) 3.73 (1.41-9.91) 5.79 (1.52-21.40)
CONFORTIN*et al.*, 2017[23]	1069	Male and female 9.3%	Adjustment for gender, age, physical activity, smoking, alcohol consumption	Anthropometric indicator (made by BMI cut points, waist/height ratio, and waist circumference).	17.21 (1.50-196.78)
SANTOS *et al.*, 2017[2]	770	Male and female 11.3%	Adjustment for income, age, and hypertension	Insufficient physical activity in free time.	2.63 (1.06-6.49)
PITANGA *et al.*, 2015[24]	257	Female 9.3%	Adjustment for menopause time and regularity of menstrual cycles	Energy expenditure of 816kcal / week on walking.	0.29 (0.10 – 0.83)
DUTRA *et al.*, 2015[25]	173	Female 17.8%	Adjustment by hierarchical model	Age (≥80 years) At least one hospital admission.	4.55 (1.58-13.05) 3.49 (1.37-8.89)
SANTOS *et al.*, 2015[26]	120	Male and female 26.6%	Multiple models with sociodemographic factors Age-adjusted chronic diseases model	Gender (male) Age (≥ 85 years old) Low weight Osteopenia / Osteoporosis	4.32 (1.66-11.23) 5.14 (1.94-13.57) 3.60 (1.30-9.97) 2.82 (1.07-7.38)
VELÁZQUEZ ALVA *et al.*, 2013[27]	90	Female 41.1%	Not adjusted	Intermediate independence or dependence.	3.31 (1.26-8.71)

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ÖZTÜRK *et al*., 2018[28]	423	Male and female 14%	Not adjusted	Sarcopenic obese vs. non-sarcopenic non-obese Vitality Sarcopenicvs. non-sarcopenic non-obese Social functioning Sarcopenicvs. non-sarcopenic non-obese Total body fat index Waist circumference Calf circumference Mini mental (<24 vs. ≥24) Daily activities Geriatric depression scale	 0.96 (0.93-0.992) 1.026 (1.007–1.046) 1.16 (1.03–1.31) 1.62 (1.24–2.11) 1.31 (1.05-1.64) 27.30 (1.65–45) 1.16 (1.04-1.29) 11.01 (1.18-86.25)
HASHEMI *et al*., 2016[29]	300	Male and female 18.3%	Adjustment for dependent variables	Non-sarcopenic x sarcopenic Age (one-year increase) Gender (male)Smoker BMI (increase of 1kg/m^2)	1.08 (1.00-1.16) 2.90 (1.00-8.42) 2.71 (1.21-6.09) 0.46 (0.33-0.64)
HAN *et al*., 2016[a30]	1069	Male and female 9.3%	Adjustment for unclear confounding factors	Male: Age (≥80 years old) BMI (≥28kg/m^2) Diabetes Female: Age (≥80 years old) BMI (≥28kg/m^2) Daily consumption of alcoholic drinks Diabetes Peptic ulcer	 10.18 (2.93-35.29) 0.11 (0.02-0.65) 5.04 (1.70-14.89) 135.74 (27.29-675.15) 0.03 (0.01-0.21) 10.60 (1.75-64.24) 2.36 (1.06-5.25) 5.58 (2.13-14.59)
BIANCHI *et al*., 2016[31]	538	Male and female 10.2%	Adjustment for age, gender, schooling, BMI, comorbidities, hemoglobin	Incapacity	2.50 (1.16-5.39)
GAO *et al*., 2015[32]	612	Male and female 9.8%	Not adjusted	Age Women Malnutrition or risk of malnutrition Rural housing Amount of medicine	1.22 (1.15-1.29) 1.71 (1.20-5.65) 3.53 (1.68-7.41) 2.15 (1.33-4.51) 1.23 (1.06□1.44)
MENG *et al*., 2015[33]	771	Male and female 5.7%	Weight adjustment	Age (≥85 years) Women vs. men Higher BMI Gout History of accidental falls Lack of regular exercise Higher albumin/creatinine ratio	5.67 (2.32-13.84) 2.07 (1.16-3.72) 1.43 (1.30-1.56) 2.46 (1.20-5.05) 2.03 (1.12□3.67) 1.90 (1.06-3.39) 2.03 (1.12□3.68)
KIM *et al*., 2015[34]	538	Female 39.6%	Adjustment for anthropometric and fitness variables, blood components, chronic conditions, and lifestyle variables	Low BMI Greater calf circumference Hyperlipidemia	1.57 (1.35-1.83) 0.83 (0.69-0.98) 1.94 (1.02-3.69)
PARK; HAM; LEE, 2014a[35]	5263	Male and female 7.0%	Adjustment for age, area of residence, BMI, smoking and alcoholism, schooling, regular physical exercise and walking, daily intake of nutrients, use of estrogen and oral pill for women, and blood tests.	Women: Vitamin D deficiency (<15ng / ml) * There was no significant difference for men	 3.64 (1.36-9.77)
VOLPATO *et al*., 2014[36]	730	Male and female 7.5%	Adjustment for age, gender, education, BMI, number of medications, Parkinson's disease, hemoglobin, IGF-I (insulin-like growth factor-1) and bioavailable testosterone.	Increased age Low levels of IGF-1 (insulin-like growth factor-1) Less bioavailability of testosterone Highest level of schooling BMI (≥ 30) Higher hemoglobin level	1.21 (1.14-1.30) 3.89 (1.03-14.6) 2.67 (1.31-5.44) 0.85 (0.74-0.98) 0.37 (0.13-1.03) 0.43 (0.18-1.06)

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YAMADA *et al*., 2013[37]	1882	Male and female 22%	Not adjusted	Women: Age between 65-69 years old Age between 70-74 years old Age between 85-89 years old Falls Fear of falling Men: Falls Fear of falling	 4.81 (1.12□20.55) 2.41 (1.18-4.91) 0.39 (0.17-0.88) 1.45 (1.09-1.93) 5.30 (3.78□7.43) 3.16 (2.04-4.89) 6.23 (4.04-9.60)
NEWMAN *et al*., 2003[38]	2984	Male and female 12%	Adjustment for age, race, drinking, smoking, physical activity, and comorbidity.	Men: Age (≥75 years old) Black BMI Smoking Physical activity (≥1,500 kcal/week) More than three comorbidities Physical performance Women: Age (≥75 years old) Black Smoking Alcoholic beverage> every day Physical activity (≥1,500 kcal/week) More than three comorbidities Physical performance	 1.6(1.2-2.1) 0.2 (0.1-0.3) 0.5 (0.5-0.6) 2.6 (1.5-4.4) 0.7 (0.5-1.0) 1.5 (1.0-2.3) 1.8 (1.3-2.5) 1.1 (0.9-1.5) 0.2 (0.1-0.3) 0.9 (0.6-1.5) 0.9 (0.4-1.8) 0.7 (0.4-1.0) 1.1 (0.7-1.6) 1.9 (1.4-2.5)

Source: designed by the author (2018).

Table 4- Relationship between sarcopenia and risk/protection factors, according to the regression models of included studies of the PubMed portal in the systematic review. Fortaleza-CE Brazil. 2018

Authors/Year	n	Gender/ Prevalence	Regression model adjusted by	Variable	OR (CI 95%)
KWON; YOON; LEE., 2018[48]	2396	Female 22,2%	Not adjusted	BMI (≥25 kg/m^2)	0.14 (0.10-0.18)
DAVIES *et al*., 2018[49]	1611	Male and female EWGSOP-21.8% FNIH- 20.6% Standard FNIH - 28.1%	Adjustment for age, gender, socioeconomic status, lifestyle, and comorbidities.	EWGSOP FNIH Standard FNIH	1.67 (0.95-2.96) 10.61 (5.80-19.40) 6.63 (3.50-12.53)
KÖNIG *et al*., 2018[50]	1502	Male and female 8.8%	Age, gender, low physical activity, hypertension, diabetes, vitamin D deficiency, gastritis / esophageal reflux, hypothyroidism, liver disease (except cirrhosis), atrial fibrillation / deep venous thrombosis / embolism, joint pain / swelling, osteoporosis, coronary artery disease, chronic lung disease, current smoking, hyperuricemia, glomerular filtration rate, LDL cholesterol, C-reactive protein, malignant neoplasms.	Polypharmacy Age Self-report of low level of physical activity Hypertension Diabetes Self-report of pain/swelling in joints Estimated glomerular filtration rate (mL / min / 1.73m^2)	2.24 (1.33-3.75) 1.09 (1.03–1.16) 2.00 (1.08-3.70) 3.28 (1.47–7.33) 3.24 (1.96-5.35) 1.66 (1.05–2.60) 1.02 (1.00-1.04)
LIM *et al*., 2018[51]	3492	Male and female 16.1%	Adjustment for age, gender, appendiceal muscle mass, moderate physical activity, smoking, drink intake, and nutrients.	Diabetes Dyslipidemia	1.24 (0.86-2.15) 1.12 (0.71-1.82)
SUN *et al*., 2017[52]	4937	Male and female 6.6%	Adjustment for age, BMI, total fat mass, smoking and drinking habits, level of physical activity, comorbidities.	Women: Self-care deficit Deficit in usual daily activities Anxiety/depression Men: Self-care deficit	 4.49 (1.53–13.13) 3.16 (1.29–7.73) 2.37 (1.09–5.14) 1.99 (1.01–3.92)
BATSIS *et al*., 2015[69]	4984	Male and female 1) 29.7% 2) 26%	Adjustment for age, race, smoking (current, old, never), diabetes, arthritis, coronary disease.	Physical Limitations (definition of appendicular lean mass / BMI): Men Women	 1.46 (1.10-1.94) 2.13 (1.41-3.20)

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HONG; LEE; KIM, 2015[70]	3193	Male and female 31.8%	Adjustment for age; gender; BMI; physical activity; smoking status; alcohol consumption; level of education; occupation; presence of diabetes, hypertension, coronary heart disease, chronic kidney disease, stroke or any cancer; and triglycerides, HDL cholesterol, alanine aminotransferase, and 25-hydroxyvitamin D levels.	Higher gamma-glutamyl transferase (GGT) values Men Women Age ≥ 65 years old BMI ≥ 25 BMI ≤ 25	2.34 (1.68-3.26) 1.26 (1.01-1.59) 1.51 (1.18-1.90) 1.33 (1.04-1.71) 1.34 (1.09-1.65) 1.34 (1.03-1.74)
HUH *et al*., 2015[71]	7162	Male and female 68.9%	Adjustment for age, height, current smoking, regular physical activity, serum creatinine, serum vitamin D, HOMA-IR, total daily energy intake, and hormone replacement therapy (women only).	Urinary sodium excretion in 24 hours ≥ 164.01 mEq/day in men. Urinary sodium excretion in 24 hours ≥ 165.97 mEq/day in women.	1.3 (1.07-1.59) 1.41 (1.16-1.73)
WEN *et al*., 2015[72]	286	Male and female 1) 0.35% 2) 5.9% 3) 3.14%	Adjustment for age and gender.	IWGS Classification: Low speed AWGS Rating: Low muscle strength Low speed	 10.38 (3.46-31.16) 16.29 (3.53-75.15) 5.57 (1.27-24.41)
BEAUDART *et al*., 2015b[45]	250	Female 8.4% to 27.6% Depending on the diagnostic method	* The study refers that they used regression measures and logistic model, but the exact values of odds ratio were not shown.	* We attempted to contact via email and the OR values provided were the same values of the article by BEAUDART *et al*., 2015a[62]	-
PARK; HAM; LEE, 2014b[73]	7208	Male and female 36%	Adjustment for age, area of residence, BMI, waist circumference, hypertension, smoking and alcoholism, schooling, regular physical exercise and walking, protein and carbohydrate intake and use of hormones and oral tablets for women.	Severe sarcopenia: In men: Insulin resistance (HOMA-IR) 25-Hydroxyvitamin D Severe sarcopenia: In women: Total cholesterol 25-Hydroxyvitamin D	 2.957 (2.609-3.305) 48.1 (44.2-52.0) 207.9 (203.6-212.2) 41.9 (39.2-44.6)
BAEK *et al*., 2014[74]	3483	Male and female 1) 51.7% 2) 50.7%	Adjustment for age, gender, schooling, family income level, smoking, alcohol consumption, physical activity, total energy consumption, and total fat consumption (%).	Definition 2: Men: Hypercholesterolemia Hypertriglyceridemia Dyslipidemia Insulin resistance (HOMA-IR) Women: Hypercholesterolemia Insulin resistance (HOMA-IR)	 1.88 (1.15–3.10) 1.59 (0.99–2.57) 1.46 (1.01–2.11) 1.89 (1.19–2.99) 1.68 (1.12–2.54) 1.00 (0.65–1.54)
YU *et al*., 2014[75]	4000	Male and female Onset: 9% In 2 years: 10.6% In 4 years: 10%	Adjustment for demographic data, socioeconomic status, medical history, lifestyle and nutritional factors, cognitive function, deficiencies in daily instrumental activities, and body mass index.	From the beginning up to four years of study: Age Stroke Physical activity Commitment to daily instrumentalactivities BMI From the beginning up to two years: Female From 2 to 4 years old:COPD	 1.11 (1.07-1.14) 2.56 (1.32-4.95) 0.995(0.991-0.999) 2.12 (1.49-3.02) 0.66 (0.62-0.70) 1.58 (1.15-2.16) 1.84 (1.02-3.31)
CHERIN *et al*., 2014[47]	1421	Male and female 15.5%	Adjustment for potential confounding factors (unspecified).	BMI> 22 kg/m^2 Physical leisure activities for 3 hours or more per week	0.72 (0.60-0.91) 0.45 (0.24-0.93)
FIGUEIREDO *et al*., 2014[8]	399	Male 1) 13.5% 2) 19.8%	No adjustments.	According to the first criterion: Age BMI Black race Current smoking Physical activity Total bone mineral density of the femur According to the second criterion: Age BMI Black race Current smoking Physical activity Total bone mineral density of the femur	 1.08 (1.00-1.18) 0.45 (0.36-0.57) 0.27 (0.08-0.88) 3.44 (1.18-9.96) 0.28 (0.08-0.95) 0.019 (0.0003-0.98) 1.05 (1.00-1.11) 0.86 (0.79-0.94) 0.31 (0.14-0.65) 2.83 (1.40-5.74) 0.35 (0.16-0.75) 0.06 (0.007-0.65)

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RYU *et al*., 2014[65]	2264	Male and female 11.5%	Adjustment for age, educational level, alcohol intake, smoking, diabetes, hypertension, hyperlipidemia, heart disease, stroke, total cholesterol, fasting glycemia, and triglycerides.	Male: High level of physical activity	 0.26 (0.13-0.54)
LEE *et al*., 2013[76]	386	Male and female 1) 21.5% 2) 42.5%	No adjustments. * * The values of the confidence interval were not detailed, therefore only the OR value was maintained.	Using the appendicular muscle mass index: Increasing age by 10 years using the IWGS criterion Increasing age by 10 years using the EWGSOP criterion Use of the IWGS criterion for diagnosis Use of the EWGSOP criterion for diagnosis Obesity by the EWGSOP criterion	 2.4 3.2 4.3 3.8 0.3
DOMICIANO *et al*., 2013[44]	611	Female 1) 3,7% 2) 19,9%	Adjustment for age.	Method 1- T score of the femoral neck Current alcohol intake (three or more daily units) Method 2- White breed Creatinine	 1.90 (1.06□3.41) 4.13 (1.18-14.45) 1.81 (1.15-2.84) 0.21 (0.07-0.63)
KIM *et al*., 2011[77]	3169	Male and female 7.76%	Adjustment for age, BMI, HOMA-IR, regular exercise, occupation, region, smoking, alcohol intake, use of vitamins and mineral supplements, and parathyroid hormone.	Vitamin D ≥ 24.1 ng/L	0.47 (0.3-0.73)

Source: designed by the author (2018).

pathway that is related to the cause of sarcopenia[81].BMI is a key variable in studies addressing sarcopenia. A Brazilian study found that there is a relationship between white race, low weight, and lower BMI when compared to sarcopenic and non-sarcopenic individuals[44]. It is believed that BMI can serve as a protective buffer in fighting functional muscle decline, hence the need to maintain a proper weight for mass preservation and muscle strength[75]. Over the years, pre-sarcopenic individuals tend to present worsening in muscle mass index, grip strength, and bone mineral density when compared to individuals without sarcopenia[83].Other potential etiological factors, which induce muscular dysfunction leading to the development of sarcopenia, are the multiple comorbidities. According to national and international literature, the most prevalent comorbidities among the sarcopenic elderly are hypertension, osteoarthritis, diabetes, and chronic obstructive pulmonary disease[82,84]. However, numerous other conditions can lead to the development of sarcopenia, such as congestive heart failure, depression, Parkinson's disease, peripheral arterial disease, kidney failure, and hip fracture[36].

The number of comorbidities is directly related to the number of drugs consumed. Polypharmacy is associated with a high risk of sarcopenia and high rates of functional restriction[50], which reinforces its clinical relevance. Lack of medical treatment and irregular or even sporadic intake of medications can have detrimental effects on the general health of the individual. For older people who use polypharmacy, it is difficult to differentiate between potentially beneficial drugs and harmful effects on body composition[50].Vitamin and hormone levels are evidenced to be related to the enhancement of some sarcopenic symptoms, such as low levels of vitamin D that exert negative effects on muscle strength. Therefore, we believe that supplementation may reduce falls in these patients[85], and, through appropriate interventions, this could influence the incidence of sarcopenia over the time[86]. However, its use for sarcopenia in the elderly is still controversial.[75]. Vitamin D deficiency is a risk factor for osteoporosis/osteopenia[82] and plays an important role in maintaining muscle strength[86]. Osteoporosis is characterized by low bone mineral density, which is positively associated with BMI and the incidence of fractures[82].We emphasize that sarcopenic individuals present a higher prevalence of fractures[82]. The decrease of bone mineral density leads to fractures directing to immobilization and disuse of the lower limbs, resulting in reduced bone and muscle mass[82]. Regarding the rate of falls, we observed that there is a greater predominance among the elderly, of both genders, who have sarcopenia and among those who have mobility conditions[4]. One study reports that since the age of 45, women may have a higher proportion of falls compared to men[87].

Sarcopenic individualstypically have significantly lower scores for all physical performance tests[37]. About such performance, older people with greater relative muscle reach faster gait speeds and shorter duration for Time Up and Go, for example[88].One study showed that the chances of a sedentary individual developing fragility syndrome and sarcopenia are almost twice as high as those for active individuals (OR = 1.45); and that the chances of progressing to a more advanced stage of sarcopenia almost tripled for fragile and sedentary individuals (OR = 2.80)[89]. Those clinical worsenings result in adverse outcomes, such as falls, fractures, hospitalizations, comorbidities, disabilities, and high mortality rates[89]. Another research found an association between low manual grip strength and lower quality of life-related to loss of mobility and presence of pain in men; and, in women, the association between low muscle mass and reduced quality of life-related to loss of mobility, daily activities, and presence of pain[90].

Studies have found that mean muscle mass was higher in men than in women[81], and that relative muscle mass is positively associated with physical fitness[88]. Thus, we suggest that older people with low muscle mass indexes are at higher risk for physical disability. Another critical condition, which may have a direct influence on sarcopenia, is fragility[80,81]. Fragility and sarcopenia overlap; most of the frail elderly patients present with sarcopenia, and vice versa[84]. Such an event is justified by the state of chronic inflammation and immunological activation, with high production of interleukins[91]. Therefore, similar approaches prevent and treat both comorbidities, such as regular physical exercises that contribute to the increase of contractile proteins, slowing the muscular loss of the elderly and improving the ability to perform daily activities[92]. Thus, sarcopenic elderly individuals who do not practice physical activities are more likely to evolve with disabilities and frailty[93]. Physical exercise, especially resistance training, has been indicated as the most effective strategy to prevent sarcopenia and progressive aging, guaranteeing the autonomy and functional independence of the elderly and, in turn, the improvement of the quality of life[93]. In general, moderate or high-intensity physical activity for 20 to 30 minutes a day for 3 to 5 days per week is a protective factor for sarcopenia[65]. Besides, resistance training induces muscle hypertrophy[65], and regular and intense exercise can prevent or reverse age-related loss of muscle mass[65]. In addition, diet is a determining factor and protection against sarcopenia. A diet in the Mediterranean style with consumption of olive oil, nuts, fruits, vegetables, and fish; can be considered a protective condition, since this pattern provides antioxidants, reducing inflammatory processes and oxidative stress, which are part of the pathogenesis mechanism of sarcopenia[60]. Despite the understanding that protein intake is necessary to avoid sarcopenia, a Chinese study has shown that the excess meat-fish dietary pattern is associated with a higher probability of developing sarcopenia in males[60]. Even so, we highlight that compared to plant proteins, which tend to be deficient in essential amino acids, the animal protein provides all the essential amino acids, hence has high biological value. Therefore, the mean total intake of 1.4 g / kg body weight and 1.2 g / kg body weight for men and women, respectively, is recommended[60].Thus, there is a strong relation between sarcopenia, increased mortality, longer hospital stay, advanced ages, comorbidities, and intense polypharmacy[5].

Conclusion

In conclusion, the main risk factors for sarcopenia refer to aging (longevity), low body mass index, comorbidities, vitamin D deficiency, and low bone density, as well as falls. Regarding the protective factors, the most cited were regular physical activity and a balanced diet. It is also pointed out that for sarcopenic individuals, there was an increased risk for hospitalization and death.

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