Sarcopenia and Frailty Profile in the Elderly Community of Surabaya: A Descriptive Study

Novira Widajanti[1], Jusri Ichwani[1], Rwahita S. Dharmanta[2], Hadiq Firdausi[1], Yudha Haryono[3], Erikavitri Yulianti[4], Stefanus G. Kandinata[5], Meilia Wulandari[5], Rastita Widyasari[5], Viranti A. Adyanita[5], Nuri I. Hapsanti[5], Diar M. Wardana[5], Titin Kristiana[5], Driyarkara[5], Hemma Wahyuda[5], Sarah Yunara[5], Kholidatul Husna[5]

[1] Department of Internal Medicine, Faculty of Medicine Universitas Airlangga - Dr. Soetomo Hospital, Surabaya, Indonesia.
[2] Department of Physical Medicine and Rehabilitation, Faculty of Medicine Universitas Airlangga - Dr. Soetomo Hospital, Surabaya, Indonesia.
[3] Department of Neurology, Faculty of Medicine Universitas Airlangga - Dr. Soetomo Hospital, Surabaya, Indonesia.
[4] Department of Psychiatry, Faculty of Medicine Universitas Airlangga - Dr. Soetomo Hospital, Surabaya, Indonesia.
[5] Faculty of Medicine Universitas Airlangga, Surabaya, Indonesia.

Corresponding Author:
Novira Widajanti, MD. Department of Internal Medicine, Faculty of Medicine Universitas Airlangga – Dr. Soetomo Hospital, Surabaya. Jl. Mayjen Prof. Dr. Moestopo 47, Surabaya 60131, Indonesia. email: novirawidajanti@fk.unair.ac.id.

ABSTRAK

Latar belakang: *sarkopenia dan frailty merupakan salah satu penyebab hilangnya mobilitas, disabilitas, gangguan neuromuskular, dan sindroma kegagalan homeostatik dengan kelainan gaya berjalan dan keseimbangan pada usia lanjut. Hal ini berkontribusi terhadap peningkatan angka jatuh dan patah (fall and fractures) sekaligus meningkatan hospitalisasi, imobilisasi, bahkan mortalitas. Jumlah populasi usia lanjut dengan sarkopenia dan frailty diperkirakan meningkat di seluruh dunia, sehingga studi mengenai angka prevalensi sarkopenia dan frailty secara nasional sangat penting dilakukan sebagai dasar studi selanjutnya.* ***Metode:*** *penelitian ini merupakan penelitian deskriptif dengan menggunakan data primer dari komunitas usia lanjut di Surabaya melalui posyandu lanjut usia. Data biopsikososial, penurunan berat badan, kelelahan, dan aktivitas fisik didapat melalui wawancara, sedangkan kekuatan genggam tangan, massa otot, dan performa fisik (kecepatan berjalan) diukur melalui instrumen.* ***Hasil:*** *tiga ratus delapan subjek terkualifikasi untuk penelitian. Rerata usia subjek adalah 63 (60–100) tahun dengan 74,7% subjek berjenis kelamin perempuan. Prevalensi sarkopenia pada usia lanjut di Surabaya sebesar 41,8% (laki-laki 13,9%, perempuan 27,9%). Prevalensi frailty secara umum adalah 36,7% (laki-laki 5,2%, perempuan 31,5%).* ***Kesimpulan:*** *prevalensi sarkopenia dan frailty pada populasi usia lanjut di komunitas tergolong tinggi. Hasil penelitian ini diharapkan dapat menjadi awal dari penelitian berikutnya, terutama dalam menentukan cut-off sarkopenia yang sesuai dengan sosiodemografi Indonesia.*

Kata kunci: *sarkopenia, frailty, usia lanjut, komunitas, profil.*

ABSTRACT

Background: *sarcopenia and frailty cause immobility, disability, neuromuscular disorders, and homeostatic balance failure syndrome, characterized by gait and balance abnormalities in the elderly, and an increasing*

prevalence worldwide. This further contributes to the elevated incidence of falls and fractures, hospitalization, immobilization, and even mortality, hence, a national-level study was conducted on the prevalence rates of sarcopenia and frailty in the elderly. ***Methods:*** *this descriptive study used primary data of elderly people (n = 308) in Surabaya, Indonesia. Furthermore, the biopsychosocial data, weight loss, fatigue, and physical activity measurements were obtained through interviews, while handgrip strength, muscle mass, and physical performance (walking speed) were evaluated using instruments.* ***Results:*** *the median age of the subjects was 63 years (60–100 years), and 230 (74.7%) were women. In addition the prevalence rate of sarcopenia was 41.8% (in 86 [27.9%] women), while the prevalence rate of frailty was 36.7% (in 16 [5.2%] men and 97 [31.5%] women).* ***Conclusion:*** *the prevalence of sarcopenia and frailty in the elderly is significantly high, thus, it is expected that this study results are used as a basis for subsequent research, especially to determine the sarcopenia cut-off, in accordance with Indonesian sociodemography.*

Keywords: *sarcopenia, frailty, elderly, community, profile.*

INTRODUCTION

Sarcopenia is more often used as the subject of research compared to frailty, despite of the fact that they have been studied together for a long time.[1] Meanwhile, the absence of optimal treatment is known to cause loss of muscle strength, which further contributes to immobility, neuromuscular disorders, homeostatic balance failure syndrome,[2] as well as walking and stability disturbance.[3] These occurrences tend to increase the risk of fall and fractures in the elderly,[4-6] which ultimately leads to sarcopenia and frailty.

According to the European Working Group on Sarcopenia in Older People (EWGSOP) and the Asian Working Group for Sarcopenia (AWGS), the prevalence of sarcopenia in healthy adults aged ≥60 years is approximately 10% (95% confidence interval [CI] = 8%–12%) in men and 11% (95% CI = 8%–13%) in women.[7] A 2016 study in Bandung, West Java, Indonesia, on 229 participants showed a 7.4% prevalence in men and 1.7% in women on the basis of AWGS parameters.[7] A systematic review[8] of 31 studies on people aged ≥65 years showed a frailty incidence of 4%–17% (9.9% on average), while a study by Setiati et al.[9] (2013) on 270 elderly people in the outpatient department of Dr. Cipto Mangunkusumo Hospital, Jakarta recorded 27.4%. In addition, women are two times more likely to be frail, and the prevalence significantly increases in people aged >80 years.[10]

Currently, there is a lack of national data regarding the prevalence of sarcopenia and frailty in Indonesia, especially in Surabaya. Also, agreements have not been investigated on the instruments and cut-offs of sarcopenia. Therefore, the aim of this study is to determine the prevalence of sarcopenia and frailty as a basis for subsequent research.

METHODS

This is a cross-sectional, observational, descriptive study, where primary data were obtained using interviews and questionnaires. Also, specific instruments were used to measure sarcopenia and frailty amongst the elderly in Posyandu Lansia in Surabaya.

Study Setting

Data were collected between December 2017 and March 2018 from five clinics, part of five health centers in Surabaya, which were Puskesmas Tambak Rejo, Sememi, Menur, Perak Timur, and Putat Jaya.

Study Population and Sampling Method

The study population comprised the elderly aged ≥60 years. Cluster random sampling was used. One health center from each of the five administrative regions in Surabaya was randomly selected for data collection. The elderly selected for the study encompassed those who were recorded in the clinics, were willing and able to fill out information on the informed consent sheets, cooperative and capable of undergoing several tests. Furthermore, those with severe cardiovascular or respiration problems, a history of pacemakers utility, and incomplete

checkpoints were excluded.

The study was conducted under ethical clearance no. 273/EC/KEPK/FKUA/2017.

Study Instruments

The general characteristics of the subjects were obtained using questionnaires. Biopsychosocial profiles, including the comorbidity index, nutritional status, cognitive status, mental status, and functional status, were assessed using the Charlson Comorbidity Index (CCI), the Cumulative Illness Rating Scale (CIRS), the Mini Nutritional Assessment (MNA) questionnaire, the Abbreviated Mental Test (AMT), the Mini-Mental State Examination (MMSE), the Geriatric Depression Scale (GDS), the Barthel Activity of Daily Living (ADL) scale, and Lawton's Instrumental Activity of Daily Living (IADL). In addition, sarcopenia was measured on the basis of the following AWGS[11] parameters: (i) muscle mass, which was evaluated using the Bioelectrical Impedance Analysis Omron Karada scan model HBF-362 (Omron Corporation, Kyoto, Japan) by adopting the cut-off 2SD-derived from 40 subjects of non-sarcopenic young adults as controls[12] (men, 6.1 kg/m^2; women, 3.05 kg/m^2); (ii) hand grip strength was measured using the TKK 5001 Grip A hand dynamometer in triplicate, and the best value was collected; and (iii) walking speed was calculated using the gait speed test, where each subject was requested to walk in a straight line for 6 meters, and the time was recorded using a stopwatch.

To determine the degree of sarcopenia, the subjects were divided into the following groups: severe sarcopenia on instances of low muscle mass, hand grip strength, and gait speed; and sarcopenia if the muscle mass was low and the hand grip strength or gait speed was low; presarcopenia if only the muscle mass was low; and normal if all parameters were normal.[13]

Based on the Cardiovascular Health Study (CHS) scale[3] the measurement for frailty involved using the following items: unintentional weight loss, weakness with cut-off according to the body mass index, fatigue, slow gait speed, and low physical activity (measured using the Physical Activity Scale for the Elderly). Furthermore, the subjects were divided into groups as follows: frailty if three of five criteria were met, prefrailty if one or two were attained, and fit if none was met.

Statistical Analysis

Data collected were processed using SPSS Statistics ver. 17.0 (IBM Corporation, Armonk, NY, USA) for Windows (Microsoft Corporation Redmond, WA, USA). The categorical variables were presented in frequencies and percentages, while the continuous variables were presented according to their distributions. Furthermore,

Table 1. General characteristics of the subjects in this study

Characteristics	n (%)
Sex	
- Male	78 (25.3)
- Female	230 (74.7)
Marital status	
- Married	178 (57.8)
- Widow/widower	117 (38.0)
- Divorced	7 (2.3)
- Single	6 (1.9)
Education	
- No schooling	48 (15.6)
- Some primary	42 (13.6)
- Completed primary	98 (31.8)
- Junior high school	63 (20.5)
- High school	42 (13.6)
- Associate's Degree	7 (2.3)
- Bachelor's Degree	8 (2.6)
Monthly income (in millions Rupiahs)	
- <1.5	234 (75.9)
- 1.5–3	55 (17.9)
- >3	19 (6.2)
Financial dependency	
- Independent	69 (22.4)
- Partially dependent	55 (17.9)
- Wholly dependent	160 (51.9)
- Pension	24 (7.8)
Walker use	
- No	295 (95.8)
- Yes	13 (4.2)
Regular exercise	
- No	106 (34.4)
- Yes	202 (65.6)
History of falls in the last year	
- No	270 (87.7)
- Yes	38 (12.3)

continuous variables with normal distributions were presented as mean (standard deviation), while those without were displayed as median (minimum-maximum).

RESULTS

From December 2017 to March 2018, a total of 320 elderly were screened for the study, where none exhibited severe cardiovascular or respiration problems, and history of utilizing pacemakers. However, about 12 participants were unable to complete the checkpoints, and thus excluded from the study. Out of the 308 total subjects, 230 (74.7%) were women, with a median age of 63 (60–100) years, and **Table 1** shows other general characteristics.

The median comorbidity score based on the CCI was 4.00 (2–10). The median 10-year survival rate was 0.53 (0.00–0.90). Based on the CIRS, the three most frequent comorbidities were musculoskeletal disorders (mild: n = 187 [60.7%]; moderate: n = 23 [7.5%]), hypertension, and sensory system disorders. Based on the Lawton's IADL tool, the median functional status score was 6.00 (1–8) for men and 8.00 (0–8) for women, and **Table 2** shows other biopsychosocial profiles of the subjects.

Table 2. Biopsychosocial profile of the subjects in this study

Variables	n (%)
AMT	
- Severe mental impairment	5 (1.6)
- Mild-moderate mental impairment	22 (7.1)
- Normal	281 (91.2)
MMSE	
- Severe cognitive impairment	12 (3.9)
- Mild cognitive impairment	53 (17.2)
- Normal	243 (78.9)
GDS	
- Normal	305 (99.0)
- Depressive	3 (1.0)
Nutritional status	
- Normal	216 (70.1)
- At risk of malnutrition	81 (26.3)
- Malnourished	11 (3.6)
Barthel ADL	
- Partially dependent	4 (1.3)
- Minimally dependent	94 (30.5)
- Totally independent	210 (68.2)

AMT, abbreviated mental test; MMSE, Mini-Mental State Examination; GDS, geriatric depression scale; ADL, activity of daily living.

The median value for hand grip strength was 29.00 kg (15.00–44.00 kg) and 18.50 kg (6.00–29.00 kg) for men and women. The median gait speed for men was 0.78 m/s (0.30–1.32 m/s); whereas the mean gait speed for women was 0.70 (SD 0.20) m/s. In addition, the mean muscle mass for men was 4.89 (SD 1.30) kg/m^2; while the median muscle mass for women was 3.08 (1.33–5.52) kg/m^2. **Table 3** shows the distribution of all three sarcopenia parameters.

Table 3. Distribution of sarcopenia parameters

Variables	Male - n (%)	Female - n (%)
Hand grip strength		
- Low	27 (8.8)	101 (32.8)
- Normal	51 (16.6)	129 (41.9)
Gait speed		
- Low	42 (13.6)	162 (52.6)
- Normal	36 (11.7)	68 (22)
Muscle mass		
- Low	66 (21.4)	109 (35.4)
- Normal	12 (3.9)	121 (39.3)

The prevalence rate was 41.8%, where 43 (13.9%) men and 86 (27.9%) women were sarcopenic, and 63 (20.4%) of the subjects exhibited severe symptoms.

On the basis of the CHS scale, the prevalence rate of frailty was 36.7%, of which 16 (5.2%) were men and 97 (31.5%) were women, with details shown in **Table 4**.

DISCUSSION

Sarcopenia is defined as low muscle mass with low hand grip strength or low gait speed.[11] Furthermore, its prevalence rate in Asia (2008)[14] was 6%–23% and 8%–22% in men and women, respectively, with the lowest prevalence was found in Hong Kong (12.3% in men and 7.6% in women) and Korea (6.3% in men and 4.1% in women).[15] Conversely, the highest incidence is recorded in Taiwan (23.6% in men and 18.6% in women)[14] and Japan (21.8% in men and 22.1% in women).[16]

Table 4. Distribution of frailty parameters based on the CHS scale.

Variables	Male - n (%)	Female - n (%)
Weight loss		
- No	69 (22.4)	205 (66.6)
- Yes	9 (2.9)	25 (8.1)
Hand grip weakness		
- No	75 (24.4)	128 (41.6)
- Yes	3 (1)	102 (33.1)
Fatigue		
- No	57 (18.5)	159 (51.6)
- Yes	21 (6.8)	71 (23)
Slow gait speed		
- No	29 (9.4)	29 (9.4)
- Yes	49 (15.9)	201 (65.3)
Low levels of physical activity		
- No	35 (11.4)	95 (30.8)
- Yes	43 (14)	135 (43.8)

CHS, Cardiovascular Health Study.

Specifically, this study records a prevalence of 13.9% in men and 27.9% in women, which is much higher than the studies conducted in Bandung, reported based on the cut-off recommended by the AWGS of 9.1% (7.4% in men and 1.7% in women) and 40.6% (20.1% in men and 20.5% in women) based on the cut-off from Taiwan's population.[7] The subjects in this study had a much lower mean muscle mass for both men and women, compared to the research in Bandung, with the women in both exhibiting relatively lower values.

A study by Pongchaiyakul et al[17] in Thailand showed a higher prevalence of sarcopenia, based on the assessment of low relative skeletal muscle mass only, both in men and women, which were 35.33% and 34.74% respectively. In addition, living in the city had the strongest association with low skeletal muscle index with an odds ratio (OR) of 17.26 (SD 7.12) in men and 8.62 (SD 2.74) in women. Living in the biggest metropolitan city in the province, the people of Surabaya tend to have a more sedentary lifestyle. This contributes to the development of sarcopenia, asides from the factor associated with age, which were from the factors associated with activities and nutrition.[17-18] Similar results were established in a study of Brazilian elderly women conducted by Mazocco et al.[19], which demonstrated a higher vulnerability in those living in urban areas (OR = 9.561). In addition, less sun exposure, more diet high in fats and refined carbohydrates, and also low fiber intake are other possible reasons for the high prevalence.[17]

About 86 (27.9%) women studied were sarcopenic, which is much higher than in men (13.9%). This is in line with a study of suburb-dwelling older Chinese in 2016, recording a higher occurrence in women than men, of 11.5% and 6.4% respectively. According to the study, the higher BMI in men was identified as a protective factor against sarcopenia.[20] Also, menopause is capable of changing body composition and fat distribution, consequently the composition of fat-free body mass in women declines with increasing body weight, fat mass, and central fat deposition. This is characterized by the tendency to exhibit decreased muscle mass,[21] and a higher incidence of sarcopenia.

Interesting results were reported for the muscle mass values, as categorized in **Table 3**, which was low for the majority of men (n = 66 [21.4%]), and normal for most women (n = 121 [39.3%]). According to Roubenoff, men tend to experience a more significant decrease in muscle mass as a result of the declining growth hormone and testosterone levels.[22] Hence, some studies reported a relatively higher prevalence in men.[14-15]

Malnutrition was associated with the development of sarcopenia.[18,23-25] On the basis of the MNA questionnaire, 81 (26.3%) subjects in this study were classified to be at risk of malnutrition and 11 (3.6%) were malnourished. The prevalence of malnutrition was lower (1.2%) in Iran, where the prevalence of sarcopenia was 20.8%.[23] Lower prevalence of sarcopenia was also identified in a study among community-dwelling elderly in Taiwan (6.8%), where the prevalence of abnormal nutritional status (both at risk and already malnourished) was only 5.1%.[24] In addition, malnourished individuals tend to lack nutritional factors like protein, vitamin D, calcium, and the acid-base balance of a diet, which plays a role in maintaining muscle mass and muscle strength, as well as physical performance,[18] necessary in the diagnosis of

sarcopenia. Meanwhile, the other possible explanation is because malnourished people demonstrate reduced muscle protein synthesis.[25]

Frailty

The prevalence rate of frailty in the present study was 5.2% in men and 31.5% in women. Overall, the prevalence of frailty was 36.7%. The prevalence rate of frailty according to the CHS in the elderly aged >=65 years is 7%, reaching 30% in those aged >=80 years.[3]

Lower results were found in a study by Setiati et al.[26] recording a prevalence of 25.2%, where nutritional and functional status, as well as age were considered as essential factors. Despite the relatively older mean age (74.2%) recorded,[26] the proportion of individuals at risk and those already malnourished was lower than the values reported in the present study of 24.6% and 2.5% respectively. However, it is also noted that Setiati et al.[26] recruited the subjects from the hospital, of which some were referred from primary health care and smaller hospitals. This consequently leads to differences in the prevalence of frailty in comparison with other elderly individuals in the Indonesian population.

Another study by Setiati et al.[9] (2013), reported on the frailty prevalence rate of 27.4% in 270 elderly individuals of an outpatient setting, while 71.1% was recorded for prefrailty.

Women are known to be at a two times higher risk of being frail compared to men.[10] This phenomenon is possibly explained through various mechanisms, including the fact that women exhibit lower hand grip strength than men, with a mean value of 18.5 kg and 29 kg, respectively. This is due to the fact that women possess greater fat mass,[21] and the relatively higher vulnerable to fatigue. Specifically, fatigue is defined on the basis of two items identified in the Center for Epidemiologic Studies Depression Scale (CES-D) questionnaire:

- I find it difficult to start activities as usual.
- I feel the need for extra effort to start the activity.

Using similar definition, Vestergaard et al.[27] reported a 15% and 29% prevalence rate of fatigue in men and women, respectively in Italy. Also, using reduced energy as the definition, Tolea et al.[28] reported the experience in 12% of men and 22% of women. Comparably, women tend to exhibit a slightly lower speed, due to the variation in anthropometric size and lifestyles.[28] Among the elderly, Lenardt et al.[29] (2013) reported men as more physically active.

There was higher prevalence of frailty among women in the present study than men (31.5% vs. 5.2%). A study by Rensa et al.[30] reported a 24% proportion in women, with report of a relatively older median age (67 years old). However, the B-ADL was lower in the present study, which according to Rensa et al,[30] was associated with the frailty syndrome in elderly.

The prevalence further increases significantly in individuals >80 years of age,[10] as cellular metabolism and physiological function progressively decreases over time. In addition, the musculoskeletal system is also affected by sarcopenia, characterized by the reduced muscle strength, mobility, balance, and tolerance for activities, subsequently increasing the risk of falls and physical inactivity.[31]

Weight loss results in reduced fat mass, muscle mass, and bone.[32] Furthermore, low muscle mass is one of the factors associated with the decline in gait speed and weakness of hand grip in sarcopenia,[33] hence the overlapping relationship with frailty.[34] In addition, low muscle mass is also associated with fatigue.[35]

According to Newman[36] (2005), about 15%–20% of the elderly experience weight loss, which is defined as a loss of >=5 kg (or >5%) of the initial body weight for 5–10 years. This prevalence increases in high-risk populations, encompassing community-dwelling elderly, and it is also associated with advanced age, presence of disability, comorbidity, hospital admission history, low level of education, cognitive impairment, smoking, death of a partner, and low initial body weight.[27]

Conversely, physical activities are affected by both physiological and external factors, including opportunities, gender-related sociocultural values, motivation, and choices.[37] Health problems are risk factors for a decreased functional status, creating limitations for the elderly, which results in complications and the emergence of new problems.[38] Therefore, the presence of physical

activity is an indicator of independence in daily life, which contributes towards the reduction and control of cardiovascular and ischemic heart disease.[39]

There was an association between cognition and frailty,[40-41] which was better illustrated as a cycle as frailty increases the risk of future cognitive decline and conversely cognitive impairment increases the risk of frailty.[41] A systematic review on 10 cross-sectional studies and 9 longitudinal studies reported that cognitive impairment was more prevalent in frail elderly.[40] This result is in line with the present study, where most (75%) of the elderly with severe cognitive impairment were frail and 54.7% of those with mild cognitive impairment were frail. (**Table 5)**.

Table 5. Frequency of cognitive impairment among fit, prefrail, and frail elderly.

Cognitive Function	Fit n (%)	Prefrail n (%)	Frail n (%)
Severe cognitive impairment	0 (0)	3 (25)	9 (75)
Mild cognitive impairment	1 (1.9)	23 (43.4)	29 (54.7)
Normal	18 (7.4)	150 (61.7)	75 (30.9)

Among other instruments, the frailty criteria proposed by Fried et al.[8], using the data from CHS, remains the most frequently used,[40,42] and was shown to demonstrate a good predictive validity for adverse health outcomes in various populations.[42] However, there are some studies suggested the inclusion of cognition as a frailty component,[41-42] as impairments in both physical and cognitive function contribute to the risk of functional decline in elderly.

There were some limitations in the present study. First, the subjects were needed to undergo several tests to measure each components of sarcopenia and frailty. This could lead to fatigue which could affect the outcomes. To overcome this, all subjects were given time to eat and do ice-breaking in the middle of the tests. Second, all subjects despite exhibiting cognitive impairment were included in the present study, although some informations were collected from the care giver, not the subjects themselves.

One of the strength in this study is the mean muscle mass measurement of non-sarcopenic young adults as the reference for the diagnosis of sarcopenia. Moreover, according to the authors' knowledge, the present study is the first multicenter study in Indonesia which has nearly complete sarcopenia and frailty profile in the elderly. This study is expected to be a basis for subsequent research.

CONCLUSION

The prevalence rates of sarcopenia and frailty in the elderly population of Surabaya are high. However, the results obtained differ from other previous research perfomed in several cities of Indonesia, hence an agreement on the instruments and cut-offs is required in the determination of sarcopenia.

ACKNOWLEDGMENTS

The author is grateful to the Heads of the Tambak Rejo Community, Menur, Sememi, Perak Timur, and Putat Jaya Health Center, as well as the supervised Posyandu, Posyandu Lansia cadres in each, and all parties involved in ensuring the successful completion of this research. This Study was funded by Dr. Soetomo Hospital, Surabaya Research Program.

REFERENCES

1. Bauer JM, Sieber CC. Sarcopenia and frailty: a clinician's controversial point of view. Exp Gerontol. 2008;43(7):674-8. doi: 10.1016/j.exger.2008.03.007. PMID 18440743.
2. Vetta F, Ronzoni S, Taglieri G, et al. The impact of malnutrition on the quality of life in the elderly. Clin Nutr. 1999;18(5):259-67. doi: 10.1054/clnu.1999.0060. PMID 10601532.
3. Dutta C. Significance of sarcopenia in the elderly. J Nutr. 1997;127(5 Suppl.):992S-3S. doi: 10.1093/jn/127.5.992S. PMID 9164281.
4. Fried LP, Tangen CM, Walston J, et al. Cardiovascular health study Collaborative Research Group: frailty in older adults. J Gerontol A. 2001;56(3):M146-57. doi: 10.1093/gerona/56.3.M146.
5. Moulias R, Meaume S, Raynaud-Simon A. Sarcopenia, hypermetabolism, and aging. Z Gerontol Geriatr. 1999;32(6):425-32. doi: 10.1007/s003910050140. PMID 10654381.
6. Vanitallie TB. Frailty in the elderly: contributions of sarcopenia and visceral protein depletion. Metabolism. 2003;52(10 Suppl.):22-6. doi: 10.1016/s0026-0495(03)00297-x. PMID 14577059.
7. Vitriana, Defi IR, Irawan GN, et al. Prevalensi

sarkopenia pada lansia di Komunitas (Community Dwelling) berdasarkan dua nilai cut-off parameter diagnosis. mkb. 2016;48(3):164-70. doi: 10.15395/mkb.v48n3.417.
8. Fried LP, Walston J. Frailty and failure to thrive. In: Hazzard WR, Blass JP, Ettinger WH Jr, Halter JB, Ouslander J, editors. Principles of geriatric medicine and gerontology. 5th Ed. Vol. 1. New York: McGraw-Hill; 2003. p. 1487-502.
9. Setiati S, Seto E, Sumantri S. Frailty profile of elderly outpatient in Cipto Mangunkusumo Hospital, Jakarta. 2013
10. Morley JE, von Haehling S, Anker SD, Vellas B. From sarcopenia to frailty: a road less traveled. J Cachexia Sarcopenia Muscle. 2014;5(1):5-8. doi: 10.1007/s13539-014-0132-3. PMID 24526568.
11. Ogawa S, Yakabe M, Akishita M. Age related sarkopenia and its pathophysiological bases. Inflam Regen. 2016;36:17. doi: 10.1186/s41232-016-0022-5. PMID 29259690.
12. Chen LK, Liu LK, Woo J, et al. Sarcopenia in Asia: consensus report of the Asian Working Group for Sarcopenia. J Am Med Dir Assoc. 2014;15(2):95-101. doi: 10.1016/j.jamda.2013.11.025. PMID 24461239.
13. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, et al. Sarcopenia: European consensus on definition and diagnosis: report of the European Working Group on Sarcopenia in Older People. Age Ageing. 2010;39(4):412-23. doi: 10.1093/ageing/afq034. PMID 20392703.
14. Chien MY, Huang TY, Wu YT. Prevalence of sarcopenia estimated using a bioelectrical impedance analysis prediction equation in community-dwelling elderly people in Taiwan. J Am Geriatr Soc. 2008;56(9):1710-5. doi: 10.1111/j.1532-5415.2008.01854.x. PMID 18691288.
15. Lau EM, Lynn HS, Woo JW, et al. Prevalence of and risk factors for sarcopenia in elderly Chinese men and women. J Gerontol A Biol Sci Med Sci. 2005;60(2):213-6. doi: 10.1093/gerona/60.2.213. PMID 15814865.
16. Yamada M, Nishiguchi S, Fukutani N, et al. Prevalence of sarcopenia in community-dwelling Japanese older adults. J Am Med Dir Assoc. 2013;14(12):911-5. doi: 10.1016/j.jamda.2013.08.015. PMID 24094646.
17. Pongchaiyakul C, Limpawattana P, Kotruchin P, Rajatanavin R. Prevalence of sarcopenia and associated factors among Thai population. J Bone Mineral Metabolism. 2013;31(3):346–50. doi:10.1007/s00774-013-0422-4.
18. Beaudart C, Sanchez-Rodriguez D, Locquet M, Reginster J-Y, Lengelé L, Bruyère O. Malnutrition as a strong predictor of the onset of sarcopenia. Nutrients. 2019;11(12):2883. doi:10.3390/nu11122883.
19. Mazocco L, Gonzalez MC, Barbosa-Silva TG, Chagas P. Sarcopenia in Brazilian Rural and Urban elderly Women: Is There Any Difference? Nutrition. 2019;58:120-4. doi:10.1016/j.nut.2018.06.017.
20. Han P, Kang L, Guo Q, Wang J, Zhang W, Shen S, Niu K. Prevalence and factors associated with sarcopenia in suburb-dwelling older Chinese using the Asian Working Group for Sarcopenia Definition. J Gerontology Series A: Biol Sci Med Sci. 2015;71(4):529–35. doi:10.1093/gerona/glv108.
21. Dehghan M, Merchant AT. Is bioelectrical impedance accurate for use in large epidemiological studies? Nutr J. 2008;7(1):26. doi: 10.1186/1475-2891-7-26. PMID 18778488.
22. Roubenoff R, Hughes VA. Sarcopenia: current concepts. J Gerontol A Biol Sci Med Sci. 2000;55(12):M716-24. doi: 10.1093/gerona/55.12.m716. PMID 11129393.
23. Nasimi N, Dabbaghmanesh MH, Sohrabi Z. Nutritional status and body fat mass: Determinants of sarcopenia in community-dwelling older adults. Exp Gerontol. 2019;122:67-73. doi:10.1016/j.exger.2019.04.009.
24. Kuo Y-H, Wang T-F, Liu L-K, Lee W-J, Peng L-N, Chen L-K. Epidemiology of sarcopenia and factors associated with it among community-dwelling older adults in Taiwan. Am J Med Sci. doi:10.1016/j.amjms.2018.11.008.
25. Hai S, Cao L, Wang H, Zhou J, Liu P, Yang Y, Dong B. Association between sarcopenia and nutritional status and physical activity among community-dwelling Chinese adults aged 60 years and older. Geriatrics Gerontol Int. 2017;17(11):1959–66. doi:10.1111/ggi.13001.
26. Setiati S, Laksmi PW, Aryana I, et al. Frailty state among Indonesian elderly: prevalence, associated factors, and frailty state transition. BMC Geriatrics. 2019;19(1). doi:10.1186/s12877-019-1198-8
27. Vestergaard S, Nayfield SG, Patel KV, et al. Fatigue in a representative population of older persons and its association with functional impairment, functional limitation, and disability. J Gerontol A Biol Sci Med Sci. 2009;64(1):76-82. doi: 10.1093/gerona/gln017. PMID 19176328.
28. Tolea MI, Costa PT, Terracciano A, et al. Sex-specific correlates of walking speed in a wide age-ranged population. J Gerontol S B Psychol Soc Sci. 2010;65B(2):174-84.
29. Lenardt MH, Sousa JR, Carneiro NHK, et al. Physical activity of older adults and factors associated with pre-frailty. Acta Paul Enferm. 2013;26(3):269-75. doi: 10.1590/S0103-21002013000300011.
30. Rensa R, Setiati S, Laksmi PW, Rinaldi I. Factors associated with physical frailty in elderly women with low socioeconomic status in urban communities: a cross-sectional study. Acta Med Indones. 2019;51(3):220-229. PMID: 31699945
31. Silva TA, Frisoli Junior A, Pinheiro MM, et al. Sarcopenia and aging: etiological aspects and therapeutic options. Rev Bras Reumatol. 2013;46(6):391-7.
32. Huo YR, Suriyaarachchi P, Gomez F, et al. Comprehensive nutritional status in sarcoosteoporotic

older fallers. J Nutr Health Aging. 2015;19(4):474-80. doi: 10.1007/s12603-014-0543-z. PMID 25809813.
33. Masanes F, Rojano I, Luque X, et al. Cut-off points for muscle mass–not grip strength or gait speed-determine variations in sarcopenia prevalence. J Nutr Health Aging. 2017;21:825-9.
34. Molina-Garrido MJ, Guillén-Ponce C, Fernández-Félix BM. Relationship between sarcopenia and frailty in a Spanish cancer in the elderly unit: the ONCOSARCO project. J Am Med Dir Assoc. 2016;17(8):760-1. doi: 10.1016/j.jamda.2016.04.025. PMID 27287932.
35. De Groot CP, Perdigao AL, Deurenberg P. Longitudinal changes in anthropometric characteristics of elderly Europeans. Seneca Investigators. Eur J Clin Nutr. 1996;50;Suppl 2:S9-15. PMID 8841780.
36. Newman AB, Lee JS, Visser M, et al. Weight change and the conservation of lean mass in old age: the Health, Aging and Body Composition Study. Am J Clin Nutr. 2005;82(4):872-8; quiz 915. doi: 10.1093/ajcn/82.4.872. PMID 16210719.
37. Costa TB, Neri AL. Indicators of physical activity and frailty in the elderly: data from the FIBRA study in Campinas, São Paulo State, Brazil. Cad Saúde Publ. 2001;27(8):1537-50.
38. Rodrigues RAP, Scudeller PG, Pedrazzi EC, et al. Morbidity and interference in seniors' functional ability. Acta Paul Enferm. 2008;21(4):643-8. doi: 10.1590/S0103-21002008000400017.
39. Pereira JC, Barreto SM, Passos VM. The profile of cardiovascular health of elderly Brazilian people needs to improve: a population-based study. Arq Bras Cardiol. 2008;91(1):1-10. doi: 10.1590/s0066-782x2008001300001. PMID 18660938.
40. Brigola AG, Rossetti ES, Santos BR. dos Neri AL, Zazzetta MS, Inouye K, Pavarini SCI. Relationship between cognition and frailty in elderly: A systematic review. Dementia Neuropsychol. 2015;9(2):110–9. doi:10.1590/1980-57642015dn92000005.
41. Sternberg SA, Schwartz AW, Karunananthan S, Bergman H, Mark Clarfield A. The identification of frailty: A systematic literature review. J the American Geriatrics Society. 2011;59(11):2129–38. doi:10.1111/j.1532-5415.2011.03597.
42. Ávila-Funes JA, Pina-Escudero SD, Aguilar-Navarro S, Gutierrez-Robledo LM, Ruiz-Arregui L, Amieva H. Cognitive impairment and low physical activity are the components of frailty more strongly associated with disability. J Nutr Health Aging. 2011;15(8):683–89. doi:10.1007/s12603-011-0111-8.