Body Composition and Sarcopenia Indicator among Elderly in the Nursing Home

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Abstract: Sarcopenia is definite as the age-related loss of muscle mass and muscle function with the highest prevalence was reported in institutionalized older adults. Body composition consisted of many compartments of muscle mass and types of fat mass. This study aims to analyse the association between body composition (muscle mass and fat mass) and physical performance as sarcopenia indicator among elderly in the nursing home. We examined the skeletal muscle mass index (SMI), grip strength (GS) and walking speed (WS) as sarcopenia indicator. For muscle mass area, we measured whole, arms, legs, and trunk skeletal. We also measured body fat, visceral fat, and subcutaneous fat as component of fat mass. A total of 54 elderly (75.9 % was female) participated with mean age was 71 ± 8.2 years. The prevalence rates of sarcopenia were 98% based on three indicators of sarcopenia. Almost of muscle mass areas except trunk were associated with SMI and GS, meanwhile all areas of subcutaneous fat were correlated with GS. Among elderly nursing home, the prevalence of sarcopenia was high. Muscle mass area and subcutaneous fat was correlated with sarcopenia indicators.

1 INTRODUCTION

Nowadays, the pace of population ageing around the world is increasing dramatically. Between 2015 and 2050, the proportion of people aged 60 years will increase from 12% to 22%. It means the number of older will be expected to total 2 billion by 2050 and 80% of elderly will be living in low and middle income countries (World Health Organization, 2018). Based on the central bureau of statistics data, it is stated that Indonesia's life expectancy rate increased from 71.20 years in 2018 to 71.34 years in 2019 with an average life expectancy for men is 69.44 years and for women is 73.33 years (Central Bureau of Statistics, 2020a, 2020b). The fruitfulness of the government to increasing life expectancy certainly be in line with the increase in the dependency ratio of the productive age against the unproductive age, where the unproductive age is assumed with elderly (Ministry of Health, 2014). The physical and psychological conditions of the elderly who have setbacks will cause them to will have dependency on productive groups (Central Bureau of Statistics, 2017). Like we know that the elderly has many health problems such as hearing loss, cataracts, back and neck pain, depression, and dementia (World Health Organization, 2018). Furthermore, mostly of elderly often suffer non-communicable disease or non-communicable disease (Cicih, 2019).

The emergence of various diseases and other health problems that suffered by the elderly can be caused by aging factors and comorbidities that the elderly had previously suffered before entering old age (Favora-Moreira et al,. 2016; Fatmawati & Imron, 2017). A lot of health problems that suffered by elderly due to physiological and pathological problems can cause a decrease of normal body function and adversely affect to body composition, physiological function, and other clinical impacts (Sttraton et al., 2003; Favora-Moreira et al., 2016). Physiological functions changes of the body due to aging can affect to function of vital organs of the body, such as a decrease in cardiac output in a resting state, maximum respiratory capacity, kidney filtration rate, and nerve conduction velocity (JafariNasabian et al., 2017; Strait & Lakatta, 2012). Changes in body composition in the elderly that are often encountered are a decrease in bone mass, decrease in muscle mass

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and strength and an increase in body fat (Ilich et al., 2014; Schlenker & Roth, 2013).

Body composition changes that occur in the proportion of muscle and body fat both have contradictory differences. Muscle mass and strength tend to decrease with age, whereas body fat tends to increase with age (JafariNasabian et al., 2017). Muscle mass will decrease about 1-2% after a person enters to 50 years and muscle strength will decrease around 12-15% every 10 years after entering the age of 50 years (Papa et al., 2017; Quittan, 2016). A longitudinal study that had conducted on Caucasian men with age 70 years-over showed that fat-free mass decreased by 0.5-0.8% per year (Dey et al., 2009; Kemmler et al., 2019). Similar with this, other studies have shown that a decrease also occurs in the thigh muscle mass of both men and women aged 70 years (Cameron et al., 2020). Aging factors can interfere with homeostasis in skeletal muscles with be caused an imbalance between anabolic and catabolic pathways in muscle protein (Cruz-Jentoft et al., 2019). The imbalance is mediated by the presence of pro inflammatory cytokines such as TNF-α and IL-6 which have been shown to be abundant in the skeletal muscles of the elderly (Dhillon & Hasni, 2017). In this case, skeletal muscles are important and very influential in muscle strength in the elderly.

It is known that sarcopenia is associated with decreased function and disability in the elderly which can have an impact on decreasing quality of life (Vitriana et al., 2016). On progress, many studies were carried out to analyze various things related to sarcopenia. At 2010, the Working Group on Older People (EWGSOP) included muscle mass, gait speed and hand grip strength as the main parameters in diagnosing sarcopenia and then in 2018 EWGSOP revised it to EWGSOP2 by changing the step strength criteria as criteria for diagnosing normal sarcopenia (Cruz-Jentoft et al., 2010, 2019). Until now, Indonesia does not yet have a decision to diagnose sarcopenia. However, the Asian Working Group for Sarcopenia (AWGS) conducted a study related to the diagnosis of sarcopenia that can be carried out for Asian populations including Indonesia by using the EWGSOP approcach. Nevertheless since its inception, muscle mass is an indicator that constantly used to diagnose sarcopenia (Cederholm et al., 2011; Reiss et al., 2019). Eventually, based on the EWGSOP has assigned muscle mass, gait speed, and hand grip strength are the main indicators (Cruz-Jentoft et al., 2019). To diagnosis, skeletal muscle becomes the main variable in determining the muscle mass index used in diagnosing sarcopenia (Vitriana et al., 2016). As we know that skeletal muscles are responsible for the movement of the body, so automatically the skeletal muscles will play an important role in optimizing physical performance (Tieland et al., 2018). Another side, various studies show that as getting older there will also be an increase in body fat mass (Reid & Fielding, 2012).

Since body composition consisted of many compartments of muscle mass and types of fat mass and changes with aging have effect on poor physical performance. Furthermore, it is known that the highest prevalence of sarcopenia was reported in institutionalized older adults. It is important to analyze the association between body composition (muscle mass and fat mass) and physical performance as sarcopenia indicator among elderly in the nursing home (Benzinger et al., 2020).

2 MATERIALS AND METHODS

The research was conducted in October - November 2020, located at UPTD Griya Werdha Surabaya using a cross sectional research design. Respondents were selected by purposive sampling from elderly residing at Griya Wredha. Elderly who fulfill study criteria were selected as subjects in this study. Researchers have determined several inclusion criteria for respondents who are allowed to participate in the study, including elderly people aged ≥ 60 years, fully aware, not bed rest, and able to communicate with them. As for the exclusion criteria, including respondents who resigned, were sick or bedrest at the time when the data were collecting, and were not cooperative in the study. Total samples in the study were 54 elderly people. This study has an ethical number: 183 / HRECC.FODM / III / 2020.

Primary and secondary data were collected. Primary data was conducted to obtain data in the form of anthropometry and sarcopenia indicators in the form of skeletal muscle mass index (SMI), hand-grip strength (HS), and walking speed (WS). Secondary data of medical record were disease history, length of stay in the institution, and age. The skeletal muscle mass index (SMI) was calculated by measuring the mass of skeletal muscles by bioelectrical impedance analysis (BIA Karada Scan HBF375). The hand-grip strength (HS) was measured using a handgrip dynamometer (Camry EH 101) in kilograms. Subjects were instructed to hold the dynamometer as hard as they could while seated in an upright posture with arms by their sides and elbows flexed 90 degrees. The measurement was performed twice, each the left and right hand and the maximum value was taken. In the measurement of walking speed,

subjects are tested on a 3-meter walked, then travel time is measured and calculated to be the speed of walking time in meters per second (m/s).

Cut-off point value for diagnosis of sarcopenia on three parameters, namely muscle mass index (kg/m2) <7.0 (male) and <5.7 (female); the standard values of handgrip strength (kg) were <26 (male) and <18 (female); walking speed (m/s) ≤0.8 (Vitriana et al., 2016). In addition, the way to diagnose sarcopenia are as follows: (1) Measurement of handgrip strength and gait speed; (2) If handgrip strength and gait speed are normal based on cut-off then the respondent don't have sarcopenia but if handgrip and/or gait speed are low then the next measurement to diagnosis have to done; (3) Measurement of muscle mass, that if the measurement is normal then respondent don't have sarcopenia and vice versa. All measurement is then carried out an approach according to the cut-off on the AWGS (Asian Working Group for Sarcopenia) parameter because Indonesia does not yet have the most determined diagnosis of sarcopenia. The AWGS determination has referred to the EWGSOP (European Working Group on Sarcopenia in Older People) and has been adapted to the conditions of the Asian community. Therefore, researchers chose AWGS in making the diagnosis of sarcopenia in this study. This study was a cross-sectional observational analytic study. To analyze correlation of body composition and sarcopenia indicators in elderly all statistical analyses were performed using IBM SPSS Statistics 20.0 version. The distributed variables are shown as mean ± standard deviation while the correlation analysis using *Pearson Correlation Coefficient.* As for the significance value of the analysis results if the p-value <0.05.

3 RESULTS AND DISCUSSION

Distribution about characteristics of subject showed in Table 1. It is known that most of the respondents are female (75.9%) with average of age about 71 ± 8.2 years old, continuous mean of long stayed in nursing home 21.6 ± 17.2 month.

This study shows that respondents have a mean of body weight 51 ± 12.2 kg with a body mass index (BMI) of 21.6 ± 4.5 kg/m^2. The percentage of fat mass and muscle mass in the elderly, respectively, has a mean of 30.6 ± 7.25 (%) and 23.0 ± 2.8 (%), the details are summarized in Table 2. Data that were released states that fat in the elderly can reach 30% while the Lean Body Mass (LBM) that consisting of protein, water, and mineral mass is 12%, 53%, and 5%, respectively (Brown et al., 2011).

Table 1: Characteristics of subject.

Variable	Total (n) or mean ±SD	%
Age (years) Long stayed (month) Body weight (kg)	71 ± 8.2 21.6 ± 17.2 51.1 ± 12.2	
Gender		
Male	13	24.1
Female	41	75.9

It is known that the elderly tends to have a higher body fat mass when compared to their fat-free mass including muscle mass in the elderly, it is because when someone getting older, the fat mass tends to increase while the muscle mass will decrease (JafariNasabian et al., 2017; Kemmler et al., 2019). In contrast, fat mass increases gradually around the age of 20-25 years and peaks at around 60-70 years of age (Cruz-Jentoft et al., 2019; JafariNasabian et al., 2017). Muscle loss accompanied by an increase in fat mass is common in the elderly, known as sarcopenia obesity syndrome (JafariNasabian et al., 2017; Kalyani et al., 2014). Physical activity, food intake, and hormonal changes due to aging can all be associated with changes in body composition in the elderly (Brown et al., 2011).

In addition to changes in body composition due to aging, other effects that can be caused by aging include the limited physical performance of the elderly which tends to decline so that they may have limitations in movement (S. Kim et al., 2017; Mikkola et al., 2020). Furthermore, various factors that cause decreased body function in the elderly, including physical performance are also associated with sarcopenia (Sims et al., 2013). Sarcopenia is an age-related change that effects to changes in body fat and muscle. Muscle loss is even referred to as a universal phenomenon that commonly occurs due to increasing age even in healthy people (Amarya et al., 2015). Association between age and aging factors, skeletal muscles will also run into atrophy (Tieland et al., 2018). A study conducted ina quantitative review showed that the rate of reduction in muscle mass during life was about 0.37% a year for women, and 0.47% a year for men (Mitchell et al., 2012). Based on longitudinal research, it was found that the elderly who are more than 75 years old, on average will lose muscle mass of about 0.64-0.70% a year for women and about 0.80-0.98% a year for men (Mitchell et al., 2012). Skeletal muscles, also known as striated muscles, are known to be numerous and attached to the limbs of the body (Ministry of Health, 2017).

Table 3 describe a descriptive analysis of the measurement results of several indicators of

Table 2: Characteristics of body composition in elderly.

Characteristics	Total (n=54)	Male (n=13)	Female (n=41)
	Mean ± SD	Mean ± SD	Mean ± SD
Body Mass Index (kg/m^2)	21.6 ± 12.2	21.8 ± 3.5	21.5 ± 4.8
Body Fat (%)	30.6 ± 7.25	25.4 ± 7.1	32.2 ± 6.59
Visceral Fat (%)	6.6 ± 5.1	9.1 ± 5.3	5.8 ± 4.8
Subcutaneous Fat			
Whole (%)	25.0 ± 6.8	18.3 ± 5.3	27.2 ± 6.09
Arms (%)	24.0 ± 8.7	17.6 ± 4.8	26.02 ± 8.6
Legs (%)	38.2 ± 10.8	23.1 ± 5.5	42.9 ± 7.03
Trunk (%)	31.3 ± 9.2	21.9 ± 6.8	34.3 ± 7.75
Muscle Mass			
Whole (%)	23.0 ± 2.8	26.2 ± 2.8	21.9 ± 1.9
Arms (%)	18.2 ± 4.85	22.7 ± 7.4	16.7 ± 2.45
Legs (%)	28.3 ± 6.2	36.1 ± 4.9	25.8 ± 4.2
Trunk (%)	33.7 ± 7.5	37.6 ± 10.2	32.5 ± 6.05

sarcopenia which include the mean muscle mass index (3.9 ± 1.05 kg / m2), handgrip strength (14.5 ± 5.1 kg), and gait speed (0.5 ± 0.19 m/s). Moreover, based on gender it can be concluded that male respondents tend to have higher mean results for each indicator of sarcopenia when compared to female respondents. It is in line with a study conducted by measuring muscle mass between male and female respondents and the results showed that male muscle mass (31.23 ± 4.19 kg) was higher when compared to elderly female respondents (21.01 ± 3.20 kg) (Krzymińska-Siemaszko et al., 2014). Likewise, the results of research conducted in Indonesia found that the muscle mass index, physical performance and muscle strength of men tended to be higher than that of women (Vitriana et al., 2016). The differences that occur can be caused by various factors such as age, body weight, protein intake, menopause, and hormones (Chen et al., 2016; Lowe et al., 2010; Skrzek et al., 2012). Men will tend to have higher muscle mass it can be caused by the hormone testosterone which can affect muscle building (Gentil & Bottaro, 2010).

If be observed at each characteristic indicator of sarcopenia regardless of gender, most of the three indicators will be categorized as low with a percentage reached up to 90%. The low category of respondents' muscle mass index variable reached 96.3%. It is known that the muscle mass index is associated with height, physical activity, obesity, and comorbidities (Bosy-Westphal & Müller, 2015; Serra-Prat et al., 2017). A study that related with muscle mass index states that only 39.3 ± 4.5% are categorized as normal and the rest are known to have moderate and low muscle mass index (Chang et al., 2017). The indicators of hand grip strength and walking speed, it is known that it is related to physical performance. In line with the indicators on the muscle mass index, indicators on physical performance also have a very high percentage that reached up to 90%. Several studies have stated that physical performance will be related to the muscle mass in the thighs and in the hand muscles which are represented by hand grip strength (Altubasi, 2017; Kristiana et al., 2020). The study also stated that 44.3% of respondents had moderate physical performance (Kristiana et al., 2020). Based on the mean value of three indicators of sarcopenia, it can be concluded that most of the elderly (> 90%) have values that are below the cut-off point value for sarcopenia (Vitriana et al., 2016). According to a systematic review and meta-analysis study conducted to compare the prevalence of sarcopenia in the population of community people, hospitals, and nursing home, it was found that the elderly who live in nursing home have the highest prevalence of sarcopenia up to 38%, elderly people who are hospitalized are 23%, while the elderly who live in the community are only 10% of the total respondents of 34.955 people (Papadopoulou et al., 2020). Another study was stated that the prevalence of sarcopenia in the elderly living in social institutions reached 41% (Shen et al., 2019). This prevalence is lower when compared to the results of the sarcopenia study conducted by researchers, which reached a prevalence of 98.1% of the elderly have sarcopenia. However, in a different study conducted in Japan, it was found that the prevalence of sarcopenia in elderly people can reach 7.1-98.0% in men and 19.8-88.0% in women (H. Kim et al., 2016). Based on a comparative study that has been

Table 3: Indicators of sarcopenia.

Characteristics	Total (n=54)	Male (n=13)	Female (n=41)
	Mean ± SD	Mean ± SD	Mean ± SD
Skeletal Muscle Mass Index (kg/m^2)	3.9 ± 1.05	5.09 ± 1.1	3.6 ± 0.7
Low (%)	96.3	92.3	97.6
Enough (%)	7.3	7.7	2.4
Handgrip Strength (kg)	14.5 ± 5.1	19.6 ± 5.5	12.98 ± 3.8
Low (%)	90.7	92.3	90.2
Enough (%)	9.3	7.7	9.8
Gait Speed (m/s)	0.5 ± 0.19	0.69 ± 0.16	0.45 ± 0.17
Low (%)	90.7	84.6	95.1
Enough (%)	9.3	15.4	4.9
Sarcopenia (person)	53	12	41
Prevalence (%)	98.1	92.3	100

conducted, it shows that the elderly who live with the family tend to have a higher sense of independence and are significantly different from the elderly in the nursing home so that they tend to feel capable of doing many activities while the elderly in social institutions tend to feel that they are weak and always needing other people (Putri et al., 2015). Furthermore, the elderly often feel boredom while in the orphanage due to the limited food choices they can choose so that it can affect the elderly's food intake and will significantly affect their body weight (Crogan et al., 2013).

As we known that measurement of the indicators of sarcopenia and the skeletal muscle of respondents has been carried out by researchers with the distribution results described in Table 3. Furthermore, in Table 4. Researchers processed the data to see the relationship between both of them, and it was found that there was a significant relationship between muscle mass index and the whole skeletal, skeletal arms, and skeletal legs. In the indicator of handgrip strength with whole skeletal, and skeletal legs, a significant relationship was also found. The last, on gait speed indicator with the whole skeletal, skeletal arms, and skeletal legs are related to. From the skeletal trunk data, it is known that there is no relationship with the muscle mass index, hand grip, and gait strength.

Muscle mass index calculated by involving the proportion of total skeletal muscle in the body is known to be associated with total skeletal muscles, arm muscles, and leg muscles. It can be due to the theory that most of the skeletal muscles are attached to the bones of the limbs such as the limbs (Ministry of Health, 2017). Skeletal muscle has the main function to move such as in the hands, fingers, and feet that there are many skeletal muscles in them (Kedkar, 2016). In other studies, it was found that the arm muscle mass index (arms SMI) was significantly associated with the anthropometric index of muscle mass (Shimono et al., 2020). Moreover, handgrip was known to be positively associated with leg muscles ($p = 0.011$). In line with the results of this study, according to Fragala et al. (2016) mention that handgrip strength is significantly related to the strength of the leg's existence. In the variable of stride strength with leg muscles, it is known to have a positive relationship, which means that the lower of gait speed, the weaker the leg muscles of the elderly. In elderly, aging followed by the susceptibility of the elderly to have health problems such as muscle disorders will significantly reduce muscle strength in the legs and ankles (World Health Organization, 2018; Zhao et al., 2018).

In addition, the researchers also included the variables of body fat (body fat, visceral fat, and subcutaneous fat) into the correlation analysis. From the table above, it can be concluded that the variable body fat which has a significant correlation with the sarcopenia indicator tends to have a negative relationship. This is because the main variable in measuring sarcopenia is related to body muscles (Cruz-Jentoft et al., 2019; Shimokata et al., 2018). In elderly, it is known that body muscle tends to be inversely related with body fat, meaning that the elderly often sustain an increase in fat mass but a decrease in muscle mass (Kemmler et al., 2019). The condition of decreased muscle mass that followed with increased of body fat in the elderly is known as sarcopenic obesity (Hong & Choi, 2020). Based on a cohort study using the National Health and Nutrition Examination Survey (NHANES), the percentage of obese sarcopenia in men reaches 12.6% and in women is 33.5% and in the elderly who are over 80 years old it can increase to 27.5% in men and 48% in women (Batsis et al., 2017).

Table 4: Correlation between body composition with indicators of sarcopenia.

Characteristics	Indicators of Sarcopenia (correlation, significance)		
	Skeletal Muscle Mass Index	Handgrip Strength	Gait Speed
Skeletal Muscle			
Whole	r=0.62 (p=0.000)*	r=0.301 (p=0.027)*	r=0.348 (p=0.010)*
Arms	r=0.68 (p=0.000)*	r=0.246 (p=0.073)	r=0.336 (p=0.013)*
Legs	r=0.58 (p=0.000)*	r=0.342 (p=0.011)*	r=0.405 (p=0.002)*
Trunk	r=0.06 (p=0.668)	r=0.196 (p=0.436)	r=0.108 (p=0.436)
Body Fat	r=-0.09 (p=0.516)	r=-0.169 (p=0221)	r=-0.252 (p=0.066)
Visceral Fat	r=0.604 (p=0.000)*	r=0.181 (p=0.191)	r=0.147 (p=0.290)
Subcutaneous Fat			
Whole	r=-0.339 (p=0.012)*	r=-0.265 (p=0,053)	r=-0.308 (p=0.023)*
Arms	r=-0.181 (p=0.191)	r=-0.261 (p=0,056)	r=-0.274 (p=0.045)*
Legs	r=-0.510 (p=0.000)*	r=-0.357 (p=0.008)*	r=-0,395 (p=0.003)*
Trunk	r=-406 (p=0.002)*	r=-0.220 (p=0.109)	r=-0.303 (p=0.026)*

A recent meta-analysis study showed that fat mass can weaken the relationship of muscle mass and function mobility in elderly adults (Schaap et al., 2013). Furthermore, another research also states that fat mass is known to be negatively related with muscle performance in adults and the elderly, in this case is using a jump strength test (Moore et al., 2020). It can be caused by adipose tissue that can cause muscle shortening that is not optimal and weaken the calcium signal which can affect future muscle formation (Rahemi et al., 2015; Tallis et al., 2018). High of fat mass is also known to reduce the activation of agonist muscles on the other hand, high adipose will also increase the activity of body muscle loss which can have an impact on reducing muscle fiber formation (Moore et al., 2020). Adipose is also associated with a higher infiltration of Adipose Tissue of Skeletal Muscles (ATSM) which is associated with decreased strength capacity and strength formation by muscles leading to deterioration of muscle quality (Moore et al., 2020; Tuttle et al., 2012). Even though, there are many other factors that might affect it such as age, weight, height, physical activity, etc.

The lack of this study is that it does not study detailed information on the factors that cause sarcopenia each individual. Although living in an elderly nursing home with the same physical activity and diet, data on physical activity and food intake per individual may show different results. Other factors such as stress levels, hormonal changes, other comorbidities in the elderly may be the cause of sarcopenia which still needs further investigation. While the strengths of this study are to explore sarcopenia data based on three indicators, namely muscle mass index, hand grip strength, and walking speed and also analyzes body composition in the form of body fat (body fat, visceral fat, and subcutaneous fat).

4 CONCLUSIONS

In summary, muscle mass area and subcutaneous fat was correlated with sarcopenia indicators. The important finding is the prevalence of sarcopenia was high among elderly in the nursing home. Further research is needed to investigate factors associated with sarcopenia in the population. The most important thing is implementing preventive strategies and effective treatment to get better physical performance and optimal health impact.

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