Cut-off of Anthropometry Measurement and Nutritional Status Among Elderly Outpatient in Indonesia: Multi-centre Study

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ABSTRACT

Aim: *to obtain the cut-off value of anthropometric measurements and nutritional status of elderly in Indonesia.*

Methods: *a multicentre-cross sectional study was performed at 9 hospitals in Indonesia. The data collected comprises of samples characteristics, anthropometric measurements (weight, height, trisep, bisep, subscapular, suprailiac, and circumference of the hip, waist, arm, calf, and thigh), albumin value, MNA score and ADL Index of Barthel.*

Results: *a total of 702 subjects were collected. The average value of serum albumin is 4.28 g/dl, with 98% subjects had normal serum albumin (>3.5 g/dl). The mean MNA score and BMI was 23.07 and 22.54 respectively. Most of subjects (56.70%) had risk of malnutrition based on MNA score, and 45.01% had normal nutritional status based on body mass index. Average value of several anthropometric measures (weight, stature, and body mass index; sub-scapular and supra-iliac skinfolds; thigh, calf, mid-arm, and waist circumferences) in various age groups in both groups of women and men were obtained. Cut-off values of various anthropometric indicators were also analyzed in this study with MNA as a gold standard.*

Conclussion: *this study showed age related anthropometric measurement differences in both men and women aged 60 years and older.*

Key words: *nutritional status, anthropometry, elderly, Indonesia, outpatient.*

INTRODUCTION

The elderly population number is growing rapidly in Indonesia, following the increase in life expectancy from 67.8 years in the period of 2000-2005 to 73.6 years in the period of 2020-2025.[1] The increase of elderly population will be followed by the emergence of various problems in health care and services. Malnutrition is a major issue that must not be overlooked in the elderly and is associated with several diseases. Malnutrition in old age is often not diagnosed properly, resulting in a failure to meet the nutritional needs of the elderly. Therefore, early identification of nutritional status of elderly is helpful for understanding their health and to prevent them from disease co-morbidities. One of the risk factors of malnutrition in sick elderly is due to health workers who do not care for screening of malnutrition in the elderly earlier.[2]

Anthropometric measurements are important indicators of an individual's nutritional status. It is non-invasive, inexpensive, and easily applied. Anthropometric reference value of older adult can not be applied in elderly due to ageing process which result in changes of body composition, such as height and weight loss, muscular mass loss, and fat mass increase.[3] The distribution of anthropometric

characteristics is affected by non pathological factors such as age, gender, and geographical area.[4] The World Health Organization (WHO) Expert Committee encourages countries to collect data on elderly through anthropometric surveys conducted at regular intervals, coupled with monitoring of the health and functional status of this segment of the population.[5] This means that there is a need of local gender and age specific reference value for elderly. Studies had been done in several countries to obtain anthropometric values of elderly based on sex and age. [3,4,6]

Data on anthropometric value of elderly in Indonesia is limited, especially for elderly in outpatients setting. Such information would be useful for early detection of nutritional status of elderly and can correct nutritional evaluation. Early detection of malnutrition in elderly patients in outpatient setting is imperative for effective treatment and prevents from hospitalization. Some studies had been done to obtain nutritional status of elderly in Indonesia, but there are no multi-centre data of nutritional status of elderly in outpatient setting. The objective of present study was to obtain cut-off value of anthropometric measures and nutritional status of elderly outpatient.

METHODS

This is a cross-sectional multi-centre study conducted in hospitals in 10 cities in Indonesia (Jakarta, Bandung, Bali, Surabaya, Surakarta, Malang, Jogjakarta, Semarang, Padang, and Makasar). The study population consisted of individuals aged 60 years and older, of both genders who attend the outpatient clinic of hospitals in those cities. The inclusion criteria included elderly who have no disability (indicated by Barthel index of ADL score of 20), no chronic diseases, and willing to participate in this research.

The anthropometric measurements were done by trained staffs. The questionnaire included socio-demographic variables such as age, gender, education, occupation. Functional status as measured by Barthel index was also collected in this study. The measures analyzed were weight, height, knee height, triceps, biceps, subscapular, suprailiac, thigh circumference, calf circumference, upper arm circumference, waist circumference, hip circumference, fat mass, and fat-free mass. Nutritional status was assessed by using Mini Nutritional Assessment (MNA), Body Mass Index (BMI), and albumin serum. The maximum score MNA is 30 and the cutoff point is 18.5. The at-risk group had an MNA score between 18.5 and 23.5, while the nourished group had an MNA score above 23.5.

Anthropometry Assessments

Weight was measured by a portable scale with 100 kg maximum capacity, with the individual barefoot and using the smallest possible amount of clothing. Measurement of height was taken when subjects stood with their scapula, buttocks and heels resting against a wall, the neck were held in a natural non-stretched position, the heels were touching each other, the toe tips formed 45^0 angle. Knee height is the distance from the bottom of the foot on the heel to the anterior surface of the ankle joints of each knee (flexed 90^0).

The formula for Malaysian to calculate height based on knee height:[7]

Male height (cm) = (1.924 x knee height) + 69.38
Women's height (cm) = (2.225 x knee height) + 50.25
Body mass index was calculated by weight and height. BMI formula is weight / $(height)^2$.

Subcutaneous fat (triceps, biceps, subscapular, suprailiaka) were measured by means of caliper. The triceps skinfold was measured in the midline of the posterior aspect of the arm, over the tricep muscle, at a point midway between the lateral projection of the acromion process of the scapula and the inferior margin of the olecranon process of the ulna. Biceps skinfold was measured as the thickness of a vertical fold raised on the anterior aspect of the arm, over the belly of the biceps muscle. The subscapular skinfold is picked up on a diagonal, inclined infero-laterally approximately 45^o to the horizontal plane in the natural cleavage lines in the skin. The site is just inferior to the inferior angle of the scapula. The suprailiac skinfold was measured in the midaxillary line immediately superior to the iliac crest. Upper arm, waist, thigh, hip, abdominal, and calf circumferences were measured using a flexible non-elastic measuring tape. The waist circumference was measured at the end of a normal expiration, without the tape compressing the skin. The hip circumference was measured at the maximum posterior protrusion of the buttocks. To measure thigh circumference, the measuring tape is placed horizontally around the thigh at the level of the thigh skinfold measurement, that is midway between the midpoint of the inguinal crease and the proximal border of the platella. Abdominal circumference was measured by the tape placed around the subject at the level of the greatest anterior extension of the abdomen in a horizontal plane. To measure the calf circumference, an inelastic tape measure is positioned horizontally around the calf and moved up and down to locate the maximum circumference in a plane perpendicular to the long axis of the calf. The maximum circumference

is recorded to the nearest 0.1 cm, with the tape incontact with the whole circumference but not indenting the skin.[8] All measurements were taken in triplicate (same visit), and the mean values were used in the analyses.

Statistical Procedure

Data were recorded and analyzed using STATA v.10.0. Data analysis used means and standard deviations, in accordance with gender and age group (60-64, 65-69, 70-74, 75-79, ≥80 years). Age group effect was analyzed by ANOVA. Cut off value of anthropometric measures was obtained by analyzed area under ROC curve and logistic regression test. Statistical significance was defined with 5% confidence intervals ($p<0.05$).

RESULTS

A total of 702 subjects were recruited in this study. **Table 1** showed characteristics of all subjects. Most of the subjects (60.68%) were women. Based on the functional status, 96.01% are independent and only 3.99% had a mild dependency status.

Table 1. Characteristics of subjects

Characteristics	n (%)
Gender	
- Men	276 (39.32)
- Women	426 (60.68)
Education	
- None	7 (1.00)
- Elementary	95 (13.63)
- Junior high	134 (19.23)
- Senior high	241 (34.58)
- College	220 (31.56)
Age group	
- 60-64	156 (22.22)
- 65-69	234 (33.33)
- 70-74	164 (23.26)
- 75-79	96 (13.68)
- ≥ 80	52 (7.41)
Functional status	
- Independen	674 (96.01)
- Mild dependency	28 (3.99)
- Moderate dependency	0 (0.00)
- Full dependency	0 (0.00)

Nutritional status of subjects which is assessed by MNA, BMI, and albumin serum is shown in **Table 2**. Based on these three parameters, most subjects had normal nutritional status. The average value of serum albumin is 4.28 g/dl, with 98% subjects had normal serum albumin (>3.5 g/dl). The mean MNA score was 23.07. If the MNA score is further categorized to obtain the nutritional status of subjects, 41.17% were well nourished, 56.07% are at risk of malnutrition and 2.14% suffer from malnutrition. Average BMI value of the subject is 22.54 Kg/m^2, with 45.01% had normal nutritional status.

Table 2. Nutritional status based on albumin serum levels, MNA score, and body mass index

Nutrition Status	Men n (%)	Women n (%)	Total n (%)
Albumin serum			
- Normal (≥ 3.5 gr/dl)	271 (98.19)	417 (97.89)	688 (98.01)
- Deficiency (< 3.5 gr/dl)	5 (1.81)	9 (2.11)	14 (1.99)
MNA score			
- Well nourished	126 (45.65)	163 (38.26)	289 (41.17)
- Risk of malnutrition	147 (53.26)	251 (58.92)	398 (56.70)
- Malnourished	3 (1.09)	12 (2.82)	15 (2.14)
Body Mass Index (BMI)			
- < 18.5 kg/m^2 (underweight)	31 (11.23)	42 (9.86)	73 (10.40)
- 18.5 – 22.9 kg/m^2 (normal)	131 (47.46)	185 (43.43)	316 (45.01)
- 23 – 24.9 kg/m^2 (overweight)	60 (21.74)	98 (23.00)	158 (22.51)
- ≥ 25.0 kg/m^2 (obese)	54 (19.57)	101 (23.71)	155 (22.08)

Table 3 summarizes anthropometric value based on gender and age group. As with several other studies, the mean weight and height of men in this study are larger than females. The mean of body weight decreased significantly ($p<0.05$) according to age groups in both male and women groups. Mean body mass index values in the group of women are larger than men. The mean of upper arm, thigh, calf, waist, hip, abdomen circumference, subscapular, and suprailiac decreased significantly among age group in both sex ($p<0.05$).

In this study we also tried to obtain the cut off value of anthropometric measures (**Table 4**) MNA was used as gold standard and categorized into two categories: 1) well-nourished (score MNA >23.5); 2) risk of malnutrition and malnutrition (score of MNA ≤23.5).

DISCUSSION

Diagnosing the nutritional status of elderly is essential. Malnourished elderly have a higher risk to infections, osteoporosis, fractures, respiratory and cardiac problems, and also mortality which is correlated with the severity of nutritional deficiencies. Malnourished elderly usually have longer hospital stay which will increase the health care cost.[9] One of the tools to screen malnutrition in elderly patients is Mini

Table 3. Anthropometric values for men and women

Anthropometric Measures	Age Group (mean [sd])					
	60-64	65-69	70-74	75-79	≥ 80	Total
Weight (kg)†						
- Men	63.80 (8.54)	63.74 (8.91)	61.93 (8.09)	57.99(10.41)	57.01 (9.18)	61.70 (9.23)
- Women	56.59 (7.51)	54.60 (7.72)	53.00 (7.66)	52.61 (9.49)	48.01 (12.43)	54.19 (8.37)
- Total	58.72 (8.47)	58.19 (9.33)	56.59(8.96)	54.79 (10.17)	53.72 (11.25)	57.14 (9.45)
Height (cm)						
- Men	165.69 (4.39)	165.86 (4.76)	166.95 (4.66)	165.99 (4.76)	165.73 (4.22)	166.09 (4.61)
- Women	154.82 (4.68)	154.57 (4.76)	154.77 (4.63)	154.19 (4.67)	153.22 (3.51)	154.57 (4.64)
- Total	158.02 (6.76)	159.01 (7.28)	159.67 (7.57)	158.99 (7.47)	161.16 (7.25)	159.10 (7.29)
Body Mass Index (kg/m^2)†						
- Men	23.27 (3.19)	23.14 (2.83)	22.25 (2.95)	20.97 (3.29)	20.71 (2.96)	22.35 (3.14)
- Women	23.62 (3.08)	22.86 (3.10)	22.12 (2.97)	22.09 (3.72)	20.39 (4.95)	22.67 (3.33)
- Total	23.52 (3.11)	22.97 (2.99)	22.27 (2.96)	21.64 (3.58)	20.59 (3.76)	22.54 (3.26)
Knee height (cm)						
- Men	50.01(1.05)	50.08 (1.05)	50.66 (1.05)	50.15 (1.05)	50.03 (1.04)	50.21 (1.05)
- Women	46.95 (1.05)	46.84 (1.05)	46.93 (1.05)	46.67 (1.05)	46.25 (1.03)	46.84 (1.05)
- Total	47.83 (1.05)	48.09 (1.06)	48.39 (1.06)	48.05 (1.06)	48.62 (1.06)	48.14 (1.06)
Triceps (mm)						
- Men	18.48 (1.47)	16.78 (1.03)	16.18 (0.76)	15.73 (0.81)	14.78 (0.86)	16.52 (0.99)
- Women	20.07 (0.60)	20.18 (0.63)	19.40 (0.64)	18.57 (0.43)	18.05 (0.76)	19.66 (0.60)
- Total	19.59 (0.86)	18.81 (0.82)	18.07 (0.72)	17.39 (0.61)	15.94 (0.83)	18.39 (0.79)
Biceps (mm)						
- Men	10.73 (2.05)	9.53 (1.74)	8.42 (1.74)	9.13 (1.84)	7.94 (1.80)	9.18 (1.82)
- Women	11.77 (1.55)	11.47 (1.64)	11.75 (1.65)	10.03 (1.54)	9.76 (1.83)	11.32 (1.62)
- Total	11.45 (1.71)	10.66 (1.69)	10.28 (1.72)	9.65 (1.67)	8.56 (1.82)	10.42 (1.71)
Subscapular†						
- Men	19.76 (0.86)	20.08 (0.69)	17.25 (0.68)	15.91 (0.75)	15.13 (0.72)	18.12 (0.77)
- Women	21.03 (0.52)	19.16 (0.69)	19.52 (0.57)	16.81 (0.60)	15.63 (0.75)	19.22 (0.63)
- Total	20.65 (0.62)	19.52 (0.69)	18.59 (0.63)	16.44 (0.66)	15.31 (0.72)	18.79 (0.69)
Suprailiac (mm) †						
- Men	23.53 (0.68)	23.66 (0.79)	20.74 (0.80)	18.91 (1.00)	17.95 (1.03)	21.53(0.88)
- Women	23.91 (0.66)	21.60 (0.75)	21.19 (0.61)	19.46 (0.59)	15.97 (0.99)	21.52 (0.72)
- Total	23.79 (0.66)	22.40 (0.77)	21.01 (0.69)	19.24 (0.75)	17.21 (1.01)	21.52 (0.78)
Thigh circumference (cm) †						
- Men	44.41 (4.29)	43.67 (4.87)	42.30 (5.19)	40.27 (4.85)	41.29 (3.85)	42.70 (4.91)
- Women	43.44 (5.02)	42.93 (4.69)	42.15 (4.64)	41.11 (5.02)	40.96 (6.40)	42.55 (4.94)
- Total	43.73 (4.83)	43.22 (4.76)	42.21 (4.85)	40.77 (4.95)	41.17 (4.88)	42.61 (4.93)
Calf circumference (cm) †						
- Men	34.49(15.87)	34.06 (16.19)	32.63 (16.09)	31.43 (15.33)	32.89 (14.02)	33.29 (16.01)
- Women	31.87 (14.38)	32.38 (15.57)	31.23 (14.99)	30.93 (15.02)	30.65 (15.57)	31.72 (15.14)
- Total	32.67 (15.31)	33.05 (15.99)	31.81 (15.57)	31.13 (15.13)	32.09 (14.94)	32.35 (15.67)
Upper arm circumference (cm) †						
- Men	27.22 (3.66)	27.41 (4.05)	26.12 (4.06)	24.48 (3.84)	26.13 (3.05)	26.50 (3.95)
- Women	26.98 (3.41)	26.62 (3.69)	25.71 (3.59)	25.57 (4.31)	25.27 (4.14)	26.30 (3.74)
- Total	27.05 (3.48)	26.93 (3.85)	25.88 (3.78)	25.13 (4.14)	25.82 (3.47)	26.38 (3.82)
Waist circumference (cm) †						
- Men	85.84 (7.96)	86.45 (8.34)	85.01(8.57)	82.14 (9.07)	83.38 (8.68)	85.03 (8.55)
- Women	83.02 (8.41)	80.53 (8.97)	79.46 (7.91)	80.64 (10.46)	77.20 (10.67)	80.79 (8.98)
- Total	83.85 (8.36)	82.86 (9.18)	81.69 (8.60)	81.25 (9.89)	81.16 (9.81)	82.46 (9.05)
Hip circumference (cm) †						
- Men	93.22 (7.96)	93.35 (8.29)	91.89 (7.23)	89.43 (8.43)	92.35 (7.28)	92.30 (7.95)
- Women	95.62 (7.38)	94.32(7.48)	93.39 (7.44)	93.38 (8.68)	90.35 (11.89)	94.14 (7.91)
- Total	94.91 (7.61)	93.94 (7.81)	92.79(7.37)	91.78 (8.75)	91.62 (9.17)	93.42 (7.97)
Abdomen circumference (cm) †						
- Men	90.22 (39.57)	90.42 (37.19)	89.16 (39.20)	85.27 (39.56)	86.47 (38.89)	88.91 (38.99)
- Women	90.28 (38.37)	88.08 (39.24)	87.54 (39.41)	89.38 (42.03)	84.98 (44.25)	88.57 (39.84)
- Total	90.27 (38.68)	89.01 (38.61)	88.19 (39.35)	87.73 (41.43)	85.93 (40.92)	88.71 (39.50)

† Statistically significant difference of mean value across age groups (ANOVA)

Table 4. Cut-off value of anthropometric measures in men and women

Anthropometric measures	Men			Women		
	Cut-off	AUC	*P-value*†	cutoff	AUC	*P-value*†
Upper arm circumference (cm)	≥ 27.00	67.17	0.00	≥ 27.00	66.53	0.00
Waist circumference (cm)	≥ 88.50	71.03	0.00	≥ 85.90	61.54	0.00
Thigh circumference (cm)	≥ 44.00	61.05	0.00	≥ 43.70	65.61	0.00
Hip circumference (cm)	≥ 96.00	65.60	0.00	≥ 99.00	60.14	0.00
Abdomen circumference (cm)	≥ 95.10	63.90	0.00	≥ 93.00	63.94	0.00
Calf circumference (cm)	≥ 34.80	63.79	0.00	≥ 32.50	67.37	0.00
Trisep (mm)	≥ 29.70	57.79	0.00	≥ 27.50	60.19	0.00
Bisep (mm)	≥ 24.30	56.21	0.00	≥ 20.00	59.96	0.00
Subscapular (mm)	≥ 28.00	57.32	0.00	≥ 26.00	61.63	0.00
Suprailiaka (mm)	≥ 27.00	56.46	0.00	≥ 28.30	59.40	0.00

† *Logistic regression analysis*

Nutritional Assessment (MNA) which has high predictive value for morbidity and mortality. It consists of 18 assessment items which is composed by an anthropometric assessment, diet characteristics questionnaire, general health, and self evaluation of health and nutritional state.[10,11] Based on MNA score, the prevalence of malnutrition in this study is quite small (2.14%). This prevalence is lower compared to other study among free living elderly in Iran which found malnutrition of 12.0%.[12] Compare to other study done in Asian country (Japan) among frail elderly which found malnutrition of 19.9%, this prevalence was also lower.[13] The prevalence of malnutrition ranges from 5-10% in free living elderly to 3-85% in homebound, nursing home, and hospitalized elderly.[14]

Despite malnutrition prevalence is quite small in the present study, it should be pointed out that the prevalence of malnutrition risk is substantial (56.70%). Research conducted by Pearson et al elaborates that malnutrition and malnutrition risk have a 3-year death risk of 3.3% (CI 95%=1.11-9.79).[15] Appropriate interventions for subjects at risk of malnutrition are necessary to prevent them from becoming malnourished.

Based on albumin level, present study only find 1.99% subject who were malnourished (albumin level < 3,5 gr/dl). This means that most of elderly patients still have good nutritional status based on biochemical parameter. BMI is the most widely used indicator to determine individual nutritional status, which positively correlates with certain health and longevity indicators.[6,16,17] The value of BMI is generally considered to define and classify overweight and obese.[18] In the present study, underweight was observed in 10.4% population, and was higher in men (11.23%) than in women (9.86%). Malnutrition prevalence in this study is higher compare with study conducted by Sergio among healthy elderly which found malnutrition prevalence of 1.4%.[6]

In contrast to underweight prevalence, overweight and obese prevalence were higher in this study. This phenomenon could be an impact of nutrition transition in Indonesia. As a developing country, Indonesia is facing dramatic change in age structure, which then followed by changes in dietary behaviour and physical activity patterns. Those changes will lead to increased risk of obesity and chronic disease. Dietary behaviour changed from high in fibre and low in fat into rich in animal fats, sugars and refined products that are low in fibre.[19] Overweight and obesity in elderly were associated with diminished lung function, decreased in physical well being, lower quality of life, and increased mortality.[20,21,22] Bannerman, et al recommended overweight elderly to maintain weight, or undergo weight loss strategies and increase physical activities to help preserve fat-free mass.[23]

Concerning anthropometric measurements, this study is the pilot study targeting on the elderly in Indonesia. This study elaborates the values of anthropometry which then are described in means, as well as by gender and age groups with a large number of subjects participated. Because this study was conducted in several regions in Indonesia, the expected results could then be generalized to older populations of Indonesia. Because of the lack of national epidemiologic data for reference, this research data is expected to be used for reference and comparison data of nutritional status in older people, either for epidemiological and/or clinical studies in the future.

Considering anthropometric indicators, it is necessary to find the pattern of their association with characteristics factors, such as gender and age. Numerous changes in body composition occur along with aging process, such as changes in the size of body

organ, decreased bone mass, changed in body fat, and age related decline in stature. On average, elderly men were taller and heavier than elderly women in this study. There was a decrease in height and weight along with an increasing age, consistent with study done by Suriah.[24] One study find that there is a decreased of height for 2-3 cm/decade. The Euronut Seneca Study reported a height decrease in both men and women of 1-2 cm in 4 years.[25]

Upper arm circumference and thigh circumference are both useful in estimating muscle mass, which could serve as an indicator to detect the lack of nutrition in old age. Recommended method of measuring fat mass loss in elderly is thigh circumference which is relatively sensitive. Waist circumference has been used to identify the risk of cardiovascular disease and metabolic disorders.[26,27] Skin fold measurement is independent of height and correlates with body fat. It is less affected by hydration status than weight. In our study, elderly men showed a decrease in all skin fold thickness and hip circumference. This may be explained by a reduction in body frame, fat, and muscle mass in elderly.

Mean value of triceps and biceps in elderly women are greater than men. Although not statistically significant, we found a decrease in the value of biceps and triceps along with an increase in age groups for both gender. Overall, the decline in the value of biceps and triceps correlates significantly with age ($p < 0.05$). The triceps value in this study is larger when compared with the results from Sao Paulo research.[28] Upper arm circumference value is larger in the group of men than women. This is different from the value obtained from studies in Brazil, which obtain upper arm circumference values greater in women than men.

The difference values of anthropometry measurements in the population must be examined with caution, as aging process itself is influenced by many exogenous factors and genetic differences. Upper arm circumference and triceps values are often difficult to interpret, because differences in measurements could illustrate the difference between subcutaneous tissue compressibility caused by tissue hydration and redistribution of fat mass from the internal subcutaneous areas, especially in abdominal fat deposition.

Body composition will change its trend along with the increase in age, mainly marked by weight gain, which reached its peak earlier in men than women. Increased body fat and visceral intramiocellular lipid deposition is generally found in older person.[29,30] They also have tendency to be more obese, following a decrease muscle mass and increase in visceral fat.[31]

Cut off value of various anthropometric measurements and body composition for elderly men and women are obtained in this study with MNA as a gold standard. For example, the cut off value of upper arm circumference for elderly men and women is $\geq$ 27 cm, and the cut off value of waist circumference for elderly men and women are $\geq$ 88.5 cm and $\geq$ 85.9 cm respectively. The elderly who has upper arm and waist circumference value less than value above is considered to have risk of malnutrition. Study done by Snelatha among 10,042 healthy Asian Indian adults (mean age 40 years) revealed lower waist circumference cut off. It was reported that waist circumference cut off for men and women were 85 and 80 cm respectively.[32]

CONCLUSION

This study showed significant age-related anthropometric (weight, body mass index, subscapular, suprailiac, thigh circumference, calf circumference, upper arm circumference, waist circumference, hip circumference) differences in both men and women aged 60 years and older. Cut off value of various anthropometric measurements for Indonesian elderly men and women were obtained in this study.

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