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Correlation between hand grip strength and nutritional status in elderly patients

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Abstract. The process of aging impacts the function of the human body. Sarcopenia can cause frailty, which leads to changes in energy balance due to malnutrition, and it can progress if not treated properly. Hand grip strength is well known to be associated with several conditions in elderly, such as sarcopenia and frailty. We determined the correlation between hand grip strength and nutritional status in a cross-sectional study of 98 geriatric patients conducted between January and September 2016. Hand grip strength and nutritional status were measured. Median hand grip strength was 18. Six patients (6.1%) suffered malnutrition, 59 (60.2%) were at risk for malnutrition, and 33 (33.7%) had normal nutritional status. Based on Pearson correlation test, hand grip strength was correlated with nutritional status ($P = 0.008$, $r = 0.268$).

1. Introduction

Indonesia has the fifth largest elderly population in the world, which is increasing annually [1]. In 2010, the United Nations Population Fund stated that Indonesian population aged over 60 years reached approximately 18.1 million or 7.6% of the total population [2]. The proportion is predicted to reach approximately 13% by 2025 and approximately 25% by 2050. This means that a quarter of the Indonesian population in 2050 will be occupied by elderly [1,2].

In addition, the continuous aging process has several clinical effects on various body functions, such as sarcopenia. Sarcopenia involves progressive and comprehensive reduction in skeletal muscle mass and strength. These conditions affect functional mobility and become predisposing factors for other health risks, such as falls, in elderly [1,3]. Sarcopenia can cause frailty if not treated early. Decreased physical activity in patients with sarcopenia and frailty lead to changes in patient needs and energy balance, which can lead to malnutrition [4].

The interaction between sarcopenia and frailty, accompanied by various metabolic component changes that follow the aging process, classify the elderly population as a vulnerable group with poor nutritional status or malnutrition [5,6]. Saka et al. [7] claimed that the prevalence of malnutrition in



the elderly population reached approximately 44%. Chronic malnutrition in elderly may also cause decreased muscle mass, which can aggravate sarcopenia and malnutrition itself [7].

Presently, an easy and valid recognized method exists to determine sarcopenia by measuring hand grip muscle strength using a hand dynamometer [6,8]. Based on the literatures, hand grip strength is currently used as a predictor of mortality, disability, complications, and prolonged hospitalization. In some studies, measurement of hand grip strength is the best predictor, rather than other values, such as laboratory tests or other clinical measurements [9].

Meanwhile, nutritional status can be measured using various instruments, such as a Mini Nutritional Assessment (MNA) questionnaire. Various studies have claimed that this questionnaire are valid and reliable to measure nutritional status and determine malnutrition in the elderly [10,11].

Based on the previous studies, hand grip strength has been associated with muscle mass, which correlates with deterioration in elderly nutritional status [5,9]. To date, studies examining the correlation between hand grip strength and nutritional status remain limited, and to our knowledge, no such study has been done in Indonesia. Previous research was done in Europe and United States populations, which have different hand grip strength reference values from the Indonesian population [6]. In addition, the previous studies only assessed nutritional status based on the body mass index (BMI) and not the MNA questionnaire. Controversy also exists in the meta-analysis conducted by Milne et al. [12] which showed no positive correlation between improved nutritional status and increased hand grip strength.

The increasing number of elderly people with sarcopenia (which can be predicted with hand grip strength) and a decrease in nutritional status in elderly patients demonstrate the need to conduct research identifying the correlation between hand grip strength and nutritional status.

2. Methods

A cross-sectional study was conducted on 98 patients consecutively sampled from Geriatric Outpatient Clinic of Cipto Mangunkusumo Hospital from June to September 2016. The study protocol had been approved by the Health Research Ethics Committee of Faculty of Medicine, Universitas Indonesia-Cipto Mangunkusumo Hospital. Primary data were obtained directly from the research subjects. Inclusion criteria were subjects ≥ 60 years old who were able to understand and carry out instructions. Exclusion criteria were subjects who experienced arthralgia, dementia, schizophrenia, paralysis, other neurological disorders, arm fracture based on medical records, or the patient was unwilling to follow a series of tests required in this research. The minimum sample size was calculated using formula for correlative analysis and the obtained minimum sample value was 69 subjects.

The Jamar dynamometer was used to measure hand grip strength, and the MNA questionnaire was used to measure nutritional status. Height, weight, and arm circumference were measured.

Data were recorded and processed using SPSS version 23.0. A univariate study analysis was conducted to determine the characteristics of subjects and the distribution and normality of the data. A bivariate analysis was done to study the correlation of the independent and dependent variables. The Pearson test was used in normal data distribution to obtain the significance value (P) and correlation coefficient (r). $P < 0.05$ was considered significant, and r values of 0–0.4, 0.4–0.6, 0.6–0.8, and 0.8–1 indicated weak, moderate, strong, and very strong correlation, respectively.

3. Results

The demographic characteristics of the 98 study patients are shown in Table 1.

Table 1. The research subject characteristics.

Category	Number (n)	Percentage (%)
Age		
60–74 years old	61	62.2
>75 years old	37	37.8
Sex		
Male	52	53.1
Female	46	46.9

Table 1. *Continue*

Category	Number (n)	Percentage (%)
Comorbidities		
Hypertension	60	61.2
Diabetes mellitus	35	35.7
Dyslipidemia	27	27.6
OA	15	15.3
Dyspepsia	6	6.1
Etc.	45	45.9
The number of accompanied comorbidities		
1	30	30.6
2	30	30.6
3	31	31.6
>3	7	7.2
Dominant hand		
Right	98	100
Left	0	0

The majority of subjects were males aged 70–75 years old. The most frequent comorbidities was hypertension. Most subjects had three comorbidities. All subjects were right-handed. Hand grip strength values of the research subjects are shown in Table 2.

Table 2. Mean hand grip strength by sex and age

Hand Grip Strength Values	Average	Standard Deviation
Mean MNA for the overall nutritional status	18.586	± 6.726
Mean MNA for the nutritional status based on sex and age		
Male		
60–74 years	22.066	± 7.532
>75 years	21.454	± 4.973
Female		
60–74 years	16.4194	± 4.780
>75 years	11.900	± 3.566

The results of nutritional status data collection using MNA values are shown in Table 3. MNA values were categorized based on the cutoff value according to the MNA questionnaire instructions.

Table 3. Research subject nutritional status

Nutritional Status	Number (n)	Percentage (%)
Malnutrition (MNA score <17)	6	6.1
Potential malnutrition (MNA score 17–23.5)	59	60.2
Normal/No-risk (MNA grades 24–30)	33	33.7

Average nutritional status (MNA value) based on sex and age is shown in Table 4.

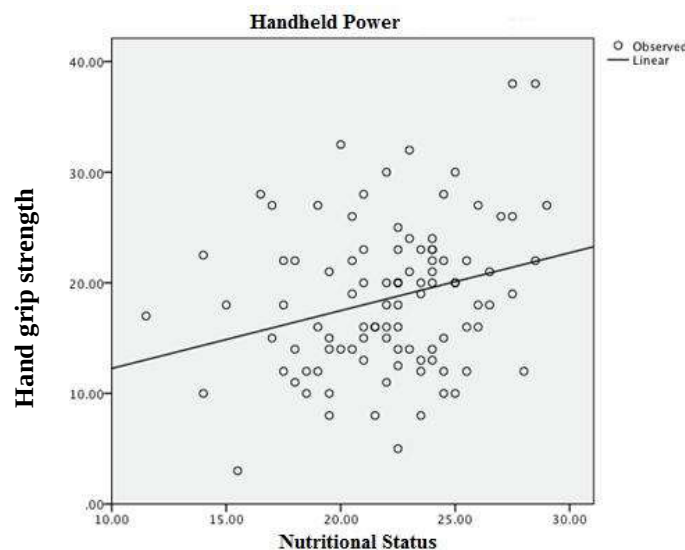
Table 4. Mean MNA based on sex and age

MNA Value for Nutritional Status	Average	Standard Deviation
Mean MNA for the overall nutritional status	22.1071	± 3.448
Mean MNA for the nutritional status based on sex and age		
Male		
60–74 years	22.566	± 3.951
>75 years	21.783	± 3.441

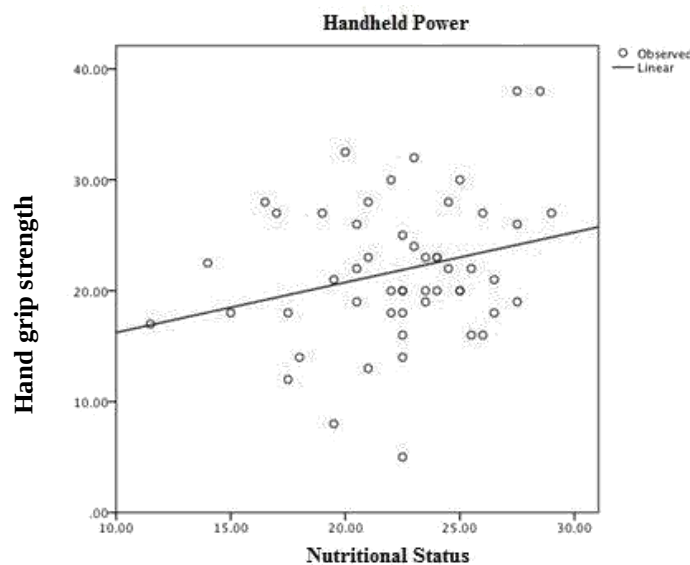
Table 4. *Continue*

MNA Value for Nutritional Status	Average	Standard Deviation
60–74 years	22.048	± 2.902
>75 years	21.433	± 3.644

The normality test showed that $P = 0.056$ and 0.0050 for hand grip strength and nutritional status, respectively, categorized as normal data distribution. The Pearson correlation test showed that $P = 0.008$ ($P < 0.05$), showing a significant correlation between hand grip strength and nutritional status. Furthermore, the correlation test results (Fig. 1) indicated a weak correlation ($r = 0.268$).

**Figure 1.** Correlation between nutritional status (x-axis) and hand grip strength (y-axis).

A bivariate test was conducted by separating the subject based on sex (male/female). The normality test of hand grip strength and nutritional status in 52 male subjects showed $P = 0.200$ and $P = 0.069$, respectively, and the Pearson test showed that $P = 0.065$ and $r = 0.258$ (Fig. 2).

**Figure 2.** Correlation between nutritional status (x-axis) and hand grip strength (y-axis) in male subjects.

The normality test of the hand grip test and nutritional status in 46 female subjects showed that $P = 0.08$ and $P = 0.200$, respectively, with abnormal and normal data distributions, respectively (Fig. 3). Data transformation was performed for hand grip strength, but the data distribution remained abnormal, so the Spearman test was used to analyze this variable ($P = 0.273$ and $r = 0.165$).

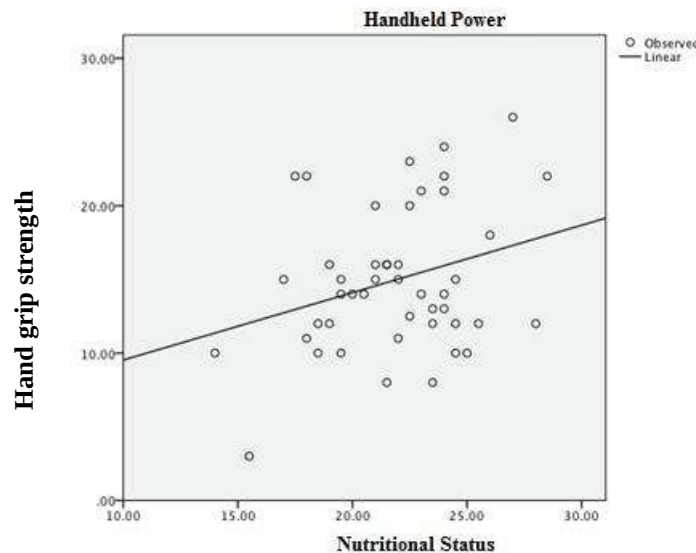


Figure 3. Correlation between nutritional status (x-axis) and hand grip strength (y-axis) in female subjects.

4. Discussion

Mean hand grip strength was 18.586 ± 6.72 (standard deviation), and males had greater values than females. Aging caused decreased hand grip strength. These findings were consistent with previous studies. Muscle strength and mass reduction along with muscle disuse, disease, and decreased activity because of aging result in the decreased amount of muscle fibers [13].

Compared to one meta-analysis from Bohannon et al., this study showed that our subjects had lower average hand grip strength values in each age group [14]. Based on the Asian Working Group for Sarcopenia (AWGS) criteria, the mean hand grip strength of most subjects was below the cutoff value, so their hand grip strength was classified as low (<26 kg for males and <18 kg for females) [9].

The low hand grip strength caused by subject characteristics, particularly regarding the ethnic factor [15], while the meta-analysis included studies from developed countries, such as the United States, Australia, Canada, England, and Sweden [14]. Hand grip strength in our study was lower compared with that in a study of elderly patients (55–94 years old) with low economic status in Malawi (mean 28.0 and 21.7 for males and females, respectively) [13]. Our results were similar compared with those of other studies conducted in a dense population in India (mean 22.9 and 13.4 for males and females, respectively, 50–96 years old) [16].

Dodds et al. revealed that a difference in ethnicity may affect hand grip strength. Caucasians in Europe had a higher mean hand grip strength than Mongoloid Asians. Our lower hand grip strength compared with the reference value was caused by the difference in ethnicity of the subject [17].

Meanwhile, hand grip strength in our study was lower compared with that of the AWGS study criteria, which can be due to various factors. Although the AWGS study was conducted on Asians, in our study, age, comorbid disease and physical activity might be factors that caused low hand grip strength [8].

The prevalence of malnutrition in elderly patients ranges between 20% and 60% depending on the location of the population. The prevalence of malnutrition obtained in our study was approximately 6.1%. This lower result might be due to the characteristic differences compared with the reference study. The outpatients tended to have good nutrition because of routine periodic controls and better education regarding good nutrition. The differences in prevalence also might be due to other factors,

such as socioeconomic conditions and different foods ingested by the subject [18]. If the instrument used to analyze malnutrition status had a higher specificity than that of the MNA questionnaire, it is possible that 49.1% of the potential malnutrition group were included in the malnutrition group.

This study showed a correlation between hand grip strength and nutritional status. These results supported the previous study of Guo et al. [19] on oral and maxillofacial cancer patients in which hand grip strength correlated with nutritional status, which was assessed by arm circumference (males, $n = 88$, $P < 0.01$, and $r = 0.596$; females, $n = 39$, $P < 0.01$, and $r = 0.565$) and creatinine index (males, $P < 0.01$ and $r = 0.661$; females, $P < 0.01$ and $r = 0.601$).

Chilima et al. reported on elderly subjects in Malawi and found that hand grip strength correlated with BMI ($P < 0.01$, $r = 0.40$ [males] and $r = 0.34$ [females]), upper arm circumference ($P < 0.01$, $r = 0.45$ [males] and $r = 0.38$ [females]), and arm muscle area ($P < 0.01$, $r = 0.39$ [males] and $r = 0.37$ [females]). A low BMI indicated a lack of fat and muscle mass. The relationships with lower hand grip strength were explained by lack of muscle mass. Decreased muscle mass is associated with decreased muscle strength along with the aging process [16].

Pieterse et al. [20] studied people aged 50–92 years old and showed that hand grip strength correlated positively with BMI ($r = 0.26$ and $r = 0.16$ for males and females, respectively) and arm muscle area ($r = 0.41$ and $r = 0.26$, respectively) [13]. A similar result was obtained by Singh et al. who found that elderly subjects with malnutrition from two housing areas in Kuala Lumpur, Malaysia, had a lower hand grip strength. In their study, hand grip strength correlated with ferritin levels ($P = 0.026$, $r = 0.325$). Therefore, deficiency in ferritin levels can lead to decreased muscle activity and muscle fatigue.

Flood et al. [21] studied patients at several hospitals in Australia and found that hand grip strength correlated with nutritional status, which was measured using a Patient-Generated Subjective Global Assessment (PG-SGA) questionnaire, and these factors can be used as nutritional status predictors and nutritional status changes ($P < 0.01$, $r = 0.292$). Most subjects were observed prospectively for 3 weeks. Changes in hand grip strength correlated with nutritional status changes ($P = 0.002$ and $r = 0.767$) [22]. In both studies, correlation strength was weak compared with that in our study. This may be due to a lack of samples in our research. Many confounding variables influenced hand grip strength and nutritional status, such as the number of illnesses, medications, age, and sex [21].

The correlation test separating the subjects based on sex (men and women) did not reveal any significant correlation. These results did not support those of a correlation test conducted on the total sample and previous research. These results may be due to the insufficient number of subjects.

In our study, nutritional status was measured using the MNA questionnaire, which differed from the methods used in previous research. This positive correlation showed that even though our study used different instruments than the previous study, hand grip strength constantly had a correlation with nutritional status.

The correlation between hand grip strength and nutritional status may be explained through a variety of mechanisms. Norman et al. [6,23] explained that the decrease in muscle function is associated with decreased nutritional status. In the elderly, decreased nutritional intake will result in body compensation in the form of protein decrease. Muscle mass contains the highest amount of protein in the body. Muscle function correlates with body proteins, body cell mass, anthropometric arm mass, and BMI. Loss of weight and muscle mass can lead to muscle strength decrease [6,23].

There are six possible connecting paths between malnutrition and decreased muscle function, such as a reduction in protein synthesis, proteolysis increase, reduction in glycolytic enzymes activity, creatinine decrease, reduction in mitochondrial complex activity, and increased intracellular calcium. The decline in protein intake in people suffering from malnutrition would decrease the synthesis of proteins in the body and increase proteolysis as a source of energy, which causes muscle fiber atrophy and decreased muscle mass and function. Cellular alteration through decreased activity of glycolytic enzymes, creatinine, and mitochondrial complex leads to damage to cell energetics and potential cell membrane, which influences muscle function [6].

A previous study reported 25.8% low hand grip strength values in malnutrition subjects. A study conducted in cancer patients, as assessed by Subjective Global Assessment (SGA) questionnaires, showed that hand grip strength could be a powerful predictor of malnutrition [22]. In a state of malnutrition, muscle morphology is changed, resulting in decreased muscle function. On the basis of research conducted in malnourished children, muscle biopsy results showed a myopathic change in the form of selective fiber type II atrophy and degeneration of the Z ribbon [20]. Eight studies conducted on different subjects showed an increase in hand grip strength after intervention, such as a nutritional change in malnourished patients. Indicators of muscle function improvement usually were accompanied by an increase in functional status and quality of life [6].

Norman et al. [23] suggested the use of hand grip strength to predict nutritional status because changes in hand grip strength tend to occur faster with restoration/ recovery of nutritional status. Hand grip strength could detect earlier changes rather than anthropometric screening examination. Early detection of malnutrition could determine early nutritional intervention, resulting in a better outcome for patients [23].

Nutritional status assessment using MNA and PG-SGA questionnaires had minimal repetition lag time (PG-SGA repeated at least 2 weeks). This method required a weight measurement to determine weight decrease compared with the previous data. This was difficult to apply in critically ill patients who were unable to be weighed [22]. Nutritional status assessed without weight data could result in inaccurate or delayed assessment, which could lead to incompatibility of nutritional intervention and prolongation of therapy.

Hand grip strength can be used as a monitoring instrument of changes that are interpreted as changes in nutritional status. Although hand grip strength was not recommended as the first and primary measurement, it was a potentially rapid, easy, noninvasive, objective, and high inter-reliability method to identify nutritional status [21,22].

The cross-sectional design was used in this study, so that data were obtained at a certain time. This design could not assess cause and effect as good as could cohort studies. A variety of confounding variables could affect both variables, such as age, comorbid disease, socioeconomic conditions, and food intake, and these were not assessed nor analyzed in this study.

5. Conclusion

Hand grip strength correlated with nutritional status. The correlation test showed $P = 0.008$ ($P < 0.05$) and $r = 0.268$. Six subjects (6.1%) suffered from malnutrition, 59 (60.2%) had a malnutrition risk, and 33 (33.7%) had a normal nutritional status. Average hand grip strength was 18.586 ± 6.726 kg.

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