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The Relationship of Blood Sugar and Albumin Levels to Hand Grip Strength and Walking Speed in the Elderly

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ABSTRACT: This cross-sectional study examined the relationship between blood glucose and albumin levels, handgrip strength, and walking speed in elderly individuals in Semarang, Indonesia. Forty female participants aged 60-72 were recruited from a local health center. Handgrip strength was measured using a dynamometer, whereas walking speed was assessed using the 10meter walk test. Blood glucose and albumin levels were determined by laboratory analysis. The mean age of participants was 63.70 ± 3.16 years, with an average handgrip strength of 15.95 ± 3.17 kg and walking speed of 1.03 ± 0.21 m/s. Most participants had normal blood glucose (87.5%) and albumin (97.5%) levels. Statistical analysis revealed no significant correlations between blood glucose or albumin levels and the measured functional parameters. However, a significant positive relationship was observed between handgrip strength and walking speed ($r = 0.331$, $p = 0.037$). With increasing age, the study found a decreasing trend in handgrip strength and walking speed. While blood glucose and albumin levels did not show significant associations with muscle strength or walking speed, the positive correlation between handgrip strength and walking speed supports their use as key indicators of physical function in the elderly population. These findings highlight the importance of maintaining muscle strength to preserve mobility in older adults. However, further research is needed to elucidate the complex relationships between metabolic factors and physical performance in this population.

KEYWORDS: Sarcopenia, elderly, blood glucose, albumin, handgrip strength, walking speed

I. INTRODUCTION

The population of individuals aged 60 and above is experiencing a consistent annual increase, a phenomenon attributable to extended life expectancies and declining birth rates.[1,2] This expanding demographic of older adults in Indonesia presents significant health implications, including diminished muscle function (sarcopenia) and an elevated prevalence of chronic conditions such as cancer, cardiovascular disease, chronic obstructive pulmonary disease (COPD), joint disease, and type 2 diabetes mellitus.[2–4]

The aging process leads to a deterioration in muscle function, including strength, flexibility, and mobility, which consequently impacts the balance of elderly individuals.[5] Furthermore, there is an increased risk of elevated blood glucose levels and impaired glucose tolerance.[6] According to the 2018 Indonesian Basic Health Research, the prevalence of type 2 diabetes mellitus (DM) among the elderly aged 55-64 years was 6.3%, and among those aged 65-74 years, it was 6.0%, reflecting an increase compared to the 2013 findings.[7,8]

Type 2 DM is characterized by insulin resistance, inflammation, accumulation of glycosylation products, and increased oxidative stress, all of which can be detrimental to muscle health. This impacts muscle mass, strength, and function through impaired protein metabolism, vascular and mitochondrial dysfunction, and cell death.[9] Insulin resistance can lead to a reduction in muscle mass or sarcopenia. According to the Asian Working Group for Sarcopenia (AWGS), sarcopenia is a geriatric syndrome characterized by age-related decline in skeletal muscle, accompanied by low muscle strength and/or decreased physical performance.[10] Common manifestations include decreased handgrip strength (handgrip strength) and walking speed (gait speed). The European Working Group on Sarcopenia in Older People (EWGSOP) recommends a variety of physical performance tests, including the Short Physical

Performance Battery (SPPB), walking speed, 6-minute walk test, stair-climbing power test, and timed up-and-go test (TUG). On the other hand, the AWGS suggests focusing on the 6-meter walking speed to evaluate physical performance.[10,11]

Several studies have shown that type 2 DM or high blood glucose levels are associated with decreased handgrip strength in the elderly.[6] However, other studies have found no significant association between muscle weakness and DM in the elderly, which differences may influence age and weight distribution between diabetic and non-diabetic groups. Therefore, the relationship between a history of type 2 DM or blood glucose levels with handgrip strength and its effect on walking speed needs to be further explored.[12,13]

Sarcopenia is also closely related to muscle mass and strength.[14] A significant factor influencing muscle strength is the level of albumin. Albumin is the most abundant circulating protein in plasma, representing half the total plasma protein content (3.5 g/dL - 5 g/dL) in healthy humans. Low albumin levels are a risk factor for frailty in older people with diabetes and are associated with handgrip strength and walking speed.[14]

Research conducted by Atteveld et al. in Amsterdam in 2019 showed that low albumin levels were associated with decreased walking speed and muscle strength. A 4-meter walk test proved this at a regular speed with units of meters/second and measured muscle strength by measuring hand grip with a handgrip dynamometer in a standing position.[15] Meanwhile, research conducted by Caryn Snyder et al. in the United States showed that serum albumin levels had no significant relationship with changes in muscle mass or strength in elderly men.[16]

Based on these two factors, it can be concluded that there is still much unknown about the relationship between blood glucose and serum albumin levels and walking speed and hand grip strength in the elderly population in Semarang.

II. METHOD

This study was conducted with a cross-sectional design through an analytic observational approach at a local health center in Ngaliyan, Semarang, Indonesia. This study involved elderly individuals who were chosen through consecutive sampling based on the following specific criteria: female participants aged between 60 and 75 years, capable of effective communication without any uncorrected visual or hearing impairments, and who were alert and willing to cooperate. Individuals with neuromusculoskeletal issues in the upper extremities (such as CTS, Parkinsonism, hand paresis, drop hand, hand arthritis, amputation, and hand joint contractures) or disorders affecting the lower extremities (such as hemiparesis or hemiplegia) were omitted.

Measurement of grip strength was performed using a handgrip dynamometer. The subjects were measured in a sitting position with the wrist extending 0^o-30^o. The same researcher measured all respondents. Measurements were performed three times to ensure accuracy, and the average of the three results was taken as the final score.

The 10-meter Walk Test was used to assess walking speed. This involves setting up a 10-meter track, which includes a 2meter section at the beginning for acceleration and another 2-meter section near the end for deceleration, neither of which is timed. Timing commences when the leading foot crosses the 2-meter mark and concludes when it crosses the 8-meter mark. The test was performed thrice, and the average of these times was used as the final measurement.

Blood glucose levels were measured using the enzymatic hexokinase method with EDTA plasma as the specimen type. Hand grip strength and walking speed were classified according to the 2019 AWGS standards, where a grip strength of less than 18 kg was considered low for women, and a walking speed of 0.8 m/s or less was the threshold for low physical performance in females.

The BCG method was employed to measure albumin levels using a BCG solution, buffer, and albumin standard, all assessed with a spectrophotometer. The serum from the respondents was centrifuged, and the BCG solution was mixed with the serum sample. The albumin concentration was determined by comparing the absorbance of the sample with that of the albumin standard, which has a known concentration. The absorbance was then translated into concentration units using a calibration curve, and the results were evaluated against the established reference values.

Data analysis will start with the Shapiro-Wilk test to evaluate normality, followed by hypothesis tests using the Spearman approach.

Ethical clearance was obtained from the Health Research Ethics Commission (KEPK) of the Faculty of Medicine, Diponegoro University (Semarang No. 520/EC/KEPK/FK-UNDIP/IX/2024. The research subjects will be given a brief explanation of the purpose and objectives of the study. In addition, the benefits and procedures of the study were explained.

III. RESULT

The demographic and anthropometric characteristics of Tables 1 and 2 show that the average age of respondents was 63.70 ± 3.16 years, ranging from 60 to 72 years. Most respondents (70%) were in the 60-65 age group. Respondents' average body mass index (BMI) is 26.51 ± 4.32 kg/m^2, indicating a tendency towards overweight in the studied population.

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Functional measurements showed an average handgrip strength of 15.95 ± 3.17 kg and a walking speed of 1.03 ± 0.21 m/s. There was variation in handgrip strength across age groups, with the lowest value in the 71-75 age group (5.6 kg), showing a decreasing trend with age. Walking speed also declines with increasing age, from 1.06 m/s in the 60-65 age group to 0.88 m/s in the 71-75 age group.

Table 1. Demographic and Clinical Characteristics of Elderly Participants

Variable	Mean ± SD	Median (Min-Max)
Age (Years)	63,70±3,16	64 (60-72)
Body Weight (kg)	61,79±10,89	60,15 (40,7-85,2)
Height (cm)	152,54±6,58	152,4 (140,5-178,7)
Body Mass Index (BMI) (kg/m²)	26,51±4,32	25,95 (17,4-34,9)
Upper Arm Circumference (cm)	30,75±3,72	30,25 (20-38)
Blood Glucose Level (mg/dL)	128,05±60,06	106 (91-355)
Serum Albumin Level (g/dL)	4,16±0,48	4,0 (2,7-5,5)
Handgrip Strength (kg)	15,95±3,17	16,15 (5,6-24,5)
Walking Speed (m/s)	1,03±0,21	1,01 (0,6-1,5)

Table 2. Patient Characteristics by Age Group, Blood Glucose Level, and Albumin Status, Including Handgrip Strength and Walking Speed

Patient Characteristic	Frequency (n)	Percentage (%)	Mean Handgrip Strength (kg)	Mean Walking Speed (m/s)
Age Group (years)				
60-65	28	70	16,36	1,06
66-70	11	27,5	15,84	0,96
71-75	1	2,5	5,6	0,88
Blood Glucose Level				
Normal	35	87,5	15,97	1,04
High	5	12,5	15,8	0,78
Albumin Level				
Normal	39	97,5	15,97	1,03
Hypoalbuminemia	1	2,5	15,3	1,2

Table 3. Correlation Between Blood Glucose Level, Albumin Level, Handgrip Strength, and Walking Speed

Variable 1	Variable 2	r (correlation coefficient)	p-value*
Blood glucose level	Handgrip strength	-0,130	0,936
Blood glucose level	Walking speed	-0,138	0,396
Albumin level	Handgrip strength	0,151	0,352
Albumin level	Walking speed	0,035	0,829
Handgrip strength	Walking speed	0,331	0,037*

* Spearman test, $p \leq 0,05$

Biochemical parameters showed an average blood glucose level of 128.05 ± 60.06 mg/dL, with 87.5% of respondents having normal blood glucose levels. Notably, there was a minimal difference in handgrip strength between participants with normal blood glucose levels (15.97 kg) and those with high blood glucose levels (15.8 kg). The average albumin level is 4.16 ± 0.48 g/dL, with 97.5% of respondents having normal albumin levels. Among those with normal albumin levels, the mean handgrip strength was

15.97 kg, and the mean walking speed was 1.03 m/s. A single participant with hypoalbuminemia demonstrated a handgrip strength of 15.3 kg and a walking speed of 1.2 m/s.

Correlation analysis showed a significant positive relationship between handgrip strength and walking speed ($r = 0.331$, $p = 0.037$). No significant correlations were found between blood glucose or albumin levels and the measured functional parameters. These results indicate a decline in functional capacity with increasing age, particularly handgrip strength. However, most respondents had normal biochemical parameters, indicating a relatively good health status in the elderly population studied.

IV. DISCUSSION

Hand grip strength measurements showed an average of 15,95 ± 3,17 kg, which was categorized as weak. Meanwhile, walking speed data showed an average of 1,03 ± 0,21 m/s with the lowest value of 0,6 m/s and the highest value of 1,5 m/s, which is still included in the category of good physical performance (>0,8 m/s).[10] One of the consequences of aging is the loss of muscle mass, strength, and function, around 3-8% per decade after the age of 30 years, with acceleration after the age of 60 years. The results of this study are in line with this theory, where the mean handgrip strength was higher in the 60-65 years age group (16,36 kg) compared to the 66-70 years age group (15.84 kg) and the 70-75 years age group showed a more drastic decline (5.6 kg). The mean walking speed also decreased with age, from 1.06 m/s at 60-65 years, 0.96 m/s at 66-70 years, to 0.88 m/s at 70-75 years. Decreased physical capacity in the elderly can lead to weakness and limited mobility, which impacts balance and the body's response to changes in the center of gravity.

Bivariate analysis between blood sugar levels and hand grip strength showed $p=0.936$ ($p>0.05$), indicating no significant relationship between the two variables. This finding aligns with the research conducted by Palacios et al., who also found no association between weak muscle strength (sarcopenia) and hyperglycemia in the elderly.[13] Other factors affecting muscle weakness include age, weight distribution, sex, and the consumption of certain medications. Although not statistically significant, elderly with normal blood sugar levels have slightly better mean hand grip strength than elderly with high blood sugar levels; as stated in a study by Komang Ayu et al., hyperglycemia conditions have a significant influence on weaker hand grip strength.[2]

The subjects in this study were mostly elderly people who actively participated in local health center activities such as morning exercises and household activities. This can be a bias that causes their fitness level to be better than that of other elderly people, thus affecting the results of hand grip strength and walking speed measurements.

The bivariate analysis results between blood sugar levels and walking speed showed a value of $p=0.396$ ($p>0.05$), which also showed no significant relationship between the two variables. This result does not follow the initial hypothesis that hyperglycemia can inhibit the energy metabolism process of muscle cells due to dysfunction of the GLUT4 transporter protein, which ultimately affects walking speed. This discrepancy could be due to the uneven distribution of subjects, differences in body mass index (BMI), and different fitness levels.[17]

Although the hypothesis test results did not show a significant relationship, elderly people with normal blood sugar levels still had a better average walking speed than those with high blood sugar levels. This suggests that although hyperglycemia is not directly related to walking speed, a more stable metabolic condition provides advantages regarding daily mobility.

Bivariate analysis between handgrip strength and walking speed showed $p=0.037$ and $r=0.331$, indicating a significant relationship with a weak positive correlation. This finding aligns with the findings of Pham et al., who found a similar correlation between hand grip strength and walking speed (Pearson $r=0.25$, $p<0.001$).[17] This positive relationship means that the greater the hand grip strength, the higher the walking speed. This supports the theory that these two variables are key indicators in the diagnosis of sarcopenia, and their values are directly proportional.[10]

Clinical handgrip strength often indicates overall skeletal muscle strength and reflects physical health and mobility in the elderly. Walking speed is also an essential parameter for assessing physical performance and is strongly influenced by muscle strength. Therefore, a decrease in hand grip strength may contribute to the decline in walking speed, signalling impaired general physical function.[18]

In addition to blood sugar levels, albumin also affects muscle function. Albumin is the primary circulating protein in plasma that plays a role in osmotic balance and as a transporter of various bodily substances. In this study, the mean albumin level was 4.16 ± 0.48 g/dL, which is in the normal category (3.5-5 g/dL). However, the results of the analysis showed no significant relationship between albumin levels and hand grip strength ($p=0.352$, $r=0.151$), which contradicts the findings of Nur Riviati et al., who found a substantial relationship between albumin levels and hand grip strength ($p=0.012$, $r=0.35$).[19] This may have been caused by differences in physiological factors in the elderly, where albumin has no direct relationship with muscle size, and other factors, such as hemodialysis, that can affect muscle strength.

The bivariate analysis of albumin levels and walking speed also showed no significant relationship ($p=0.829$, $r=0.035$). Atteveld et al. (2019) previously found that low albumin levels were associated with decreased walking speed, but the results of this study

suggest that other factors, such as physical fitness and daily activities, play a greater role in determining walking speed in the elderly than albumin levels.[15]

This study has several limitations that need to be considered. First, the cross-sectional research design only describes conditions at one point; therefore, it cannot capture changes that may occur over time. Second, this study did not consider the history of comorbidities, such as heart disease, diabetes mellitus, or stroke, which may have affected the results. In addition, differences in fitness levels between participants could be a bias factor affecting handgrip strength and walking speed.

Despite these limitations, this study provides insights into the relationship between blood sugar, albumin, hand grip strength, and walking speed in the elderly. The results showed that blood sugar and albumin levels were not significantly associated with muscle strength and walking speed, but hand grip strength was positively associated with walking speed. Therefore, physical activity and muscle strength training remain the main factors that can improve the physical health of older adults and prevent sarcopenia.

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