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ORIGINAL ARTICLE

Relation between nutrition intake, prediabetes, and central obesity with handgrip strength in Indonesian medical student

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Abstract

Background: Muscles are crucial in creating movement, stabilising body posture, and regulating body temperature. Muscle strength can be assessed using handgrip strength. Handgrip strength can predict muscle function, nutritional status, diabetes risk, and the risk of metabolic syndrome. Handgrip strength can be influenced by muscle mass, nutritional intake, fat mass, physical activity level, and metabolic syndrome.
Objective: This research is to find relationship between handgrip strength and nutritional intake, muscle mass, and central obesity.
Methods: The research was conducted as a cross-sectional study using observational analytical methods. The sample consisted of 53 individuals selected through purposive sampling. Handgrip strength can be measured using a hand dynamometer, nutritional intake using a 2x24 hour food recall, muscle mass using a body composition analyzer, central obesity using waist to hip ratio, and fasting blood sugar using a glucometer. Statistical data analysis employed the chi-square test and independent T-test.
Results: The results indicated a relationship between central obesity and handgrip strength ($p = 0.006$). Researchers are interested in studying muscle strength and its predictors concerning central obesity, prediabetes, and nutritional status in medical students. The results indicated a relationship between handgrip strength and central obesity ($p = 0.006$), but no relationship was found between handgrip strength and energy intake ($p = 0.235$), protein intake ($p = 0.524$), and prediabetes ($p = 0.272$).
Conclusion: There is a relationship between central obesity and handgrip strength. Future researchers are encouraged to consider additional factors, including physical activity, muscle mass index, and comorbidities.

Keywords: handgrip strength, energy intake, protein intake, central obesity, prediabetes

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Introduction

Muscles facilitate movement, stabilise body posture, and regulate body temperature. All muscle tissue in the body is called muscle mass.[1] If muscle mass increases, muscle strength also tends to increase.[2] Likewise, if muscle mass decreases, muscle strength will also decrease.[3] Muscle mass is influenced by an individual's nutritional intake and lifestyle, with the availability of nutrients affecting the muscle's ability to contract.

Adequate protein intake is vital in muscle synthesis.[4] On the other hand, excess energy intake, particularly from foods high in calories and low in nutrients, will increase the triglycerides, thereby increasing the incidence of metabolic syndrome.[5, 6]

According to the International Diabetes Federation (IDF), some metabolic syndrome symptoms are central obesity and increased fasting blood sugar levels.[7] In Indonesia, the prevalence of obesity and diabetes mellitus continues to increase.[8] Central obesity is a condition where fat accumulates in the middle of the stomach (intra-abdominal fat) (Lestari et al., 2021). The diagnosis of central obesity is made if waist to hip ratio ≥0.95 in men, or ≥80 in women. Central obesity triggers a pro-inflammatory state caused by cytokine release, resulting in a decrease in muscle strength, muscle function, and muscle mass.[9]

Indonesian National Health Survey 2018 shows that the proportion of impaired fasting blood sugar (fasting blood sugar = 100-125 mg/dL) in the population aged >15 years is 26.3%[8]. Increasing blood sugar levels can have a negative impact on muscle health, causing a decrease in muscle mass so that muscle strength will also decrease.[10,11] Muscle strength can be measured using the handgrip strength method.[12]

Handgrip strength is a method for measuring muscle strength and function.[12] Handgrip strength can be influenced by several factors, for example, muscle mass, nutritional intake, body mass index, metabolic syndrome, fat mass, age, and physical activity level.[13–16] Previous research has demonstrated that handgrip strength can predict muscle function, nutritional status, and several diseases, such as the risk of diabetes, the risk of metabolic syndrome, and even a person's mortality.[17–19]

Medical students have high academic demands. The time spent on average used for studying and completing assignments makes it difficult to engage in physical activities.[20,21] This can decrease muscle function due to infrequent use.[22] Additionally, a hectic schedule and numerous course assignments cause students to neglect meals, reducing the frequency and quantity of meals, which can impact nutritional intake.[23]

Convenience in accessing sweet and fatty foods, along with strong media influence in promoting these foods, can trigger the formation of unbalanced eating habits. This leads to a tendency to consume high-calorie but low-protein foods.[23] All these risk factors collectively contribute to decreased muscle strength, central obesity, and prediabetes. Previous research indicates a prevalence of metabolic syndrome in adolescents at 15.8%,[24] prompting researchers to explore the relationship between central obesity, prediabetes, nutritional intake, and handgrip strength.

Previous research has had a narrower scope, focusing on specific diseases with elderly and adult respondents. The planned study targets adolescents, an area with limited current research. Additionally, research on handgrip strength and the chosen independent variables –nutritional intake, fasting blood sugar, and central obesity – is still very limited, especially in Indonesia. Therefore, researchers are interested in studying muscle strength and its predictors concerning central obesity, prediabetes, and nutritional status in medical students. With this research, it is hoped that it can increase public knowledge about central obesity, prediabetes, muscle strength, and the importance of maintaining diet to improve lifestyle and prevent disease as early as possible.

Methods

The research followed a quantitative approach with observational analytical methods, employing a cross-sectional design. The data analysis employs the Chi-Square test and independent T-test. The chosen significance level for the p-value is 0.05.

The sample consisted of medical students from Universitas Pembangunan Nasional Veteran Jakarta (UPNVJ), selected using the purposive sampling method. Sample size estimation with two proportions and the minimum sample is 46. Sampling involved distributing questionnaires to the population and selecting samples that met the inclusion and exclusion criteria. Inclusion criteria for this study were individuals aged 18-24 years with a body mass index of more than 23 kg/m^2. BMI around 23- 24,9 with Asian Pacific classification is categorized as overweight thereby the risk of cardiovascular disease is increase. The selection of BMI ≥ 23 it is hoped that it will include respondents with metabolic syndrome. Exclusion criteria included those with a history of upper extremity injuries, deformities of the hands and fingers, neurological and motor disorders, arthritis, and chronic diseases. The research took place at UPNVJ's Pondok Labu and Limo campuses over three months, from October 2023 to December 2023.

Data collection involved measuring handgrip strength using a hand dynamometer, specifically a mechanical/Smedley type with the Camry Hand Dynamometer brand. The result will be categorized into 2 groups, low (< 35,7kg in men and <19,2 in women) and normal (35,7- 56,6 kg in men and 19,2- 35,3 in women).

Energy and protein intake measurements were obtained through interviews between nutritionists and respondents, recorded on the 2x24-hour Food Recall to document all food and drink consumed within two 24-hour periods, one on a weekday and one on a weekend taken by. The data was analyzed in Nutrisurvey application. Protein intake is divided into 2 groups, low (<0.8 g/kg) and normal (≥0,8 g/kg). Meanwhile, energy intake divided into 3 groups based on Indonesian Dietary Recommendation, low (<80%), normal (80-110%), and high (>110%).

Central obesity was measured using the waist-to-hip ratio. The diagnosis of central obesity is made if waist to hip ratio ≥0.95 in men, or ≥80 in women. Prediabetes was determined based on fasting blood sugar using a glucometer with the Easy Touch GCU brand. If glucose fasting level ≥100 mg/dL, it is categorized as a prediabetes condition. Before the examination, respondents were required to fast for at least 8 hours.

Results

Data collection took place in October - December 2023 at the Faculty of Medicine, UPN "Veteran" Jakarta, involving 53 respondents. Among the respondents, there were nine males (16.9%) and 44 females (83.1%). The age range of the respondents was 18 to 22 years, with the most common age being 20 years. All respondents had a BMI >23 kg/m^2 with 19 people (35.8%) in the overweight category, 21 people (39.6%) classified as grade 1 obesity, and 13 people (24.5%) classified as grade 2 obesity (**Table 1**).

In the distribution of handgrip strength among medical students at UPNVJ, the majority, 30 respondents (56.6%), had normal handgrip strength. Meanwhile, 23 respondents (43.4%) had low handgrip strength, and none had high handgrip strength. The average handgrip strength obtained in this study was 24.5 kg, with the highest value of 46.6 kg and the lowest value of 10.4 kg.

Energy intake is divided into three categories: excessive, sufficient, and insufficient. A total of 13 respondents (24.5%) were in the excessive energy intake category, 22 respondents (41.5%) had sufficient energy intake, and 18 respondents (34%) had insufficient energy intake. The average energy intake was 1,917 kcal, with a maximum value of 13,180 kcal and a minimum of 1,007 kcal.

Protein intake is divided into two categories: normal and low. Most respondents had sufficient protein intake (69.8%), while the remaining 30.2% had low protein intake. The average protein intake was 63.4 grams, with a maximum value of 156.9 grams and a minimum of 32.6 grams.

The average waist circumference of female respondents was 84.3 cm, and for male respondents, it was 82.7 cm. Meanwhile, the average waist-to-hip ratio for female respondents was 0.82, and for male respondents, it was 0.87. Thirty-four respondents (64.2%) did not have central obesity, while 19 (35.8%) had central obesity.

A total of 45 respondents (84.9%) had normal fasting blood glucose, while 8 respondents (15.1%)

had increased fasting blood glucose or could be said to be in prediabetes. The mean fasting blood glucose in this study was 87.3 mg/dL, with a minimum value of 64 mg/dL and a maximum of 108 mg/dL. When prediabetes condition is adjusted for nutritional status, the prediabetes in the overweight group is 37.5%, in the degree 1 obesity group is 25%, and in the degree 2 obesity group is 37.5%.

The group with sufficient energy intake showed a 20.8% distribution for both normal and low handgrip strength. Meanwhile, groups with higher and lower energy intake demonstrated a relatively even distribution of handgrip strength, except for the group with lower energy intake, which exhibited lower handgrip strength with a percentage of 5.7%. The chi-square test analysis resulted in a p-value of 0.235 ($p > 0.05$), signifying no statistically significant relationship between energy intake and handgrip strength. (**Table 2**)

The group with sufficient protein intake and normal handgrip strength constituted 41.5%. Conversely, the group with insufficient protein intake displayed equal percentages for low and normal handgrip strength, both at 15.1%.

Table 1. Characteristics of the respondents

Characteristics	n	%
Sex		
Male	9	16.9
Female	44	83
Age		
18 years	2	3.7
19 years	13	24.5
20 years	18	33.96
21 years	17	32
22 years	3	5.6
BMI		
Overweight	19	35.8
Obesity grade 1	21	39.6
Obesity grade 2	13	24.5
Handgrip Strength		
Normal	30	56.6
Low	23	43.4
Protein Intake		
Normal	37	69.8
Low	16	30.2
Energy Intake		
Excess	13	24.5
Sufficient	22	41.5
Insufficient	18	34
Fasting Blood Glucose		
Normal	45	84.9
Increase	8	15.1
Central Obesity		
No	34	64.2
Yes	19	35.8

Table 2. Bivariate analysis result (Chi Square test)

Characteristics	Handgrip strength				p- value
	Normal		Low		
	n	%	n	%	
Protein Intake					
Normal	22	41.5	15	28.3	0.524
Low	8	15.1	8	15.1	
Energy Intake					
High	10	18.9	3	17	0.235
Normal	11	20.8	11	20.8	
Low	9	17	9	5.7	
Prediabetes					
No	27	50.9	18	34	0.272
Yes	3	5.7	5	9.4	
Central Obesity					
No	24	45.3	10	18.9	0.006
Yes	6	11.3	13	24.5	

The chi-square test analysis yielded a p-value of 0.524 (p>0.05), indicating no statistically significant relationship between protein intake and handgrip strength.

The group without central obesity and normal handgrip strength accounted for 45.3%. On the other hand, the central obesity group with low handgrip strength constituted 24.5%. The chi-square test analysis resulted in a p-value of 0.006 (p<0.05), suggesting a statistically significant relationship between central obesity status and handgrip strength.

More than half of the respondents were represented in the group without prediabetes condition and normal handgrip strength (50.9%). The group with prediabetes conditions and low handgrip strength had a percentage of 9.4%. The group with the lowest percentage was the prediabetes group with normal handgrip strength, at 5.7%. Due to the expected count value being 50% (>20%) with a value of less than 5, the chi-square test requirements were not met. Therefore, the Fisher exact test was employed as an alternative to the chi-square test. The obtained p-value was 0.272 (p>0.05), signifying no statistically significant relationship between prediabetes and handgrip strength.

Discussion

Energy intake and handgrip strength

Bivariate analysis showed that the p-value obtained was 0.235 (p>0.05), concluding no relationship between energy intake and handgrip strength. These findings align with a study conducted by Lisnawati,[29] indicating no correlation between energy intake and handgrip strength in junior high school children, with a p-value of 0.770. In contrast, research conducted on teenagers in Malaysia demonstrated a positive relationship and correlation between energy intake and handgrip strength.[25]

Energy restriction may occur in respondents with low energy intake and low handgrip strength, leading to a decrease in protein synthesis. Especially when energy intake is insufficient for the body's physiological functions, muscles may undergo catabolism to provide energy, ultimately reducing muscle strength.[26] Additionally, inadequate energy intake results in low energy availability and insufficient for proper muscle contractions.[27] This theory is supported by research on children and adolescents with poor nutritional intake and insufficient energy intake, leading to decreased handgrip strength.[28] Therefore, ensuring adequate energy intake is crucial to enable protein to enhance muscle formation and strength.[25]

Protein intake and handgrip strength

Bivariate analysis showed a p-value of 0.524 (p>0.005), so it can be concluded that there is no significant relationship between protein intake and

handgrip strength. These findings align with a study conducted by Lisnawati,[29] demonstrating no correlation between protein intake and handgrip strength in junior high school children, with a p-value of 0.663. Similarly, Andarbeni's [29] research found no relationship between protein intake and handgrip strength in adolescent girls aged 12-15 years (p=0.074). However, this contrasts with a study conducted by Fitriani [23], which states that late adolescents with low handgrip strength correlate with less protein intake (p=0.0).

Increased protein intake is associated with increased muscle mass, resulting in muscle strength. However, it is crucial to balance increased protein intake with sufficient energy intake to impact muscle mass positively.[29] The results of this study may be linked to the quality of the protein intake consumed. Animal and vegetable proteins have different capacities for increasing muscle mass and strength. Empirical studies indicate that consuming at least 25 grams of high-quality protein (8-10 grams of essential amino acids and high in leucine) can enhance muscle protein synthesis and improve muscle strength.[25] Notably, this study did not consider muscle quality, which could be influenced by the type of protein consumed (animal/vegetable protein), potentially as a contributing factor. Furthermore, muscle strength is not only influenced by energy intake but also by nutritional status, physical activity, body fat percentage,[23] and hand anthropometry.[30]

Central obesity and handgrip strength

This study identified a relationship between central obesity and handgrip strength with a p-value of 0.006 ($p<0.05$). These findings align with research conducted in Chile involving subjects from adolescents to the elderly, demonstrating a correlation between central obesity and handgrip strength.[32] The decline in handgrip strength observed in individuals with central obesity is attributed to excessive adiposity, which hinders the regulation of testosterone, growth hormone, and insulin, leading to a reduction in muscle mass and function. Moreover, excessive adiposity can induce a pro-inflammatory state through the release of cytokines such as TNF-α and IL-6, further contributing to a decrease in muscle strength.[33]

According to research, elevated adipose tissue from a young age can negatively impact muscle performance, even with an increase in muscle mass. Conditions of central obesity trigger inflammation and insulin resistance, affecting muscle function.[32] Previous studies have indicated that excessive adipose tissue induces a pro-inflammatory state mediated by cytokines (tumour necrosis factor-alpha and interleukin-6). Elevated plasma cytokine levels are associated with a decrease in muscle strength, function, and mass.[9]

Prediabetes and handgrip strength

In this study, a p-value of 0.272 was obtained, indicating no significant relation between prediabetes and handgrip strength. This finding aligns with research conducted by Astrom on adult respondents, which showed no association between prediabetes and low handgrip strength.[34] However, this study contradicts research conducted in Korea, which asserted a negative relationship between handgrip strength and fasting blood sugar.[35] Another study on Korean adults indicates a negative relationship between prediabetes and handgrip strength in men but not in women.[17]

According to research by Astrom et al.,[34] individuals with diabetes, whether newly diagnosed or with a long-standing diagnosis, tend to exhibit lower handgrip strength compared to those with normal blood sugar levels. This is attributed to an accelerated decrease in skeletal muscle mass and increased intramuscular fat infiltration in individuals with diabetes. Not only does muscle strength decrease, but insulin resistance also worsens due to the suboptimal functioning of skeletal muscle tissue as a site for glucose absorption. Furthermore, chronic hyperglycemia can lead to the accumulation of advanced glycosylation end products (AGEs) in skeletal muscles, resulting in decreased handgrip strength, leg extension strength, and walking speed. In this study, none of the respondents was diagnosed with diabetes, so the AGEs might not have fully accumulated. However, individuals in the early stages of impaired glucose regulation,

such as prediabetes, may not experience a significant decline in grip strength.[34] Prediabetes conditions can still be addressed through lifestyle changes, including nutritional intake and exercise[36]

Conclusion

Based on research that has been conducted, a relationship was found between central obesity and handgrip strength. Central obesity conditions can reduce handgrip strength. Meanwhile, no associations were found between energy intake, protein intake and prediabetes with handgrip strength. The limitation of this study is that there is the possibility of flat slope syndrome. Flat slope syndrome is the tendency of underweight respondents to report consuming more food, while respondents who are overweight tend to report consuming less food. In addition, other variables such as physical activity, muscle quality, BMI, fat mass, and comorbidities that could influence hand grip strength were not studied. Other researchers conducting related research are expected to consider other factors, such as physical activity, muscle quality and comorbidities.

Conflict of interest

The authors declare that there is no conflict of interest.

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