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HANDGRIP STRENGTH AND DASH EATING BEHAVIOR IS RELATED TO HIGHER BLOOD PRESSURE ON PRE-ELDERLY AND ELDERLY IN YOGYAKARTA

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ABSTRACT

Handgrip strength (HGS) reflects muscle health and is linked to hypertension, yet its relationship with blood pressure (BP) in older adults is underexplored. DASH dietary patterns, crucial for BP management, may provide further insights into this connection. This study aims to examine the association between HGS and DASH eating behavior with blood pressure in pre-elderly and elderly populations. A cross-sectional study was conducted on pre-elderly and elderly outpatient at Wirosaban Hospital, Yogyakarta in July to August 2024. HGS was measured using a hand dynamometer, while BP was recorded using a standard sphygmomanometer. Adherence to DASH were measured by 24-hour food recall and then categorized by questionnaire of DASH eating behavior. Data were analyzed by correlation and multiple regression, with α 5%. Hypertension was found in about 68.8% of subjects. Subjects who have lower HGS were about 68.8% and 81.7% of low category of DASH eating behavior. Participants with lower HGS had notably higher systolic and diastolic BP compared to those with higher HGS. Stratification analysis revealed that there were no significant association between HGS and high blood pressure both in elderly and pre-elderly (p 0.063 and p 1.000). In the other hand, low DASH eating behavior was significantly related to higher blood pressure in pre-elderly group (p 0.031). Reduced HGS is likely linked to higher BP in the elderly. Maintaining DASH-like diet adherence and muscle strength may be crucial in mitigating hypertension risk and comorbidity in older adults.

Keywords: *DASH diet; elderly; handgrip strength; hypertension; malnutrition*

INTRODUCTION

Hypertension is a common illness, especially in elderly people, and presents considerable risks for metabolic disorders such as cardiovascular diseases, stroke, and renal failure (Fuchs & Whelton, 2020; Leszczak et al., 2024; Zhou et al., 2021). Hypertension is predicted to impact about 1.28 billion persons globally, with a greater prevalence among the older population (WHO, 2023). Effective management and prevention of hypertension are critical for reducing its associated health risks, especially in the context of aging (Carey et al., 2018).

In Indonesia, prevalence of hypertension based on diagnosed was 8% and based on measurement was 30.8% over age of 18 years old (Kementerian Kesehatan RI, 2024). This prevalence was slightly decreased from 2018 which was 34.1% (Kementerian Kesehatan RI, 2018).

One emerging area of interest in managing hypertension in the elderly is the interrelation between muscle strength, specifically handgrip strength, and blood pressure regulation (Feng et al., 2021). Handgrip strength is broadly acknowledged as a measure of overall muscular strength and physical fitness (Cruz-Jentoft et al., 2019; Wiśniowska-Szurlej et al., 2019). The reduction in the function and mass of muscle that occurs with aging, a condition known as sarcopenia, has been linked to compromised cardiovascular health (Larsson et al., 2019). Research indicates a possible inverse correlation between handgrip strength and hypertension prevalence, suggesting that diminished muscle strength may be associated with elevated blood pressure levels in older adults (Ji et al., 2018). In contrast, for overweight or obese individuals, enhanced grip strength correlates with elevated blood pressure (Pratt et al., 2023).

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Alongside physical aspects like muscle strength, and dietary practices are essential in the management and prevention of hypertension (Altawili et al., 2023). Diets rich in fruits and vegetables, and low in sodium, have demonstrated efficacy in lowering blood pressure (Challa et al., 2024). Nutrients such as potassium, magnesium, and fiber are essential in maintaining healthy blood pressure levels, and their intake can have significant effects on reducing hypertension risk (Park et al., 2017).

This study aims to examine the relationship between handgrip strength, DASH eating behavior, and blood pressure in pre-elderly and elderly populations. Understanding these relationships may offer new insights into non-pharmacological strategies for hypertension prevention and management in aging populations.

METHODS

Study Design and Sampling

This was a cross-sectional study in Wirosaban Hospital' outpatient, in Yogyakarta between July - August 2024. Study participants were pre-elderly and elderly as outpatient in Wirosaban Hospital and signed the informed consent. Pre-elderly is defined by an individual within age of 45-59 years old and elderly is an individual within age of 60-74 years old (Departemen Kesehatan RI, 2005). The recruitment used purposive sampling. The minimum sample size was calculated using the one-proportion formula, resulting in a minimum of 86.

Data characteristics were measured by questionnaire and confirmation through medical records including age, gender, socioeconomic background, the medication use, and the presence of comorbidities. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were assessed by a trained nurse utilizing a validated automated sphygmomanometer (HEM-7156, Omron, Japan) following a 15-minute period of quiet rest for participants. his study defined high blood pressure as a systolic blood pressure (SBP) greater than 140 mmHg or a diastolic blood pressure (DBP) greater than 85 mmHg. (James et al., 2014; Unger et al., 2020).

Two trained nutritionists conducted measurement of weight, height and waist circumference. Each measurement was taken twice, and the average value was used for further analysis. Participants' height was measured barefoot with a stadiometer (OneHealth, Indonesia) and recorded to the closest 0.1 cm. Weight was assessed using a digital scale (GEA) to the nearest 0.1 kg. The body mass index (BMI) is calculated by dividing weight (in kilograms) by the square of height (in meters). Waist circumference (WC) was determined to the closest 0.1 cm at the approximately between the 10th rib and the iliac crest. Measurements were acquired with subjects positioned at the conclusion of a standard exhale, utilizing a non-elastic measuring tape.

A 24 hours food recall was administered by nutritionist. DASH eating behavior describes a dietary pattern that aligns with the DASH guidelines. It was calculated using the average intakes of each component of food intake compared to the portion based on Indonesian Dietary Guideline (Kementerian Kesehatan RI, 2019) and for some food components were based on Joyce et al. (2019). The food components comprised vegetables (excluding potatoes), fruits (including juices), whole grains, red and processed meat, nuts, seeds, legumes, dairy, fats, oils, and sweets. Each component was rated on a scale of 0–10 using predefined cut-off values, and the scores were summed to produce an overall DASH score ranging from 0 to 80. Median value was used as cut-off points to classify DASH eating behavior into high (>22 points) and low categories (≤22 points) (Joyce et al., 2019)

Handgrip strength was assessed utilizing a hand dynamometer (Onemed) while participants stood straight with feet positioned shoulder-width apart. The device was individually adjusted to align with the second knuckle of each participant's fingers to ensure proper grip. Upon the cue from trained personnel, participants were instructed to exert maximal force for 2–3 seconds. Each hand was measured twice, and the highest value obtained to the nearest 0.1 kg. Reference values for handgrip strength were determined based on age- and sex-specific data. Normal HGP for females were ranged to 45-59 yo (18,6-32,4), 50-54 yo

(18,1-31,9), 55-59 yo (17,7-31,5), 60-64 yo (17,2-31,0) and 65-69 yo (15,4-27,2). For males normal HGP were ranged to 45-59 yo (34,7-54,5), 50-54 yo (32,9-50,7), 55-59 yo (30,7-48,5), 60-64 yo (30,2-48,5) and 65-69 yo (28,2-44,0) (Gaikwad et al., 2016).

The data collected were analyzed using statistical software. Frequencies and percentages were used to summarize respondent's characteristics and assess the prevalence of categorical variables, whereas means and standard deviations were employed to describe continuous variables.. For categorical data, the Pearson Chi-square and Fischer exact test were applied to examine associations or independence between variables, with a significance level of α = 5%. Differences between independent groups were analyzed using the Mann-Whitney test.

RESULTS AND DISCUSSION

Table 1 presents the characteristics of study subjects divided into pre-elderly and elderly groups, along with corresponding p-values to indicate statistical significance. There were 31 males (33.3%) and 63 females (66.7%) across all subjects, with no significant distinction gender distribution between the pre-elderly and elderly

Table 1. Characteristics of study subjects

	All	Pre-elderly	Elderly	*p-value*
Age (yrs)	63.2±0.93	54.1±5.2	68.5±5.9	0.000[a]
Sex				
Male	31 (33.3)	11 (11.8)	20 (21.5)	0.879[b]
Female	63 (66.7)	23 (24.7)	39 (41.9)	
Comorbidities				0.349[b]
Yes	63 (67.7)	21 (22.6)	42 (45.2)	
No	30 (32.3)	13 (14.0)	17 (18.3)	
Medication				0.581[b]
One type	43 (46.2)	17 (18.3)	26 (28.0)	
Combination	50 (53.8)	17 (18.3)	33 (35.5)	
BMI category				0.130[c]
Underweight	6 (6.5)	2 (2.2)	4 (4.3)	
Normal	18 (19.4)	3 (3.2)	15 (16.1)	
Overweight	17 (18.3)	7 (7.5)	10 (10.8)	
Obese	52 (55.9)	22 (23.7)	30 (32.3)	
Waist circumference				0.068[b]
Normal	30 (32.3)	7 (7.5)	23 (24.7)	
At risk	63 (67.7)	27 (29.0)	36 (38.7)	
Handgrip strength (kg)	-	23.39±15.0	31.87±26.9	0.055[a]
Handgrip strength				0.265[b]
Low	64 (68.8)	21 (22.6)	43 (46.2)	
Normal	29 (31.2)	13 (14.0)	16 (17.2)	
SBP				0.676[b]
High	68 (73.1)	10 (10.8)	15 (16.1)	
Normal	25 (26.9)	24 (25.8)	44 (47.3)	
DBP				0.008*[b]
High	16 (16.1)	24 (25.8)	54 (58.1)	
Normal	78 (83.9)	10 (10.8	5 (5.4)	
Hypertension				0.780[b]
High	64 (68.8)	10 (10.8)	19 (20.4)	
Normal	29 (31.2)	24 (25.8)	40 (43.2)	

*p-value < 0.05; [a]Mann-Whitney test; [b]Pearson Chi-square; [c]Fischer exact test groups (p=0.879). Regarding comorbidities, 67.7% of subjects had comorbidities, with a higher prevalence among the elderly (45.2% vs. 22.6%), despite the lack of statistical significance in this difference (p=0.349).

In the analysis of drug usage, 53.8% of participants were undergoing combination therapy, with no notable differences observed between groups (p=0.581). Obesity was prevalent in 55.9% of all subjects, with more elderly individuals being obese (32.3%).

Waist circumference measurements revealed that 67.7% of participants were at risk, with a greater prevalence among elderly individuals (38.7%); however, this distinction was not statistically significant (p=0.068). Handgrip strength was lower among the elderly group (23.39 ± 15.0 kg), with 68.8% of subjects categorized as having low handgrip strength. Systolic blood pressure (SBP) did not demonstrate notable variations (p=0.676); however, diastolic blood pressure (DBP) was significantly elevated in the elderly group (p=0.008). Hypertension was observed in 68.8% of all subjects, with barely any distinctions between groups (p=0.780).

The table presents a summary of food Approaches to Stop Hypertension (DASH) scores and food intake among all participants, comparing pre-elderly and elderly groups. Most subjects (81.7%) exhibited low DASH behavior, with no significant difference between pre-elderly (28.0%) and elderly (53.8%) groups (P=0.320).

Fat intake was higher in the pre-elderly group (47.4±52.8 g) compared to the elderly (30.6±20.7 g), though not significantly (P=0.083). Fiber intake was slightly higher in the pre-elderly group (9.8±13.6 g) than the elderly (7.16±4.6 g), nonetheless, this distinction did not attain statistical significance (p=0.282). Sodium, potassium, calcium, magnesium, and polyunsaturated fatty acids (PUFA) intake, it also demonstrated no notable differences between the groups. Potassium intake was higher in the pre-elderly (1454.9±1218 mg) compared to the elderly (1168.3±914 mg), but this variation was also not significant (p=0.238). No statistically significant variations in dietary intake were observed between the groups.

The graph illustrates the adherence to several elements of the DASH (Dietary Approaches to Stop Hypertension) diet among pre-elderly and elderly populations. Both groups exhibit high adherence to limiting sugar (83% and 82%) and fat/oil intake (85% and 68%). However, adherence to other components is generally low, particularly for low-fat milk, dairy, fruits, vegetables, and cereal/grains, with most below 10% or zero. Meat and poultry consumption is relatively higher (59% in elderly, 50% in pre-elderly), while legumes/nuts show modest adherence (14% and 26%). Staple food intake adherence is low but slightly better (22% and 24%).

Table 2. DASH Eating Scores and Dietary Intake of pre-elderly and elderly

	All	Pre-elderly	Elderly	P value
DASH Eating Behavior				0.320
Low	76 (81..7)	26 (28.0)	50 (53.8)	
High	17 (18.3)	8 (8.6)	9 (9.7)	
Fat intake (g)	36.7±27	47.4±52.8	30.6±20.7	0.083
Fiber intake (g)	8.1±6.0	9.8±13.6	7.16±4.6	0.282
Sodium intake (mg)	266.4±163	245.3±321	278.6±308	0.622
Potassium intake (mg)	1273.1±988	1454.9±1218	1168.3±914	0.238
Calcium intake (mg)	269.3±40.7	323.8±391	237.9±393	0.312
Magnesium intake (mg)	174.3±139	201.4±197	158.6±109	0.215
PUFA intake (mg)	9.73±6.0	12.04±19.6	8.4±8.3	0.310

*p-value < 0.05; Mann-Whitney test

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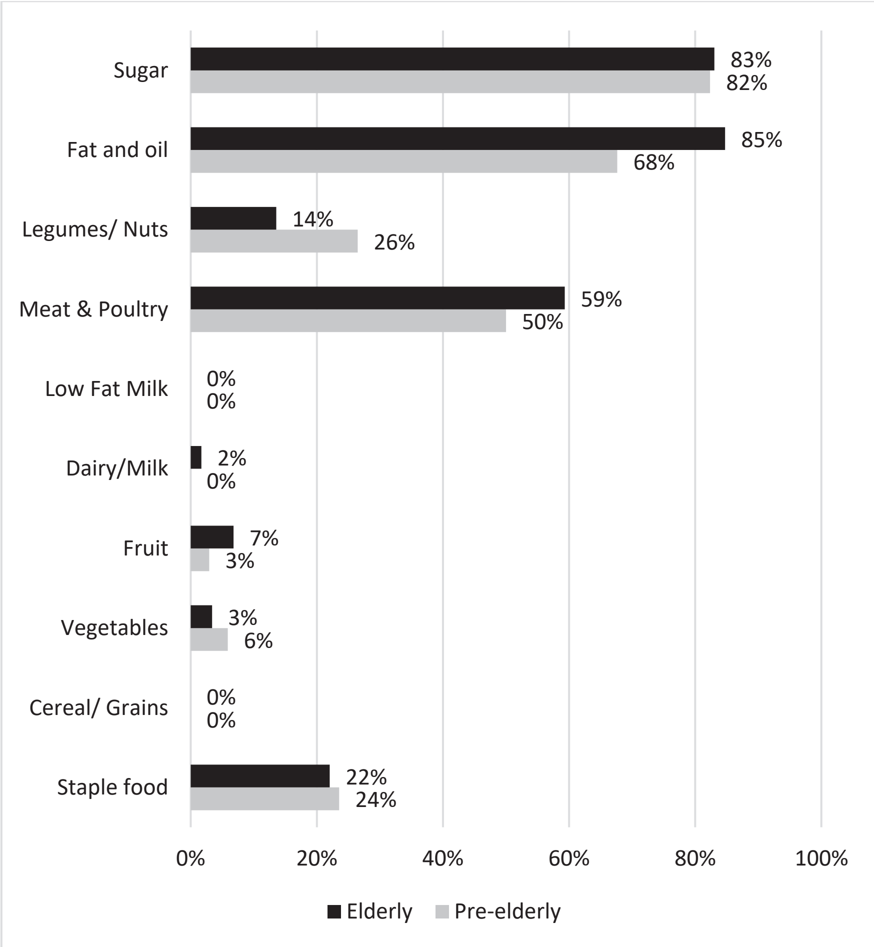

Graph 1. Percentage of adherence to DASH Eating Behavior's component in Elderly and Pre-elderly (in portion)

Table 3. Association between Handgrip, DASH Behavior, and Blood Pressure in Pre-elderly and Elderly

	Blood Pressure		**p-value**
	Normal	**Hypertension**	
Handgrip			
Pre-elderly			
Low handgrip	6 (17.6)	15 (44.1)	1.000
Normal handgrip	4 (11.8)	9 (26.5)	
Elderly			
Low handgrip	17 (28.8)	26 (44.1)	0.063
Normal handgrip	2 (3.4)	14 (23.7)	
DASH behavior			
Pre-elderly			
Low	5 (14.7)	21 (61.8)	0.031*
High	5 (14.7)	3 (8.8)	
Elderly			
Low	14 (23.7)	36 (61.0)	0.131
High	5 (8.5)	4 (6.8)	

*p-value < 0.05; Statistic Fisher exact test

Table 3 illustrates the association between handgrip strength, DASH dietary habits, and blood pressure classification (hypertension versus normal) in pre-elderly and elderly populations. In the pre-elderly cohort, the incidence of hypertension was greater in individuals with diminished handgrip strength (44.1%) compared to those with normative handgrip strength (26.5%); however, this difference was not statistically significant (p=1.000). Reduced handgrip strength was more common in hypertension patients (44.1%) compared to normotensive persons (28.8%), nearing statistical significance (p=0.063). No significant link exists between handgrip strength (HGS) and hypertension in pre-old and elderly populations; however, a potential correlation between lower HGS and hypertension in the elderly is suggested (p=0.063). Nonetheless, such results were not seen in the pre-elderly population.

A study in Southern China indicated that greater handgrip strength was strongly correlated with a lowered risk of hypertension in women, even after controlling for sociodemographic characteristics, lifestyle habits, and health-related variables. The study identified a significantly elevated risk of hypertension in older women, with odds ratios rising in the 60–74 years and ≥75 years age categories, respectively (Zhang et al., 2020).

Some mechanisms could explain the associations between HGS and hypertension. With aging, increased peripheral vascular resistance arises from reduced sympatholysis, heightened sympathetic activity, and morphological changes in the arteriolar network (Parker et al., 2007). Another potential explanation is that the age-related decrease in lean muscle mass may be linked to blood pressure. In this study, in elderly group, we found that individuals with lower handgrip strength were more likely to present with elevated blood pressure, which may be caused by reduced muscle strength to metabolic syndrome and cardiovascular biomarkers (Wang & Xu, 2017).

Sarcopenia, an age-related loss of muscle mass and function that has been connected to worsening cardiovascular health, could be the cause of this connection (Larsson et al., 2019). Therefore, handgrip strength may be a valuable tool for identifying those at risk for hypertension and other chronic conditions, as it is an easily measured predictor of overall muscular strength for diagnosing sarcopenia (Jang et al., 2021).

The relationship between handgrip strength and metabolic syndrome may be partially elucidated by an elevation in insulin resistance (Kawamoto et al., 2016). Insulin resistance impairs muscle glucose uptake and promotes fat accumulation, resulting in elevated levels of free fatty acids (FFAs) in the plasma. Obesity and elevated FFAs disrupt fatty acid oxidation, reducing mitochondrial function and causing metabolic dysfunction in muscle. FFAs also contribute to oxidative stress, inflammation, and vascular dysfunction, potentially leading to hypertension, highlighting the complex relationship between metabolism, muscle health, and cardiovascular regulation (Wolfe, 2006).

A significant relationship with DASH eating behavior was identified in the pre-elderly cohort (p 0.031). Individuals with low adherence to the DASH diet exhibited a higher prevalence of normal blood pressure (61.8%) compared to those with high adherence (8.8%), as the DASH diet is associated with improved blood pressure outcomes. No significant connection between DASH behavior and blood pressure was detected among the elderly (p = 0.131).

DASH diet has been originally to control hypertension (Conlin et al., 2000). The DASH diet has been linked to distinctive associations with cardiometabolic outcomes, such as metabolically obese/normal weight, which are distinct from other dietary patterns (Park et al., 2017). It emphasizes the intake of vegetables, fruits, lean meats, and dairy, encourages the inclusion of micronutrients, reduces dietary sodium, and limits the consumption of processed foods. (Challa et al., 2024).

In this study, we used DASH eating behavior which included eight types of food and scored based on how the portion matched on DASH diet recommendation. The results of this study suggest that diets that are high in fruits and vegetables and low in sodium are associated with enhanced blood pressure control in both pre-elderly and elderly populations. In this study, only 18.3% have high score of DASH eating behaviors.

The fulfillment of components of the DASH only showed on fat/oil dan sugar in both groups. However, consumption of low-fat milk and cereal/grains were nothing found in subject's typical intake which usually consume staple food like rice, and tubers. The typical of food choice of most of Indonesian population is likely to be high fat and density content, and low in fiber. The elderly's low consumption of grains and cereals may be influenced by factors such as lack of awareness, availability and accessibility, limited knowledge and skills, cost considerations, reduced motivation to cook, and a lack of awareness (Jung et al., 2022).

The results of this study emphasize that both handgrip strength and diet appear to play crucial involvement in the control of blood pressure, and their contributions may offer valuable insights for non-pharmacological interventions that are designed to reduce the risk of hypertension in aging populations. A notable correlation exists between isometric handgrip exercise, a reduction in blood pressure, and an improvement in patient comfort (Veralia et al., 2023). But the implication must consider the physical abilities of the elderly. Engaging in regular physical activity, especially resistance training, can improve cardiovascular health and muscle strength. In addition, one of the key insights from this study is the potential for combined interventions targeting both muscle strength and dietary improvements to mitigate the risk of hypertension.

CONCLUSION

There were no significant association between HGS and high blood pressure both in elderly and pre-elderly. However, low DASH eating behavior was significantly related to higher blood pressure in pre-elderly group. This study emphasizes The importance of preserving muscle strength and following a healthy diet highlights a critical aspect of a comprehensive approach to managing hypertension in pre-elderly and elderly individuals. Future research should focus on intervention studies that explore the combined effects of resistance training and dietary modifications on blood pressure regulation, as well as the long-term health benefits of such interventions in aging populations.

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Authors' Contribution

AF, AFN and MJB contributed to the design and implementation of the research, AFN contributed to the data survey, AF contributed to the analysis of the results and writing of the draft, AFN and MJB contributed to finishing the manuscript.

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