ASSOCIATION OF MACRONUTRIENT AND MICRONUTRIENT INTAKE, AND NUTRITIONAL STATUS WITH SYSTOLIC BLOOD PRESSURE IN ELDERLY

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Abstract. WHO data shows that people with hypertension in the world in 2021 are estimated to reach 29.2%. The Health Profile of East Java in 2020 shows the proportion of hypertension in male was 48.83% male and in female was 51.17%. Several studies have showed that change in blood pressure can be caused by several factors such as excess intake of macronutrients (carbohydrates, protein, and fat), imbalanced intake of micronutrients (sodium, potassium, calcium, and magnesium), as well as nutritional status. The purpose of this study was to determine the association between intake of macronutrients (protein, fat, carbohydrates), micronutrients (sodium, potassium, calcium, magnesium) and nutritional status with systolic blood pressure in the older people in Probolinggo Regency, East Java. This research method was cross-sectional observational study. The number of samples in this study were 110 elderly people who were recruited using the simple random sampling technique. The bivariate test used was Spearman's rank correlation. The results showed a positive association between sodium intake with systolic blood pressure (p=0.010; r=0.776) and negative association between calcium intake with systolic blood pressure in the older people (p=0.030; r=-0.207). However, there was no association between carbohydrate intake (p=0.258), protein intake (p=0.125), fat intake (p=0.296), potassium intake (p=0.760), magnesium intake (p=0.226), and nutritional status (p=0.967) with systolic blood pressure in the older people. We concluded elderly people should maintain a diet that was a source of carbohydrates, protein, fat, and maintain an appropriate diet for micronutrients such as sodium, potassium, magnesium and calcium to maintain blood pressure.

Keywords: elderly people; blood pressure; macronutrient; micronutrient; nutritional status

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INTRODUCTION

The number of people aged 30-79 years with hypertension doubled from 331 million women in 1990 to 626 million in 2019, and also from 317 million men in 1990 to 652 million in 2019 despite stable global age-standardized prevalence (NCD-RisC, 2021). In 2019, treatment and control rates of hypertension were highest in South Korea, Canada, and Iceland (treatment >70%; control >50%), followed by the USA, Costa Rica, Germany, Portugal, and Taiwan (NCD-RisC, 2021). Treatment rates were less than 25% for women and less than 20% for men in Nepal, Indonesia, and some countries in sub-Saharan Africa and Oceania (NCD-RisC, 2021). The Health Profile of East Java in 2020 shows the proportion of hypertension in males was 48.83% male and female was 51.17% (East Java Provincial Health Department, 2021). Getting old is a natural process that cannot be avoided. In the older people, there will be changes in physical, mental and social decline. Based on data from the Probolinggo District Health Office in 2013 the number of older people who received health services was 20.20% and increased to 54.14% in 2014 (Probolinggo Regency Health Department, 2020). Health problems that are often experienced by the older people are hypertension, hypotension, orthostasis, coronary heart disease or even heart failure are diseases that commonly occur in the older people.

Hypertension was an example of a degenerative disease that has a fairly high level of morbidity (illness) and mortality (death rate), because older people are very important considering that there are complications, the course disease, and how to manage it are not the same as adults with hypertension (Anggara and Prayitno, 2013). Data from the Probolinggo District Health Office in 2017 showed that the prevalence of high blood disease was 3.3% (Probolinggo Regency Health Department, 2020). Qi *et al* (2022) state that there are two types of risk factors that can affect blood pressure: risk factors that are uncontrollable, like aging, gender, and heredity, and risk factors that are controllable, like eating too much fat, protein, and carbs, or too much of certain micronutrients such as calcium, magnesium, sodium, and potassium, or the nutritional status of older adults.

Based on the data and description above, it can be stated that blood pressure in the older people needs good treatment. Therefore, it was necessary to conduct research to determine the relationship between intake of macronutrients (protein, fat, carbohydrates), micronutrients (sodium, potassium, calcium, magnesium), and nutritional status with blood pressure in the older people in Probolinggo Regency.

MATERIALS AND METHODS

This research was cross-sectional observational study. The sample size was 110 older people that was calculated with Yamane's formula (Yamane, 1967).

$$n = \frac{N}{(1+N(e)^2)}$$

where n = number of samples

N = population (for Probolinggo Regency, the population is 136,235)

e = error level (in this study, we allowed 10%)

Such calculation resulted in n = 99.93 or 100 research participants required.

The inclusion criteria in this study were elderly aged ≥55 years, not having physical disabilities, being able to communicate well, willing to be a respondent in the study, domiciled in Probolinggo Regency while the exclusion criteria were the elderly who were bed rest and experiencing senility. The sampling technique was simple random sampling. The independent variables of the study were macronutrient intake (protein, fat, carbohydrates), micronutrients intake (sodium, potassium, calcium, magnesium) and nutritional status. The dependent variable in this study was blood pressure in the older people in Probolinggo Regency. Research tool to collect data on the intake of carbohydrates, protein, fat, sodium, potassium, calcium, and magnesium was a semi-quantitative food frequency questionnaire (SQ-FFQ) which was developed by Fahmida and Dillon (2007). For the measurement of nutritional status (anthropometric measurements for height and weight), the researchers used a digital bathroom scale OMRON manufactured by OMRON Healthcare Group (Dalian, PR China) which has an accuracy of 0.1 kg; and to measure the height, the Onemed manufactured by PT. Jayamas Medica Industri TBK (Sidoarjo East Java, Indonesia) which has an accuracy of 0.1 cm was used. Measurement of blood pressure was performed using a mercury sphygmomanometer OMRON (OMRON Healthcare Group, Dalian, China) with an accuracy of 1 mmHg.

The statistical test used and the instrument for each variable was Spearman Test.

The study received ethical clearance from the Medical Faculty of Universitas Brawijaya, Approval Number 363/EC/KEPK-S1-GZ/12/2018.

RESULTS

The results of the study (Table 1) show that most of the respondents are female (76.6%). Most of the age the older people are 60-74 years old (65.5%). Most of the older people have primary school education (45.5%) and do not work (50.9%). Regarding smoking habits and alcohol consumption, most of the older people do not smoking (90%) and all of them do not consume alcohol (100%). Regarding macronutrient intake, 34.5% of the elderly has normal carbohydrate intake, 21.8% has normal protein intake, and 80% has normal fat intake. In terms of micronutrient intake,

Table 1
Respondent characteristics (N = 110)

Characteristic	Frequency *n* (%)
Gender	
Male	26 (23.6)
Female	84 (76.4)
Age	
45-59 years old	23 (20.9)
60-74 years old	72 (65.5)
75-90 years old	15 (13.6)
>90 years old	0 (0.0)
Education	
College	6 (5.5)
Senior High School	3 (2.7)
Junior High School	8 (7.3
Elementary School	50 (45.5)
No school	43 (39.1)

Table 1 (cont)

Characteristic	Frequency *n* (%)
Work	
Not working	56 (50.9)
Working	54 (49.1)
Smoking habits	
Smoking	11 (10.0)
Not smoking	99 (90.0)
Alcohol consumption	
Yes	0 (0.0)
No	110 (100.0)
Carbohydrate intake (% of Indonesian recommended dietary allowance)	
High deficit (<69%)	27 (24.5)
Moderate deficit (70-79%)	11 (10.0)
Mild deficit (80-89%)	20 (18.2)
Normal (90-120%)	38 (34.5)
Excess (≥120%)	14 (12.7)
Protein intake (% of Indonesian recommended dietary allowance)	
High deficit (<69%)	1 (0.9)
Moderate deficit (70-79%)	3 (2.7)
Mild deficit (80-89%)	5 (4.5)
Normal (90-120%)	24 (21.0)
Excess	77 (70.0)
Fat intake (% of Indonesian recommended dietary allowance)	
High deficit (<69%)	2 (1.8)
Moderate deficit (70-79%)	1 (0.9)
Mild deficit (80-89%)	4 (3.6)
Normal (90-120%)	15 (13.6)
Excess (≥120%)	88 (80.0)

Table 1 (cont)

Characteristic	Frequency *n* (%)
Sodium intake	
Low (<1,100 mg/day)	1 (0.9)
Normal (1,100 mg/day)	25 (22.7)
High (>1,100 mg/day)	84 (76.4)
Potassium intake	
Low (<4,700 mg/day)	86 (78.2)
Normal (4,700 mg/day)	18 (16.4)
High (>4,700 mg/day)	6 (5.5)
Calcium intake	
Low (<1,200 mg/day)	82 (74.5)
High (≥1,200 mg/day)	28 (25.5)
Magnesium intake	
Low (350 mg/day)	11 (10.0)
High (≥350 mg/day)	99 (90.0)
Nutritional status	
Underweight (17 to <18.5 kg/m^2)	19 (17.3)
Normal (18.5-25.0 kg/m^2)	37 (33.6)
Overweight (>25.0-27.0 kg/m^2)	36 (32.7)
Obesity (>27.0 kg/m^2)	18 (16.4)

Note: Classifications of macronutrients and micronutrients follow those of Hardinsyah et al (2013) while the classification of nutritional status is based on Ministry of Health (2014).

kg/m^2: weight in kilogram per square meter of height; mg: milligram

76.4% of the elderly has high sodium intake, 78.2% has low potassium intake, 74.5% has low calcium intake, and 92.3% male elderly has high magnesium intake and also 89.3% elderly women has high magnesium intake. For the nutritional status, 33.6% elderly have normal nutritional status and 32.7% have overweight nutritional status.

There is no relationship between carbohydrate intake (p=0.258), protein intake (p=0.125), fat intake (p=0.296) and nutritional status (p=0.967) with systolic blood pressure in the older people (Table 2). The results of this study indicate that there is an association between sodium intake (p=0.010; r=0.776) and calcium intake (p=0.030; r=-0.207) with systolic blood pressure (Table 2). For sodium intake, the correlation is positive, which means that the higher the sodium intake, the higher systolic blood pressure. For calcium intake, the correlation is negative, which means that the lower calcium intake, the higher systolic blood pressure. However, there is no relationship between potassium intake (p=0.760) and magnesium intake (p=0.226) with systolic blood pressure (Table 2).

DISCUSSION

According to the data from the Probolinggo Regency Health Department in 2018, the number of male elderly in Probolinggo Regency was 550 thousand while that of female was 577 thousand (Probolinggo Regency Health Department, 2020). Therefore, the respondents at the research site are in accordance with the number of female residents in Probolinggo Regency, which are more numerous than the male population. In women, there is an increase the risk of high blood pressure (hypertension) after menopause, age over 45 years caused by hormonal factors (Giles *et al*, 2009). Premenopausal women begin to lose little by little the hormone estrogen which has been protecting blood vessels from damage. This process continues where the estrogen hormone changes in

Table 2
Factors associated with systolic blood pressure (N = 110)

Variable	Mean ± SD	Median (min-max)	*p*-value*
Carbohydrate intake† (g/day)	258.09 ± 65.67	-	0.258
Protein intake‡ (g/day)	-	92.65 (37.04-160.87)	0.125
Fat intake‡ (g/day)	-	81.39 (35.52-115.32)	0.296
Sodium intake‡ (mg/day)	-	2,491.70 (1,148.40-4,918.31)	0.010
Potassium intake† (mg/day)	3,239.0 ± 1,162.69	-	0.760
Calcium intake‡ (mg/day)	-	649.615 (182.14-2,780.22)	0.030
Magnesium intake† (mg/day)	5.69 ± 2.04	-	0.226
Nutritional status (body mass index, kg/m^2)	23.13 ± 4.74	-	0.967

*Spearman test; †Data were normally distributed and reported as mean ± SD; ‡Data were not normally distributed and reported as median (min-max)

kg/m^2: weight in kilogram per square meter of height; g: gram; mg: milligram

quantity according to the age of the woman naturally, which generally begins to occur in women aged 45-55 years before becoming older people (Giles *et al*, 2009).

This research shows that 45.5% graduated from elementary school and 39.1% did not graduate from school. It shows that these elderly people have a low level of education and knowledge. Similar with research of Kurniasih and Setiawan that the increase in blood pressure tends to be high in low education population. The high risk of developing hypertension in low education people may be due to a lack of knowledge on health and difficulty in receiving health information provided by health workers so that it has an impact on healthy behavior (Kurniasih and Setiawan, 2013).

This study also shows that carbohydrate and protein intakes were normal but fat intakes were high. There was no significant relationship between carbohydrate, protein, and fat intake with systolic blood pressure (Table 2) which agreed with other research studies (Appel *et al*, 2005; Kusumawaty *et al*, 2016). According to Appel *et al* (2005), there was no evidence of a significant correlation between the intake of fat, protein, or carbohydrates and hypertension. And other study of Kusumawaty *et al* (2016) states that protein intake in adequate amount can control blood pressure. Other factors that may have a greater impact on hypertension include stress, obesity, physical activity, excessive sodium consumption, genetics, and other degenerative diseases (Kotchen, 2010).

This study shows that there was a significant relationship between sodium and calcium intake with systolic blood pressure, but there was no significant relationship between potassium and magnesium intake with systolic blood pressure (Table 2). These results are similar to another study that reported a relationship between daily sodium intake and blood pressure (Stamler *et al*, 2018). Sodium is an electrolyte in the body and is a mineral that the body needs according to nutritional adequacy (Baila

et al, 2022).

High sodium can trigger sodium retention which can result in increased fluid volume and blood pressure. Blood pressure was directly related to the risk of heart disease and stroke (Martin and Fischer, 2012). Other studies have shown that high sodium and low potassium intakes are associated with increased blood pressure, and there was a relationship between calcium intake in women's systolic blood pressure and diastolic blood pressure in men (Van Leer *et al*, 1995). This study is similar with another study that showed sodium and potassium intakes were not associated with either systolic or diastolic blood pressure (Park *et al*, 2010). Calcium was inversely associated with both systolic or diastolic blood pressure (Magalhães *et al*, 2017).

The results of this study show no association between nutritional status and systolic blood pressure which is in contrast with other studies. Zhang *et al* (2013) showed that obesity was positively associated with both pre-hypertension and hypertension, ie, obese people have 1.44 times greater risk of developing hypertension than people with normal nutritional status. Park *et al* (2010) also showed that BMI were positively associated with diastolic and systolic blood pressure. The reason for no association between nutritional status and systolic blood pressure in this study could be due to the nutritional status of the older people; most of them were normal.

In conclusion, there is a positive association between sodium intake with systolic blood pressure and negative association between calcium intake with systolic blood pressure in the elderly people. However, there was no association between carbohydrate intake, protein intake, fat intake, potassium intake, magnesium intake, and nutritional status with systolic blood pressure in the elderly. Our findings suggest that arrangement of sodium and calcium consumption pattern may be needed for primary prevention and management of hypertension.

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CONFLICT OF INTEREST DISCLOSURE

The authors declare no conflict of interest.

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