

# SODIUM, IRON, ZINC, FIBER, POLYUNSATURATED FATTY ACIDS, CHOLESTEROL INTAKE AND BLOOD PRESSURE IN ELDERLY WITH CORONARY ARTERY DISEASE

Cleonara Yanuar Dini<sup>1</sup>, Dian Handayani<sup>2</sup>, Mohammad Saifur Rohman<sup>3</sup>, Annisa Rizky Maulidiana<sup>2</sup>, Amarida Viena Sabillia<sup>2</sup>, Antafani Eka Mawardani<sup>2</sup>, Maya Amalia Sugianto<sup>2</sup>, Nova Anevia Erfitian<sup>2</sup>, Rhisma Mutiara Devi<sup>2</sup>, Yasmin Shofiyah<sup>2</sup> and Agustiana Dwi Indiah Ventiyarningsih<sup>2</sup>

<sup>1</sup>Department of Nutrition, Faculty of Exercise and Health Science, Universitas Negeri Surabaya, Surabaya, Indonesia; <sup>2</sup>Department of Nutrition, Faculty of Health Sciences, Universitas Brawijaya, Malang, Indonesia; <sup>3</sup>Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia

**Abstract.** Inadequate intake of sodium, iron, zinc, fiber, polyunsaturated fatty acid (PUFA), and cholesterol are associated with increased risk of hypertension. This study aimed to investigate the daily intake adequacy of those nutrients related to hypertension in older adults with coronary artery disease history. Fifty respondents (51-75 years old) involved in the study had cardiovascular disease history while they checked with the cardiologist monthly and had an optimum medical treatment history. Dietary intake was assessed using repeated 24-hours recall questionnaire. Blood pressure was measured three times using calibrated digital sphygmomanometer. Spearman's rank was used to analyze relationship between PUFA, cholesterol, iron and blood pressure while Pearson chi-squared test was used to analyze the relationship between sodium, zinc, fiber intakes and blood pressure. Most respondents had appropriate controlled blood pressure, *i.e.*, below 130/90 mmHg. Around 89.1% of respondents had optimal cholesterol intake with an average intake about 124.61 mg. However, respondents experienced deficiencies in the average intake of zinc ( $4.23 \pm 1.71$  mg), sodium ( $859.9 \pm 654.1$  mg), iron ( $7.4 \pm 4.6$  mg), PUFA ( $8.6 \pm 6.6$  g), and fiber ( $11.2 \pm 5.7$  g). Blood pressure was not associated with intakes of iron ( $p=0.531$ ), cholesterol ( $p=0.755$ ), fiber ( $p=0.221$ ), PUFA ( $p=0.295$ ), zinc ( $p=0.761$ ), sodium ( $p=0.066$ ). In summary, there was no relationship statistically between daily micronutrient intake and blood pressure in older adults with controlled blood pressure even though they had cardiovascular disease history.

**Keywords:** sodium, iron, zinc, fiber, polyunsaturated fatty acid, PUFA, cholesterol, hypertension

---

Correspondence: Cleonara Yanuar Dini, Department of Nutrition, Universitas Negeri Surabaya, Kampus Lidah Wetan, Jl Lidah Wetan Kec. Lakarsantri, Kota Surabaya, Jawa Timur 60213, Indonesia  
Tel: +62 816246473 E-mail: cleonaradini@unesa.ac.id

## INTRODUCTION

Hypertension is a condition related to rising blood pressure when the systolic blood pressure and diastolic pressures are more than 140 mmHg and 90 mmHg, respectively (Larkin and Cavanagh, 2016). The number of people with hypertension globally has increased by 25% since 2000. It was predicted that the number of people with hypertension will increase to 29% or around 1.6 billion worldwide in 2025 (Mills *et al*, 2016). Hypertension became one of the risk factors for coronary heart disease and an essential factor in the circulatory system that mostly happens in people with coronary heart disease (CHD) (Fuchs and Whelton, 2020). CHD is one of the various degenerative diseases related to the obstruction of the arteries that supply blood to the heart muscle due to fat deposits leading to the narrowing of the arteries on the walls of blood vessels (atherosclerosis). As a result, the heart cannot get blood and oxygen as needed, which changes the role and shape of the arteries in the coronary arteries of the heart (Hanson *et al*, 2013). Based on data from Indonesian Basic Health Research (2018), the prevalence of CHD in Indonesia based on symptom diagnosis was 1.5% or around 2,650,340 population, and elderly (more than 65 years old) had the highest incidence of CHD, *ie* 4.7% (Ministry of Health Republic of Indonesia, 2018). The highest prevalence of coronary syndrome sufferers in Indonesia was in East Java Province, which constituted 1.3% or around 433,437 people and the mortality rate due to hypertension reached 4.81% and the prevalence of hypertension reached 17.3% (Andrianto *et al*, 2023; Pusparina *et al*, 2020).

It has been known that nutrient intakes, both macro- and micronutrients, are associated with the incidence of hypertension (Chiu *et al*, 2021; Molitor *et al*, 2014). Adequate intake of PUFA, fiber, sodium, zinc, and iron can reduce the risk of hypertension (Brosolo *et al*, 2023; Domellöf *et al*, 2013; Du *et al*, 2021; Félix-Redondo *et al*, 2013; Grillo *et al*, 2019; Reynolds *et al*, 2022; Zhang *et al*, 2022a). PUFAs, namely Omega 3 and Omega 6, have been shown to specifically reduce blood pressure through increased prostaglandin substances in the body functioning as a vasodilator that can stabilize high blood pressure or hypertension. A review of several research studies about omega-3 fatty acids in arterial hypertension explained that there is no significant relationship between the intake of polyunsaturated fat sources with the incidence of hypertension due to the mixing of polyunsaturated fat food sources with oil in the frying process which results in the modification of nutrients in food (Brosolo *et al*, 2023). The results of Lidiyawati and Kartini (2014) emphasized that the processing incident can cause a confounding factor in the content of polyunsaturated fat. Blood cholesterol levels exceeding normal limits will cause atherosclerosis and will block the arteries (Félix-Redondo *et al*, 2013). The walls of atherosclerosis arteries will become thick stiff because of cholesterol deposits, and the arteries will experience narrowing, hardening, losing flexibility then becoming stiff. Epidemiological, biochemical, and experimental studies have stated that cholesterol plays a vital role in the formation of atherosclerosis (Kannel *et al*, 1964; Lin *et al*, 1994; Lin *et al* 1995; Weggemans *et al*, 2001; Katz *et al*, 2015; Blesso *et al*, 2013; Soliman 2018; Wang *et al*, 2017). Plasma cholesterol concentrations generally increase with increased dietary cholesterol in most people. Increased levels of total cholesterol and LDL cholesterol in plasma due to consuming saturated fatty acids food are significant risk factor for the emergence of cardiovascular illnesses in both people and experimental animals (Wang *et al*, 2017). Atherosclerosis is thickening process of the intimal layer of arteries and accumulation of fat. Fatty material is located in the central core of the plaque, covered by fibrous cap. Hyperlipidemia is related to increased oxidative damage, which affects antioxidant status and

lipoprotein levels while a decrease in regulating blood pressure influences incidence of hypertension (Rafieian-Kopaei *et al*, 2014). According to Dahl and Stewart (2015), high fiber consumption is associated with lowering blood pressure and preventing cardiovascular disease. Fiber intake is associated with hypertension because fiber can help increase cholesterol expenditure through feces by increasing the transit time of foodstuffs through the intestine. In addition, excessive sodium intake from salt can result in an imbalance in the renin-angiotensin-aldosterone (RAAS) system, causing sodium retention and increased blood volume (Drenjančević-Perić *et al*, 2011). Furthermore, excessive sodium consumption causes sodium concentration in the extracellular fluid to increase. Consequently, the intracellular fluid is pulled out, increasing extracellular fluid volume increases. The increased volume of extracellular fluid causes an increase in blood volume, which impacts the onset of hypertension. In addition, high sodium intake causes the diameter of the arteries to shrink, and the high blood volume and the narrower diameter of the arteries force the heart to pump harder until blood pressure increases (Dahl and Stewart, 2015). The average fiber consumption in Indonesia was generally still low, *i.e.*, at around 10.5 g/day particularly in elderly (Ministry of Health Republic of Indonesia, 2018). Several studies concluded that average intake of fiber in elderly were less than 80% Indonesia recommended dietary allowance (RDA) (Arjuna *et al*, 2017; Fauziyana *et al*, 2021; Setiati *et al*, 2013).

Suliburska *et al* (2011) showed that a decrease in zinc intake and a decrease in serum zinc in the body were associated with insulin resistance, diabetes, hypertension, and hypertriglyceridemia. Some of the impacts when zinc intake is deficit are a decrease in the sense of salty taste and a decrease in the ability to vasodilate blood vessels which causes an increase in blood pressure (Carpenter *et al*, 2013). Meanwhile, lack of iron intake can cause anemia, increase the risk of heart failure, and increase mortality in patients with chronic heart failure. In addition, anemia will increase the workload because it increases the heart rate, which leads to ischemia or myocardial

infarction. Furthermore, anemia will cause tissue ischemia resulting in vasodilation and a decrease in blood pressure. In addition, anemia is related to an iron deficiency. A previous review study suggested that iron deficiency can cause pulmonary artery hypertension due to dysregulation of intracellular iron control, which is controlled by hepcidin autocrine action (Sonnweber *et al*, 2020). However, a review of 55 studies showed that 27 studies supported the effect of iron on increasing the risk of CHD, while 20 studies showed no association between iron and CHD, and 8 studies showed the opposite result; iron can reduce the risk of CHD (Lakhal-Littleton, 2019; Muñoz-Bravo *et al*, 2013).

This study aimed to analyze the adequacy of several micronutrient intake compare to Indonesian recommended dietary allowance (RDA), then examined the relationship between micronutrient intake and the incidence of hypertension in the elderly with coronary heart disease in well-managed population, *i.e.*, Malang Cardiovascular Care Community (MC3).

## MATERIALS AND METHODS

### Study design

It was an observational with cross-sectional study involving the elderly. This research has received ethical approval from the Faculty of Medicine, Universitas Brawijaya, Malang (No. 400/016/K.3/302/2020).

### Participants

Sample size was calculated with G\*Power version 3.1 (<https://www.psychologie.hhu.de/arbeitsgruppen/allgemeine-psychologie-und-arbeitspsychologie/gpower>). With 95% power and 5% significance level, the study required a total sample size of 46 subjects to detect significant interactions in a bivariate normal model of correlation of micronutrient

intake to blood pressure (effect size of 0.5). Purposive sampling was used to select fifty participants from the Malang Cardiovascular Care Community (MC3) for this study. MC3 is a community of elderly who suffer from coronary artery disease in the Malang area, East Java.

The inclusion criteria were being regularly checked, once a month, for blood pressure, blood lipids, blood glucose, medication adherence, and consumption of food and supplements. They must also attend education sessions from cardiologists and nutritionists to broaden their understanding of heart disease or nutrition through weekly peer group discussions and do aerobics exercise at least once a week held by MC3 every Sunday for a year. Those whose nutrition consumption data could not be obtained for 3 non-consecutive days (2 weekdays, 1 weekend) were excluded from the study. Members of MC3 who met the criteria, signed the informed consent form.

## **Data collection**

Data on participants characteristics including gender, age, last education, occupation, comorbidities, physical activity, medication, and supplements consumed by respondents were collected. Blood pressure was measured three times using Omron Blood Pressure Monitor Model No: HEM 742 (Omron, Kyoto, Japan). In addition, blood pressure data in medical records were also used to view the history of blood pressure in the past three months. Anthropometric measurements were carried out by measuring height using a stature meter (Seca, Hamburg, Germany) and body weight using a digital scale (Tanita Corp, Tokyo, Japan) to get a picture of the respondent's body mass index. Interviews related to food intake were conducted using repeated 24-hour recall (3 days, non- consecutive; twice on a weekday, once at the weekend) to determine the intake of PUFA, cholesterol, sodium, zinc, iron, and fiber. All questionnaires used in this study were tested on 16 other respondents who had similar characteristics as the 50 primary research respondents for validation process. Their average

daily intake of micronutrient compared to the Indonesian Recommended Dietary Allowance for people over 65 years old (Ministry of Health Republic of Indonesia, 2019).

## Data analysis

Spearman's rank was used to analyze relationship between PUFA, cholesterol, and iron with blood pressure, while the Pearson's chi-squared test was used to determine the relationship between sodium, zinc, fiber intake and blood pressure with a 95% confidence level and  $p < 0.05$  was considered significantly different.

## RESULTS

Most respondents (66%) who were members of the MC3 were men aged over 50 years old who had retired. The majority of respondents were in tertiary education. They were primarily overweight with dyslipidemia and diabetes mellitus (Table 1). Factors might relate to the respondent-controlled blood pressure was patient compliance with pharmacological (antihypertensive and or anti-cholesterol drugs) and non-pharmacological therapy (diet, lifestyle, physical activity and exercise). Respondents took statin as anti-cholesterol, beta blocker and calcium channel as anti-hypertension and clopidogrel as anti-platelet (Table 2). As much as 22% of the total respondents had normal blood pressure, and 50% had prehypertension, as depicted in Table 3. The majority of respondents experienced deficiencies in the average daily intake of micronutrients, such as intake of zinc ( $4.23 \pm 1.71$  mg) and sodium ( $859.9 \pm 654.1$  mg) (Table 4). The iron intake of 26 respondents (52%) was found to be deficient because it was below 8 mg/day for women and 9 mg/day for men. Most of the respondents' fiber intake was less than 25 mg/day (92%). PUFA intake was classified as a deficit in 70% of respondents. The average respondent's dietary cholesterol intake was  $124.6 \pm 10.6$  mg/day, or below

Table 1  
Characteristic of respondents (N = 50)

Characteristic	Frequency <i>n</i> (%)
Gender	
Male	33 (66)
Female	17 (34)
Age	
51-65 years	24 (48)
>65 years	26 (52)
Body mass index (BMI)	
Underweight (<18.5 kg/m <sup>2</sup> )	1 (2)
Normal weight (18.5-22.9 kg/m <sup>2</sup> )	9 (18)
Overweight (23.0-24.9 kg/m <sup>2</sup> )	24 (48)
Obese (≥25 kg/m <sup>2</sup> )	16 (32)
Academic background	
Elementary School	1 (2)
Junior High School	3 (6)
Senior High School	10 (20)
Undergraduate	36 (72)
Occupation	
Household work	9 (18)
Retired	31 (62)
Civil servant	5 (10)
Entrepreneur	3 (6)
Others	2 (4)
Comorbidity	
Dyslipidemia	5 (10)
Diabetes mellitus	4 (8)

kg/m<sup>2</sup>: kilogram per square meter

Table 2  
 Medical treatment (drugs) and supplement intake (N = 50)

Medical treatment	Frequency <i>n</i> (%)
Anti-hypertension	
ACE inhibitor	3 (3.0)
Angiotensin receptor	23 (23.2)
Calcium channel blocker	26 (26.2)
Alpha 2 receptor agonist	1 (1.0)
Beta blocker	32 (32.3)
Potassium sparing diuretic	3 (3.0)
None	11 (11.1)
Anti-cholesterol	
Statin	39 (78)
Gemfibrozil	2 (4)
Fenofibrate	1 (2)
None	8 (16)
Anti-platelet	
Clopidogrel	25 (50)
Acetylsalicylic acid	17 (34)
None	8 (16)
Proton-pump inhibitors	5 (10)
Nitrate	11 (22)
Anti-arrythmia	3 (6)
Anti-diabetes	6 (12)
Supplement intake	
Yes	39 (78)
No	11 (22)

Table 3  
Systolic and diastolic blood pressure

Blood pressure	Frequency <i>n</i> (%)
Systolic blood pressure	
<130 mmHg	26 (52)
131-139 mmHg	1 (20)
≥140 mmHg	14 (28)
Diastolic blood pressure	
<85 mmHg	40 (80)
86-89 mmHg	8 (16)
≥90 mmHg	2 (4)
Normal (<130/85 mmHg)	11 (22)
Pre-hypertension (131-139/86-89 mmHg)	25 (50)
Hypertension (≥140/≥90 mmHg)	14 (28)

mmHg: millimeter of mercury

300 mg/day. However, their blood pressure had insignificant statistically to intakes of iron ( $p=0.531$ ), cholesterol ( $p=0.755$ ), fiber ( $p=0.221$ ), PUFA ( $p=0.295$ ), zinc ( $p=0.761$ ) and sodium ( $p= 0.066$ ) (Table 4).

## DISCUSSION

Eighty percent of our respondents were overweight and obese, the highest education attained was undergraduate (72%). Several studies mentioned that body mass index (BMI) was determinant for blood pressure in the overweight/obese older adult individuals in Indonesia (Astutik *et al*, 2021; Kamso *et al*, 2007; Kurniawan *et al*, 2021; Mitra and Wulandari, 2019). Based on evidence from Population-Based Indonesian Family Life Survey,

Table 4  
Nutrient intake adequacy and blood pressure per category

Daily nutrient intake (Mean $\pm$ SD)	Categorization of nutrient intake and criteria	Blood pressure, n (%)			p-value
		Normal	Pre-hypertension	Hypertension	
Iron (7.4 $\pm$ 4.6 mg)	Adequate	5 (10)	12 (24)	5 (10)	0.531 <sup>a</sup>
	(Male: $\geq$ 9 mg/day; Female: $\geq$ 8 mg/day)				
Cholesterol (124.6 $\pm$ 10.6 mg)	Inadequate	7 (14)	11 (22)	10 (20)	0.755 <sup>a</sup>
	(Male: $<$ 9 mg/day; Female: $<$ 8 mg/day)				
Fiber (11.2 $\pm$ 5.7 g)	Adequate	5 (10)	10 (20)	5 (10)	0.211 <sup>b</sup>
	( $\geq$ 25 g/day)				
PUFA (8.6 $\pm$ 6.6 g)	Over intake	9 (18)	11 (22)	10 (20)	0.295 <sup>a</sup>
	(>200 mg/day)				
PUFA (8.6 $\pm$ 6.6 g)	Adequate	5 (10)	5 (10)	2 (4)	0.295 <sup>a</sup>
	( $\geq$ 25 g/day)				
PUFA (8.6 $\pm$ 6.6 g)	Inadequate	9 (18)	24 (48)	14 (28)	0.295 <sup>a</sup>
	(Male: $\geq$ 1.6 g/day; Female: $\geq$ 1.1 g/day)				
PUFA (8.6 $\pm$ 6.6 g)	Adequate	4 (8)	5 (10)	6 (12)	0.295 <sup>a</sup>
	(Male: $\geq$ 1.6 g/day; Female: $\geq$ 1.1 g/day)				
PUFA (8.6 $\pm$ 6.6 g)	Inadequate	5 (10)	17 (34)	13 (26)	0.295 <sup>a</sup>
	(Male: $<$ 1.6 g/day; Female: $<$ 1.1 g/day)				

Table 4 (cont)

Daily nutrient intake (Mean $\pm$ SD)	Categorization of nutrient intake and criteria	Blood pressure, <i>n</i> (%)			<i>p</i> -value
		Normal	Pre-hypertension	Hypertension	
Zinc (4.23 $\pm$ 1.71 mg)	Adequate	2 (4)	4 (8)	5 (10)	0.761 <sup>b</sup>
	(Male: $\geq$ 9 g/day; Female: $\geq$ 8 g/day)				
Sodium (859.9 $\pm$ 654.1 mg)	Inadequate	6 (12)	24 (14)	9 (10)	0.660 <sup>b</sup>
	(Male: $<$ 9 g/day; Female: $<$ 8 g/day)				
	Adequate	2 (4)	4 (8)	4 (8)	0.660 <sup>b</sup>
	(1,100-1,400 mg/day)				
	Inadequate	10 (20)	21 (42)	9 (18)	
	( $<$ 1,100 mg/day)				

Note: Categorizations of adequacy intake of iron, cholesterol, fiber, PUFA, zinc and sodium follow nutrition adequacy rate for Indonesian aged  $>$ 50 years old (Ministry of Health Republic of Indonesia, 2019).

<sup>a</sup>Spearman's rank test; <sup>b</sup>Pearson correlation test

g: gram; mg: milligram; PUFA: polyunsaturated fatty acid; SD: standard deviation

several determinants associated with cardiovascular diseases (CVDs) in elderly including hypertension, educational background, unemployment and obesity. More than fifty percent of respondents were more than 50 years old have controlled blood pressure (<130/90 mmHg) and only 28% of the total respondents have hypertension. The result of a study about prevalence and determinants of hypertension control among adults in UK showed that hypertension control was reversely associated with older age, male gender and obesity (Tapela *et al*, 2021). The possible reason was that most of the respondent of this study were overweight and obese yet their blood pressure was well- managed. A study conducted by Sinuraya *et al* (2018) showed a significant correlation between the level of education and adherence to therapy. Respondents with higher levels of education had better adherence than those with low education. However, the research conducted by Rasajati *et al* (2015) explained that there was no relationship between the level of education and adherence to hypertension treatment. It might be due to our respondents receiving education related to cardiovascular disease therapy regularly that influences adherence to medication or diet so their level of education and occupation have no correlation to their blood pressure.

Inadequate intake of PUFA, sodium, fiber, iron and zinc experienced by more than 50% respondents. According to a systematic review of observational studies identified that Indonesian community-dwelling elderly experienced high prevalence of nutrient inadequacies, particularly for protein, calcium, vitamin D, and vitamin B12 (Dewiasty *et al*, 2022). Another study about nutrition intake and health status of elderly in Indonesia showed similar result (Arjuna *et al*, 2017). Intake may decrease in the elderly due to several aspects, *i.e.*, decreased chewing ability from animal protein sources, psychosocial factors, drug interactions, and altered subcellular mechanisms (Mocchegiani *et al*, 2013). The elderly population have physical and economic problems that can limit food intake, such as decline in sense of smell and taste, problems with chewing and swallowing, living alone, and limited financial resources (Setiati *et al*, 2013). Micronutrient insufficiency in the

elderly produces a number of comorbidities, including high blood pressure, that diminish the elderly's quality of life in old age (Mustofa *et al*, 2023).

We found that inadequate intake of PUFA, cholesterol, sodium, fiber, zinc, and iron had no correlation to their blood pressure. In spite of the fact that most of our respondents liked eating PUFA sources such as omega-3 supplements, fish, and nuts, their average daily intake was inadequate ( $8.6 \pm 6.6$  g). A study investigated the determinants of controlled blood pressure among Indonesian elderly in the urban area showed a similar result that intakes PUFA of the respondents were deficit and statistically insignificant to blood pressure (Kamsu *et al*, 2007). This outcome is comparable to the meta-analysis results in that no significant correlation was discovered for dietary consumption of PUFA, namely long-chain fatty acid omega 3 (Yang *et al*, 2016). However, another study showed that long-chain n-3 PUFA from seafood could reduce blood pressure (Bagge *et al*, 2017). Another clinical study showed that long-chain n-3 PUFA consumption diminishes the risk of cardiac death, potentially through the regulation of triglycerides, heart rate, and blood pressure (BP) (Mozaffarian and Wu, 2011). Individual plasma n-6 PUFA was inversely correlated with blood pressure in black South African individuals, but EPA was negatively correlated with hypertension (Zec *et al*, 2019).

In general, our respondents' mean intakes of cholesterol were within the recommended daily consumption of maximum 300 mg per day (Carson *et al*, 2020). Respondents were reported unwilling to increase cholesterol levels so they decided to limit the consumption of animal protein sources from poultry, goat, and beef. They limit their consumption of protein intake that undergoes processing, drying, or so-called ready-to-use packaged food. Some of the respondents also adopted a vegan lifestyle. Only a few of our respondents consumed fatty foods such as duck, beef or mutton because the patients' knowledge limited fatty foods that could trigger high blood pressure. Blood pressure status in the current investigation, which was dominated by normotension and pre- hypertension, may be related to low

cholesterol consumption, although there was no significant relationship between cholesterol intake and systolic blood pressure in the respondents based on the correlation test ( $p=0.755$ ). Our findings contrast with another study in which INTERMAP found a positive association of low levels of dietary cholesterol intake with systolic blood pressure (SBP) in controls for several possible confounders (Sakurai *et al*, 2011). A cross-sectional analysis of the PURE study showed that a higher intake of dietary cholesterol was associated with higher systolic and diastolic blood pressure (Mente *et al*, 2017). A study of 51 dockworkers at Cepiring fishing port in Kendal, Central Java, Indonesia found that cholesterol consumption was related to diastolic blood pressure (Rahfiludin and Suroto, 2023). A review of several observational studies found no consistent association between cholesterol intake and blood pressure; maybe because most foods that contribute to cholesterol in the diet are usually high in saturated fat or consumed with foods high in saturated fat (Carson *et al*, 2020; Soliman, 2018). Heart-healthy dietary patterns (e.g., Mediterranean-style and DASH-style diets) are inherently low in cholesterol, with a typical menu containing <300 mg/day of cholesterol (Carson *et al*, 2020), similar to the average respondent's current intake.

The average fiber intake of the respondents in this study was  $11.2 \pm 5.7$  g/day while Carson *et al* (2020) mentioned the recommendation of 20-30 g/day dietary fiber from food (not supplements) to lower cholesterol levels and reduce hypertension. Regarding the bivariate test, our daily fiber intake in this study has no correlation with blood pressure. This result is in line with a study of dockworkers at 51 Indonesian fishing port which showed an average intake of fiber was 12 g/day and had no correlation with blood pressure ( $p=0.889$ ) (Rahfiludin and Suroto, 2023). Total dietary fiber and dietary fiber consumption from multiple food sources were not substantially associated with chronic diseases such as hypertension in a large prospective cohort of Chinese (Zhang *et al*, 2022b). However, another study shown that fiber intake has a relationship with pre-elderly and elderly blood

pressure in Lubang Buaya and Kampung Tengah Indonesia (Fitrianti and Simanulangkit, 2021). A systematic review and meta-analysis of dietary fiber in the management of hypertension and cardiovascular disease showed that increasing fiber consumption reduced systolic mean difference (MD) by 4.3 mmHg; 95% confidence interval (CI): 2.2 - 5.8) and diastolic blood pressure MD was reduced by 3.1 mmHg; 95% CI: 1.7 - 4.4) (Reynold *et al*, 2022). Our findings only partially replicate some of the findings of previous studies, which may be due to demographic variations (e.g., nationality, race, age, sex) and dietary variety. In addition, our respondents' intake of dietary fiber was quite low and probably lower than levels that would give significant effect to their blood pressure.

Our respondents' daily average sodium intake was  $859.9 \pm 654.1$  mg while the current recommendation should be below 2.3 g/day (Mente *et al*, 2021). Respondents' low sodium intake can affect their BP, as can be seen that more than 50% of our respondents had their blood pressure below 130/90 mmHg. Meta-analyses of clinical trials have shown mean BP to decrease with salt reduction which is usually consistent with the results of cohort studies (Graudal *et al*, 2017; He *et al*, 2013). However, there is no relationship between sodium intake and blood pressure, both systolic and diastolic in this study. These results are similar to a study of a family-based diet management program on dietary hypertension patient behavior in Tasikmalaya, Indonesia showing that sodium consumption does not affect hypertension (Kurnia *et al*, 2020). In contrast, a study shown that one of the factors that have a significant effect on controlled blood pressure is sodium intake (Mitra and Wulandari, 2019). These controversial results can be explained by the PURE study (Mente *et al*, 2017) which involved more than 102,000 participants from 18 countries, the most extensive international investigation of salt consumption and blood pressure. PURE study found a threshold positive relationship between sodium intake and blood pressure (BP increase of 2.11/0.78 mmHg per 1 g daily increase in sodium), which was only statistically significant for sodium intake above 3 g/d and was strongest

in those consuming more than 5 g/day (BP increase of 2.58 mmHg per 1 g increase in sodium) (Mente *et al*, 2017). These reverse results may also be related to other factors such as age, genetics, smoking habits, and lack of sports activity (Kurnia *et al*, 2020).

Mean iron consumption and blood pressure of our respondent had no correlation significantly. This finding contradicts to the study of the Mozos (2015) who found a link between high iron consumption and high blood pressure. It occurs in vasoconstriction in the heart blood vessels, which causes systolic and diastolic blood pressure to increase and peripheral vascular resistance. Likewise, another study revealed that inadequate iron intake is common in patients with hypertension and predominantly occurs in pre-menopausal women (Soon *et al*, 2011). However, an analytical study showed that there is no substantial evidence of a relationship between iron and increased blood pressure in CHD patients. The similar results were also obtained, which concluded that there was no relationship between iron intake, serum ferritin, and hepcidin in patients with hypertension. Although the research results are inconsistent, the effect of food on increasing blood pressure in CHD patients is more influential than micronutrients, such as high consumption of saturated fat, high consumption of alcoholic foods, and frequent consumption of red meat (Xi *et al*, 2014).

The respondent's intake of zinc ( $4.23 \pm 1.71$  mg) was lower than RDA for old age in Indonesia (RDA for male: 11 mg/day; RDA for female: 8 mg/day) (Ministry of Health Republic of Indonesia, 2019). The lower intake of zinc in elderly is also found in Thai and Korean elderly (Kwon *et al*, 2023; Ruangritchankul *et al*, 2023). However, the result of our bivariate test showed that intake of zinc did not correlate with either systolic blood pressure (SBP) or diastolic blood pressure (DBP). This finding contradicts with other research (Kwon *et al*, 2023; Ruangritchankul *et al*, 2023). Dietary zinc intake may be an independent risk factor for elevated SBP, but not in DBP in Korean obese women (Kim, 2013). Low dietary zinc intake was associated with higher CVD mortality (Kwon *et al*, 2023). Previous research

works found an inconsistency between dietary zinc consumption and mortality, including hypertension (Bates *et al*, 2011; Shi *et al*, 2018; Zhang *et al*, 2022b). The contradictory results might be attributed to disparities in dietary supplies, food processing, and average zinc intake by sex, race, and other demographic characteristics (de Oliveira Otto *et al*, 2012). The majority of investigations of zinc are linked to mortality. Most of the research was undertaken in Western countries, with just a few studies investigating the longitudinal relationship between dietary zinc and mortality in Asian populations. Furthermore, no study took into account the cut-off value ranges of dietary zinc to enhance the prediction capacity for hypertension.

The current study's blood pressure status, which was dominated by normotensive and prehypertensive instances, might be attributed to respondents' aerobic exercise, medication adherence, and receiving advice on nutrition once a month. Respondents did aerobic exercise at least once per week (every Sunday) for the past year which was organized by MC3. Aerobic exercise might induce beta-blocker effects, which lower sympathetic nerves, allowing the generation of catecholamine hormone in the kidneys, which activates the renin-angiotensin-aldosterone (RAAS) system, to be decreased, followed by a decrease in blood pressure (Mulyani *et al*, 2018). Furthermore, nutrition knowledge is frequently cited as a factor that may influence our respondents' regulated blood pressure. Higher nutrition knowledge is linked with higher diet quality and lower blood pressure, although the interdependence of these factors is complicated (Geaney *et al*, 2015). Individual nutrition education is more effective than group nutrition education in improving anthropometric and biochemical parameters in hypertensive people who are overweight or obese (Gajewska *et al*, 2019). Regularly providing nutrition education to the MC3 community on cardiovascular disease treatment, either directly or through social media platforms, might enhance respondents' level of knowledge and affect their daily nutrient intake. Further research into the impact of nutrition education interventions, medical adherence, and level of physical activity on their level

of knowledge, attitude, and behavior should be conducted.

According to Mitra and Wulandari (2019), another factor that also influence controlled blood was routine taking antihypertensive. The elderly who did not regularly use antihypertensive medicines were three times more likely to have uncontrolled blood pressure than the elderly who did (odds ratio (OR) = 2.963). Irregular use of antihypertensive medications will cause blood pressure to rise (Mitra and Wulandari, 2019). Controlling hypertension in the elderly as self-care for hypertensive individuals requires taking appropriate antihypertensive medications on a regular basis (Peltzer and Phaswana-Mafuya, 2013). Furthermore, 39 respondents (78%) took supplements such as vitamin C, vitamin E, vitamin B complex, fish oil, omega 3, honey, and herbs. These supplements have a role in lowering blood pressure, one of which is vitamin C and vitamin E, which can play a role in preventing the oxidation of cholesterol in the arterial walls, which is one of the causes of hypertension due to fat accumulation in the arteries (Chiu *et al*, 2021). In addition, vitamin C can increase the production of prostaglandins that play a role in vasodilation (Amalia and Triyono, 2018). A study conducted by Putri and Wirawanni (2013) showed a significant decrease in blood pressure of 5.52 mmHg for systolic blood pressure and 6.04 for diastolic blood pressure following fish oil supplements omega 3. Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) can inhibit blood clotting and increase prostaglandins. In addition, EPA and DHA increase cyclooxygenase activity, and levels of thromboxane B3 cause vasodilation (Fonda *et al*, 2016). Further study should analysis on medication and supplement intake and blood pressure.

Perhaps the lower intake of micronutrients could affect the control of blood pressure, but this needs to be investigated on a larger sample size. Although the study's findings did not show a statistically significant correlation between PUFA, cholesterol, sodium, iron, zinc intake, and blood pressure due to the small sample size, it can provide a capture of inadequate micronutrient intake on elderly in Malang, Indonesia. This study was cross-

sectional design makes it impossible to determine causal linkages between inadequate micronutrient intake to hypertension, even if we considered their knowledge, medication adherence, and regular exercise.

In conclusion, micronutrient intakes of PUFA, iron, zinc, sodium, and fiber were deficient while cholesterol intake was optimal. Most respondents did not have hypertension, so there was no statistically significant relationship between the intake of specific micronutrients and the incidence of hypertension. It might be related to taking anti-hypertensive drugs, anti-cholesterol, and supplements that can help lower blood pressure. In addition, most respondents are supported by medical and nutrition therapy education. They also doing regular aerobic exercise every week. These things might affect the controlled blood pressure of the respondents.

## ACKNOWLEDGMENTS

This work was supported by Competitive Grants of Non-Tax State Revenue, Faculty of Medicine, Universitas Brawijaya in 2020 (Hibah Kompetitif PNPB FKUB TA. 2020).

## CONFLICT OF INTEREST DISCLOSURE

The authors declare they have no conflict of interest.

## REFERENCES

Amalia IPR, Triyono EA. Dietary intake of vitamins A, C, E, and body mass index (BMI) among elderly with hypertension and non-hypertension at Puskesmas Banyu Urip, Surabaya, 2018 [cited 2022 Sep 18]. Available from: URL: <https://e-journal.unair.ac.id/AMNT/article/view/9597/5890> [in Indonesian]

- Andrianto, Bhisma MS, Triastuti F, Pikir BS, Trissatharra, A. Association between dietary patterns of salty foods, sweet drinks, fruit and vegetables and the prevalence of hypertension in East Java: multivariate analysis of Indonesian Basic Health Surveys data 2018, 2023 [cited 2023 Feb 11]. Available from: URL: <https://e-journal.unair.ac.id/MGI/article/view/38263/23867>
- Arjuna T, Soenen S, Hasnawati RA, Lange K, Chapman I, Luscombe-Marsh ND. A cross-sectional study of nutrient intake and health status among older adults in Yogyakarta Indonesia. *Nutrients* 2017; 9: 1240.
- Astutik E, Farapti F, Tama TD, Puspikawati SI. Differences risk factors for hypertension among elderly woman in rural and urban Indonesia. *Yale J Biol Med* 2021; 94: 407-15.
- Bagge CN, Strandhave C, Skov CM, Svensson M, Schmidt EB, Christensen JH. Marine n-3 polyunsaturated fatty acids affect the blood pressure control in patients with newly diagnosed hypertension – a 1-year follow-up study. *Nutr Res* 2017; 38: 71-8.
- Bates CJ, Hamer M, Mishra GD. Redox-modulatory vitamins and minerals that prospectively predict mortality in older British people: the National Diet and Nutrition Survey of people aged 65 years and over. *Br J Nutr* 2011; 105: 123-32.
- Blesso CN, Andersen CJ, Barona J, Volk B, Volek JS, Fernandez ML. Effects of carbohydrate restriction and dietary cholesterol provided by eggs on clinical risk factors in metabolic syndrome. *J Clin Lipidol* 2013; 7: 463-71.
- Brosolo G, Da Porto A, Marcante S, et al. Omega-3 fatty acids in arterial hypertension: is there any good news? *Int J Mol Sci* 2023; 24: 9520.
- Carpenter WE, Lam D, Toney GM, Weintraub NL, Qin Z. Zinc, copper, and blood pressure: human population studies. *Med Sci Monit* 2013; 19: 1-8.

- Carson JAS, Lichtenstein AH, Anderson CAM, *et al.* Dietary cholesterol and cardiovascular risk: a science advisory from the American Heart Association. *Circulation* 2020; 141: e39-53.
- Chiu HF, Venkatakrisnan K, Golovinskaia O, Wang CK. Impact of micronutrients on hypertension: evidence from clinical trials with a special focus on meta-analysis. *Nutrients* 2021; 13: 588.
- Dahl WJ, Stewart ML. Position of the Academy of Nutrition and Dietetics: health implications of dietary fiber. *J Acad Nutr Diet* 2015; 115: 1861-70.
- de Oliveira Otto MC, Alonso A, Lee DH, *et al.* Dietary intakes of zinc and heme iron from red meat, but not from other sources, are associated with greater risk of metabolic syndrome and cardiovascular disease. *J Nutr* 2012; 142: 526-33.
- Dewiasty E, Agustina R, Saldi SRF, *et al.* Malnutrition prevalence and nutrient intakes of Indonesian community-dwelling older adults: a systematic review of observational studies. *Front Nutr* 2022; 9: 780003.
- Domellöf M, Thorsdottir I, Thorstensen K. Health effects of different dietary iron intakes: a systematic literature review for the 5th Nordic Nutrition Recommendations. *Food Nutr Res* 2013; 57: 21667.
- Drenjančević-Perić I, Jelaković B, Lombard JH, Kunert MP, Kibel A, Gros M. High-salt diet and hypertension: focus on the renin-angiotensin system. *Kidney Blood Press Res* 2011; 34: 1-11.
- Du P, Luo K, Wang Y, *et al.* Intake of dietary fiber from grains and the risk of hypertension in late midlife women: results from the SWAN study. *Front Nutr* 2021; 8: 730205.
- Fauziyana N, Prafiantini E, Hardiany NS. Pattern of fiber intake in different socio-demographic settings among elderly in Jakarta, Indonesia and its associated factors. *World Nutr J* 2021; 4(2): 1-9.

- Félix-Redondo FJ, Grau M, Fernández-Bergés D. Cholesterol and cardiovascular disease in the elderly. Facts and gaps. *Aging Dis* 2013; 4: 154-69.
- Fitrianti E, Simanungkalit SF. Relationship of fiber intake, stress level, physical activity with blood pressure of pre-elderly and elderly in Lubang Buaya and Kampung Tengah, 2021 [cited 2022 Sep 18]. Available from: URL: <https://ejournal.upnvj.ac.id/IJNS/article/view/2461/pdf>
- Fonda G, Pranata R, Deka H. Role of omega-3 fatty acids in dyslipidemia and cardiovascular diseases, 2016 [cited 2022 Sep 15]. Available from: URL: <https://ijconline.id/index.php/ijc/article/view/586/435> [in Indonesian]
- Fuchs FD, Whelton PK. High blood pressure and cardiovascular disease. *Hypertension* 2020; 75: 285-92.
- Gajewska D, Kucharska A, Kozak M, Wunderlich S, Niegowska J. Effectiveness of individual nutrition education compared to group education, in improving anthropometric and biochemical indices among hypertensive adults with excessive body weight: a randomized controlled trial. *Nutrients* 2019; 11: 2921.
- Geaney F, Fitzgerald S, Harrington JM, Kelly C, Greiner BA, Perry IJ. Nutrition knowledge, diet quality and hypertension in a working population. *Prev Med Rep* 2015; 2: 105-13.
- Graudal NA, Hubeck-Graudal T, Jurgens G. Effects of low sodium diet versus high sodium diet on blood pressure, renin, aldosterone, catecholamines, cholesterol, and triglyceride. *Cochrane Database Syst Rev* 2017; 11: CD004022.
- Grillo A, Salvi L, Coruzzi P, Salvi P, Parati G. Sodium intake and hypertension. *Nutrients* 2019; 11: 1970.
- Hanson MA, Fareed MT, Argenio SL, Agunwamba AO, Hanson TR.

Coronary artery disease. *Prim Care* 2013; 40: 1-16.

He FJ, Li J, MacGregor GA. Effect of longer- term modest salt reduction on blood pressure: Cochrane systematic review and meta-analysis of randomized trials. *BMJ* 2013; 346: f1325.

Kamso S, Rumawas JS, Lukito W, Purwastyastuti. Determinants of blood pressure among Indonesian elderly individuals who are of normal and over-weight: a cross sectional study in an urban population. *Asia Pac J Clin Nutr* 2007; 16: 546-53.

Kannel WB, Dawber TR, Friedman GD, Glennon WE, McNamara PM. Risk factors in coronary heart disease. An evaluation of several serum lipids as predictors of coronary heart disease; the Framingham Study. *Ann Intern Med* 1964; 61: 888-99.

Katz DL, Gnanaraj J, Treu JA, Ma Y, Kavak Y, Njike VY. Effects of egg ingestion on endothelial function in adults with coronary artery disease: a randomized, controlled, crossover trial. *Am Heart J* 2015; 169: 162-9.

Kim J. Dietary zinc intake is inversely associated with systolic blood pressure in young obese women. *Nutr Res Pract* 2013; 7: 380-4.

Kurnia A, Lukman M, Indrayani D, Yulyana A, Agustin T. Potential of family-based diet management programs to behavior of diet hypertension patients in four areas of community health centers Cibereum working areas in Tasikmalaya City, Indonesia, 2020 [cited 2022 Sep 18]. Available from: URL: <https://www.atlantispress.com/article/125941142.pdf>

Kurniawan AH, Suwandi BH, Prakoso DT, *et al.* Correlation between body mass index to hypertension in a rural area in East Java, 2021 [cited 2022 Sep 18]. Available from: URL: <https://journal.umy.ac.id/index.php/mm/article/download/7385/pdf>

Kwon YJ, Lee HS, Park G, Yang J, Kim HM, Lee JW. Dietary zinc intake

- and all-cause and cardiovascular mortality in Korean middle-aged and older adults. *Nutrients* 2023; 15: 358.
- Lakhal-Littleton S. Iron deficiency as a therapeutic target in cardiovascular disease. *Pharmaceuticals* 2019; 12: 125.
- Larkin KT, Cavanagh C. Encyclopedia of Mental Health. 2<sup>nd</sup> ed. Amsterdam, The Netherlands: Elsevier Inc; 2016. Hypertension; p. 354-60.
- Lidiyawati, Kartini A. Association of saturated fatty acids, unsaturated fatty acids and sodium intake with incidence of hypertension in menopausal women at Bojongsalam Residence, 2014 [cited 2022 Sep 15]. Available from: URL: <https://ejournal3.undip.ac.id/index.php/jnc/article/download/6860/6584> [in Indonesian]
- Lin EC, Fernandez ML, McNamara DJ. High density lipoprotein metabolism is altered by dietary cholesterol but not fat saturation in guinea pigs. *Atherosclerosis* 1995; 112:161-75.
- Lin EC, Fernandez ML, Tosca MA, McNamara DJ. Regulation of hepatic LDL metabolism in the guinea pig by dietary fat and cholesterol. *J Lipid Res* 1994; 35: 446-57.
- Mente A, Dehghan M, Rangarajan S, *et al.* Association of dietary nutrients with blood lipids and blood pressure in 18 countries: a cross-sectional analysis from the PURE study. *Lancet Diabetes Endocrinol* 2017; 5: 774-87.
- Mente A, O'donnell M, Yusuf S. Sodium intake and health: what should we recommend based on the current evidence? *Nutrients* 2021; 13: 3232.
- Mills KT, Bundy JD, Kelly TN, *et al.* Global disparities of hypertension prevalence and control. *Circulation* 2016; 134: 441-50.
- Ministry of Health Republic of Indonesia. Key Results of Basic Health Research 2018, 2018 [cited 2022 Sep 18]. Available from: URL: [https://kesmas.kemkes.go.id/assets/upload/dir\\_519d41d8cd98f00/files/Hasil-risikesdas-2018\\_1274.pdf](https://kesmas.kemkes.go.id/assets/upload/dir_519d41d8cd98f00/files/Hasil-risikesdas-2018_1274.pdf) [in Indonesian]

- Ministry of Health Republic of Indonesia. Regulation of the Minister of Health No. 28 of 2019 about adequacy of nutrition for Indonesian people, 2019 [cited 2022 Sep 05] Available from: URL: [http://hukor.kemkes.go.id/uploads/produk\\_hukum/PMK\\_No\\_28\\_Th\\_2019\\_ttg\\_Angka\\_Kecukupan\\_Gizi\\_Yang\\_Dianjurkan\\_Untuk\\_Masyarakat\\_Indonesia.pdf](http://hukor.kemkes.go.id/uploads/produk_hukum/PMK_No_28_Th_2019_ttg_Angka_Kecukupan_Gizi_Yang_Dianjurkan_Untuk_Masyarakat_Indonesia.pdf) [in Indonesian]
- Mitra M, Wulandari W. Factors affecting uncontrolled blood pressure among elderly hypertensive patients in Pekanbaru City, Indonesia. *Open Access Maced J Med Sci* 2019; 7: 1209-13.
- Mocchegiani E, Romeo J, Malavolta M, *et al.* Zinc: dietary intake and impact of supplementation on immune function in elderly. *Age* 2013; 35: 839-60.
- Molitor J, Brown IJ, Chan Q, *et al.* Blood pressure differences associated with Optimal Macronutrient Intake Trial for Heart Health (OMNIHEART)-like diet compared with a typical American diet. *Hypertension* 2014; 64: 1198-204.
- Mozaffarian D, Wu JH. Omega-3 fatty acids and cardiovascular disease. *J Am Coll Cardiol* 2011; 58: 2047-67.
- Mozos I. Mechanisms linking red blood cell disorders and cardiovascular diseases. *Biomed Res Int* 2015;2015: 682054.
- Mulyani NS, Al Rahmad AH, Jannah R. Risk factors for blood cholesterol levels in outpatients with coronary heart disease in Meuraxa Hospital, 2018 [cited 2022 Sep 18]. Available from: URL: <https://ejournal.poltekkesaceh.ac.id/index.php/an/article/view/113/78> [in Indonesian]
- Muñoz-Bravo C, Gutiérrez-Bedmar M, Gómez-Aracena J, García-Rodríguez A, Navajas JF. Iron: protector or risk factor for cardiovascular disease? Still controversial. *Nutrients* 2013; 5: 2384-2404.
- Mustofa VF, Prasetyo B, Indriani D, Rahmawati NA. Management of micro

- nutrition and health impacts on the elderly: literature review, 2023 [cited 2023 Jun 01]. Available from: URL: <https://e-journal.unair.ac.id/AMNT/article/view/43068/24574>
- Peltzer K, Phaswana-Mafuya N. Hypertension and associated factors in older adults in South Africa. *Cardiovasc J Afr* 2013; 24: 66-71.
- Pusparina A, Alma LR, Nurrochmah S. A cross sectional study of determinants of hypertension in Batu City, Indonesia. *Adv Health Sci Res* 2020; 31: 133-8.
- Putri WAK, Wirawanni Y. Effect of fish oil on blood pressure in women with hypertension, 2013 [cited 2022 Sep 10]. Available from: URL: <https://ejournal3.undip.ac.id/index.php/jnc/article/download/3438/3370> [in Indonesian]
- Rafieian-Kopaei M, Setorki M, Douidi M, Baradaran A, Nasri H. Atherosclerosis: process, indicators, risk factors and new hopes. *Int J Prev Med* 2014; 5: 927-46.
- Rahfiludin MZ, Suroto S. Correlation between nutritional intake, physical activity, and occupational stress with blood pressure in dockworkers at Indonesia fishing port. *Open Access Maced J Med Sci* 2023; 11(E): 126-31.
- Rasajati QP, Raharjo BB, Ningrum DNA. Factors associated with treatment compliance in hypertension sufferers in the work area of the Kedungmundu Health Center, Semarang City, 2015 [cited 2022 Sep 09]. Available from: URL: <https://journal.unnes.ac.id/sju/index.php/ujph/article/view/6339/4758> [in Indonesian]
- Reynolds AN, Akerman A, Kumar S, Diep Pham HT, Coffey S, Mann J. Dietary fibre in hypertension and cardiovascular disease management: systematic review and meta-analyses. *BMC Med* 2022; 20: 139.
- Ruangritchankul S, Sumananusorn C, Sirivarasai J, Monsuwan W, Sritara P. Association between dietary zinc intake, serum zinc level and

- multiple comorbidities in older adults. *Nutrients* 2023; 15: 322.
- Sakurai M, Stamler J, Miura K, *et al.* Relationship of dietary cholesterol to blood pressure: the INTERMAP study. *J Hypertens* 2011; 29: 222-8.
- Setiati S, Harimurti K, Dewiasty E, *et al.* Profile of food and nutrient intake among Indonesian elderly population and factors associated with energy intake: a multi-centre study. *Acta Med Indones* 2013; 45: 265-74.
- Shi Z, Chu A, Zhen S, *et al.* Association between dietary zinc intake and mortality among Chinese adults: findings from 10-year follow-up in the Jiangsu Nutrition Study. *Eur J Nutr* 2018; 57: 2839-46.
- Sinuraya RK, Destiani DP, Puspitasari IM, Diantini A. Medication adherence among hypertensive patients in primary healthcare in Bandung City, 2018 [cited 2022 Sep 19]. Available from: URL: <http://jurnal.unpad.ac.id/ijcp/article/view/16375/pdf> [in Indonesian]
- Soliman G. Dietary cholesterol and the lack of evidence in cardiovascular disease. *Nutrients* 2018; 10: 780.
- Sonnweber T, Pizzini A, Tancevski I, Löffler-Ragg J, Weiss G. Anaemia, iron homeostasis and pulmonary hypertension: a review. *Intern Emerg Med* 2020; 15: 573-85.
- Soon E, Treacy CM, Toshner MR, *et al.* Unexplained iron deficiency in idiopathic and heritable pulmonary arterial hypertension. *Thorax* 2011; 66: 326-32.
- Suliburska J, Bogdański P, Pupek-Musialik D, Krejpcio Z. Dietary intake, serum and hair concentrations of minerals and their relationship with serum lipids and glucose levels in hypertensive and obese patients with insulin resistance. *Biol Trace Elem Res* 2011; 139: 137-50.
- Tapela N, Collister J, Clifton L, Turnbull I, Rahimi K, Hunter DJ. Prevalence and determinants of hypertension control among almost 100 000 treated adults in the UK. *Open Heart* 2021; 8: e001461.

- Wang HH, Garutti G, Liu M, Portincasa P, Wang DQ. Cholesterol and lipoprotein metabolism and atherosclerosis: recent advances in reverse cholesterol transport. *Ann Hepatol* 2017; 16 (Suppl 1): S27-42.
- Weggemans RM, Zock PL, Katan MB. Dietary cholesterol from eggs increases the ratio of total cholesterol to high-density lipoprotein cholesterol in humans: a meta-analysis. *Am J Clin Nutr* 2001; 73: 885-91.
- Xi Q, Liu Z, Liu W, Zhao Z, Luo Q, Huang Z. Chronic thromboembolic pulmonary hypertension is not associated with iron overload. *Cardiovasc Pathol* 2015; 24:76-9.
- Yang B, Shi MQ, Li ZH, Yang JJ, Li D. Fish, long-chain n-3 PUFA and incidence of elevated blood pressure: a meta-analysis of prospective cohort studies. *Nutrients* 2016; 8: 58.
- Zec MM, Schutte AE, Ricci C, Baumgartner J, Kruger IM, Smuts CM. Long-chain polyunsaturated fatty acids are associated with blood pressure and hypertension over 10-years in black South African adults undergoing nutritional transition. *Foods* 2019; 8: 394.
- Zhang X, Ritonja JA, Zhou N, Chen BE, Li X. Omega-3 polyunsaturated fatty acids intake and blood pressure: a dose-response meta-analysis of randomized controlled trials. *J Am Heart Assoc* 2022a; 11: e025071.
- Zhang Z, Chen B, Zeng J, *et al.* Associations between consumption of dietary fibers and the risk of type 2 diabetes, hypertension, obesity, cardiovascular diseases, and mortality in Chinese adults: longitudinal analyses from the China Health and Nutrition Survey. *Nutrients* 2022b; 14: 2650.