Research Article

The Effect of the Mediterranean Diet Components on Blood Pressure, Mean Arterial Pressure, and Pulse Pressure in Hypertensive Patients

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Abstract.

According to the 2018 Basic Health Research Data (RISKESDAS), the prevalence of hypertension in West Java was 39.6%, while in Cimahi City it was 41.83%. The composition of the Mediterranean diet contains a high proportion of MUFA and PUFA which act as anti-inflammatory, antioxidant, and cardioprotective with a potential to lower blood pressure. The aim of this study is to determine the impact of Mediterranean diet components on blood pressure in patients with hypertension. The study uses observational analytic methods as the design and also employs a prospective cohort sample of 36 patients with hypertension for three months, using a systematic random sampling technique. The research subjects were checked for blood pressure in the first month (T1) and the last month of the study (T2). The relative Mediterranean Diet (rMED) was used as a source of data on component intakes by administering the Food Frequency Questionnaire (FFQ) 12 times within three months. The differences in Mediterranean diet composition and blood pressure in all Mediterranean diet adherence groups were examined using the ANOVA test and Tuckey's post-hoc test, as well as to test comparisons of proportions between rMED adherence groups. The impact of each component of the Mediterranean Diet on blood pressure was evaluated using a linear regression analysis test. The results showed that the average age of hypertensive patients who underwent the Mediterranean diet was 57.94 years and 69.44% were female. The components of fruit and nuts, vegetables, and fish have a significant effect on systolic blood pressure. Fish components have a significant effect on diastolic blood pressure. The components of vegetables and fish have a significant effect on the mean arterial pressure (MAP). Fruit and nut components have a significant effect on pulse pressure. The limitations of this study are the short research time, the absence of salt consumption restrictions on the Mediterranean diet, and the presence of smoking and physical activity as confounding activities.

Keywords: blood pressure, composition, Mediterranean diet, mean arterial pressure, pulse pressure

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1. Introduction

Hypertension (high blood pressure) is an elevation in blood pressure in the arteries. Hypertension is diagnosed if the systolic blood pressure have reach 140 mmHg and/or diastolic blood pressure have reach 90 mmHg or more during a blood pressure check at a health facility [1–3]. The 2018 Basic Health Research (RISKESDAS) revealed that the prevalence of hypertension in West Java was 39.6%, while in Cimahi City was 41.83%. In these measurements, it was found that the prevalence of people with hypertension differed in each age group of the population, with each percentage of hypertension being 18 years old (34.1%), 31-44 years old. (31.6%), aged 45-54 years (45.3%), and aged 55- 64 years (55.2%). The data concludes that the percentage of hypertension prevalence is higher with increasing age [4,5].

Over the past decades, the Mediterranean diet has been shown to have cardiovascular protection. This is due to lower rates of atherosclerosis in people who adopt a Mediterranean diet. Through several trials, it has been shown that the Mediterranean diet reduces the incidence of metabolic syndrome, obesity, and type 2 diabetes mellitus which counts as cardiovascular disease risk factors [6,7]. The difference and advantages of the Mediterranean Diet compared to DASH is how the Mediterranean Diet is also various other beneficial effects in preventing hypertension and lowering blood pressure both directly and indirectly, and not only focused on a low sodium diet, but there are also various other beneficial [7–9].

The food components on the Mediterranean diet include having antioxidant potential contained in the Mediterranean diet have beneficial effects of improve blood pressure in hypertension.

Olive oil that has been known contains MUFA (monounsaturated fatty acids) and PUFA (polyunsaturated fatty acids) can act as an anti-inflammatory. Olive oil which contained in the Mediterranean diet can improve systolic blood pressure and diastolic blood pressure in hypertension [6,7].

Research on the impact of each component contained in the Mediterranean diet on blood pressure has so far not been carried out in Indonesia, based on data from various literature and research, many beneficial effects that can be utilized from the Mediterranean diet. On the other hand, until now the prevalence of hypertension continues to rise and remains as the major risk factors for other cardiovascular diseases which has a fairly high mortality. Therefore, by seeing the opportunities that can be utilized from the various components contained in the Mediterranean diet for hypertension,

the researchers are interested in conducting research on the effect on blood pressure, MAP, and pulse pressure in hypertensive patients, by consuming the composition of the Mediterranean diet.

2. Methods

The method employed in this research is an analytic observation design in the form of a prospective cohort. The data were collected from patients with chronic disease management program at a clinic in the city of Bandung 12 times for three months who filled out the Mediterranean diet questionnaire using the Food Frequency Questionnaire (FFQ).

Examination using a digital sphygmomanometer twice, namely in the first month of the study (T1) and in the third month of the study (T2) was used to check blood pressure, pulse pressure, and mean arterial pressure (MAP). FFQ data were presented in the form of rMED, then an ANOVA test was performed to determine the variations in the amount of each composition of the Mediterranean diet at each level of adherence, then a Tuckey posthoc test was carried out to determine the different adherence groups to each component of the Mediterranean diet. Then for each of these components, a linear regression test was carried out on all the variables of this study including blood pressure, mean arterial pressure (MAP), and pulse pressure. The data from the linear regression can then be used as a reference to see which components have the most influence on each of the variables in this study.

The study population consisted of hypertensive patients, both men and women, that aged ≥40 years, who received education regarding the application of the Mediterranean diet from the clinic and joined the Chronic Disease Management program at a clinic in the city of Bandung. The inclusion criteria in this study were Hypertensive patients that have ≥140 mmHg systolic blood pressure and/or ≥90 mmHg diastolic blood pressure, also hypertensive patients who are on regular treatment and are willing to become research subjects. This study excluded subjects who unwilling to follow all research procedures.

In this study, the composition of the Mediterranean diet was an independent variables, and systolic blood pressure, diastolic blood pressure, and mean arterial pressure (MAP) and pulse pressure was an dependent variables.

3. Results

The characteristics of hypertensive patients based on age are summarized in Table 1 below. Table 1 shows mean age of 57.94 years with median of 58.50 years and standard deviation of 10.84 years. In this study, the youngest and youngest hypertensive patients in this study were 30 years, whereas the oldest patients was 86 years.

TABLE 1: Characteristics of hypertensive patients based on age.

Variable	Mean	Median	SD	Min- max	95% CI
Age	57,94	58,50	10,84	30 – 86	54,27-61-61

Characteristics of hypertensive patients based on gender was shown in Table 2, it was found that the majority of hypertensive patients who underwent the Mediterranean diet in this study were female, namely 25 people (69.44%) and as many as 11 people (30.56%) were diabetic. male genital.

TABLE 2: Characteristics of hypertensive patients by sex.

Sex	N	Percentage
Male	11	30.56
Female	25	69.44
Total	36	100.00

Characteristics of hypertensive patients based on blood pressure, mean arterial pressure (MAP), and pulse pressure showed that the systolic blood pressure of hypertensive subjects who followed the Mediterranean diet had an average value of 135.75 mmHg with a median of 136 mmHg and a standard deviation of 15.73 mmHg. The diastolic blood pressure of hypertensive subjects who followed the Mediterranean diet had an average value of 85.97 mmHg with a median of 86.50 mmHg and a standard deviation of 8.57 mmHg. The mean arterial pressure (MAP) of hypertensive subjects who followed the Mediterranean diet had an average value of 102.48 mmHg with a median of 104.15 mmHg and a standard deviation of 9.99 mmHg. Pulse pressure of hypertensive subjects who followed the Mediterranean diet had a mean value of 0.502 mmHg with a median of 51 mmHg and a standard deviation of 12.45 mmHg.

3.1. Distribution of consumption of food components based on rMED compliance group

The distribution of consumption of food components can be seen in Table which shows that the highest average consumption of fruit and nut components was found in the hypertensive patient group with high adherence to the Mediterranean diet, namely 4030.33 grams. The highest average consumption of vegetable components was found in the hypertensive patient group with adherence to the high Mediterranean diet, namely 4406.83 grams. The highest average consumption of legume components was found in the hypertensive patient group with high adherence to the Mediterranean diet, namely 659.67 grams. The highest average consumption of whole grain components was found in the hypertensive patient group with high adherence to the Mediterranean diet, namely 473.17 grams. The highest average consumption of fish components was found in the hypertensive patient group with moderate adherence to the Mediterranean diet, namely 472.50 grams. The highest average consumption of olive oil components was found in the group of hypertensive subjects with high obedience to the Mediterranean diet, namely 28.83 grams. The highest average consumption of meat components was found in the hypertensive patient group with moderate adherence to the Mediterranean diet, namely 442.50 grams, and the highest average consumption of product components was found in the hypertensive patient group with high obedience to the Mediterranean diet, namely 375 grams with a standard deviation of 23 grams.

The distribution of consumption of food components presented in Table 3 also states that there are significant differences between the Mediterranean diet adherence groups in the amount of fruit and nut component consumption, and also vegetables, legumes, whole grains, fish and meat consumption. The relationship between the Mediterranean diet adherence group in the amount of consumption of components of olive oil and dairy products was not significant.

3.2. Effects of mediterranean diet food components on systolic blood pressure, diastolic blood pressure, mean arterial pressure, and pulse pressure

The effect of the Mediterranean diet food components on systolic blood pressure, diastolic blood pressure, mean arterial pressure, and pulse pressure can be seen in Table 3 below. Table 3 shows that the effect between the components of fruit and nuts,

vegetables, fish on systolic blood pressure is significant. The effect between the fish component on diastolic blood pressure is also significant. The effect of components of vegetables and fish on the mean arterial pressure (MAP) is significant. It also has been stated that the effect between fruit and nut components on pulse pressure is significant.

TABLE 3: Effects of mediterranean diet food components on systolic blood pressure, diastolic blood pressure, Mean Arterial Pressure (MAP), and pulse pressure.

	p-value			
	Systolic BP	**Diastolic BP**	**MAP**	**Pulse Pressure**
Fruit & Nuts	0,037	0,762	0,241	0,009
Vegetables	0,03	0,059	0,03	0,063
Legumes	0,952	0,441	0,711	0,594
Grains	0,403	0,133	0,211	0,864
Fish	0,037	0,017	0,018	0,536
Olive Oil	0,189	0,422	0,425	0,670
Meat	0,495	0,067	0,094	0,670
Diary product	0,344	0,187	0,226	0,648

4. Discussion

The effect of age on hypertension is thought to be through several mechanisms including inflammation, oxidative stress, and endothelial dysfunction that occur due to aging. In addition, changes in the nature of arteries in the aging process can lead to atherosclerosis which can lead to elevated blood pressure and become risk of cardiovascular disease [10–13]. Other mechanisms that are also thought to be related, namely chronic inflammation which increases with increasing age are thought to have a close relationship with increased activity. Sympathetic co-morbid diseases that are common in old age such as obesity and autoimmune diseases also have a role on the process in increasing the risk of developing hypertension [13,14].

Gender differences are mainly related to the occurrence of hypertension, which is influenced by interactions between various hormones, in addition there are also different lifestyle as risk factors between men and women including physical activity, smoking, also body mass index which result in complex factors that affect related to gender other than biological factors. Basically, this difference is based on the two most influential hormones, namely androgen in males and estrogen in females. Androgen hormones are able to increase sympathetic activity which can increase levels of angiotensin II and

aldosterone in the body which causes an increase in renal vasoconstriction and sodium reabsorption so that it occurs increased blood pressure [15,16].

In the Mediterranean diet, fruits have rich flavonoids as antioxidants which can prevent endothelial dysfunction, and besides that, water-soluble dietary fiber such as fructans or inulin reduces the absorption of cholesterol and bile acids in the small intestine, resulting in increased absorption of LDL C by the liveras, and the effect is lowering blood pressure. High intake of fruits have an important role in lowering cholesterol levels by competing with intestinal cholesterol absorption, thus reducing atherosclerosis which causes a decrease in blood pressure, as the effect of phytosterols contained in the fruits [17,18].

Nuts have many benefits in lowering blood pressure, including having a role in reducing levels of the ET-1 vasoconstrictor which act as an important role in the endothelial dysfunction occurrence, besides that the unsaturated fatty acids contained in nuts act as anti-inflammatory. . Nuts are a component of the Mediterranean diet as an important source of tocopherols and phenolic compounds which act as antioxidants, so that the anti-inflammatory and anti-oxidative roles present in nuts can play a role in inhibiting atherosclerosis [19–21].

Phenolic compounds in the components of the Mediterranean was sourced from the vegetables, especially phenolics from the flavonoid group, that have a role as antioxidants that can prevent endothelial dysfunction. In addition, vegetables also contain phytosterols which can compete with the absorption of cholesterol in the intestine and reduce cholesterol levels [17,22,23]

There was no significant effect between the components of the leguminous diet on systolic blood pressure, diastolic blood pressure, mean arterial pressure (MAP), and pulse pressure. This is due to the consumption of the Mediterranean diet with a size below the recommended consumption of legumes per day according to research conducted by Perera, T in 2020, namely 37.5–87.49 g/day, so this results in no effect between the consumption of legumes and blood pressure [24].

The effect between the components of whole grain foods on systolic blood pressure, diastolic blood pressure, mean arterial pressure, and pulse pressure is not significant. This is possible because the content of biologically active compounds in grain components is lost during processing [17,24].

Fish components have an effect on reducing blood pressure by inhibiting atherosclerosis through their rich content of omega-3 which can act as an anti-inflammatory to

prevent endothelial dysfunction, besides that omega-3 also act in lowering LDL levels in the body, so all of these mechanisms can prevent the occurrence atherosclerosis which can indirectly reduce peripheral resistance in the arteries with the impact of a decrease in blood pressure [17,19].

There is no significant effect between the food components of olive oil on systolic blood pressure, diastolic blood pressure, mean arterial pressure (MAP), and pulse pressure. this is possibly due to the linolenic acid content contained in the olive oil, especially in the type of Olive Pomace Oil which is the cheapest and easy to obtain olive oil. The linolenic acid compound is thought to be able to reduce eNOS expression which then causes a decrease in NO levels in the body, this causes a tendency for blood vessels to vasoconstrict, resulting in an increase in peripheral resistance which leads to an increase in blood pressure [17,25].

There was no significant effect between the components of the meat diet on systolic blood pressure, diastolic blood pressure, mean arterial pressure (MAP), and pulse pressure. This is caused by 2 main mechanisms including sodium levels in meat which can cause fluid retention in the body, thus causing an increase in preload. there was no significant effect between the components of the meat diet on systolic blood pressure, diastolic blood pressure, mean arterial pressure (MAP), and pulse pressure. This is caused by 2 main mechanisms including sodium levels in meat which can cause fluid retention in the body, thus causing an increase in preload. Carnitine content can increase peripheral resistance due to blood vessel proliferation triggered by oxidative stress for a long time, causing an increase in blood pressure [26–28].

There is no significant effect between the components of dairy products on systolic blood pressure, diastolic blood pressure, mean arterial pressure (MAP), and pulse pressure. This is related to the relationship between the components of milk with blood pressure, presumably this difference mainly occurs between low-fat and milk whole fat milk, according to several studies it is said that whole-fat milk is able to increase levels of saturated fatty acids in the body so that it will cause an increase in atherosclerotic plaques which is the main pathophysiological basis of hypertension through the mechanism of increasing peripheral resistance [26,27].

5. Conclusion

According to the results of the study above, we can conclude that hypertensive patients who followed the Mediterranean diet had an average age of 57.94 years and 69.44% were female. The effect between the components of fruit and nuts, vegetables, fish on systolic blood pressure is significant. The effect between fish components on diastolic blood pressure is also significant. There is a significant effect between the components of vegetables and fish on the mean arterial pressure (MAP). This study also conclude that the effect between fruit and nut components on pulse pressure is significant. It is better if the research is carried out for more than 3 months, this aims to see the consistency of the impact of the Mediterranean diet components on lowering blood pressure so the effect can be seen even more clearly. factors of physical activity and smoking in the sample, so as not to be a confounding factor in the study.

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