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Effectiveness of Tempe Yogurt and Tempe Juice on Pregnancy Hypertension

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A B S T R A C T

Data from the Global World Health Organization shows that hypertension is currently a global concern. Hypertension is caused by cardiovascular disease, and all of them cause death. According to report, only 54% of adults with hypertension were diagnosed, 42% received treatment, and only 21% had treatable hypertension. This needs to be underlined that efforts to increase awareness and management of hypertension are required. One of the non-communicable diseases that causes most deaths is hypertension. Based on the performance report of the South City Community Health Center, there were relatively high cases of hypertension in pregnant women in the last six months, namely 10 cases. Age, genetic factors, and parity can cause hypertension in pregnant women. This study aims to determine the effectiveness of tempeh yogurt and tempeh spice juice against hypertension in pregnancy in the South City Health Center Working Area. A quantitative study with a quasi-experimental two-group pretest-posttest design was conducted from April to September 2023. Samples were taken using purposive sampling of 40 samples, where the samples were divided into two intervention groups, namely 20 respondents who were given intervention using tempe yogurt three times a day, 200 ml, and 20 respondents were given 200 ml of tempeh spice yogurt three times a day. The results of the analysis showed that respondents aged >35 years (45%) in group A and aged 20-35 years (40%) in group B. Parity <2->4 (65%) in group A, parity 2-4 in group B. There was no history of hereditary hypertension (85%) in group A and (80%) in group B. There was a significant difference before and after the tempeh yogurt and tempeh spice juice intervention on systolic and diastolic blood pressure ($p<0.05$). There was a significant difference in the reduction in systolic blood pressure after being given tempeh yogurt and tempeh spice juice ($p<0.05$). It can be concluded that one effort to reduce pregnancy hypertension is by consuming tempeh yogurt and tempeh spice juice regularly.

Introduction

Public health problems, known as Non-Communicable Diseases (NCDs), have become a significant global, national, regional and local concern. According to the WHO report, in 2019, non-communicable diseases (NCDs) killed 40 types of diseases throughout the world. This NCD causes around 60% of total deaths in the world and plagues 43% of the global population with pain and suffering. In 2020, the number of adults suffering from hypertension is estimated to reach around 1.56 billion. In Indonesia, hypertension is one of the main causes of death. According to the results of Riskesdas in 2019, hypertension in Indonesia had a prevalence of 34.1%, with a ratio of 35.9% for women and 32.3% for men. Hypertension in pregnancy in Indonesia is ranked second as a cause of maternal death after bleeding. In this case, severe preeclampsia causes hypertension in pregnancy, which

has an impact on the risk of complications and the danger of death for the mother. Cases of hypertension in pregnancy in Indonesia are increasing. The effect is that almost 30% of maternal deaths in this country are caused by this condition. Bleeding is a cause of maternal death, especially during pregnancy. However, the increasing number of cases of hypertension in pregnancy has also caused an increase in maternal mortality rates in Indonesia.

Based on data from the South City Health Center, data on the number of pregnant women in 2022 who suffer from hypertension is 8% (20 out of a total of 224) pregnancies, in 2023, between January – April, there will be ten pregnant women with hypertension. A person is considered at risk of hypertension if the systolic blood pressure measurement exceeds 140 mmHg and the diastolic blood pressure exceeds 90 mmHg. There are two groups of risk factors for hypertension. Namely, the first group is risk factors that can be changed, such as age, gender, genetic factors, and risk factors such as parity in pregnant women. The second group is risk factors that cannot be changed, such as obesity, stress, smoking, alcohol consumption, and salt consumption (Jayanti et al., 2022)

To overcome the problem of hypertension, two treatment methods can be chosen, namely by using particular medicines or through non-drug measures. To achieve the desired effect, there is an alternative option that can be considered, namely consuming processed tempeh, which is made into a drink for pregnant women with hypertension. The results of research conducted by Evrianasari (2019) show a significant difference in mean systolic and diastolic blood pressure in pregnant women with pre-eclampsia who were given yogurt compared to those who were not given yogurt. Yogurt can prevent preeclampsia in pregnant women (Evrianasari et al., 2019), and the results of research conducted by Mulyani *et al.* (2018) show that there is a significant effect of giving tempe juice on total cholesterol levels, LDL cholesterol levels, HDL cholesterol levels, and triglyceride cholesterol levels, namely ($p<0.05$) (Mulyani & Rafiqa, 2018)

Tempeh is a fermented food that can be processed into drinks, is easy to consume, and lasts longer than similar products. This product has two main advantages, which make it easy to consume and last longer. The protein in soybeans contains the amino acid arginine, which acts as a precursor to nitric oxide (NO), which has the effect of opening blood vessels. Nitric oxide inhibits the aggregation (clumping) of blood platelets, thus facilitating smooth blood circulation. Yogurt is a dairy product that contains potassium, calcium, and magnesium. A balanced intake of potassium, calcium, and magnesium in the body has very positive benefits in reducing blood pressure (Evrianasari et al., 2019)

This study aims to determine the effectiveness of tempeh yogurt and tempeh spice juice against hypertension in pregnancy in the South City Health Center Working Area. The novelty in this research is the result of processed tempeh, which is made as a base for safe drinks for pregnant women to consume to reduce hypertension through tempeh yogurt drinks and tempeh spice juice.

Method

This research used quantitative research methods with a quasi-experimental design consisting of two groups: a two-group pretest-posttest design. The research was conducted in April – September 2023

at the South City Health Center. In this research, the independent variables were tempeh yogurt and spice juice. Tempeh yogurt and tempeh juice were given for three days at 200 cc. The dependent variable observed in this study was hypertension in pregnant women. The population is all pregnant women who come for pregnancy checks in the South City Health Center Work Area. The number of samples in this research was 40 people. The method chosen for sampling was purposive sampling, and respondents were selected using inclusion and exclusion criteria. Inclusion criteria included the patient being declared pregnant, willing to participate in research, and having complete medical records. The exclusion criteria are patients aged <20 years who have a history of heart disease in multiple pregnancies, kidney disease, and hypertension in previous pregnancies. The instrument used is a blood pressure monitor or sphygmomanometer to measure blood pressure. We also used questionnaires to obtain information regarding the history of hypertension in pregnant women, such as age, parity, and heredity, and observation sheets for monitoring blood pressure. In carrying out the normality test in this research, the Shapiro-Wilk, statistical, paired t-test, and independent t-test were used. This research has gone through an ethical test carried out by the Gorontalo Health Polytechnic ethical committee number DP.01.01/KEPK/201/2023 on August 24, 2023.

Results

Univariate analysis

Table 1. Characteristics of Pregnancy Hypertension in South City Health Centers

Variable	Categories	Group A		Group B	
		f	%	f	%
Mother's Age	<20 Years	3	15	6	30
	20-35 Years	8	40	8	40
	>35 Years	9	45	6	30
		20	100	20	100
Parity	2-4	7	35	18	90
	<2- >4	13	65	2	10
		20	100	20	100
Ancestral History	Yes	3	15	4	20
	No	17	85	16	80
		20	100	20	100

Based on the results in Table 1, it was found that respondents aged 20-35 years were 8 (40%) respondents in groups A and B, respondents aged <20 years were 3 (15%) in group A and 6 (30%) in group B. Respondents aged >35 years were 9 (45%) in group A and 6 (30%) in group B. The results showed that parity 2-4 was obtained by 7 (35%) in group A and 18 (90%) in group B, while <2->4 was obtained by 13 (65%) in group A and 2 (10%) in group B. 3 (15%) pregnant women who had a history of hypertension in group A and 4 (20%) in group B, while those who did not have a history of hypertension were 17 (85%) in group A and 16 (85%) in group A. 80%) in group B.

Bivariate Analysis

The analysis used in this study was the pariate t-test and independent t-test analysis. An independent samples t-test (or independent t-test for short) compares the means between two unrelated groups on the same dependent, continuous variable. Which was first carried out by the *Shapiro Wilk test* with the results obtained before the intervention was given; the systole was 0.124, the diastole was

0.500, and after the treatment, the systole was 0.119, and the diastole was 0.223. meaning it is usually distributed.

Table 2. Differences in blood pressure in pregnant women in Group (A) Tempeh Yogurt Intervention and Differences in Blood Pressure in Pregnant Women in Group (B) Intervention Tempeh Spice Juice

Group		Pre-Test		Post-Test		p Value
		Mean	Standard Deviation	Mean	Standard Deviation	
Group A	Systole	139	7.88	122	6.15	0,000
	Diastole	97	7.32	83	8.12	0,001
Group B	Systole	140	7.94	116	4.84	0,000
	Diastole	97	7.16	80	7.59	0,000

Based on the data obtained from group A, changes in blood pressure in group A can be observed before (pretest) and after (posttest) the intervention. Before the intervention, there was an average systolic blood pressure of 139 mmHg with a standard deviation of 7.88, After the intervention, the average blood pressure was 122 mmHg with a standard deviation of 6.15. This shows a significant difference, with a p-value of less than 0.05 ($p<0.05$). This means there was a significant reduction in systolic blood pressure before and after the intervention in group A. Meanwhile, the diastolic pressure before treatment was 87 mmHg, with a standard deviation 7.32. The results showed that after treatment, the average diastolic blood pressure in group A was 83 mmHg with a standard deviation of 8.12 and a p-value of 0.000 ($p < 0.05$). This indicates a significant reduction in group A diastolic blood pressure.

Based on the data obtained from group B, changes in blood pressure in group B can be observed before (pretest) and after (posttest) the intervention. Before the intervention, there was an average systolic blood pressure of 140 mmHg with a standard deviation 7.94. After the intervention, the average blood pressure was 116 mmHg, with a standard deviation of 4.84. This shows a significant difference, with a p-value of less than 0.05 ($p<0.05$). This means there was a significant reduction in systolic blood pressure before and after the intervention in group B. Meanwhile, the diastolic pressure before treatment was 97 mmHg, with a standard deviation 7.16. The results showed that after treatment, the average diastolic blood pressure in group B was 80 mmHg with a standard deviation of 7.59 and a p-value of 0.000 ($p < 0.05$). This indicates a significant reduction in group B diastolic blood pressure.

Table 3. Differences in Systolic and Diastolic Blood Pressure After Being Given Tempeh Yogurt and Tempeh Spice Juice in Group A and Group B

Group	Blood pressure		Mean	Deviation Standards	P Value
Group A	Systole	Posttest	122	6.15	0.0023
Group B	Systole	Posttest	116	4.48	

Based on the data obtained from group A, a p-value of 0.0023 or $P<0.05$ was obtained for systolic blood pressure in group A and group B, which means that there was a significant difference in the reduction in systolic blood pressure after being given tempeh yogurt and tempeh spice juice.

Discussion

This research is different from previous research, which obtained data that more pregnant women aged less than 20 or more than 35 years experienced hypertension (13 respondents). In contrast, nine

respondents in the 20-35 year age group experienced hypertension. Using the chi-square test, this study found a relationship between the incidence of hypertension in pregnant women and the p-value of 0.032, which was greater than 0.05. Researchers say that those aged <20 or >35 years are more at risk of developing hypertension in pregnancy compared to those aged 20-35 years. Age is related to structural and functional changes in the body. Age 20-35 years is the ripe age for pregnancy, but age 20-35 years also has the opportunity for hypertension because it is caused by changes in body function that are triggered by unhealthy habits and food consumption. The ages that have risk factors for hypertension are <20 years and >35 years. This can affect the cardiovascular system, leading to endothelial dysfunction. Age <20 and >35 years is the age at risk of developing hypertension in pregnancy, this is because age <20 years is when the reproductive organs are not yet fully functioning, so it will affect the body's metabolism and trigger hypertension, while age >35 years is the age at risk for experiencing hypertension during pregnancy is due to the mother's reproductive system whose function is decreasing.

Parity refers to the number of births, whether babies were born alive or died. Parity (para) is the number of children born to a mother, including children born alive and those who died. If parity is more than 4, it is considered unsafe parity. Meanwhile, a parity of four or less is considered safe parity. Based on research results from Sinambela (2018), there is a significant correlation between parity and the incidence of hypertension (preeclampsia). The risk of developing hypertension (preeclampsia-eclampsia) in women who have just become mothers or have a new partner is 6 to 8 times higher than in women who have been pregnant before. Around 85% of cases of hypertension (preeclampsia-eclampsia) occur in the first pregnancy. Parity (para) is the number of children a mother has given birth to, whether live or stillborn, parity > 3 is unsafe, and parity ≤ 3 is safe parity. Older primigravidae are at higher risk for severe preeclampsia. The ideal parity is 2 –3, mothers who have > 3 children are twice as likely to develop hypertension. (Pratiwi et al., 2022) Immunologic theory explains the relationship between parity and the incidence of hypertension (preeclampsia-eclampsia). This theory states that blocking antibodies against placental antigens that are formed in the first pregnancy is the cause of hypertension and can lead to pregnancy poisoning in the majority of primigravida from 28 to 32 weeks of pregnancy, showing an increase in diastolic pressure of at least 20 mmHg which can lead to preeclampsia in pregnancy (Pratiwi et al., 2022)

This is similar to research conducted by Moazzeni (2021), which stated that respondents who had parity three and ≥ four live births had a higher risk of developing hypertension by an HR of 1.25 [95% CI: 1.02-1.55] and 1.39 [1.12-1.72]. The risk and prevalence of hypertension are associated with metabolic changes (weight gain, dyslipidemia, insulin resistance, and increased plasma glucose) that occur during pregnancy. In addition, increased parity can be associated with metabolic diseases such as metabolic syndrome, obesity, T2DM, and CVD. Respondents who have obesity, DM, lipid profile, and also prehypertension are at increased risk factors for hypertension if they have high parity (Moazzeni *et al.*, 2021)

According to Alatas (2019), hypertension can occur due to genetic factors. If a pregnant woman has a family history of hypertension, then the pregnant woman has a greater risk of developing

hypertension during pregnancy. Women who have experienced hypertension in their first pregnancy will experience hypertension in subsequent pregnancies. If there is a pregnancy with children too far apart and a history of hypertension, then in primigravida, the incidence of hypertension will increase four times **(Ratumbuysang, 2014).**

This differs from research conducted by Pratiwi, Leda, et al., 2022 which obtained data from 100 respondents. Most respondents did not have a history of hypertension, totaling 66 respondents (66.0%), and those with a history of hypertension totaling 34 respondents (34.0%). %) (Pratiwi et al., 2022). This can be influenced by the lifestyle and habits of pregnant women in consuming foods that contain too much salt, drinking alcoholic drinks, or smoking.

Hypertension in pregnancy (HDK) often occurs during pregnancy and is classified as the three main causes of maternal death, namely bleeding and infection. Hypertension is a factor that affects around 10% of pregnancies and contributes to maternal and perinatal mortality rates. Hypertension can be a dangerous disease when it occurs in pregnant women because there are no particular signs. This has the potential to cause death for the mother and baby to be born. Several factors can increase the risk of pregnancy hypertension, such as pre-eclampsia, eclampsia, gestational hypertension, chronic hypertension, obesity, severe anemia at gestational age, and hereditary factors. Pregnancy hypertension can disrupt organ function, especially vital organs such as the heart, kidneys, and eyes. Pregnant women who experience hypertension during their first pregnancy will have a higher risk of experiencing preeclampsia in subsequent pregnancies. Pregnant women with hypertension are at high risk of severe complications such as placental abruption, cerebrovascular disease, organ failure, and intravascular coagulation.

Based on the data obtained in Table 3, it was obtained that the p-value was 0.0023 or P<0.005 for systolic blood pressure in group A and group B, which means that there was a significant difference in the reduction in systolic blood pressure after being given tempeh yogurt and tempeh spice juice. This is because the protein content in soybeans contains the amino acid arginine, which acts as a precursor to nitric oxide (NO), which has the effect of opening blood vessels. Nitric oxide inhibits the aggregation (clumping) of blood platelets, thus facilitating smooth blood circulation. Tempeh also contains saponins, which have been proven effective in lowering cholesterol levels. This means that tempeh can reduce LDL cholesterol and total cholesterol levels and increase HD cholesterol levels to improve blood circulation to the heart.

Soybeans in tempeh contain isoflavones, which are phytoestrogens that are structurally similar to estrogen and are thought to show antihypertensive activity by increasing NO and reducing angiotensin and being able to stop the reaction of free radical formation. In soybeans, there are three types of isoflavones: daidzein, glycitein, and genistein. Several studies show that soybeans have a positive effect on blood pressure in people with hypertension (Yang et al., 2015)

Tempeh has several advantages compared to soybeans: it has better digestibility of protein, carbohydrates, and fats, higher vitamin content, and better mineral bioavailability. The germination treatment can increase protein levels (Astawan et al., 2016). The fermentation process by R. oligosporus

that occurs in the processing of soybeans into tempeh can hydrolyze proteins and several other complex compounds into simpler forms, such as amino acids and peptides. Tempeh's hypotensive properties are also caused by tempeh bioactive peptides, capable of acting as ACE (Angiotensin Converting Enzyme) inhibitors. ACE is an enzyme that converts angiotensin I to angiotensin II. Angiotensin has a crucial role in raising blood pressure. So, food prepared from tempeh can affect the lowering of blood pressure (Astawan et al., 2016).

According to research by Evrianasari et al. (2019), giving yogurt to pregnant women with hypertension can significantly reduce blood pressure. The results of research conducted by Misnawati et al. (2021) show that tempeh contains the amino acid arginine, which acts as a precursor to nitric oxide (NO) and contains saponin, which has the effect of opening blood vessels, inhibiting blood aggregation (clotting), thereby facilitating smooth blood circulation.

Tempeh yogurt in this study is made from tempeh and made into a yogurt drink consumed by pregnant women three times as much as 200 ml. This tempeh yogurt can reduce hypertension in pregnancy because it contains protein in soybeans containing the amino acid arginine and also contains lactic acid, which is processed through fermentation using high-quality organism cultures, which have the potential to lower blood pressure. Various studies have proven that giving soybeans can reduce hypertension. Research by Sari et al. in 2023 shows that soybeans can significantly reduce systolic and diastolic blood pressure (Sari et al., 2023). Likewise, research has shown that 500 ml of soy yogurt/tempeh yogurt for three months can reduce systolic blood pressure. And diastolic blood pressure. This was explained in Utari's research in 2022 by administering 160 g of tempeh/day for four weeks, it could reduce LDL, triglyceride, and total cholesterol levels, which are risk factors for hypertension (Utari et al., 2022). Research conducted by Sari (2023) showed that giving tempeh milk (tempeh yogurt) did not significantly affect blood pressure. Because the researchers carried out the intervention for one month, this research obtained insignificant results because it was thought that the research time span was not long enough. (Sari et al., 2023).

Tempeh spice juice in this study is a drink made from steamed tempeh and then added spices such as ginger, cinnamon, palm sugar, and milk consumed for three days, and 200 ml consumed regularly. This spice juice contains soybeans and the amino acid arginine; the spice content combined in this juice also contains compounds in ginger and cinnamon, which have a working mechanism similar to high blood pressure drugs such as ACE inhibitors and calcium-channel blockers (CCB). The decrease in systolic blood pressure is thought to be caused by soy protein, which contains the amino acid arginine, a precursor of nitric oxide (NO) that has a vasodilator effect. Nitric oxide has the property of inhibiting the aggregation (clumping) of blood platelets so that it can improve blood circulation. This research is different from that of Ansarullah et al. (2017), which shows that giving tempe drinks to people with hypertension and hypercholesterolemia has not reduced blood pressure (systolic and diastolic). This is because the length/duration of intervention, especially for hypertension sufferers, is not long, so it does not have the effect of lowering blood pressure.

Based on the results of the research above, researchers assume that the incidence of hypertension during pregnancy, if not treated, can cause preeclampsia in pregnancy, which can hurt the growth and development of the fetus and is dangerous for the mother herself, even causing death. The efforts made in this research are to provide an alternative treatment for hypertension through non-pharmacological treatment, namely by consuming tempeh yogurt drinks and tempeh spice juice.

Conclusions

One treatment that can be applied to reduce pregnancy hypertension is by consuming tempeh yogurt and tempeh spice juice regularly. Tempe yogurt and Tempe juice, a dose of 200 cc/day, are equally effective in reducing blood pressure in pregnant women with hypertension.

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