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The Analysis of Blood Glucose Level and Blood Pressure on Hypertension Patients in Mersi Village, East Purwokerto, Central Java

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Abstract_The number of diabetes mellitus patients keeps increasing from year to year. The condition of hyperglycemia in DM patients causes an increase in angiotensin II hormone which leads to the hypertension. The prevalence of cardiovascular disease complication in DM patients is 29%. The purpose of this study was to analyze the blood glucose level and blood pressure in patients with hypertension in Mersi village, East Purwokerto. The design of this study was descriptive correlation. The population comprised of 105 hypertension patients who became the members of the Hypertension Care Group in Mersi Village, Purwokerto. The samples were 84 respondents. The sampling technique used was simple random sampling. The instrument to collect blood glucose level data employed glucose meter and the one for blood pressure used digital sphygmomanometer. Data were analyzed using Pearson correlation test. The majority of respondents were female with 58 people (69.9%), and most of the respondent, 64 people (77.1%), had DM disease. The mean of blood glucose level was 212.94 mg / dl and it was categorized into hyperglycemia. The mean of blood pressure was 125.42 / 80.98 mmHg and it was normal. There was a significant correlation (p systolic; 0.026, and p diastolic; 0.032) and strong correlation (r obtained systolic; 0.815 and r obtained diastolic; 0.777) between blood glucose level and blood pressure. Blood glucose level is closely related to blood pressure in patients with hypertension and the higher the blood glucose level, the greater the blood pressure.

Keywords: blood glucose level, blood pressure, hypertension

I. INTRODUCTION

One of the diseases that keeps increasing in term of the patients number from year to year and also threatens human health in the 21st century is Diabetes Mellitus (DM). The World Health Organization predicts that there will be an increase in DM patients in Indonesia from 8.4 million in 2000 to around 21.3 million in 2030 [1]. Based on population growth statistics, the number of DM patients is predicted to double between 2000 and 2030 [2]. Hyperglycemia is a DM symptom caused by absolute or relative insulin deficiency [3]. It is caused by three main factors: 1) a pancreatic disorder, which can be a decrease in sensitivity to blood glucose levels and or abnormal insulin secretion, 2) an increase in glucose produced by liver due to increased gluconeogenesis, 3) stimulation of glucagon and catecholamines as well as insulin resistance in peripheral tissues which causes impaired glucose transportation and metabolism [4].

Chronic hyperglycemia leads to endothelial dysfunction through various mechanisms, such as: 1) causing protein glycosylation resulting in changes in intravascular pressure and disturbing cerebrovascular reactivity due to imbalance of Nitrite Oxside (NO) and prostaglandin; 2) increassing intracellular PKC activation which will inhibit NO production; 3) increassing the synthesis of diacylglycerol (DAG) which has an effect on vasoconstriction; 4) creating a risk for oxidative stress and improving the amount of oxidized lipoproteins, especially small cholesterol LDL (oxidized LDL) which is more atherogenic; and 5) increasing prothrombosis and platelet aggregation [5].

The condition of hyperglycemia in DM patients also gives rise to an increase in the hormone of angiotensin II, which creates the increase on blood pressure / hypertension [6]. It occurs due to peripheral resistance growth (direct action on vascular smooth muscle cells) and blood volume (aldosterone secretion stimulation, increased sodium reabsorption in the distal tubule) which will increase cardiac output [3]. This is caused by the vasoconstriction effect that exceeds the vasodilation effect. An increase in vasoconstriction can be caused by the effects of adrenergic α, excessive activation of the angiotensin renin system or a rise in the sensitivity of peripheral arterioles to the mechanism of normal vasoconstriction [7].

The prevalence of cardiovascular disease complications in DM is 29%. Research on the Diabetes Control and Complications Trial and U.K. Prospective Diabetes Study proves that the condition of hyperglycemia in patients with type 1 (DMT1) and type 2 (DMT2) diabetes mellitus is closely related to the incidence of chronic vascular

complications. Diabetes mellitus patients have a risk of cardiovascular disease two times higher than those who are not suffering from DM and will increase the mortality and morbidity of DM patients. The death of DM patients due to complications of cardiovascular disease is 75% [8]. Coronary heart disease, cardiomyopathy and peripheral vascular disease are DM chronic complications that occur in cardiovascular system. The combination of hyperlipidemia, endothelial cell abnormalities, hypertension, and oxidative stress that occurs in DM will increase the incidence of coronary heart disease. Hypertension is one of the complications that is often found in type 2 DM. All patients with DM and hypertension must maintain their blood pressure under 140/90 mmHg or targeted below 130/80 mmHg to avoid further complications [3].

Blood pressure is the force produced by blood against the blood vessel walls. The normal systolic pressure is 120 mmHg and the normal diastolic pressure is 80 mmHg. Blood pressure is a very important factor in the cardiovascular system. The disorder on blood pressure homeostasis is a disorder on the function of other body systems [7].

Based on preliminary studies conducted in Mersi Village, Purwokerto on March 20, 2018, there were 105 elderly people and a hypertension care group that had been established since 2016. The result of assessment on 10 people showed that two people (20%) had normal blood pressure; four people (40%) had level 1 hypertension; and four people (40%) had level 2 hypertension. The result of random blood glucose test indicated that five people (50%) had normal blood glucose level and five people (50%) were categorized into hyperglycemia. Four people (40%) with normal blood glucose levels were classified into level 2 hypertension, and one person (10%) from hyperglycemia group was classified into normal blood pressure. According to the chairman of the hypertension care group, the elderly begins to consciously control their blood pressure by coming to *Posyandu* for the elderly held each month, doing elderly gymnastic once a week, and joining health education about hypertension management.

Based on the phenomenon above, the writer is interested to conduct a research on the analysis of blood glucose level toward blood pressure on hypertension patients in Mersi village, East Purwokerto.

II. Method

The research design used in this study was descriptive correlation. The population were 105 people with hypertension who became the members of the Hypertension Care Group in Mersi Village, Purwokerto. The samples were calculated using the Slovin formula and the result was 83.19, then it was rounded to 84 people. The sampling technique used was simple random sampling by drawing the name. The inclusion criteria for respondents were elderly and able to do basic physical activities with the Katz index category A. While the exclusion criteria were those being hospitalized, having stroke, and having DMT1. Data was collected from May to June 2019.

The independent variable in this study was blood glucose level, which was the result of random test using peripheral blood samples in the fingers by utilizing stick glucose meter. The result is categorized normal if it is <200 mg / dl, and named hyperglycemic if it is > 200 mg / dl. While the dependent variable of this study was blood pressure, which was the result of blood pressure measurement on blood vessels indirectly using a digital sphygmomanometer on the right arm. The result is categorized normal if the systolic is <140 or diastolic is <90 mmHg, level 1 hypertension if systolic is 140-159 or diastolic is 90-99 mmHg, and level 2 hypertension if systolic is ≥160 or diastolic is ≥ 100 mmHg. This research had passed the ethical test.

The univariate analysis used descriptive statistics. The normality test of elderly's blood glucose and blood pressure employed the Kolmogorov Smirnov test which generated p value of blood glucose: 0.000; p value of systolic blood pressure 0.000; and p value of *diastolic* blood pressure: 0,001. Hence, the bivariate analysis used the Pearson correlation.

III. Result and Discussion

A. Blood Glucose Level

Blood glucose is the product of carbohydrate metabolism in the body which serves as the body's most important energy besides fatty acids and ketones. Fasting blood glucose concentration is maintained at less than 100 mg / dl, while the concentration for two hours post prandial is less than 140 mg / dl, and the other one for random test is less than 200 mg / dl. Blood glucose is obtained from food that enters intestinal cells and is transported through blood vessels throughout the body. Moreover, glucose synthesis in the liver and kidneys are generated from fructose and galactose or from the process of gluconeogenesis from noncarbohydrates. The liver serves as a "glucostate" or a regulator of glucose levels [9].

Glucose homeostasis is controlled by the insulin hormone and glucagon. Insulin secreted by β cells on the island of Langerhans will reduce blood glucose level. It works through kinase tyrosine receptors. The condition of increasing blood glucose level after meal will rise the glucose in pancreatic cells through glucose transporters. Glucose will be metabolized and create an increase in the ATP-ADP ratio that will inhibit ATP-sensitive K^+ (K^+

channel) and cause depolarization of the pancreatic β cell wall. The activated calcium channel causes the entry of intracellular Ca^{2+}. The increase in Ca^{2+} ions leads to insulin secretion from pancreatic β cells that have previously been stored in insulin vesicles [10].

The rise of blood glucose levels or hyperglycemia is caused by three main factors: 1) damage on the pancreatic gland, such as sensitivity reduction to blood glucose levels and or decrease in insulin secretion; 2) increase in gluconeogenesis in the liver causing a rise in plasma glucose; 3) insulin resistance in peripheral tissues that will stimulate the secretion of glucagon and catecholamines resulting in impaired glucose transportation and metabolism [11].

The glucagon hormone works through the glucagon receptor (GCGR). Glucagon elevates blood glucose with liver glycogenolysis, glycogen breakdown, and liver gluconeogenesis, synthesis of new glucose molecules, and decrease of glycogenesis and glycolysis. The activation of GCGR induces G protein and increases intracellular cyclic AMP (cAMP) levels. Cyclic AMP activates protein kinase A (PKA), which promotes the degradation of glycogen into glucose-1 phosphate and is converted to glucose-6phosphatase and finally becomes glucose in the lumen of the endoplasmic reticulum. Glucose is transported from the endoplasmic reticulum to the cytoplasm by glucose transporters located in the membrane of the endoplasmic reticulum [9]. Table 1 illustrates that the majority of respondents are female as many as 58 people (69.9%), and most of them have diabetes mellitus with 64 people (77.1%).

Table 1. Characteristics of respondent (n: 83)

Characteristic		Frequency	Percentage
Sex	Male	25	30.1
	Female	58	69.9
Diabetes Mellitus	Patient	64	77.1
	Non-patient	19	22.9

The result of this study indicates that the average blood glucose level of respondents is 212.94 mg / dl and is categorized into hyperglycemia. The majority of respondents have DM disease with 64 peple (77.1%). An increase in the production of glucose from the liver on DM patients is predicted due to some factors such as loss of insulin inhibitory effect on glucose produced by liver, insulin resistance in liver tissue because of chronic hyperglycemia, and an increase in levels and activity of anti-insulin hormones such as glucagon. The direct effect of insulin in reducing endogenous glucose production in the liver is an inhibition of glycogenolysis through a rise of phosphodiesterase enzyme activity as well as a decrease of enzyme phosphatase activity. The indirect effect of insulin is inhibiting glucagon secretion by pancreatic alpha cells and reducing the levels of free fatty acids by inhibiting lipolysis.Insulin resistance indicates a disruption of biological responses toward insulin. It is in the form of glucose transportation drop that is mediated by insulin, metabolic disorders in fat cells and skeletal muscles, and impairment in gluconeogenesis limitation [11].

Respondents of this study are elderly. It is estimated that about 20% of the elderly suffer from DM, and approximately half of them are unaware of this disease. Therefore, the American Diabetes Association (ADA) recommends that DM screening should be done on people aged 45 years and over with once in three years interval. This interval can be shorter in high-risk patients (especially those with hypertension and dyslipidemia [12].

B. Blood Pressure

Blood pressure is clinically the pressure in the arteries produced by the left ventricle during systole and the pressure left in the arteries when the ventricles are in diastole. Normal systolic blood pressure for young adult man is less than 120 mm Hg and the diastolic blood pressure is less than 80 mmHg. Blood pressure in young adult woman is 8 to 10 mm Hg lower than that in man [13], [14]. The result of blood pressure measurements to the respondents showed that the average of elderly systolic blood pressure was 125.42 mmHg and the average of diastolic pressure was 80.98 mmHg. The average of blood pressure on elderly with hypertension is included into normal hypertension. JNC 8 committee recommends that blood pressure should be maintained under 140/90 mmHg [15].

The result of this study indicates that the respondents were dominated by female with 58 people (69.9%). Men have a higher risk of hypertension in the early adulthood, after that, women have a higher incidence [7]. Gender affects the organ structure and hormones. Women have dominant estrogen hormone which can increase the levels of high density lipoprotein/HDL. As the people grow, estrogen will decrease towards the age of 45 until elderly. As the result, post menopause women are vulnerable to suffer from hypertension [16].

Respondents of this study were elderly who had hypertension and became a member of the Hypertension Care Group in Mersi Village, Purwokerto. As someone gets older, the risk of suffering from hypertension becomes greater. Hypertension is a disease that arises due to the interaction of various risk factors of hypertension. The risk

factors for hypertension in the elderly include 1) change in blood vessel structure; 2) stiffness and decreased elasticity of blood vessels; and 3) natural decline in kidney function [17]. Based on Tabel. 2, we can see that the mean of elderly's blood glucose is 212.94 mg/dl and is categorized into hyperglikemia.

Table 2. The Depiction of respondent's blood glucose level (n: 83)

Minimal	Maximal	Mean	Standard deviation
87	451	212.94	88.20

Tabel 3 shows that the mean of elderly's blood pressure is 125.42/80.98 mmHg and it is categorized normal.

Table 3. The Depiction of Respondent's Blood Pressure (n: 83)

Blood pressure	Min	Max	Mean	SD
Systolic	100	155	125.42	13.033
Diastolic	60	120	80.98	9.161

The results showed that the majority of respondents, 64 people had DM disease with the percentage 77.1.
Hypertension is one of complications that is often found in type 2 DM (Shahab, 2009; Munson, 2015). The incidence of hypertension in elderly people with DM increases. The prevalence of 40% at the age of 45 rises to 60% at the age of 75. Hypertension is one of the factors that plays a role in the occurrence of macrovascular and microvascular complications in DM. The UKPDS study shows that good blood pressure control with any anti-hypertension agent reduces the risk of macrovascular and microvascular complications [18].

C. Correlatin between Blood Glucose Level and Blood Pressure

Type 2 diabetes mellitus in the elderly is a chronic disease that causes macrovascular and microvascular complications. Based on a 9-year-study held by United Kingdom Prospective Diabetes Study, 9% of DM patients had microvascular complications and 20% of them had macrovascular complications. Atherosclerotic is the form of macrovascular complications that attack 75% of respondents and it is the cause of death in type 2 DM [18].

The condition of hyperglycemia will stimulate the secretion of the angiotensin II hormone. It increases the morbidity and mortality rates of DM patients due to complications of cardiovascular disease [19]. Hyperglycemia causes a variety of cellular changes: 1) abundant glucose will be processed in the cytoplasm through glycolysis so that an increase in glyceraldehyde 3 phosphate levels (GAD 3P) occurs. Glyceraldehyde 3 phosphate activates Protein Kinase C / PKC isoform which increases diacylglycerol (DAG) production and synthesis of advanced glycation end (AGE) products. The increased AGE inclines angiotensinogen, renin, and chimase products. 2) increased use of glucose in the hexosamine biosynthetic pathway results in a modification of the o-glycosylation transcription factor. Both of these activate the RAS component [20].

The renin-angiotensin system increases blood pressure through mechanisms 1) sodium depletion, blood pressure decline, and dehydration will stimulate renin release. 2) renin converts angiotensiogen to angiotensin I. The effect of this hormone increases preload and afterload. 3) angiotensin I is converted to angiotensin II. Angiotensin II is a strong vasoconstrictor in arterioles increasing preload and afterload by stimulating the adrenal cortex to secrete aldosterone. The aldosterone hormone will reabsorb the sodium and the water will then follow, thereby increasing blood volume. The formation of angiotensin II will constrict arterioles and increase blood volume which contributes to increase the blood pressure [21]. Table 4 demonstrates that there is a significant correlation between blood glucose level and blood pressure with positive correlation. It means that the higher the blood glucose level, the greater the blood pressure.

Table 4. The Correlation between blood glucose level and blood pressure (n:83)

Correlation	Rcounted	p. value
Blood glucose – systolic blood pressure	0.815	0.026
Blood glucose – dyastolic blood pressure	0.777	0.032

The results of this study showed that there was a significant correlation (p systolic; 0.026, and p diastolic; 0.032) and strong correlation (r obtained systolic; 0.815 and r obtained diastolic; 0.777) between blood glucose level and blood pressure with positive correlation. It means the higher the blood glucose level, the greater the blood pressure. Two out of three DM patients have hypertension [22]. This is in line with the research conducted by [23] about the correlation of blood glucose levels and hypertension in patients with type 2 diabetes mellitus at Karanganyar Regional Hospital, which showed a significant correlation between the two variables.

The increase in AGE can also cause damage to blood vessel walls. There is an adhesion stimulation of cholesterol and saturated fat acid in the endothelial cell causing inflammation. The accumulation of leucocytes,

thrombocytes and other components produces plaque that causes the stiffness on blood vessel wall. As a result it leads to blockage causing an increase in blood pressure [9]. The condition of hyperglycemic anemia can also lead to the activation of bronectine and type IV collagen. Both of them will stimulate dysfunction of blood vessels endothelial so the stiffness of blood vessel and hypertension occur [24].

IV. Conclusion and Recommendation

A. Conclusion

The average of elderly's blood glucose is 212.94 mg/dl and it is categorized into hyperglicemia. The average of elderly's blood pressure is 125.42/80.98 mmHg and it is categorized into normal. There is strong and significant correlation between blood glucose level and blood pressure with positive correlation. It means the higher the blood glucose level, the higher the blood pressure.

B. Recommendation

It is suggested to the elderly to control blood glucose level to reduce cardiovascular complication especially hypertension. For nurses, it is expected that this study can be used as evident base nursing research to improve nursing care plan for hypertension patients.

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