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Correlation of Blood Glucose, Creatinine, and Uric Acid with Blood Pressure in Hypertension Patients

Korelasi Glukosa Darah, Kreatinin, dan Asam Urat dengan Tekanan Darah Pada Pasien Hipertensi

Ingrid Faustine, Yuliet, Ririen Hardani, Silviana Hamdani, Dhara Alfia, Ni Made Susilawati, Arya Dibyo Adisaputra*

Department of Pharmacy, Faculty of Mathematics and Natural Sciences, Tadulako University, Palu, Indonesia

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Corresponding Author:
Arya Dibyo Adisaputra
Department of Pharmacy
Faculty of Mathematics and Natural Science
Tadulako University
Palu
90245
Indonesia
email:
adibyoadisaputraa@gmail.com

ABSTRACT

Poorly controlled hypertension in hypertensive patients can increase the risk of cardiovascular disease in the future. Some of the triggering factors are impaired kidney function which is characterized by an increase in creatinine levels and other factors as well, namely an increase in uric acid levels and an increase in blood sugar levels. This study aims to analyze the correlation between blood glucose, creatinine, and uric acid levels in hypertensive patients in Central Sulawesi. With a cross-sectional design, this observational study involved 50 adult hypertensive patients in health facilities. Data were taken from laboratory examination results during visits and analyzed descriptively and analytically. The results showed that 60% of hypertensive patients were female, 62% had a family history of hypertension, and 80% still had blood pressure that was included in the criteria for hypertension. As many as 34% of hypertensive patients had abnormal blood glucose levels, 32% had abnormal creatinine levels, and 26% had abnormal uric acid levels. Still, no relationship was found between the three with blood pressure ($p > 0.05$). The correlation between blood glucose and blood pressure was -0.221, creatinine and blood pressure was -0.112, and uric acid and blood pressure was 0.132. It can be concluded that there is a positive correlation with a very weak correlation strength between uric acid levels and blood pressure in hypertensive patients.

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INTRODUCTION

Hypertension can be found as a disease requiring an increase in blood pressure where the systolic pressure is at least 140 mmHg and the diastolic pressure is at least 90 mmHg (Kementrian Kesehatan RI, 2013). Hypertension is one of the noncommunicable diseases (NCDs), which is a significant health problem because it causes ~70% of deaths in the world (Shibata et al., 2020). In 2019, around 30% of the people in Central Sulawesi suffered from hypertension, and 25% did not receive treatment (Tim Dinkes Sulawesi Tengah, 2019).

Blood pressure can trigger various health problems, such as heart failure, stroke, and impaired kidney function (Octviani et al., 2015). Hypertension, in the long term, can compromise kidney function, and conversely, an increase in blood pressure can lead to kidney disease (Grundy et al., 2019). Kidney function evaluation can be conducted by assessing several biochemical parameters, such as serum creatinine, blood glucose, and uric acid levels. Creatinine is a metabolic waste product derived from muscle metabolism. When kidney function declines, creatinine levels in the blood tend to increase. Likewise, uncontrolled hypertension can contribute to insulin resistance and hyperglycemia, making it a risk factor for the development of type 2 diabetes mellitus (Petrie et al., 2018). Elevated blood glucose can further damage blood vessels and nephrons in the kidneys, worsening renal function. In addition, high uric acid levels, which are often found in hypertensive patients, have been associated with endothelial dysfunction, oxidative stress, and inflammation, all of which may contribute to the progression of hypertension and chronic kidney disease (CKD). Therefore, monitoring these biochemical parameters in individuals with hypertension is crucial for detecting early signs of metabolic and renal complications.

According to Petrie (2018), Hypertension is an independent risk factor for type 2 diabetes (Petrie et al., 2018) . Faustine's research (2021) shows that diabetes mellitus is the highest comorbidity in COVID-19 sufferers with hypertension (29%), while CKD is in third place (Faustine et al., 2021). However, it is unclear how the relationship between controlled and uncontrolled blood pressure and blood glucose, creatinine, and uric acid values can trigger diabetes and kidney disorders. This study aims to determine the relationship between blood glucose, creatinine levels, and blood pressure in patients with hypertension in Central Sulawesi.

MATERIAL AND METHODS

Participant and Design

This research was approved by the Human Research Ethics Committee of the Faculty of Medicine, Tadulako University (No. 7916/UN28.1.30/KL/2020). This observational study, with a cross-sectional design involving 50 adult hypertensive patients, was regularly monitored at a health facility from

February to May 2021. The sample that follows the inclusion criteria is age ≥18 years, diagnosed with hypertension, and carries out routine control and medication taking at the health facility, fasting at least 8 hours before sampling. The exclusion criteria were patients who did not receive the study. The blood samples were collected from patients during routine visits to the regional general hospital in Central Sulawesi and examined by the clinical chemistry analyzer at the hospital laboratory. Supporting data includes demographic, diagnosis, and clinical features from the medical record system. The research variables were creatinine levels, uric acid, blood glucose, and blood pressure.

Data Analysis

Data analysis was carried out using R 4.3.2 software. Results are presented in the form of proportion percentages and significance values. P-value <0.05 is considered statistically significant.

RESULTS AND DISCUSSION

High blood pressure in the long term can trigger various health problems, such as heart failure, stroke, and impaired kidney function (Dipiro J, Talbert R, Yee G, Matzke G, Wells B, 2017). This study provides information on the relationship between blood pressure, blood glucose, and creatinine in hypertensive patients in Central Sulawesi. Characteristic data and diagnoses of hypertensive patients come from patient medical records and interviews. Clinical parameters are obtained from clinical chemistry testing using patient blood samples. Fifty hypertensive patients were hospitalized, met the sample criteria, and were included in this study. Table 1 shows that of 50 samples, the percentage of women is 60% and men is 40%, and 62% of them were found to have a history of hypertension in the family. According to Heriziana (2017), a history of hypertension inherited from the parents can be a risk factor for primary hypertension. This can occur due to hereditary factors. This is proven by the discovery that out of 10 people with hypertension, 90% of them have a family history of hypertension. This result is the same as the results of research conducted in Karanganyar Regency with a case-control design, which stated that a family history of hypertension was proven to be a causal factor in the occurrence of hypertension with an OR value of 4.04, meaning that respondents with a family history of hypertension were 4.04 times more at risk of developing hypertension. The high percentage of women in this study is in line with previous research, which also revealed that women have a greater chance of developing hypertension. Women are more likely to suffer from hypertension due to hormonal factors (Azhari, 2017; Falah, 2019). During menopause, estrogen levels in the body will decrease, where this estrogen hormone functions to increase high-density lipoprotein (HDL) levels, which play a very important role in maintaining healthy blood vessels. When estrogen decreases, it will be followed by a decrease in HDL, so the impact will be caused when HDL is low, and then Low-Density Lipoprotein (LDL) increases and atherosclerosis will occur, which will cause high blood pressure (Falah, 2019).

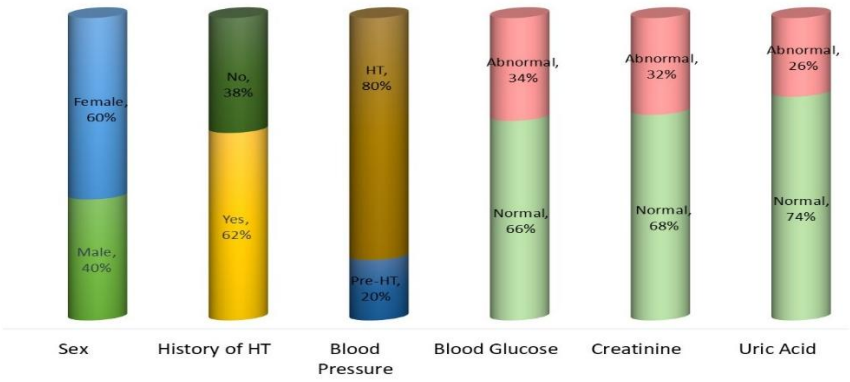

Figure 1. Characteristics and clinical parameters of hypertensive patients

Based on blood pressure measurements, as many as 20% of patients had reached the prehypertension blood pressure range and were entering to continue therapy. In comparison, as many as 80% of patients still had high blood pressure, and 20% of patients had reached the prehypertension blood pressure range and were entering to continue therapy.

Blood pressure is inherited, but biological pathways and environmental responses also influence it. Several factors have been reported to be associated with hypertension, including sociodemographic factors (family history, age, gender, education, and income), as well as other factors such as body weight, health behaviors, dietary patterns, and stress levels (Peltzer & Pengpid, 2018; Unger et al., 2020). Some of these hypertension factors are modifiable, while others are not. Family history is a genetic factor that can increase blood pressure by 30-50% (Oliveira-Paula et al., 2019).

Next, a correlation analysis was conducted between clinical parameters and blood pressure. The correlation value of each clinical parameter is shown in Table 1.

Table 1. Correlation of Laboratory Parameters with Blood Pressure

Parameter	Prehypertension	Hypertension Stage 1	Hypertension Stage 2	*p*-Value	r-Value
Blood Glucose					
Normal	5 (15%)	15 (44%)	14 (41%)	0.362	-0.221
Abnormal	5 (31%)	5 (31%)	6 (38%)		
Creatinine					
Normal	5 (15%)	15 (44%)	14 (41%)	0.439	-0.112
Abnormal	5 (31%)	5 (31%)	6 (38%)		
Uric Acid					
Normal	6 (16%)	14 (38%)	17 (46%)	0.123	0.132

Abnormal	4 (31%)	6 (46%)	3 (23%)

Based on the results of the Spearman correlation test, a negative correlation with a weak correlation strength was obtained between blood glucose levels and blood pressure (r = -0.221). Creatinine levels and blood pressure also showed a negative correlation with a very weak correlation strength (r = -0.112). In contrast, uric acid and blood pressure showed a positive correlation with a very weak correlation strength (r = 0.132). In this study, a negative correlation was observed between blood glucose and creatinine levels, as well as blood pressure, with a correlation strength ranging from very weak to weak. This can be influenced by factors such as age, gender, comorbidities, and the therapy received (Sofa et al., 2018). Zhou's research 2017 showed that metformin treatment can reduce systolic blood pressure by 1.98 mmHg but was not accompanied by a decrease in diastolic blood pressure (Zhou et al., 2017). Another effect of metformin is that it can significantly reduce macrovascular complications (Gerardo González-González et al., 2022; Soetomo, 2015).

According to the results of Zhang's study, 2013 the combination of sulfonylurea and metformin did not significantly change systolic blood pressure compared to the use of metformin alone (Zhang et al., 2013). For insulin, based on the results of Persson's study, in 2007, systolic and diastolic blood pressure increased significantly during insulin treatment for two months. After using insulin for four months, systolic and diastolic blood pressure values decreased (Persson et al., 2007). Insulin treatment in patients with type 2 diabetes mellitus is not well controlled because it causes a temporary increase in systolic and diastolic blood pressure. Changes in blood pressure appear small, but most patients experience increased systolic and diastolic blood pressure. This supports the results of this study that blood glucose levels are inversely proportional to blood pressure in hypertensive patients.

Previous studies show a correlation between blood pressure and human serum creatinine levels. Other studies show that the higher the systolic and diastolic blood pressure, the higher the serum creatinine levels (Collard et al., 2018; Luman & Lubis, 2014). This result occurs when someone suffers from hypertension. It will cause decreased kidney function and increased serum creatinine values in humans (Armiyati, 2010). The results of this study are not based on previous studies. This can happen because many other factors affect creatinine levels in the body. Novitasari's (2014) study showed results that were in line with the study, where it was found that increased uric acid levels were directly proportional to an increased chance of hypertension (Novitasari et al., 2017). The relationship between uric acid levels and blood pressure can be caused by the tendency of uric acid to increase oxidative stress and activate the renin-angiotensin system, where this will trigger endothelial and peripheral vessel vasoconstriction so that it can trigger hypertension.

This study has limitations. This study only involved one population, and the number of patients willing to participate was limited, making it difficult to generalize the results of the analysis of the association of blood glucose, creatinine, and uric acid in hypertensive patients to other ethnic groups. However, our results can be a reference and comparison to assess further the association of blood glucose, creatinine, and uric acid with blood pressure in hypertension in the broader study population.

CONCLUSION

It can be concluded that there is a positive correlation with a very weak correlation strength between uric acid levels and blood pressure. In contrast, blood glucose and creatinine levels correlate negatively with blood pressure in hypertensive patients.

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CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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