Correlation Glucose, Uric Acid, and Cholesterol Levels Towards Health Conditions in the Highlands: POCT Approach

Arifa Mustika[1,2], Yetti Hernaningsih[3], Puspa Wardhani[3], Siti Khaerunnisa[4], Nastasya Nunki[5], Baiq Nasha Islaeli[5], Uli Mas'uliyah Indarwati[5], Musholli Himmatun Nabilah[5], Teguh Satrio[5], Alfino Validita Sidiq[5], Fita Triastuti[5], Mochammad Reza Desianto[5], Agil Saputra[5], Novi Ersanto[5], Widaninggar Rahma Putri[5], Desty Indah Sari[5]

[1] Master program of Basic Medical Science, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia. E-mail: arifa-m@fk.unair.ac.id
[2] Department of Pharmacology, Faculty of Medicine Universitas Airlangga, Surabaya, Indonesia
[3] Department of Clinical Pathology, Faculty of Medicine, Universitas Airlangga/Dr. Soetomo General Academic Teaching Hospital, Surabaya, Indonesia
[4] Department of Medical Biochemistry, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia
[5] Laboratory Medicine Study Interest, Master Program of Basic Medical Science, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

ABSTRACT

Degenerative diseases arise when age increases due to the weakening of the body's physiological condition. The purpose of this study was to measure glucose, uric acid, and cholesterol levels in residents of Segunung Village to improve lifestyles and quality of life. As many as 110 residents of Segunung Village were used as subjects in this cross-sectional study. Glucose, uric acid, and cholesterol levels were measured using Point of Care Testing (POCT). A cut-off value of <200 was used to define high cholesterol levels. Only cholesterol levels showed an increase when compared with reference values, while glucose and uric acid levels were normal. Interestingly glucose was significantly correlated with age (r=0.309, p=0.001). The approach using POCT describes the overall condition of Segunung villagers and can be used as a basis for glucose, uric acid, and cholesterol screening tests.

Keywords: Blood pressure, cholesterol, glucose, health services, hypertension, POCT, uric acid

INTRODUCTION

The increasing age of a person will be associated with the incidence of degenerative diseases. The percentage of degenerative diseases such as diabetes mellitus, hypercholesterolemia, and gout continues to increase causing death and decreasing quality of life.[1] Death with a rate of 43% occurred due to high glucose levels experienced by those under 70. A significant increase in people with diabetes occurred from 1980 to 2014. Type 2 diabetes mellitus is a health problem with an increasing prevalence worldwide. Indonesia is included in the top ten countries with the most estimated diabetes cases, collecting around 10.7 in 2019 and will jump to 13.7 million in 2030, then 16.6 million in 2045.[2]

Based on the Health Profile of Jombang Regency, people with diabetes reached 34,924; in Wonosalam village, there were 888 diabetics. Segunung traditional village is located around the hills of Mount Anjasmoro. Currently, the village is starting to become a traditional tourist village destination. Not much is known about the health status of residents. Also, low air temperatures and heavy physical activity require local people to often consume fatty and oily foods. These things trigger non-communicable diseases; thus, that is our concern. Two factors cause a person to suffer from non-communicable diseases: factors that can be controlled and those that cannot. Based on the non-communicable disease management manual, the factors that cannot be controlled are gender, age, and genetics. At the same time, the factors that can be controlled are diet, visual activity, alcohol, tobacco consumption, and a healthy lifestyle.[3]

Diabetes mellitus is a group of metabolic diseases characterized by chronic hyperglycemia that occurs because of abnormalities in insulin secretion, insulin, or both. Diabetes mellitus diagnosis is established on the basis of an examination of blood glucose levels.[4] Total cholesterol levels can be influenced by nutrient intake, namely from foods that are a source of fat. Increasing fat consumption by 100 mg/day can increase total cholesterol by 2-3 mg/dL. Cholesterol is

a fat that is useful for the body.[5] However, if the levels in the body are too high, cholesterol will accumulate in the blood vessels and interfere with blood flow. High cholesterol does not cause symptoms. As a result, many people are unaware of high cholesterol levels until serious complications such as heart disease or stroke arise.[6]

Gout is a degenerative disease caused by high uric acid as a result of the body's metabolic processes in the final stages of purines.[1] Gout is a type of arthritis that occurs due to a buildup of uric acid crystals. This condition can occur in any joint, such as in the toes, ankles, knees, and most commonly, the big toe. Under normal conditions, uric acid dissolves in the blood and is excreted in the urine.[5]

Point of Care Testing (POCT) is an examination instrument that refers to clinical laboratory testing performed outside the central laboratory. Testing is usually performed by clinical staff, such as doctors or nurses, who are not trained in a laboratory.[7] POCT is a simple laboratory test that uses a small amount of blood and the test results are relatively faster and inexpensive.[8]

This study aims to monitor glucose, uric acid, and cholesterol with the POCT approach. According to the reference, people with values who already have examination results can maintain their lifestyle or further improve it to reduce the risk of illness caused by glucose, uric acid, and cholesterol. On the other hand, people with examination values above the reference value must start changing their lifestyle or getting treatment to get a better quality of life.

METHODS

This research was an analytic observational study. The design of this research was a cross-sectional study. The subjects in this study were people who lived in the Segunung Adat village, Wonosalam, Jombang. Inclusion criteria were people aged > 18 years. The subject consists of males and females. The number of research subjects in this study was 110 people. The exclusion criteria in this study were people who were no longer in a productive condition or did not do any physical activity at all.

This study was conducted under the approval of the Description of Ethical Exemption No. 191/EC/KEPK/FKUA/2022. Before the examination, the respondents agreed to be examined for blood sugar levels, total cholesterol, and uric acid.

Examinations in this study include blood glucose, uric acid, and cholesterol. Samples were taken using instruments lancet pens, alcohol swabs, cholesterol

and uric acid meters branded Easy Touch (Bioptik Technology Inc. Taiwan), and Glucose meters branded Clever Check (Taidoc, Taiwan). Research subjects who met the inclusion criteria first had their blood pressure checked and then blood was drawn from the subject's fingertips. There was no special preparation required for the subject. These examinations also did not require fasting. The examination technique used a POCT tool using capillary blood samples. Capillary blood was inserted into the test strip on each examination strip in turn. The measurement results were then written on the examination sheet.

Data were analyzed using Jamovi version 2,3,21 statistical software for Windows. Data analysis was performed by using descriptive statistics and frequency. The analysis will describe the current blood glucose levels, total cholesterol, and uric acid according to sex, age, systole, and diastole. Blood glucose levels, total cholesterol, and uric acid were obtained from the examination results sheet on the respondents. Normally distributed data was presented in the form of mean±SD. Not normally distributed (non-parametric) data was presented as a median with a minimum-maximum value (median (min-max)). Spearman's correlation test was used for the non-normally distributed data. All data were considered significant if the p-value was less than 0.05.

RESULTS AND DISCUSSIONS

Characteristics of research subjects, based on the average age of over 40 years and less than 70 years. The number of research subjects that were obtained was dominantly female with a total of 73 subjects compared to only 37 male subjects (Table 1). The median (min-max) systolic blood pressure in the study subjects ranged from 142 mmHg (103-216). Median diastolic blood pressure (min-max) was 84 mmHg (58-128). Blood pressure tended to be higher in males. While the results of examinations for uric acid, cholesterol, and glucose levels using POCT showed a trend. Average POCT examination results for glucose and uric acid in female and male subjects showed normal values, while for cholesterol there was an increase. Glucose levels correlated with age, but glucose, cholesterol, or uric acid were not statistically correlated with blood pressure (Tables 2, 3, and 4).

Table 1. Frequencies of gender

Gender	n	% of Total
Female	73	66.4 %
Male	37	33.6 %

Table 2. Characteristics of the research subjects

Variable	Mean±SD	Median (Min-Max)	Reference Value
Aged (years)	54.9±12.9		
Systolic blood pressure (mmHg)		142 (103-216)	90-120 mmHg
Female	146.6±24.7		
Male	148.7±25.8		
Diastolic blood pressure (mmHg)		84 (58-128)	60-80 mmHg
Female	86.9±13.3		
Male	104.7±116.1		
Glucose (mg/dL)			
Female	119.4±59.2	109 (71.00-471.00)	<120 mg/dL
Male	121.8±46.1		
Uric acid (mg/dL)			
Female	5.43±1.58	5.03 (2.00-11.00)	2.6 – 6.0 mg/dL
Male	5.49±1.23		
Cholesterol (mg/dL)			
Female	228.4±45.1	227(121-638)	<200 mg/dL
Male	227.5±77.1		

Table 3. Correlation of age with glucose, cholesterol, and uric acid

		Age
Glucose	Spearman rho	0.309**
	p-value	0.001
Cholesterol	Spearman rho	0.066
	p-value	0.493
Uric Acid	Spearman rho	0.022
	p-value	0.817

Note. * p < .05, ** p < .01, *** p < .001

Table 4. Correlation of blood pressure with glucose, cholesterol, and uric acid

		Blood Pressure
Glucose	Spearman rho	0.111
	p-value	0.250
Cholesterol	Spearman rho	0.178
	p-value	0.062
Uric Acid	Spearman rho	0.097
	p-value	0.314

Figure 1A.

Figure 1B.

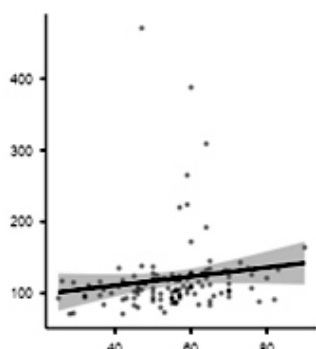**Figure 1C.**

Figure 1A. Plot correlation of age and glucose
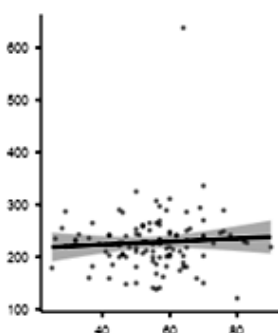
Figure 1B. Plot correlation of age and cholesterol

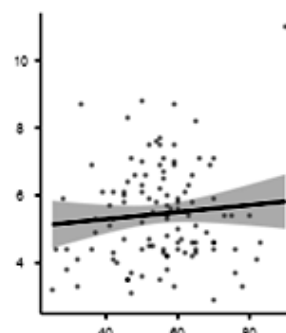**Figure 1C.** Plot correlation of age and uric acid

Statistical research data show that POCT-based glucose levels correlate with age (Figure 1A), this is in line with the statement that increasing age affects blood glucose and blood pressure, while cholesterol and uric acid are not correlated with age (Figure 1B and 1C).[9] High blood pressure is a modifiable risk factor for diabetes, but the results of the glucose, cholesterol, and uric acid examination did not correlate with blood pressure (Figure 2A-2C), blood pressure was found to increase on average in female or male subjects.[10] Blood glucose is an important component in the body's metabolic processes. If the condition of glucose in the blood tends to increase, it can result in damage to blood vessels, which leads to
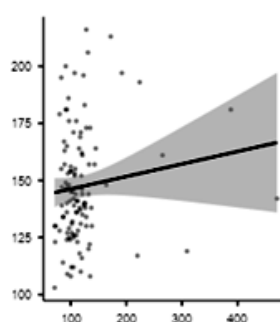
Figure 2A.

Figure 2B.

Figure 2C.

Figure 2A. Plot correlation of blood pressure and glucose
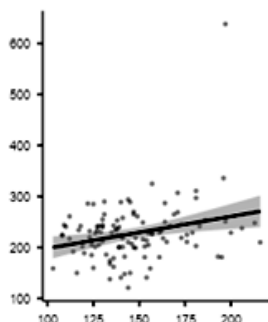
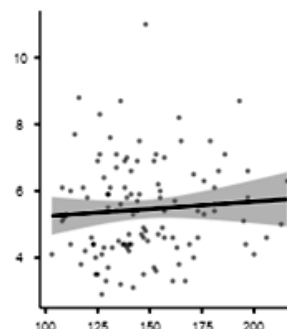**Figure 2B.** Plot correlation of blood pressure and cholesterol

Figure 2C. Plot correlation of blood pressure and uric acid

hypertension, this is the cause of fluctuations in pulse pressure.[11]

Degenerative diseases are currently a determinant of quality of life, which plays a role in mortality rates. Even though the study subjects had an average condition of high blood pressure but normal glucose levels, it is suspected this was due to the balance of strenuous activities that were routinely carried out by the residents of Segunung Village. The higher the age, the risk of developing hypertension, followed by high blood glucose levels, was in line with this study where age correlated with glucose levels (p < 0.05) although in this case correlation with blood pressure could not be proven. The higher the age, progressive β-cell dysfunction occurs, including pancreatic β-cells.[1]

Uric acid is synthesized in the liver by the enzyme xanthine oxidase. Among the causes of the buildup of uric acid levels are blood pressure and cholesterol. However, people with old age do not always have high uric acid levels, it usually decreases around the age of 50-70 years.[1] This was proven in this study where research subjects aged between 40-70 years had an average normal uric acid level. Cholesterol is a fatty substance that is produced in the liver, when there is an increase, the process of atherosclerosis is also high, resulting in the narrowing of blood vessel fat, which results in hypertension.[11]

The results of the examination showed an increase in the average cholesterol levels. An increase in blood cholesterol levels clinically can increase the risk of coronary heart disease.[12] This risk can be reduced if you carry out regular physical activity.[13] It can be assumed from the results that Segunung villagers between 40-70 years, could balance lifestyle to prevent the risk of heart disease with daily physical activity in gardening. The widespread effects of complications include hypertension, which can be caused by excess sodium accumulation, but it can also be caused by foam cells that clog blood vessels to form plaques and cause blood pressure to increase.[9] Increase in blood pressure for males or females is related to body mass index and blood pressure, but in this case, we did not evaluate blood pressure with body mass index.[14]

POCT as an alternative measurement instrument and health screening, is expected to help monitor health conditions, especially for metabolic diseases. However, this POCT inspection method is affected by temperature and humidity conditions so it has limitations in producing accurate and precise data.[8] One of the factors why POCT is not recommended as a reference for assessing health status is that the sample used in POCT only comes from a small volume of capillary blood, making it difficult to maintain the quality of the sample, which can affect the results of tests such as hemolysis, lipemia, and drugs.[15] In addition, structurally capillary blood has a small diameter due to branching from arteries, thus it cannot represent microcirculation.[16]

In general, POCT, which is widely circulated in the market uses dry reagents for easier use. The utilization of POCT in hospitals can be used to monitor the course of disease and treatment.[4] The usefulness of POCT, especially in rural areas far from access to health facilities, is that it can provide quick and clear results so that implementing health services in rural areas should know and comply with the standard guidelines for using POCT, as it is necessary to understand device evaluation process (POCT) to increase awareness during the testing process and anticipate risks when using the device.[17,7] Device selection (POCT) and supporting features are also important for optimizing clinical utility.[7]

POCT provides convenience benefits in terms of independence from the physical presence of the laboratory. Fast analysis of POCT results can improve clinical performance by eliminating waiting time with

discussion of examination results for early anticipation.[18] This research has a weakness because the respondents were not required to fast, so there may be a bias that does not reflect the actual conditions of the respondents. However, this research still provided representative results for health conditions in traditional village areas and trends in health outcomes for demographic conditions around traditional villages.

CONCLUSIONS AND SUGGESTIONS

Health screening for Segunung village residents using the POCT approach was able to provide an illustration of health including glucose, uric acid, and cholesterol. The appropriate use of POCT is an asset for health monitoring and health services to improve the quality of life for people in rural areas.

In future studies, it is recommended to carry out health examinations using POCT by conditioning prospective research subjects, thus it can observe other supporting examination parameters such as medical history and body mass index examination.

ACKNOWLEDGMENTS

REFERENCES

1. Lusiana N, Widayanti LP, Mustika I, Andiarna F. Korelasi usia dengan indeks massa tubuh, tekanan darah sistol-diastol, kadar glukosa, kolesterol, dan asam Urat. J Heal Sci Prev, 2019; 3(2): 101-8.

2. Ardiany D, Pranoto A, Soelistijo SA, Libriansyah, Widjaja SA. Association between neutrophil-lymphocyte ratio on arterial stiffness in type-2 diabetes mellitus patients: A part of DiORS study. Int J Diabetes Dev Ctries [Internet]. 2022; 42(2): 305-12. Available from: https://doi.org/10.1007/s13410-021-00965-1 (accessed May 6, 2023).

3. Budreviciute A, Damiati S, Sabir DK, Onder K, Schuller-Goetzburg P, *et al.* Management and prevention strategies for Non-Communicable Diseases (NCDs) and their risk factors. Front Public Health, 2020; 8: 574111.

4. Baharuddin B, Nurulita A, Arif M. Uji glukosa darah antara metode heksokinase dengan glukosa oksidase dan glukosa dehidrogenase di diabetes melitus. Indones J Clin Pathol Med Lab, 2018; 21(2): 170-3.

5. Yully, Made. Pemeriksaan glukosa, kolesterol, dan asam urat untuk meningkatkan kesehatan masyarakat di wilayah UPTD Pelayanan Sosial Lanjut Usia Tresna Werdha Natar provinsi Lampung. J Kreativitas PKM, 2022; 5(6): 1812-1817.

6. Wang H, Zhang H, Sun L, Guo W. Roles of hyperuricemia in metabolic syndrome and cardiac-kidney-vascular system diseases. Am J Transl Res, 2018; 10(9): 2749-63.

7. Venner AA, Beach LA, Shea JL, Knauer MJ, Huang Y, *et al.* Quality assurance practices for point of care testing programs: Recommendations by the Canadian society of clinical chemists point of care testing interest group. Clin Biochem [Internet]. 2021; 88(September 2020): 11-7. Available from: https://doi.org/10.1016/j.clinbiochem.2020.11.008 (accessed May 6, 2023).

8. Ermiyanti, T AC, Yusuf RN. Perbandingan kadar asam urat antara metode POCT dan enzimatik. J Kesehat Med Saintika, 2022; 13(2): 11-24.

9. Husen F, Ratnaningtyas NI. Hubungan dan profil tekanan darah dengan peningkatan kadar glukosa darah pedagang di desa Mandiraja Wetan. J Penelit dan Pengabdi Kpd Masy UNSIQ, 2022; 9(3): 209-16.

10. Nazarzadeh M, Bidel Z, Canoy D, Copland E, Wamil M, *et al.* Blood pressure lowering and risk of new-onset type 2 diabetes: An individual participant data meta-analysis. Lancet, 2021; 398(10313): 1803-10.

11. Alimansur M, Irawan H. Pengaruh peningkatan kadar kolesterol dan glukosa darah terhadap pulse pressure penderita hipertensi. J Keperawatan, 2017; 6.

12. Sutisna P, I Ketut Tangking Widarsa, I Wayan Darwata, I Nengah Kapti. Community survey on blood pressure and levels of blood glucose, cholesterol and uric acid among people 45 years and above in rural villages of Bali. WMJ (Warmadewa Med Journal), 2022; 7(2): 47-54.

13. Kim MK, Han K, Park YM, Kwon HS, Kang G, *et al.* Associations of variability in blood pressure, glucose and cholesterol concentrations, and body mass index with mortality and cardiovascular outcomes in the general population. Circulation, 2018; 138(23): 2627-37.

14. Bawazier LA, Sja'bani M, Irijanto F, Zulaela Z, Widiatmoko A, *et al.* Association of serum uric acid, morning home blood pressure and cardiovascular risk factors in a population with previous prehypertension: A cross-sectional study. BMJ Open, 2020; 10(9): e038046.

15. Kahar H. Keuntungan dan kerugian penjaminan mutu berdasarkan uji memastikan kecermatan (POCT). Indones J Clin Pathol Med Lab. 2018; 13(1): 38-41.

16. Ratna D, Pramita A, Haryanto E, Arifin S. Perbedaan kadar asam urat pada lansia menggunakan metode POCT (Point of Care Testing) dengan metode enzimatik kolorimetri di Puskesmas Bangunsari Kabupaten Madiun. J Anal Kesehat Sains [Internet]. 2021; 10: 26-30. Available from: http://journal.poltekkesdepkes-sby.ac.id/index.php/Ankes (accessed May 6, 2023).

17. Government TS. Scottish Government Health and Social Care Directorates review of the use of point of care testing in primary and secondary care in Scotland a report by a Short Life Working Group of the Scottish Medical and Scientific Advisory Committee. 2011. Available from: https://www.clinicalbio chemistry.scot.nhs.uk/wp-content/ uploads/2016/06/9-5_DSG_12_10a_-_SMASAC _POCT_Report.pdf (accessed May 6, 2023).

18. Lingervelder D, Koffijberg H, Kusters R, IJzerman MJ. Point-of-care testing in primary care: A systematic review on implementation aspects addressed in test evaluations. Int J Clin Pract, 2019; 73(10): 1-12.