

The Comparison of Blood Glucose Check Results Using Photometer and Glucometer

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ABSTRACT

Diabetes mellitus is a disease caused by high blood glucose levels. Blood glucose is a sugar that functions as an energy source for humans, formed from carbohydrates consumed and then stored as glycogen in the liver and muscles. Examining blood glucose levels can be done in two ways, namely using a photometer and a glucometer. This study aimed to determine differences in the results of blood glucose checks measured using a photometer and glucometer. The research was conducted with an analytic observational design with a cross-sectional approach. The study was conducted in June 2022. The population in this study were all Prolanis participants at the Klirong 1 Public Health Care Center. The sampling technique in this study used the accidental sampling technique. The data analysis used paired sample T-test. The results of the blood glucose checks using a photometer and glucometer showed a p-value (0.000) and alpha value (0.05). So it can be concluded that there is a significant difference between the results of blood glucose checks using a photometer and a glucometer.

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1. Introduction

Diabetes Mellitus (DM) is a chronic disease characterized by high blood glucose levels. The International Diabetes Federation (IDF) (2019) predicts that DM sufferers in the world will experience an increase of 51% from 2019, namely 463 million to 700 million in 2019. 2045, this number is predicted to continue to increase every year. In 2014 there were 8.5% aged 18 years suffering from DM and in 2019 diabetes mellitus caused 1.5 million deaths (WHO, 2020). The World Health Organization (WHO) predicts DM sufferers in Indonesia will increase in 2000 to 2030 from 8.4 million to around 21.3 million. The number of DM sufferers in Central Java Province has increased every year. Central Java Province with DM cases reached 496,181 cases in 2018, an increase to 652,822 cases in 2019 (Balitbangkes, 2019). Based on the results of a doctor's diagnosis, the prevalence of DM in the population aged 15 in Central Java Province increased by 0.5%, namely 1.6% in 2013 to 2.1% in 2018 (Kemenkes RI, 2019).

Examination of blood glucose is a very important examination because glucose has a role in metabolic processes in the body. The role of glucose is to become the most important carbohydrate which is widely absorbed into the bloodstream as glucose, and other glucose is converted into glucose in the liver (Ramadhani, 2019).

Blood glucose examination is the most frequently performed examination in clinical laboratories. Based on the equipment used, blood sugar examination can be carried out using two tools, namely a glucometer or POCT (Point of Care Test), a photometer and a spectrophotometer.

POCT or glucometer is a tool used to measure total blood glucose levels based on electrochemical detection with the enzyme glucose oxidase coated on a membrane strip (Kemenkes, 2010; Endiyasa et al, 2018). The advantages of the POCT tool are that it is easy to use, it can be used by nurses, patients and families for patient monitoring, the results are relatively short, the sample volume used is less, the tool is smaller so it does not need a special room and can be carried. The drawbacks of the POCT tool are limited measurement capabilities, the results are influenced by temperature, hematocrit and can be

intervened with certain substances, pre-analytic is difficult to control if the person who does it is not a competent person. (Ministry of Health, 2010; Endiyasa et al, 2018).

Photometer is a tool / instrument equipped with a light source (electromagnetic waves), either UV light (ultra-violet) or visible light (visible). The photometer is able to read/measure the color density of certain samples with certain wavelengths (Widagdho, 2013; Endiyasa et al, 2018). Measurement of blood glucose with a photometer uses an enzymatic principle that is specific to glucose, causing an enzymatic change in glucose to produce a product that is judged based on a color change reaction (colorimetry) as the final reaction of a series of chemical reactions (Firginsyah, 2016). The photometer uses serum or plasma so that it is not influenced by blood cells, while the drawback is that it requires more blood and requires a long time to process and is expensive. Examination of blood glucose with a photometer is often used in clinical laboratories because it is considered the most appropriate tool to describe blood glucose levels. No wonder the photometer is used as a standard for checking blood glucose levels (Endiyasa et al, 2018).

The results of a preliminary study conducted at the UPTD Puskesmas Klirong 1 on prolanis participants found that blood sugar examination was carried out using a glucometer with capillary blood samples and using a spectrophotometer using venous blood serum samples. Therefore, based on this explanation, researchers are interested in conducting research on "Comparison of Blood Glucose Examination Results Using Photometers and Glucometers in Prolanis Participants at Klirong 1 Kebumen Health Center".

2. Method

This study used an analytic observational research design with a cross sectional approach. The study was conducted in December - July 2022 at UPTD Puskesmas Klirong 1. The population in this study were all prolanis participants in the working area of UPTD Puskesmas Klirong 1. The sample used in this study were prolanis participants who attended prolanis activities at UPTD Puskesmas Klirong 1. The sampling technique used in this research is accidental sampling. The results of the examination of blood glucose levels using a photometer and glucometer were analyzed using the paired samples T-test. The research was carried out after obtaining approval from the Health Research Ethics Commission of the University of Muhammadiyah Purwokerto with Registration Number: KEPK/UMP/03/IV/2022.

3. Result and Discussion

Table 1

Results of Examination of Blood Glucose Levels Using a Photometer

Frekuensi	Average (SD)	Median (Min-Max)	Modus
23	164,5417 (58,14142)	154,4050 (82,18-298,46)	82,18

Based on table 1, it can be explained that the average result of glucose level examination using a photometer is 164.5417 mg/dL, standard deviation (SD) is 58.14142 mg/dL, median is 154.4050 mg/dL. The glucose level that often appears is 82.18 mg/dL, the smallest glucose level is 82.18 mg/dL while the highest glucose level is 298.56 mg/dL.

Table 2

Results of Examination of Blood Glucose Levels Using a Glucometer

Frekuensi	Average (SD)	Median (Min-Max)	Modus
23	191,3478 (61,57524)	179 (118-325)	149

Based on table 2, it can be explained that the average blood glucose level using a glucometer is 191.3478 mg/dL and the standard deviation (SD) is 61.57524 mg/dL. The median value of blood glucose levels is 179 mg/dL, with the smallest value being 118 mg/dL and the highest value being 325 mg/dL. The blood glucose level that often appears is 149 mg/dL.

Table 3

Differences in Blood Glucose Levels Using Photometer and Glucometer				
Variable	N	Average	SD	P value
Photometer Glucose Level	23	164,5417	58,14142	0,000
Glucose Level Glucometer	23	191,3478	61,57524	

Based on table 3, it is known that the p value is 0.000 which means the p value = 0.000 is smaller than $\alpha = 0.05$ (p value <). So it can be concluded that there is a significant difference between the results of the examination of blood glucose levels using a photometer and a glucometer.

3.1 Discussion

This study is a comparison of the results of examination of blood glucose levels using a photometer and glucometer on prolanis participants at the Klirong 1 Health Center Kebumen. The results of the examination of blood glucose levels using a photometer showed that the highest value was 298.56 mg/dL and the lowest was 82.18 mg/dL with an average value of 164.5417 mg/dL. While the results of the examination of blood glucose levels using a glucometer, the highest value was 328 mg/dL and the lowest was 118 mg/dL with an average value of 191.3478 mg/dL.

The results of the examination of blood glucose levels using a photometer and glucometer were compared using the paired sample T test. If the p value > α (0.05) is obtained, it can be concluded that H_0 is accepted and H_1 is rejected, meaning that there is no significant difference between the results of the examination of blood glucose levels using a photometer and glucometer. And if the p value < α (0.05) then H_1 is accepted and H_0 is rejected, meaning that there is a significant difference between the results of the examination of blood glucose levels using a photometer and glucometer. Based on table 3, it can be explained that the p value is $0.000 < \alpha 0.05$, then H_1 is accepted and H_0 is rejected, so it can be concluded that there is a significant difference between the results of checking blood glucose levels using a photometer and glucometer. This study is in line with research conducted by Firgiansyah (2016) regarding the comparison of blood glucose levels using a spectrophotometer and glucometer, the result of which is that there is a significant difference between checking blood glucose levels using a spectrophotometer and glucometer with p value = 0.000 (< 0.05) (Firgiansyah, 2016). The working principle of a spectrophotometer is almost the same as the working principle of a photometer where both are measured using light (Laisouw, 2017). Although in this study the variables are different from what the researchers did, the working principle is the same. So it can be concluded that there are differences in the results of the examination of blood glucose levels using a photometer and glucometer.

Based on research conducted by Aini (2022) regarding the comparison of blood glucose test results using the GOD-PAP method and the strip method at the Harapan Sehat Clinic laboratory, Cianjur, that this study aims to determine the comparison of blood glucose test results using the GOD-PAP method and the strip method. Based on the results of the study that the results of the paired sample T-test, the p value (0.02) < α (0.05) (Aini et al, 2022). This shows that there are differences in the results of glucose levels using a photometer and glucometer.

Research conducted by Iswanto, R (2018) regarding the comparison of the results of examination of uric acid levels using the spectrophotometer method and the POCT method shows that there are differences in the results of the examination between the spectrophotometer method and the POCT method, where the p value (0.000) < α (0.05) (Iswanto R, 2018). Therefore, even though the variables in the study are different from the research variables, the methods of examination and tests carried out are exactly the same so that it can be concluded that examinations using the photometer and glucometer methods have different results.

The results of the examination of blood glucose levels using a photometer and a glucometer are different. The different results were due to the different types of samples used even though the samples came from venous blood. In the photometer examination, the sample used was blood serum, while in the glucometer examination the sample used was whole blood. The results of the glucometer examination are higher than the results of the examination using a photometer, because the examination of venous blood samples in the form of whole blood (complete blood) is directly examined using a glucometer. Whole blood is whole venous blood fluid that still contains substances similar to blood glucose such as maltose, galactose, and xylose as well as substances such as carbon dioxide, oxygen, hormones, vitamins,

minerals and other chemicals that can make it difficult to check blood glucose. causing high blood glucose levels (Firgiansyah, 2016). While the examination using a photometer using serum. Serum is a liquid from venous blood containing molecules of the body's metabolism which is frozen for 10 minutes and then centrifuged, so the effect of delay in serum can affect the results of the examination, in addition the use of examination reagents can also affect the results of the examination (Sari, 2017).

The difference in the results of the examination on the two tools is influenced by various factors, both in the pre-analytic and analytical stages. In the pre-analytic stage, it is usually caused by the preparation of examination materials, samples contaminated with substances that are expected to affect the results of the examination, or the tools to be used have not been calibrated so that they can give false positive results. At the analytical stage, errors that often occur are inappropriate sample treatment, incubation time, incorrect mixing of reagents, and the temperature factor required by the sample before examination (Wulandari, 2019). Glucose levels are stable at cold temperatures, while at room temperature glucose will undergo glycolysis and a decrease of about 1-2% per hour (Rahmatunisa, 2021).

Examination of blood glucose levels using a photometer has the advantages of having high precision, high accuracy, specificity, relatively free from interference (hematocrit levels, vitamin C, lipids, sample volume and temperature). Photometers are dependent on reagents, require large blood samples, maintenance of equipment and reagents requires a special place and requires quite expensive costs. The POCT tool has advantages, namely the results of the examination can be immediately known, only requires a small sample, does not require special reagents, is practical and easy to use so it can be done by anyone without the need for special skills (Wulandari, 2019). The drawbacks are that the accuracy is not yet known, it has limitations that are influenced by hematocrit levels, interference with other substances (vitamin C, lipids, bilirubin and hemoglobin), the temperature of the sample volume is not enough and the strip is not used to establish a clinical diagnosis but only for monitoring glucose levels (Suryaatmadja, 2013). ; Maini, 2020).

The two tools both use the enzymatic method in their use, but each tool has differences when viewed from the working principle and the examination sample. The photometer has the working principle of the glucose oxidase enzyme catalyzing the oxidation reaction into gluconic acid and hydrogen peroxide, the hydrogen peroxide formed reacts with phenol and 4-amino phenazone with the help of the peroxidase enzyme to produce pink quinoneimine and is measured with a photometer. glucose contained in the sample (Riyani, 2012; Maini, 2020). While the glucometer is a strip that is placed on the device, when blood is dropped on the test strip reaction zone, a glucose catalyst will reduce glucose in the blood. The intensity formed from the electrons in the strip is equivalent to the concentration of glucose in the blood.

Examination of blood glucose with a photometer is often used in clinical laboratories because it is considered the most appropriate tool to describe blood glucose levels. No wonder the photometer is used as a standard for checking blood glucose levels (Endiyasa, 2018). While the glucometer is a tool that is used only to monitor or see glucose levels or initial screening (Firgiansyah, 2016).

4. Conclusion

Based on the results of the study and the discussion on the comparison of the results of the examination of blood glucose levels in prolans participants at the Klirong 1 Kebumen Health Center, it can be concluded that there is a significant difference between the results of the examination of blood glucose levels using a photometer and glucometer with a p value of 0.000 which means the p value = 0.000 smaller than $\alpha = 0.05$ (p value <). This research can be developed by taking into account several suggestions that can be made by further researchers, namely including the characteristics of the respondents and the factors that can affect blood glucose levels.

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