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Free Blood Sugar Level Checks in the Community: A Comparison between Invasive and Non-Invasive Methods

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ABSTRACT
This study aims to examine and compare the effectiveness of invasive and non-invasive blood sugar measurement methods in a free community blood sugar level check program. This activity was conducted by students from the Physics Department, Faculty of Science and Technology, Walisongo State Islamic University Semarang, in Bumiroso Village, Central Java, from July 23 to August 13, 2023. The examinations were routinely carried out every Sunday on elderly groups in four different hamlets. The non-invasive method used an oximeter sensor to measure blood sugar levels without involving blood sampling. The results showed that blood sugar levels measured by the non-invasive method ranged from 153-157 mg/dL, with an average of 155.5 mg/dL, while the invasive method showed a range of 41-418 mg/dL with an average of 123.15 mg/dL. The community response was very positive because the non-invasive method did not cause pain and reduced medical waste. However, the non-invasive device had limitations in detecting high blood sugar levels. Although the non-invasive method is convenient and environmentally friendly, the accuracy of measurements at high blood sugar levels still requires improvement. The results of this activity provide important insights into blood sugar level management and health for communities at risk of diabetes.

1. Introduction

Blood glucose is a sugar present in the blood and is obtained through daily food intake, processed into energy or calories for body cells with the help of blood oxygen to circulate throughout the body and insulin hormone in the human pancreas. In addition to being a source of energy, glucose also serves as 'fuel' for the body's organs to function normally (Gusa & Arkan, 2021). Blood glucose levels are one of the factors that cause Diabetes Mellitus. Blood glucose levels can fluctuate depending on insulin performance in the body. According to doctors, blood glucose levels should ideally be measured three times a day in acute or potential patients. Blood sugar checks are also recommended when sick, after exercise, and when weight suddenly drops drastically (Ente & Islamiyati, 2021).

Therefore, a tool is needed for regular blood sugar level checks to ensure that blood sugar levels do

not exceed normal limits. Generally, these checks are conducted in clinical laboratories or hospitals. Considering the high costs of laboratory examinations, self-monitoring with a more affordable invasive blood glucose meter, such as Autocheck, can be done. Sulehu & Senrimang (2018) in their research explained that the invasive method involves taking a blood sample after the finger is pricked with a needle. However, users sometimes forget to replace the blood lancet from previous patients, which raises concerns about the transmission of infectious diseases, and some patients have needle phobia. Additionally, the use of blood lancets increases medical waste. Medical waste differs from industrial or household waste and requires more specific management. Poor waste management can lead to an increase in medical waste, as non-medical waste mixed with medical waste is also categorized as medical waste. This can impact the health and safety of waste management personnel and the environment (Zuhriyani, 2019).

Previous research by Deviana et al. (2020) on the Analysis of Non-Invasive Blood Glucose Measurement revealed that a device using a non-invasive reflection mode method could measure glucose levels with an average error of 8.4%, due to sensitivity to finger position changes. Nevertheless, the measurement results from the device could still predict actual glucose levels. Research by Angriani (2020) on developing a prototype for measuring blood glucose, cholesterol, and uric acid using a pulse oximeter sensor accessible via a Visual Basic database resulted in a prototype with 98.79% accuracy.

This community service research aims to examine and compare the effectiveness and advantages of non- invasive and invasive blood glucose measurement methods. The non-invasive device used was developed by lecturers and students of the Physics Department at Walisongo State Islamic University Semarang. This device has been used in several previous community service activities in Demak and Semarang (Sumarti et al., 2022; Tasyakuranti et al., 2023). Understanding the differences between these methods is crucial, as it can help individuals, especially those at risk of diabetes, choose the method that best suits their needs.

2. Methods

The activities conducted by students as part of their community service are a tangible effort to improve the well-being of village residents through various programs, particularly those focused on public health services. To contribute to community health, the KKN students participated in providing free health check-ups for the elderly. This activity was held every Sunday from July 23 to August 13, 2023, in Bumiroso Village, spanning four different hamlets with the following schedule: the first Sunday in Kemiri Hamlet, the second in Drewel Hamlet, the third in Siwatu Hamlet, and the fourth in Bumiroso Hamlet.This community service was performed using free non-invasive blood glucose detection devices. This provided significant benefits to the local community and medical team, as the measurements could be conducted without cost and without causing pain, as no needles were required. Additionally, the presence of non-invasive measuring devices helped reduce medical waste in the environment.

The non-invasive device works by measuring blood glucose levels using the absorption characteristics of infrared and red LED light in the DS-100A oximeter sensor (Nugroho, 2019). Turn on all parts of the transmitter circuit and use a power bank to reduce excessive battery usage. Once the device functions as shown in Figure 1, the Arduino Uno R3 microcontroller processes the measurements and converts the analog data into digital data (Handoko, 2017; Susanto et al., 2013). The blood glucose measurement data is displayed on an LCD screen with a size of 20x4.

3. Results and Discussion

The health check-up was conducted at the Drewel Hamlet health center. The check-up targeted elderly residents of Drewel. The event began with a health education session and a brief promotion about medical physics at Walisongo State Islamic University Semarang. Figure 1 shows the registration process for the health check-up, where participants filled out a registration form that

included their name, address, age, gender, weight, height, medical history, and the time of their last meal. If participants forgot or did not know their height and weight, measurements were taken on-site.



Fig 1. Health check registration process

Figure 2 shows the health check-up process using standard equipment for blood sampling to measure blood sugar levels, and Figure 3 shows the process of measuring blood sugar levels using non-invasive equipment.



(a) (b)

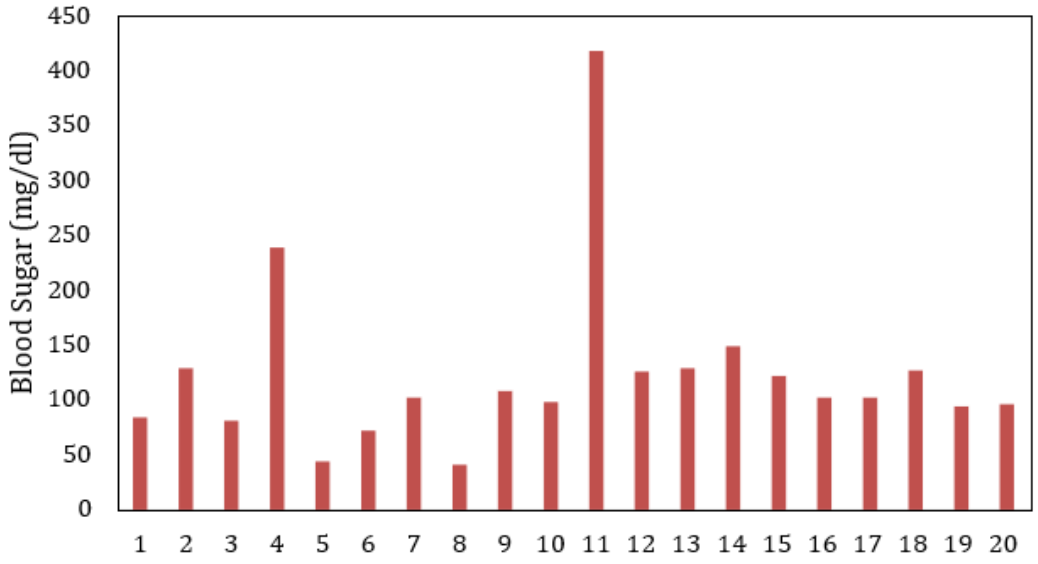
Fig 2. Health checking process (a) using standard tools and (b) Using noninvasive tools

The results of blood sugar level checks using the non-invasive device are shown in Figure 3. The blood sugar levels ranged from 153 to 157 mg/dL, with an average blood sugar level of 155.5 mg/dL. Meanwhile, the results of blood sugar checks using standard equipment ranged from 41 to 418 mg/dL, with an average blood sugar level of 123.15 mg/dL.

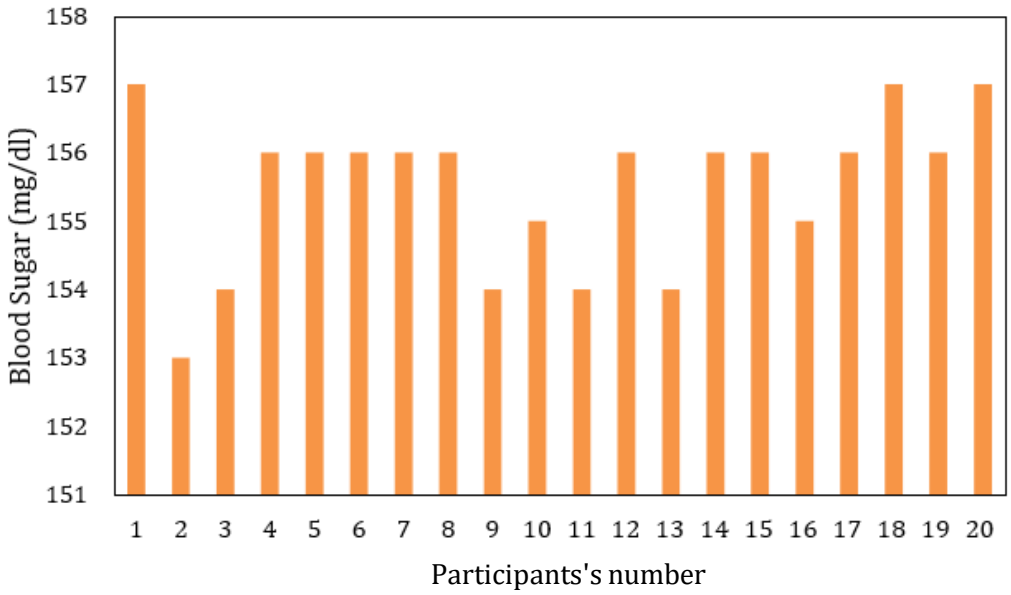
Based on interviews conducted by students with several community members and healthcare workers, the program received very positive feedback. They felt greatly assisted by this activity, as the check-ups did not cause any skin pain. Additionally, the non-invasive measurements helped reduce medical waste in the surrounding environment. This is important because medical waste can pose health risks to individuals and the community (Salam, 2018). Given the importance of reducing waste, especially medical waste, which has increased post-COVID-19 pandemic (APBN, 2022), this is a significant benefit.

However, there are challenges with using the non-invasive device, particularly regarding the

accuracy of measuring high blood sugar levels. This limitation occurs because the device can only detect low levels accurately. During calibration testing, only low blood sugar levels were used. Therefore, when the device is used to detect high levels, the results do not align with those obtained from single-use test devices using the invasive method. Thus, this non-invasive device is currently only suitable for measuring normal blood sugar levels.



(a)



(b)

Fig 3. Results of checking blood sugar levels (a) Using standard tools and (b) Using noninvasive tools

4. Conclusion

The community service activity conducted in Bumiroso Village, Watumalang District, Wonosobo Regency, Central Java, involved blood sugar level checks. The results showed an average blood sugar level profile of around 155.5 mg/dL, indicating levels above the normal range. Residents with high blood sugar levels were educated on the importance of maintaining health and were advised to adopt a healthier diet and engage in regular exercise. The response from the residents was very positive, as they appreciated the non-invasive and painless nature of the examinations.

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