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إدارة المعاهد العليا – وزارة التعليم التقني

Standard

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Abstract:

Background: Glucose is the main source of energy in the body, and its regulation is controlled by a hormonal balance between insulin and glucagon. This balance ensures a stable blood glucose level to support the body's various functions.

Objective: The purpose of this study is to determine the accuracy of home blood glucose meters in measuring blood sugar levels compared to the results of laboratory devices.

Materials and Methods: This study included 115 samples collected between November 2024 and January 2025 from the Diabetes and Endocrinology Treatment Center in Msallata. The ages of the sample donors ranged from 5 to 93 years. The Accu-Chek Active home glucose meter and the laboratory of the same center were used to measure all the samples.

Results: The results of this study indicated a slight increase in the laboratory test results compared to the home glucose meter readings. The average laboratory test results were 212.39 mg/dL, while the average readings from the home glucose meter were 192.28 mg/dL, with a difference of 20.11 mg/dL between the two measurement methods.

Conclusion: The findings of this study suggest that while there are slight differences between home glucose meters and laboratory tests, home glucose meters can be effectively relied upon for monitoring blood sugar levels in diabetic patients, provided that proper usage techniques are followed and the manufacturer's instructions are adhered to.

: Diabetes / Blood glucose / Glucose / Home glucose meter.

الملخص

يُعدّ الجلوكوز المصدر الرئيسي للطاقة في الجسم، ويتم تنظيمه من خلال توازن هرموني بين الأنسولين والغلوكاغون . ويضمن هذا التوازن الحفاظ على مستوى ثابت من سكر الدم لدعم مختلف وظائف الجسم.

الهدف:
تهدف هذه الدراسة إلى تحديد دقة أجهزة قياس سكر الدم المنزلية في قياس مستويات السكر في الدم مقارنةً بنتائج الأجهزة المخبرية.

المواد وطرق البحث:
شملت هذه الدراسة 115عينة جُمعت خلال الفترة من نوفمبر 2024 إلى يناير 2025 من مركز علاج السكري والغدد الصماء في مسلاتة .تراوحت أعمار أصحاب العينات بين 5و93 سنة .تم استخدام جهاز قياس السكر المنزلي Accu-Chek Active بالإضافة إلى مختبر المركز نفسه لقياس جميع العينات.

النتائج:
أظهرت نتائج هذه الدراسة وجود زيادة طفيفة في نتائج الفحص المخبري مقارنة بقراءات جهاز قياس السكر المنزلي. حيث بلغ متوسط نتائج الفحص المخبري 212.39 ملغ/دل، بينما كان متوسط قراءات جهاز القياس المنزلي 192.28 ملغ/دل، بفارق قدره 20.11ملغ/دل بين طريقتي القياس.

الاستنتاج:
تشير نتائج هذه الدراسة إلى أنه على الرغم من وجود اختلافات طفيفة بين أجهزة قياس السكر المنزلية والفحوصات

المخبرية، فإنه يمكن الاعتماد على أجهزة القياس المنزلية بشكل فعّال في مراقبة مستويات سكر الدم لدى مرضى السكري، بشرط استخدامها بطريقة صحيحة والالتزام بتعليمات الشركة المصنعة.

الكلمات المفتاحية:
السكري / سكر الدم / الجلوكوز / جهاز قياس السكر المنزلي / السكري من النوع الأول.

Introduction:

Glucose, a simple monosaccharide, serves as the primary energy source for living organisms, particularly for vital organs like the brain, which require a continuous and highly regulated glucose supply (Badireddy & Deepthi, 2023; Mathew et al., 2023). During the postprandial state, the majority of circulating blood glucose originates from dietary carbohydrates following their enzymatic digestion in the small intestine (Mathew et al., 2023). Conversely, during periods of fasting, the human body maintains glucose homeostasis through physiological mechanisms, namely gluconeogenesis and glycogenolysis (Badireddy & Deepthi, 2023).

Maintaining blood glucose homeostasis involves precise physiological coordination between hepatic glucose production and peripheral glucose uptake, with insulin acting as the primary regulatory hormone (Badireddy & Deepthi, 2023; Mathew et al., 2023). Any impairment in this homeostatic mechanism—whether caused by deficient insulin secretion, impaired cellular responsiveness (insulin resistance), or excessive hepatic glucose output—results in sustained hyperglycemia (Badireddy & Deepthi, 2023). Normal fasting blood glucose ranges between 70 and 100 mg/dL (Mathew et al., 2023). Fasting glucose levels exceeding 126 mg/dL or postprandial levels surpassing 140 mg/dL signify hyperglycemia, whereas levels dropping below 70 mg/dL define hypoglycemia (Badireddy & Deepthi, 2023; Mathew et al., 2023).

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by inadequate insulin production, impaired insulin action, or both, ranking among the leading global causes of morbidity and mortality (WHO, 2020). According to the International Diabetes Federation (2017), diabetes affected approximately 425 million individuals globally, with nearly 79% residing in low- and middle-income countries—a prevalence projected to rise to 629 million by 2045. Etiologically, diabetes is categorized into three primary clinical types:

- **Type 1 Diabetes (T1D):** Resulting from autoimmune destruction of pancreatic beta cells leading to absolute insulin deficiency (WHO, 2020).
- **Type 2 Diabetes (T2D):** Characterized by progressive insulin resistance combined with secretory defect (WHO, 2020).
- **Gestational Diabetes Mellitus (GDM):** Hyperglycemia first recognized during pregnancy (WHO, 2020).

Uncontrolled glycemic fluctuations can lead to severe microvascular complications (retinopathy, neuropathy, and nephropathy) and macrovascular diseases (cardiovascular disease and stroke) (Badireddy & Deepthi, 2023). Consequently, continuous and accurate glycemic monitoring is essential for optimal therapeutic management (Gillery et al., 2015; Mathew et al., 2023). Measuring venous plasma glucose in laboratory settings using automated analyzers remains the clinical gold standard for diagnosis and reference testing (International Diabetes Federation, 2017; Al-Ansari & Al-Malki, 2022).

Conversely, point-of-care capillary blood glucose (CBG) testing using portable personal glucose meters offers a practical and immediate method for self-monitoring of blood glucose (SMBG) at home (Gifford-Jorgensen et al., 1986; Zubair et al., 2023). Although point-of-care glucometers have advanced significantly in user-friendliness and accessibility, verifying their accuracy against laboratory reference methods is critical to ensure patient safety and avoid clinical mismanagement (Gillery et al., 2015; Tirimacco et al., 2015; Halder et al., 2024).

2. Materials and Methods:

This descriptive, cross-sectional study was conducted to evaluate blood glucose monitoring practices among diabetic patients. The study population comprised 115 diabetic individuals of both genders, spanning an age range of 5 to 93 years, who met the pre-established inclusion criteria. Data collection and clinical sampling were carried out at the Diabetes and Endocrinology Treatment Center in Msallata over a four-month period, extending from October 2024 to January 2025.

A structured data questionnaire was utilized to gather comprehensive demographic and clinical profiles from each participant. The instrument captured personal data, including age and gender, alongside relevant medical histories such as the overall duration of diabetes, ownership of a personal home glucose

meter, the frequency of self-monitoring, and the historical number of laboratory-based glucose tests performed.

For biochemical assessment, a 5 mL venous blood sample was aseptically collected from each patient using sterile syringes and standard venipuncture techniques. Laboratory-based reference measurements of blood glucose concentrations were performed using the MEDICA EASY RA clinical chemistry analyzer.

Concurrently, point-of-care capillary blood glucose measurements were evaluated using the ACCU-CHEK Active home glucose meter, utilizing its dedicated test strips embedded with electronic chips. While home glucose monitors generally operate on either photometric principles (measuring color intensity alterations on the strip) or electrochemical principles, the ACCU-CHEK Active device specifically utilizes an electrochemical reaction to quantify blood glucose.

The capillary glucose determination process was standardized across all subjects. A small capillary blood droplet was obtained from the participant's fingertip using a sterile lancet. The droplet was immediately applied to the reaction zone of the test strip pre-inserted into the glucose meter. Mechanistically, the glucose present in the blood sample reacts with specific enzymes embedded in the strip—such as glucose oxidase or hexokinase. This biochemical reaction generates a localized electrical current that is directly proportional to the glucose concentration in the blood. The device's internal microprocessor calibrates and converts this quantitative electrical signal into a digital glycemic reading, displayed in either milligrams per deciliter (mg/dL) or millimoles per liter (mmol/L).

Results:

Baseline Demographic and Clinical Characteristics A total of 115 diabetic participants were evaluated in this study. (Figure 1) The cohort exhibited a balanced gender distribution, comprising 57 males (49.6%) and 58 females (50.4%).

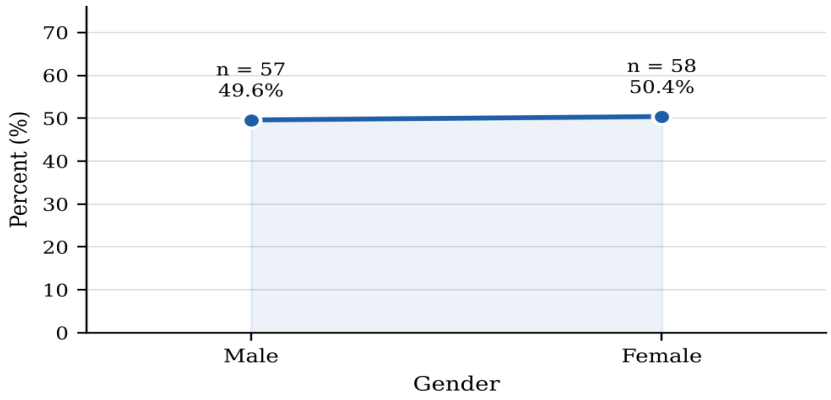


Figure 1. Frequency distribution and percentage of participants by gender

Most participants were older adults: 81 (70.4%) were over 50 years of age, which is consistent with the known increase in the prevalence of diabetes with advancing age. Participants aged 26–50 years made up 26.1% of the sample (n = 30), whereas those aged 0–25 years formed the smallest group, with only 4 participants (3.5%) (Figure 2).

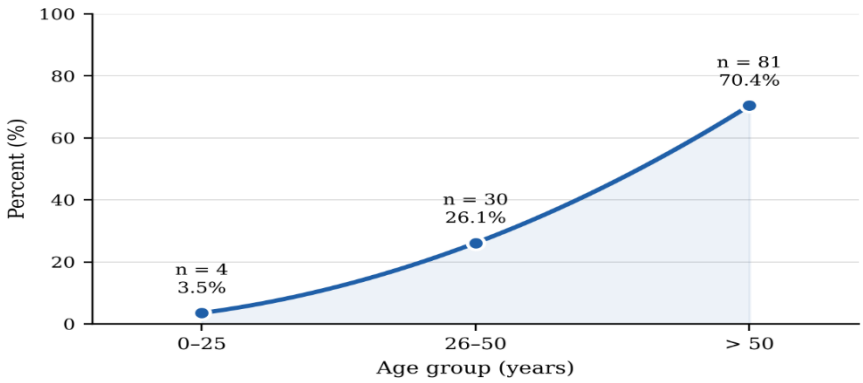


Figure 2. Frequency distribution and percentage of participants by age group

The 114 participants who answered this question, 65 (57.0%) owned a home blood glucose meter and 49 (43.0%) did not; one response (0.9%) was missing (Figure 3). Thus, more than half of the participants were able to monitor their blood glucose at home, while the rest relied mainly on laboratory testing

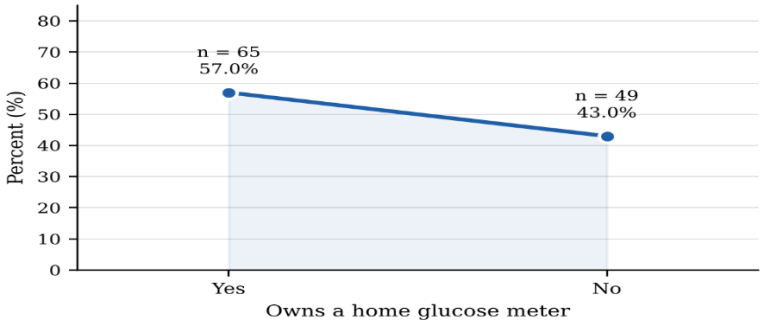


Figure 3. Frequency distribution and percentage of participants by ownership of a home glucose meter

Among the 66 participants who reported how often they use their home glucose meter, weekly use was the most common (35 participants; 53.0%), followed by daily use (25; 37.9%), whereas only 6 participants (9.1%) used the meter once a month. The remaining 49 participants (42.6% of the total sample) did not answer this question (Figure 4).

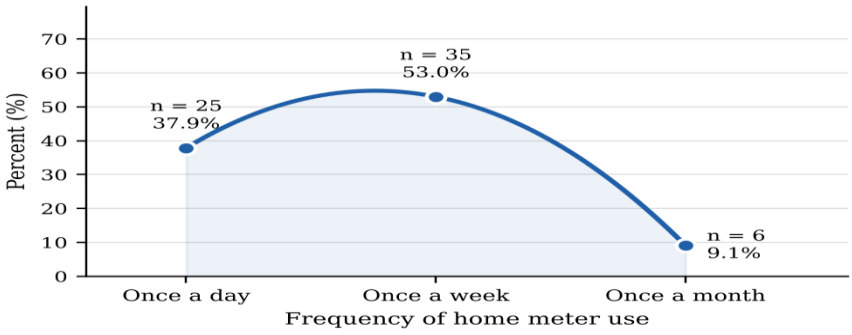


Figure 4. Frequency distribution and percentage of participants by frequency of home blood glucose measurement.

Almost all participants (109; 94.8%) reported having their blood glucose tested in a laboratory, whereas only 6 (5.2%) did not; these few participants may rely on home monitoring or may have limited access to laboratory services (Figure 5).

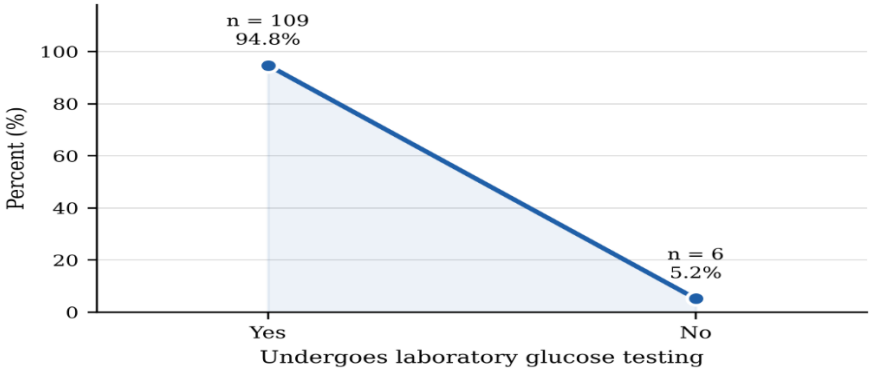


Figure 5. Frequency distribution and percentage of participants by laboratory blood glucose testing.

Among the 108 participants who reported how often they have their blood glucose tested in a laboratory, monthly testing was the most common (61 participants; 56.5%), followed by testing once every three months (34; 31.5%) and weekly testing (13; 12.0%). Seven responses (6.1%) were missing (Figure 6).

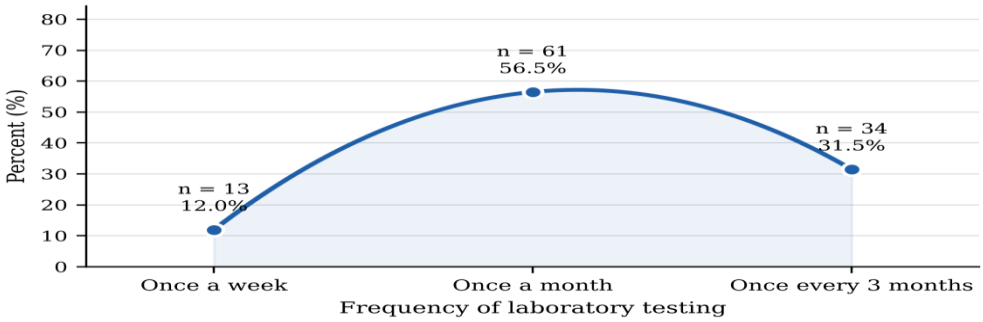


Figure 6. Frequency distribution and percentage of participants by frequency of laboratory blood glucose testing.

Nearly half of the participants (55; 47.8%) had been living with diabetes for more than 10 years, 39 (33.9%) for 1–5 years, and 21 (18.3%) for 6–10 years (Figure 7). This indicates that a large proportion of the sample had long-standing diabetes.

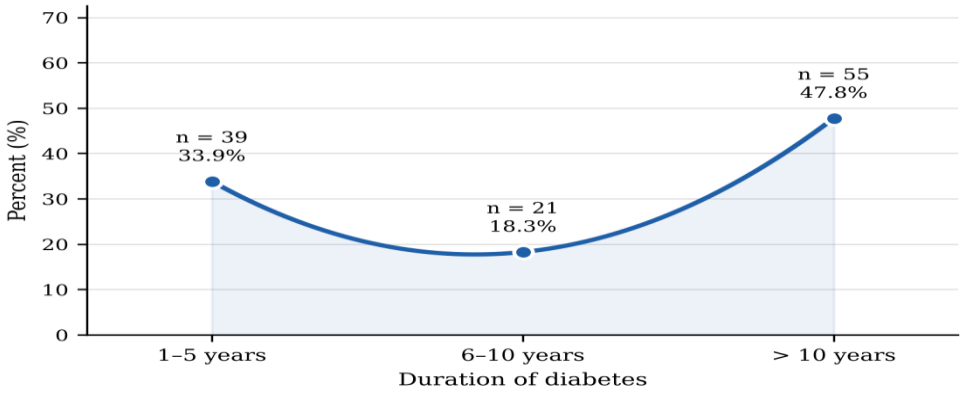


Figure 7. Frequency distribution and percentage of participants by duration of diabetes

Comparative Accuracy and Analytical Correlation Descriptive analysis revealed a mean capillary blood glucose level of 192.28 +/- 91.62 mg/dL (range: 85.00 to 585.00 mg/dL) using point-of-care home meters, compared to 212.39 +/- 101.22 mg/dL (range: 94.00 to 560.00 mg/dL) obtained via the laboratory reference analyzer. Laboratory measurements demonstrated a statistically significant higher mean value, with a mean difference of 20.11 mg/dL. Nevertheless, a strong positive linear relationship was confirmed between the two measurement modalities (Pearson r = 0.921, p < 0.001).

Conclusion:

This study demonstrated that the samples analyzed in the laboratory were slightly higher than those measured using the ACCU-CHEK ACTIVE home glucose meter. However, the difference was not significant enough to question the device's reliability. Instead, this indicates the device's effectiveness in routine blood sugar monitoring for diabetic patients, provided that the accompanying instructions are carefully followed to achieve optimal results. The findings also revealed that most diabetic patients are elderly and that half of them do not own a home glucose monitoring device. Additionally, the study indicated that the majority of diabetic patients rely more on laboratory tests to check their blood sugar levels—whether routinely or when experiencing health disturbances—rather than depending on home glucose meters for monitoring.

Recommendation:

1. Acquiring a Home Glucose Meter: Owning a home glucose meter helps diabetic patients monitor their health and track their blood sugar levels regularly.
2. Following the Instructions Provided with Home Glucose Meters: Adhering to the proper usage guidelines ensures the device provides the most accurate and reliable results.
3. Encouraging Future Researchers to Use Various Types of Home Glucose Meters Alongside Laboratory Tests: Future studies are recommended to compare different types of home glucose meters with laboratory tests to identify the most accurate and efficient devices.

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