INTERNAL MEDICINE - PEDIATRICS **ORIGINAL PAPERS**

HEMOGLOBIN A1C AND BODY MASS INDEX AS PREDICTORS OF DISCREPANCIES BETWEEN CONTINUOUS GLUCOSE MONITORING AND GLUCOMETER READINGS IN PREGNANT WOMEN WITH GESTATIONAL DIABETES

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HEMOGLOBIN A1C AND BODY MASS INDEX AS PREDICTORS OF DISCREPANCIES BETWEEN CONTINUOUS GLUCOSE MONITORING AND GLUCOMETER READINGS IN PREGNANT WOMEN WITH GESTATIONAL DIABETES (Abstract): This study investigated the relationship between differences in continuous glucose monitoring (CGM) and glucometer measurements and the clinical factors hemoglobin A1c (HbA1c) and body mass index (BMI) in women with gestational diabetes. We also evaluated if HbA1c and BMI could serve as predictors of CGM-glucometer differences. **Materials and methods**: HbA1c was measured both continuously and categorically (≥5.9% vs <5.9%), and BMI was calculated in kg/m². An independent-samples t-test compared CGM differences between the two HbA1c categories. Pearson correlations examined relationships between CGM differences and HbA1c and BMI. A multiple linear regression assessed whether HbA1c and BMI predicted CGM differences. **Results**: Patients with elevated HbA1c (≥5.9%) had significantly higher CGM differences (M = 28.71, SD = 0.73) compared to those with lower HbA1c (M = 23.17, SD = 0.91), $t(42) = -19.94$, $p < 0.001$. CGM differences were very strongly correlated with HbA1c ($r = .996$, $p < 0.001$) and BMI ($r = .984$, $p < 0.001$). In the multiple regression model, only HbA1c significantly predicted CGM differences (B = 26.52, SE = 2.18, $p < 0.001$), whereas BMI was not statistically significant. The model explained 99.3% of the variance in CGM differences ($R^2 = 0.993$). **Conclusions.** The findings of our study suggest that HbA1c is strongly associated with CGM-glucometer differences, while BMI, despite a strong correlation, does not independently predict discrepancies when HbA1c is considered. These results underscore the importance of HbA1c in assessing CGM accuracy. **Keywords:** HEMO-GLOBIN, BODY MASS INDEX, PREDICTORS, CONTINUOUS GLUCOSE MONITORING, PREGNANT WOMEN, GESTATIONAL DIABETES.

INTRODUCTION

Continuous glucose monitoring (CGM) has become an increasingly important tool for measuring glycemic control, particularly in populations at risk for glucose abnormalities such as women with gestational diabetes (1). CGM offers frequent glucose readings over time, which can reveal fluctuations that are not captured by traditional glucometer measurements (2). However, discrepancies between CGM and glucometer readings, particularly in the context of gestational diabetes, have been understudied, and investigating the factors that contribute to these differences may be critical for clinical interpretation.

Hemoglobin A1c (HbA1c) is a form of hemoglobin with glucose bound to it (3). Since red blood cells have a lifespan of approximately three months, HbA1c can provide an estimate of average blood glucose levels over that period. Therefore, HbA1 is commonly used to evaluate long-term glycemic control (3). Hence, HbA1c reflects long-term glycemic control and its relation to the extent of CGM-glucometer differences should be examined.

Body Mass Index (BMI) is calculated by dividing a person's weight in kilograms by the square of their height in meters (kg/m²) (4). BMI is a simple, widely used screening measure to estimate whether an adult's body weight is healthy relative to their height. While BMI does not directly measure body fat, it is utilized to categorize individuals as underweight, normal weight, overweight, or obese, and to examine potential health risks associated with obesity (4). Similarly, BMI has been suggested to influence glucose measurement accuracy, although evidence remains mixed (5). Therefore, the present study aimed to investigate the relationship between CGM-glucometer differences, HbA1c, and BMI, and to evaluate whether HbA1c and BMI can predict the observed differences.

MATERIALS AND METHODS

Participants. The study included 44 pregnant women. Demographic and clinical characteristics were recorded, including body mass index (BMI), and hemoglobin A1c (HbA1c). All participants underwent both continuous glucose monitoring (CGM) and glucometer measurements.

Measures. The primary variable of interest for our experimental design was the difference between CGM readings and standard glucometer measurements, recorded in mg/dL (CGM-diff). HbA1c was measured as a percentage using standard laboratory assays. For some statistical analyses, HbA1c was categorized based on a threshold of 5.9% into lower risk/normal (<5.9%) and higher risk/elevated (≥5.9%) (6). BMI was calculated as weight in kilograms divided by height in meters squared (kg/m²) (4).

Procedures. Participants underwent simultaneous CGM and glucometer glucose measurements. Data for CGM-diff, HbA1c, and BMI were collected and entered into the SPSS data set prior to the statistical analysis.

Statistical Analysis. All statistical analyses were conducted using SPSS. An independent samples t-test was performed to compare CGM differences between patients with HbA1c <5.9% and ≥5.9%. Pearson correlations were also calculated to examine the relationships between CGM-glucometer differences and the continuous variables HbA1c and BMI. Finally, a multiple linear regression was conducted to assess whether HbA1c and BMI predicted CGM-glucometer differences. Model assumptions were evaluated, and statistical significance was set at $p = 0.05$.

RESULTS

Independent Samples t-Test. Our statistical analysis showed that patients with HbA1c ≥ 5.9% had a higher mean CGM-glucometer difference (M = 28.71, SD = 0.73, n = 14) compared to patients with HbA1c < 5.9% (M = 23.17, SD = 0.91, n = 30).

The independent-samples t-test indicated that this difference was statistically significant, $t(42) = -19.94$, $p <0.001$, with a mean difference of -5.55 (95% CI (-6.11, -4.99)). In addition, Levene's test confirmed that the assumption of equal variances was met, $F = 0.77$, $p = 0.39$. The effect size was very large, Cohen's d = 6.45 (fig. 1).

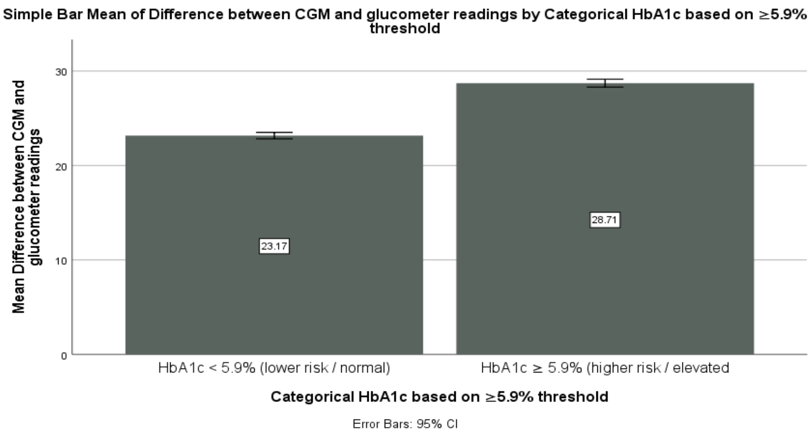

Fig. 1. Mean differences between continuous glucose monitoring (CGM) and glucometer readings for patients with HbA1c <5.9% (lower risk/normal) and ≥5.9% (higher risk/elevated). Error bars represent standard deviations. Patients with higher HbA1c levels exhibited larger CGM-glucometer differences.

Pearson Correlations

Furthermore, a Pearson correlation was conducted to examine the relationship between CGM-glucometer differences and HbA1c. There was a strong, positive correlation, $r = 0.996$, $n = 44$, $p < 0.001$ (fig. 2).

In addition, a second Pearson correlation was used to examine the relationship between CGM-glucometer differences and BMI. The results showed that there was a strong, positive correlation, $r = 0.984$, $n = 44$, $p < 0.001$ (fig. 3).

Multiple Regression

Lastly, a multiple linear regression was conducted to examine whether HbA1c and BMI can predict CGM-glucometer differences. The results showed that the overall model was statistically significant, $F(2, 41) = 2910$, $p < 0.001$, and explained 99.3% of the variance in CGM-glucometer differences (Adjusted $R^2 = 0.993$).

Examination of the coefficients indicated that HbA1c was a significant predictor of CGM-glucometer differences, $B = 26.52$, $SE = 2.18$, $\beta = 1.03$, $t(41) = 12.17$, $p < 0.001$. However, BMI was not a significant predictor, $B = -0.05$, $SE = 0.13$, $\beta = -0.03$, $t(41) = -0.37$, $p = 0.717$. The intercept was $B = -134.51$, $SE = 9.75$, $t(41) = -13.80$, $p <0.001$ (fig. 4).

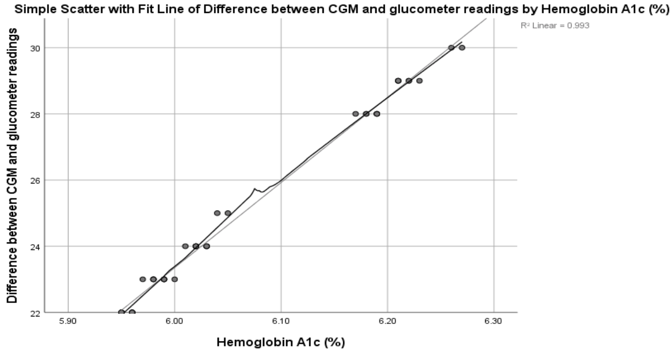

Fig. 2. Scatterplot showing the relationship between CGM-glucometer differences and hemoglobin A1c (HbA1c). The regression line illustrates the strong positive correlation ($r = 0.996$, $p < 0.001$), indicating that higher HbA1c levels are associated with larger CGM-glucometer differences.

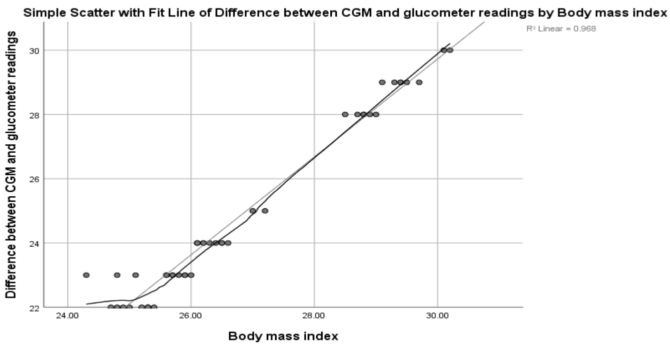

Fig. 3. Scatterplot showing the relationship between continuous CGM-glucometer differences and body mass index (BMI). The regression line illustrates the strong positive correlation ($r = 0.984$, $p < 0.001$), indicating that higher BMI values are associated with larger CGM-glucometer differences.

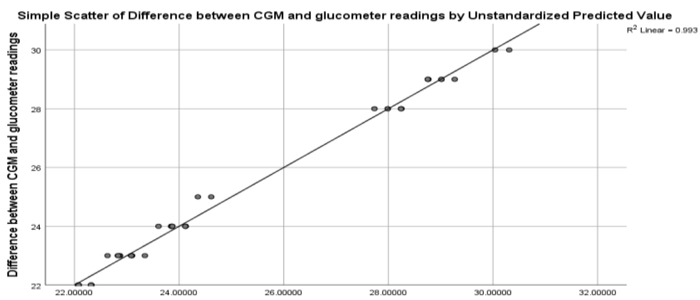

Fig. 4. Scatterplot of observed versus predicted continuous CGM-glucometer differences from the multiple regression model including hemoglobin A1c (HbA1c) and body mass index (BMI) as predictors. The X-axis shows unstandardized predicted values of CGM-glucometer differences, and the Y-axis shows the observed CGM-glucometer differences. Points close to the diagonal line indicate that the model predicts CGM-glucometer differences accurately.

DISCUSSION

The present study examined differences between continuous glucose monitoring (CGM) and glucometer readings in relation to HbA1c and BMI in a sample of 44 pregnant women. The independent-samples t-test indicated that patients with higher HbA1c levels (≥5.9%) exhibited significantly larger differences between CGM and glucometer readings compared to those with lower HbA1c levels. This suggests that HbA1c may be associated with the magnitude of discrepancy between these glucose measurement methods. Our results are in concordance with those found in the literature (7). For example, in a recent study, Lai *et al*. (2023) reported that in gestational diabetes patients with HbA1c < 6%, CGM reduced the mean glucose difference to around 23 mg/dL, closely matching our subgroup with HbA1c < 5.9%, which had a mean difference of 23.17 mg/dL (8).

In addition, our Pearson correlations revealed very strong positive relationships between CGM-glucometer differences and both HbA1c (r = 0.996) and BMI (r = 0.984). These findings indicate that as HbA1c or BMI increases, the difference between CGM and glucometer readings also increases. In another recent study on this subject, Zhu *et al.* demonstrated that CGM use in gestational diabetes resulted in a mean HbA1c of 6.0% and improved glucose detection, aligning with our results and the resulted high correlation of HbA1c with CGM-glucometer differences (9).

Ultimately, our multiple regression analysis further clarified the predictive role of these variables. While the overall model explained a very high proportion of the variance in CGM differences ($R^2 = 0.993$), only HbA1c emerged as a significant predictor. BMI did not significantly contribute to the model, suggesting that, in this dataset, HbA1c is the primary driver of CGM-glucometer discrepancies. Although previous work has demonstrated robust associations between HbA1c and CGM-derived metrics such as mean glucose (10), few studies have directly assessed whether HbA1c predicts the magnitude of discrepancy between CGM and glucometer readings, underscoring the novelty of our experimental design. Consistent with Guo *et al*, who reported a weak association between higher BMI and larger CGM-glucometer differences (11), our regression analysis also indicated that BMI was not a significant predictor, suggesting a minimal effect of BMI on glucose measurement discrepancies.

Taken together, these results highlight the potential importance of HbA1c in understanding differences between CGM and glucometer readings. Although BMI was strongly correlated with CGM-glucometer differences, it did not remain a significant predictor when considered alongside HbA1c, indicating potential collinearity between the two variables.

CONCLUSIONS

Our findings align with previous studies demonstrating that continuous glucose monitoring can detect fluctuations missed by home glucose monitoring (12) and that higher HbA1c is associated with larger CGM-glucometer differences (13, 14).

These results provide a foundation for further investigation into the factors influencing CGM accuracy, particularly in populations with elevated HbA1c. Future studies should explore additional clinical and behavioral variables that may contribute to these observed measurement discrepancies.

CONFLICT OF INTERESTS AND FUNDING

The authors declare no conflict of interests.

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