

## Case Report

# Association between HbA1c levels and mean body weight in type 2 diabetes: a five-year self-monitored case report

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### Abstract

This study proposes a novel method to predict HbA1c levels in individuals with type 2 diabetes using the mean body weight averaged over a three-month period. Weekly weight measurements and daily step counts were collected from a patient over five years, with quarterly blood samples analyzed for HbA1c levels. The analysis identified a statistically significant linear correlation between mean body weight and HbA1c levels, supported by a regression model with a high coefficient of determination. This approach offers a simple and effective means to monitor glycemic control in clinical practice, determining the optimal average weight for each patient to maintain recommended blood sugar levels, as advised by their specialist. Physical activity, specifically daily walking, has been found to positively impact HbA1c control. This report describes findings from a single-patient longitudinal observation and should be interpreted as exploratory. Further validation and broader application of this approach across diverse patient populations are recommended.

**Keywords:** type 2 diabetes, HbA1c levels, mean body weight, glycaemic control, physical activity

### Introduction

Type 2 diabetes mellitus (T2DM) presents a significant global health challenge characterized by chronic elevation of blood sugar levels, insulin resistance, and impaired insulin secretion. Often associated with obesity, hypertension, and abnormal lipid profiles, T2DM leads to complications such as cardiovascular disease, neuropathy, and retinopathy. Effective management aims to minimize long-term complications while avoiding adverse effects such as severe hypoglycemia and weight gain [1, 2].

Achieving and maintaining optimal glycemic control is essential in T2DM management. Central to this effort is monitoring HbA1c levels, which reflect average blood glucose concentrations over approximately three months. HbA1c levels, or glycated hemoglobin, serves as a critical indicator of long-term glycemic status, guiding therapeutic decisions and treatment strategies [3].

Assessing medication options that affect both glycemic control and body weight is crucial for informed T2DM management [4]. For example, daily glimepiride has demonstrated effectiveness in lowering HbA1c levels and inducing significant weight loss compared to other sulphonylureas [5].

Traditional methods for monitoring HbA1c levels involve periodic blood tests, offering snapshots of glycemic control at specific intervals. However, these methods can be expensive, inconvenient, and time-consuming, potentially reducing patient compliance [6]. Therefore, understanding alternative methods to estimate HbA1c is essential for comprehensive glycemic control assessment.

Recent studies have explored various approaches to estimating HbA1c, such as the weighted average glucose method. This method accounts for varying contributions of glucose over a three-month period and offers nuanced HbA1c levels values across diverse glycemic scenarios [7]. For instance, investigations have shown



significant reductions in blood sugar levels correlating with greater weight loss among individuals with type 2 diabetes [8]. Moreover, moderate increases in physical activity have been associated with notable reductions in both fasting glucose and HbA1c levels [9].

Moreover, correlations between increased body fat and elevated HbA1c levels highlight the impact of interventions targeting weight loss and body composition [10]. Longitudinal research indicates that obese individuals with normal HbA1c levels are more likely to progress to prediabetes or diabetes over time, emphasizing the importance of weight management [11].

This study aims to explore the relationship between mean body weight and HbA1c levels over a three-month period to determine if mean body weight can reliably predict HbA1c levels in patients with type 2 diabetes. Additionally, it aims to scientifically review the effect of physical activity, particularly daily walking, on blood sugar and HbA1c levels. Understanding these relationships could enhance diabetes management by offering a simple, cost-effective method for monitor glycemic control and promote lifestyle interventions. This work is presented as a longitudinal case report based on self-monitored data from a single patient with type 2 diabetes.

## Experimental

This study focuses on a male patient diagnosed with type 2 diabetes in 2013, aged 49 years, 179 cm tall, with a family history of type 2 diabetes on his mother's side. Since 2019, the patient has tracked his body weight using a Koia electronic personal scale, recording weekly measurements via a mobile health application. Over five years, he maintained an average weight of 95 kg, resulting in a body mass index (BMI) of 29.7, indicating overweight. He follows a balanced diet prescribed by a nutritionist and engages in regular physical activity, walking for at least an hour daily, 5–7 times per week, to support his health goals while diligently monitoring HbA1c levels. In addition to weight, he records daily steps using the Google Fit walking application, totaling approximately 2000 values over these years.

As the HbA1c level analysis reflects the blood sugar level over the previous three-month period, we similarly calculated both the Mean body weight and the average daily steps for the same preceding three-month period for each HbA1c analysis.

All medical analyses, including HbA1c levels measurements and cholesterol monitoring, were conducted

at Cerballiance, a reputable chain of medical biology laboratories in France. Blood samples were collected every three months for HbA1c determination, a standard method in diabetes care. HbA1c targets for type 2 diabetes patients vary: below 7% (53 mmol/mol) for most patients, below 6.5% (48 mmol/mol) for newly diagnosed patients with a life expectancy over 15 years and no cardiovascular disease history, and below 8% (64 mmol/mol) for those with severe comorbidities, advanced complications, or diabetes duration exceeding 10 years [12].

For treatment, he takes Fluvastatin sodium at a dosage of 80 mg daily to manage cholesterol levels. From 2019 until mid-2021, he was prescribed Metformin hydrochloride 500 mg, taking three pills daily; subsequently, his dosage was adjusted to two pills per day. He follows this streamlined medication regimen with no additional medications.

Weekly weight measurements recorded with the Koia scale were logged in a mobile health application, providing an overview of the patient's weight trends. Blood samples were collected every three months for HbA1c determination, a standard method in diabetes care.

In contrast to prior studies focused on medication effects, our approach centred on the direct relationship between average body weight and HbA1c levels, irrespective of specific medications or treatment methods. The study aimed to analyse this correlation, using the resulting equation from the regression analysis. This method aims to determine the appropriate average weight for each patient to maintain recommended cumulative blood sugar levels effectively.

## Results

The study tracked changes in HbA1c levels and average daily step counts over a three-month period. Results from February 2019 to June 2024 are summarized in Figure 1.

Results show variability in HbA1c levels from 5.8% to 7.3% over time, with a trend towards lower levels post-mid-2021, coinciding with increased daily step counts. To explore the relationship between HbA1c levels and average daily step counts, data points were analysed and plotted (Figure 2).

Figure 2 illustrates a linear regression analysis with a coefficient of determination ( $R^2$ ) of 0.6, indicating a moderate relationship between HbA1c levels and average daily steps. This correlation suggests that daily

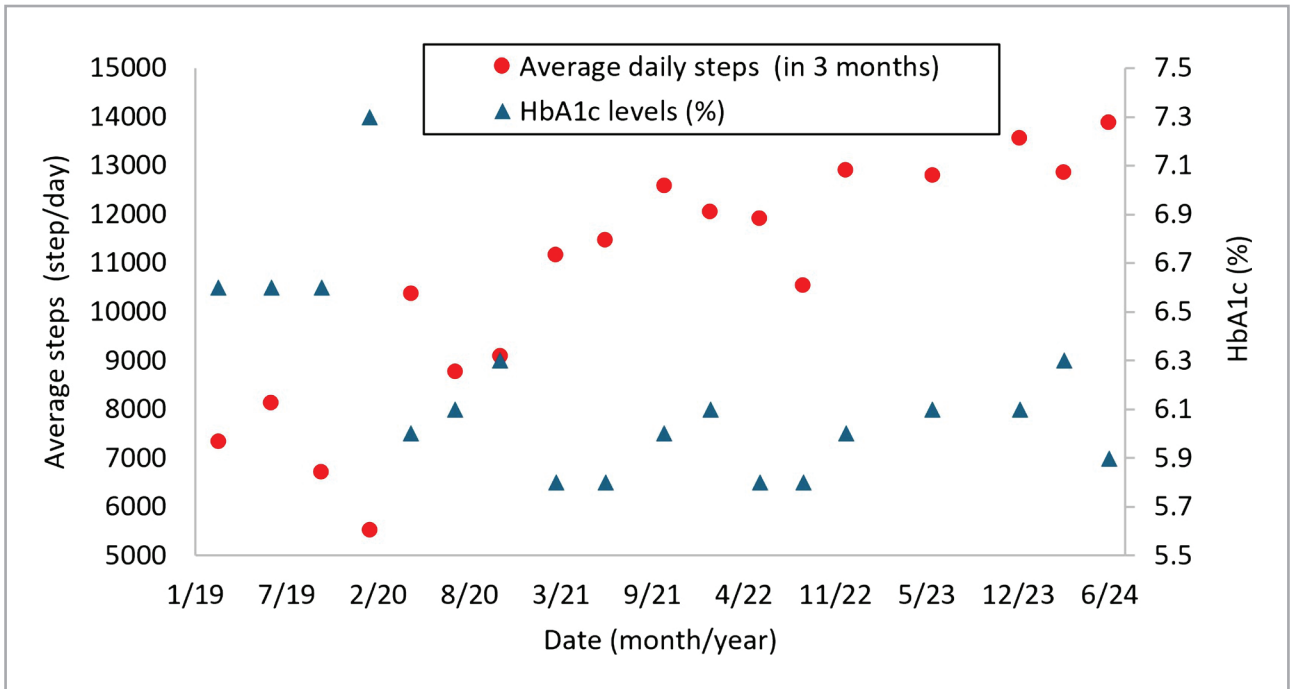


Figure 1: Relationship between HbA1c levels and average daily step counts over time. triangles denote HbA1c levels, while circles represent the average daily step counts recorded during each three-month period spanning February 2019 to June 2024.

physical activity, especially walking, may contribute to enhanced glycemic control and lower HbA1c levels. However, it's crucial to consider that factors such as diet, medication adherence, and individual metabolic variations also play significant roles in determining HbA1c outcomes.

Examining changes in average body weight alongside HbA1c levels over the study period revealed a robust correlation and agreement, as depicted in Figure 3. The data illustrate a clear pattern where fluctuations in mean body weight correspond closely with shifts in HbA1c readings. Specifically, periods of increased

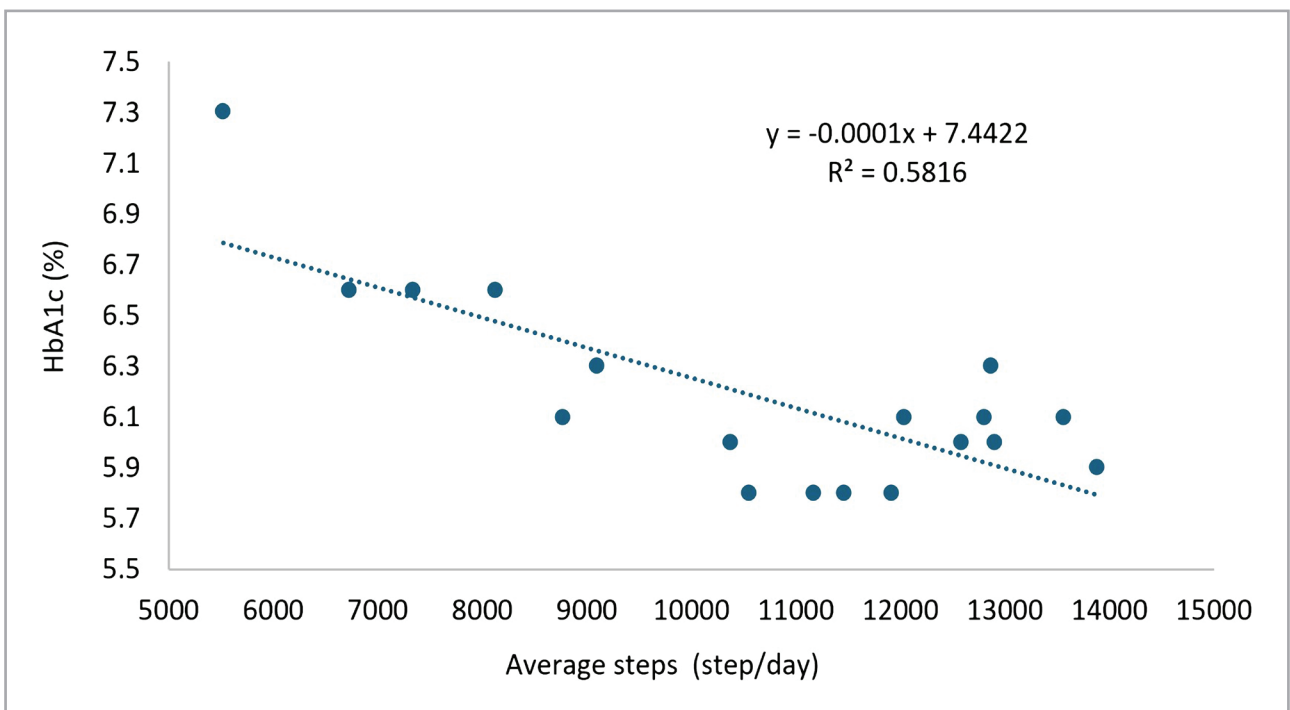


Figure 2: Scatter plot of HbA1c levels (%) vs. average daily step counts over a 3-month period.

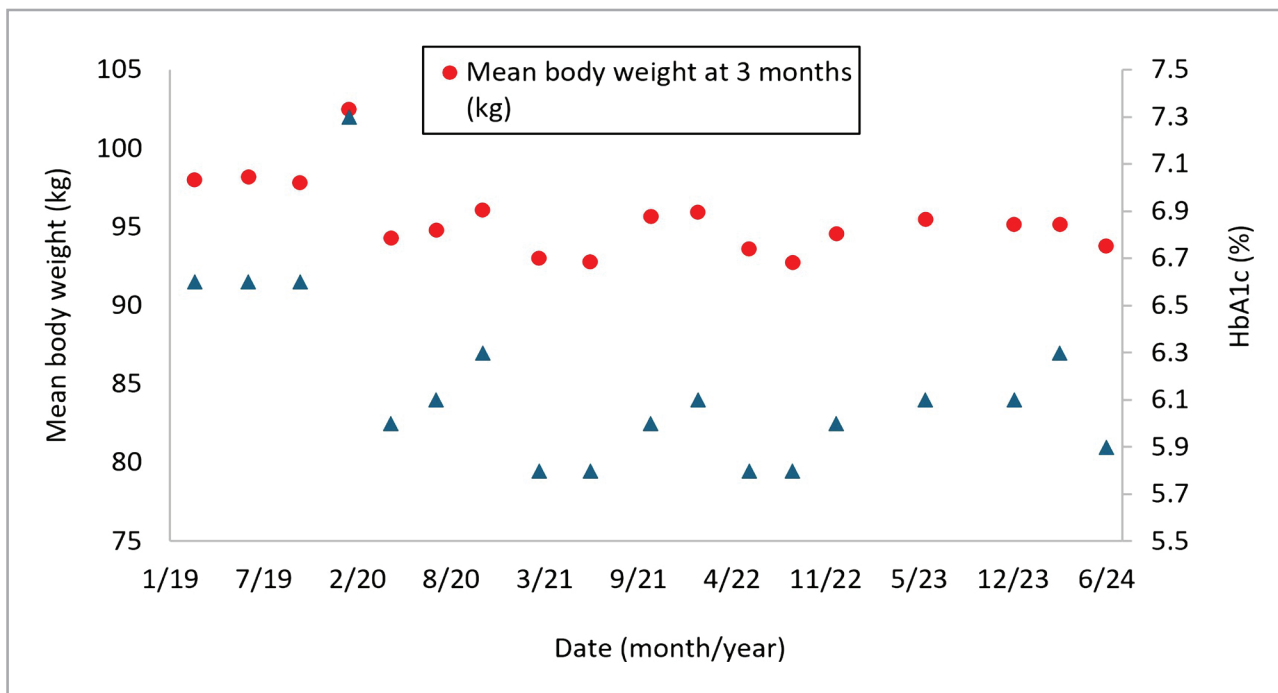


Figure 3: Relationship between HbA1c levels and mean body weight over time. Triangles denote HbA1c levels, while circles represent the mean body weight recorded for each three-month period spanning February 2019 to June 2024.

mean body weight correlated with higher HbA1c levels, while decreases in weight aligned with lower HbA1c levels. This synchronization underscores the significant impact of weight management on glycemic control among individuals with type 2 diabetes.

Furthermore, the analysis of the relationship between mean body weight and HbA1c levels demonstrated a strong linear correlation, visually represented in Figure 4. The regression analysis yielded an equation of  $HbA1c (\%) = 0.1578 \times \text{Mean Weight (kg)} - 8.8977$ , with a

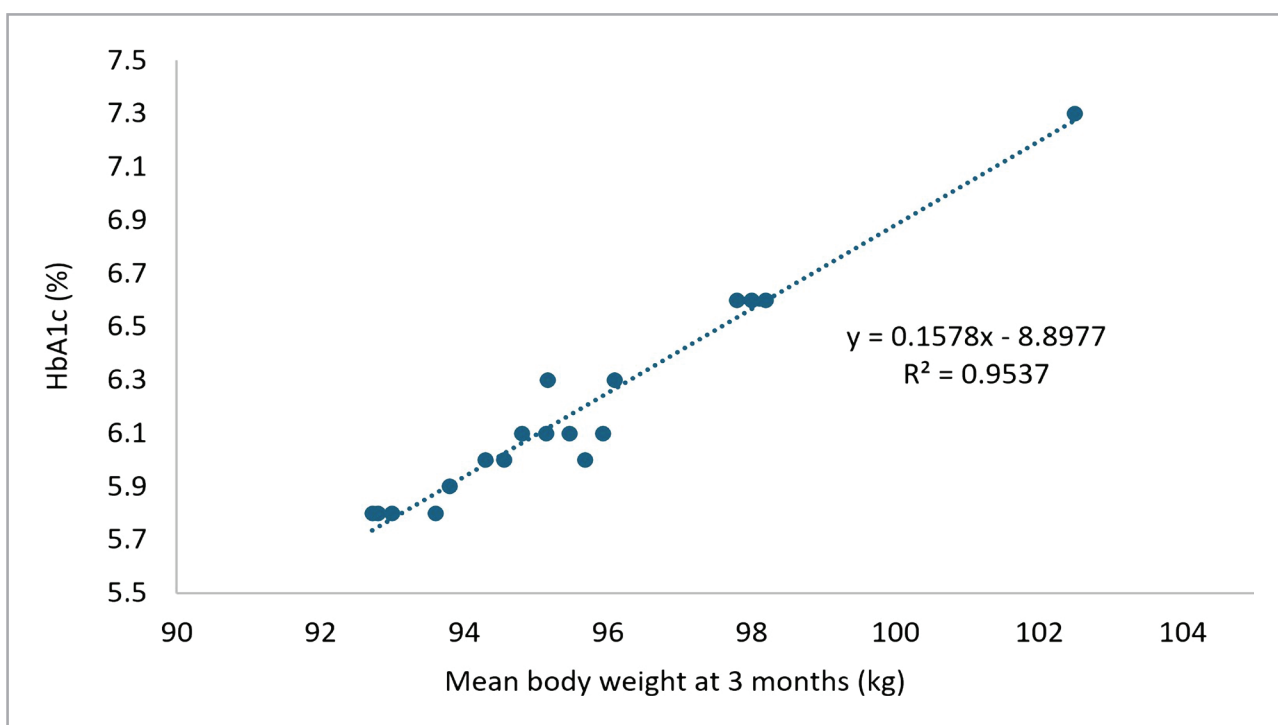


Figure 4: Scatter plot illustrating the relationship between mean body weight (kg) over three months and HbA1c levels (%).

coefficient of determination ( $R^2$ ) of 0.954. This high  $R^2$  value indicates that approximately 95% of the variability in HbA1c levels can be explained by changes in mean body weight.

This linear model suggests that as mean body weight increases, HbA1c levels also tend to increase. Small changes in body weight are associated with notable changes in HbA1c levels; for example, an increase in mean body weight by 1 kg could raise HbA1c by approximately 0.16%. This underscores the significant impact of weight management on glycemic control and emphasizes the importance of integrating weight monitoring into diabetes care routines.

Additionally, the calculated BMI values ranging from 28.94 to 31.99 underscored a direct correlation with HbA1c levels, highlighting the importance of weight management strategies in diabetes care. This linear relationship suggests a consistent increase in weight above the patient's ideal limit over the study period.

## Discussion and perspective

Findings demonstrate a significant correlation between mean body weight and HbA1c levels, proposing a promising method for monitoring and managing glycemic control in type 2 diabetes. The regression model with an  $R^2$  of 0.96 indicates that mean body weight substantially predicts HbA1c levels, underscoring the pivotal role of weight management in diabetes care. The robust relationship between weight and HbA1c aligns with literature emphasizing weight management's impact on glycemic control [11], improving insulin sensitivity and reducing hepatic glucose production [13]. Results are consistent with prior research showing significant weight loss reduces blood sugar levels [8]. Unique to this study is the immediate estimation of HbA1c levels based on real-time weight data, offering a practical tool.

Additionally, the analysis of daily step counts suggests that physical activity, particularly walking, positively contributes to glycemic control. Although the correlation between step counts and HbA1c levels was moderate ( $R^2=0.6$ ), it indicates that physical activity is an essential component of diabetes management. This is consistent with existing research such as that highlights the benefits of regular exercise, particularly walking, in improving insulin sensitivity and lowering blood glucose levels [14].

Furthermore, developing a small mobile phone application through which patients can easily obtain an

extrapolation of their HbA1c levels based on their average weight. This innovation would enable patients to monitor their health status more proactively and conveniently, providing real-time feedback and supporting proactive adjustments to treatment plans.

Despite the promising results, this study has limitations that warrant further investigation. The focus on a single patient limits the generalizability of the findings. Larger studies involving diverse patient populations are necessary to validate these results and establish broader clinical guidelines. Future research should also explore the impact of additional factors such as diet composition, medication adherence, and genetic predispositions on the relationship between weight and HbA1c.

## Conclusion

This study presents a novel and effective method for predicting HbA1c levels in patients with type 2 diabetes using mean body weight over a three-month period. The results reveal a strong linear correlation between mean body weight and HbA1c levels, supported by a regression model with a high coefficient of determination. This method provides a simple yet powerful tool for healthcare providers to monitor and manage glycemic control, emphasizing the importance of maintaining an appropriate average weight to achieve recommended HbA1c targets.

The study also highlights the beneficial impact of physical activity, particularly walking, on HbA1c levels, supporting the integration of regular exercise into diabetes care routines. Personalized diabetes management strategies, informed by individual weight-HbA1c relationships, can improve patient outcomes by providing tailored interventions and advice.

Furthermore, it is suggested to develop a mobile application that would allow patients to easily obtain an extrapolation of their HbA1c levels based on their average weight. Such an application could facilitate proactive and convenient health monitoring.

Further research is warranted to validate these findings in larger and more diverse populations, as well as to explore the integration of continuous glucose monitoring with weight and physical activity data. By deepening our understanding of the relationship between mean body weight and HbA1c levels, this approach has the potential to enhance health outcomes for individuals managing type 2 diabetes, contributing to more effective and personalized diabetes care.

Because this study is based on a single patient, the findings cannot be generalized. The results should be considered hypothesis-generating and require validation in larger populations.

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## Conflict of interest

The author declares no conflict of interest.

## Consent to participate

Written informed consent was obtained from the patient for publication of this case report and accompanying data. The patient is the author of the manuscript.

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