PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (E): 2790-9352, (P): 2790-9344
Volume 6, Issue 07 (July 2025)

Original Article

OPEN ACCESS

Effects of Home Blood Sugar Monitoring on HbA1c Among Diabetes Mellitus Patients Attending a Tertiary Care Hospital in Peshawar

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ARTICLE INFO

Keywords:
HbA1c Level, Monitoring, Blood Glucose, Type II Diabetes Mellitus

How to Cite:
Shah, S. A., Ahmad, S., Bilal, M., Khan, Y. N., Ullah, S., & Khan, M. T. H. (2025). Effects of Home Blood Sugar Monitoring on HbA1c Among Diabetes Mellitus Patients Attending a Tertiary Care Hospital in Peshawar: Effects of Home Blood Sugar Monitoring on HbA1c Levels.Pakistan Journal of Health Sciences ,6(7), 186-191. https://doi.org/10.54393/pjhs.v6i7. 3219

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Received Date: 31st May, 2025
Revised Date: 1st July, 2025
Acceptance Date: 24th July, 2025
Published Date: 31st July, 2025

ABSTRACT

Diabetes mellitus (DM), encompassing both type 1 and type 2, has escalated worldwide over the last twenty years, resulting in elevated death and morbidity rates. Prior research indicates that home blood glucose monitoring enhances metabolic control and aids in alleviating the atherosclerotic effects of type 2 diabetes mellitus. **Objectives:** To evaluate the effect of home blood glucose monitoring on HbA1c levels among diabetic patients at Lady Reading Hospital (LRH), Peshawar. **Methods:** This quasi-experimental study was performed over six months in the Department of General Medicine at LRH, Peshawar, including 62 diabetic patients. Participants were directed to assess fasting blood glucose thrice weekly for three months, maintaining their existing medical care. HbA1c was measured before and during the intervention. Means and standard deviations were used to evaluate continuous variables in SPSS version 22.0. A paired t-test was used to compare pre- and post-intervention mean HbA1c levels, with $p < 0.05$ indicating statistical significance. **Results:** The mean age of participants was 45 ± 12.29 years, with 61% male and 39% female. The average diabetes duration was 10 ± 5.8 years. Pre-monitoring HbA1c was 9.62 ± 1.87%, which significantly reduced to 8.02 ± 1.19% after three months (mean difference=1.6%, p=0.0001). Significant reductions were observed across all age groups, genders, weight categories, and diabetes durations (p<0.05). **Conclusions:** Home blood glucose monitoring significantly improves glycemic control in diabetic patients, as evidenced by the reduction in HbA1c levels, consistent across various demographics.

INTRODUCTION

The worldwide prevalence and incidence of diabetes mellitus (DM), encompassing both type 1 and type 2, have markedly escalated over the last twenty years, with forecasts suggesting continued expansion. Diabetes is linked to several chronic consequences that elevate morbidity and death globally [1]. Ensuring adequate blood glucose regulation is essential for reducing these problems, and HbA1c serves as a vital metric for evaluating long-term glycemic control and comprehensive diabetes care. HbA1c testing may yield erroneous results in persons with hemoglobin problems, chronic renal illness, or anemia [2]. Research, including results from the Diabetes Control and Complications Trial (DCCT) and later investigations, has shown substantial data concerning the health advantages of sustaining normal or near-normal blood glucose levels, especially for individuals receiving insulin

DOI: https://doi.org/10.54393/pjhs.v6i7.3219

treatment [3]. Self-monitoring of blood glucose (SMBG) has demonstrated efficacy in evaluating an individual's medication response. Subjects who continued self-monitoring of blood glucose (SMBG) maintained stable HbA1c levels, while those who discontinued SMBG exhibited an increase [4, 5]. Meta-analyses have shown that regular SMBG can reduce HbA1c by 0.25-0.3%. However, while SMBG helps patients monitor their blood glucose levels, it is not enough on its own to reduce blood glucose; it must be integrated into comprehensive diabetes management strategies that include medication, diet, and exercise [6, 7]. The worldwide prevalence of diabetes is significant, with around 463 million individuals aged 20-79 impacted, constituting 9.3% of the global adult demographic [8]. Disturbingly, 232 million individuals remain undiagnosed, with 79% located in middle- and low-income nations. Twenty percent of those aged 65 and older are diagnosed with diabetes. An extra 374 million individuals are at risk of getting type 2 diabetes. In 2019, diabetes led to 4.2 million fatalities worldwide and incurred healthcare expenses of no less than USD 760 billion, or 10% of total adult healthcare spending [8, 9]. Pakistan exhibits the third-highest prevalence of diabetes, with 19.4 million documented cases. By 2030, this figure is anticipated to increase to 26.2 million, and by 2045, to 37.1 million [10]. Research conducted at the Diabetic Clinic in Multan indicated a mean HbA1c of 8.47%, with just 31.2% of individuals attaining improved glycemic control. Variables including education, BMI, hypertension, comorbidities, diabetes knowledge, and self-care practices (e.g., exercise, glucose monitoring, medication adherence, and food management) were substantially correlated with glycemic control ($P<0.05$) [11]. SMBG has been shown to help insulin-dependent diabetics better regulate their blood glucose levels by adjusting insulin dosages based on their readings [12]. The efficacy of self-monitoring of blood glucose (SMBG) in persons with type 2 diabetes who are not undergoing insulin therapy has been variable among research trials. Certain studies indicate enhanced glycemic control when self-monitoring of blood glucose (SMBG) is integrated with dietary modifications, whilst others demonstrate diminished advantages [13, 14]. Previous studies have shown that home-monitoring of blood glucose [15]. Despite the increasing data endorsing the advantages of SMBG, there is a deficiency of localized studies regarding its effects within the setting of Pakistan. This study is to evaluate the effect of home blood glucose monitoring on HbA1c levels in diabetes mellitus patients at Lady Reading Hospital, Peshawar.

The present study aimed to assess HbA1c levels before and following individual blood glucose monitoring. The hypothesis posits that regular home blood glucose monitoring will lead to a decrease in HbA1c levels.

METHODS

This quasi-experimental study was performed in the Department of General Medicine at Lady Reading Hospital (LRH), Peshawar, during a duration of six months, from July 14, 2023, to January 14, 2024. Study approval was taken from the Ethical Review Committee of the hospital (Ref. No. 416/LRH/MTI). The sample size was determined with the WHO sample size calculator program for hypothesis testing of two population means (two-sided) [14]. The principal assumptions were a significance level of 5%, a statistical power of 80%, an expected mean HbA1c level of 8.66 ± 1.76 prior to intervention, and 7.89 ± 1.28 after intervention. The ultimate sample size was established at 62 patients based on these characteristics. A non-probability sequential sampling method was utilized. The inclusion criteria were individuals aged 30 to 60 years, of both genders, diagnosed with type II diabetes mellitus for over one year, and possessing an initial HbA1c level over 6.5%. Patients were excluded if they had a history of hypertension, renal or hepatic illness, or could not afford a glucometer. Patients were recruited from the outpatient department following ethical approval, and all participants provided informed consent. Baseline demographic data, including age, gender, weight (measured using a standardized digital scale), and diabetes duration, were recorded. Participants were instructed to monitor fasting blood glucose three times a week for three months using their own glucometers. The selected frequency of monitoring is informed by previous research, which demonstrates that assessing blood glucose three times weekly yields adequate data to see daily variations while being feasible for patients in practical environments. No modifications were implemented to their prescription antidiabetic medication during the trial duration. HbA1c levels were evaluated at baseline and again at the end of the three-month duration [16]. Data were gathered via a predetermined proforma. All of the data were examined with IBM SPSS Statistics version 22.0. Continuous data, including age, weight, duration of diabetes, and HbA1c values, were presented as means and standard deviations. Categorical characteristics, including gender, were presented as frequencies and percentages. A paired t-test was employed to evaluate the difference in mean HbA1c levels pre- and post-intervention. The threshold for statistical significance was established at a p-value of less than 0.05. Stratified analyses were done to control for potential confounding variables (age, gender, weight, and diabetes duration), and paired t-tests were utilized for each subgroup to evaluate the significance of changes within these groups.

DOI: https://doi.org/10.54393/pjhs.v6i7.3219

RESULTS

The current study examined the age distribution of 62 patients: 23% (n=14) were 30-40 years old, 37% (n=23) were 41-50 years old, and 40% (n=25) were 51-60 years old. The average age was 45 ± 12.29 years. The gender distribution of the 62 patients was 61% male (n=38) and 39% female (n=24). Diabetes duration was also analyzed: 40% (n=25) of patients had diabetes for less than 10 years, whereas 60% (n=37) had diabetes for more than 10 years. The average duration of diabetes was 10 ± 5.88 years. In terms of weight, 42% (n=26) of patients weighed less than 80 kg, while 58% (n=36) weighed more than 80 kg. The average weight was 80 ± 12.09 kg (Table 1).

Table 1: Demographic and Clinical Characteristics of Study Participants

Variables		Frequency
Age Distribution	30-40 years	23% (n=14)
	41-50 years	37% (n=23)
	51-60 years	40% (n=25)
Gender	Male	61% (n=38)
	Female	40% (n=25)
Duration of DM	≤ 10 years	40 (n=25)
	>10 years	60% (n=35)
Weight	≤ 80 Kg	42% (n=62)
	>80 Kg	58% (n=36)

A study of HbA1c readings before and after three months of home-based blood glucose monitoring in 62 individuals with type 2 diabetes mellitus revealed that the mean HbA1c level before to monitoring was 9.62 ± 1.87%. Subsequent to the intervention, it markedly decreased to 8.02 ± 1.19%. The paired t-test revealed a statistically significant mean difference of 1.6 ± 0.68, with a p-value of 0.0001 (Table 2).

Table 2: Comparison of HbA1c Levels before and After Home Monitoring

HBA1c Level	Before Home monitoring	After Home monitoring	Mean Difference	p-Value
Mean ± SD	9.62 ± 1.87	8.02 ± 1.19	1.6 ± 0.68	0.0001

Subsequent to home glucose monitoring, stratified examination of HbA1c levels revealed statistically significant decreases in all groups. The 30–40 years cohort had the most significant decrease in HbA1c, decreasing from 8.93 ± 1.11% to 7.73 ± 1.02% (p=0.006) in age-based stratification. Notable enhancements were also noted in the 41–50 and 51–60 age cohorts (p=0.0106 and p=0.0037, respectively). In gender-based stratification, males exhibited a decline from 9.58 ± 1.80% to 8.13 ± 1.23% (p=0.001), while females demonstrated a fall from 9.65 ± 1.85% to 8.10 ± 1.27% (p=0.001). Concerning the length of diabetes, patients with a duration of ≤10 years exhibited an improvement from 9.56 ± 1.81% to 8.07 ± 1.25% (p=0.001), whereas those with a period of >10 years improved from 9.69 ± 1.93% to 8.23 ± 1.31% (p = 0.001). Weight-based analysis demonstrated significant reductions in HbA1c levels in both the ≤80 kg (from 9.52 ± 1.83% to 8.15 ± 1.30%, p=0.003) and >80 kg cohorts (from 9.59 ± 1.89% to 8.21 ± 1.30%, p=0.001) (Table 3).

Table 3: Stratified Analysis of HbA1c Reduction by Age, Gender, Duration of Diabetes, and Weight

Study variables		Before Home monitoring	After Home monitoring	Mean Difference	p-Value
Age	30-40 years	8.93 ± 1.11	7.73 ± 1.02	1.2 ± 0.09	0.006
	41-50 years	9.23 ± 1.35	8.19 ± 1.29	1.04 ± 0.06	0.011
	51-60 years	9.58 ± 1.62	8.66 ± 1.41	0.92 ± 0.21	0.037
Gender	Male	9.58 ± 1.80	8.13 ± 1.23	1.45 ± 0.57	0.001
	Female	9.65 ± 1.85	8.10 ± 1.27	1.55 ± 0.58	0.001
Duration of DM	≤ 10 years	9.56 ± 1.81	7.73 ± 1.02	1.49 ± 0.56	0.001
	>10 years	9.69 ±1.93	8.23 ± 1.31	1.46 ± 0.62	0.001
Weight	≤ 80 Kg	9.52 ± 1.83	8.15 ± 1.30	1.37 ± 0.53	0.003
	>80 Kg	9.59 ± 1.88	8.21 ± 1.37	1.38 ± 0.51	0.001

DISCUSSION

This quasi-experimental study illustrates the potential advantages of enabling diabetes patients to self-monitor their blood glucose levels, especially in a context of escalating diabetes prevalence. The research had 62 individuals, with a mean age of 45 ± 12.29 years, including 61% men and 39% females. The average duration of diabetes among the subjects was 10 ± 5.88 years. Concerning weight, 42% of patients weighed ≤80 kg, whereas 58% weighed >80 kg, with a mean weight of 80 ± 12.09 kg. The research indicated a substantial reduction in the mean HbA1c level during home monitoring. Before the intervention, the average HbA1c level was 9.62 ± 1.87%, which decreased to 8.02 ± 1.19% after three months of home blood glucose monitoring. This is in close alignment with prior findings. HbA1c levels were consistently lower in the Best_group compared to the other groups at all time points (all P < 0.001). However, the proportion of patients achieving target HbA1c levels of <6.5% or <7.0% declined over time [17]. The mean HbA1c among 1,198 patients with diabetes was 8.01 ± 1.76%, with over 66% exhibiting HbA1c levels above 7%, indicating poor glycemic control. The highest average HbA1c was observed in patients with a diabetes duration of more than 10 years (8.47 ± 1.77%) [18]. The impact of self-monitoring on HbA1c levels was also reported in study 56% of patients had good or fair HbA1c levels compared to controls. A study shows that effective self-management is generally associated with better glycaemic control, with dietary control being the most significant factor linked to HbA1c levels [19]. Another study found that regular blood glucose monitoring and diet adherence enhanced glycemic control and patient empowerment, comparable with worldwide literature. These findings imply that frequent blood glucose

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monitoring and diet adherence might greatly enhance diabetes treatment. Our research highlights the importance of lifestyle factors, such as smoking, in diabetes control. Smokers had diminished Diabetes Empowerment Scores (DES), perhaps due to the development of peripheral neuropathy, a common symptom among diabetics. This finding supports previous research linking smoking and poor foot care to diabetic neuropathy [20, 21]. Similar study, adhering to a specific diet for the past seven days significantly enhanced the empowerment of a type II diabetes patient. Our findings, along with those of Hernandez-Tejada [22], indicate that adhering to a proper specialized diet over the past seven days fosters empowerment among [23]. The mean estimated overall Diabetes Empowerment scores of smokers are 0.088 times higher than those of non-smokers when foot care days increase by one. Smokers may develop peripheral diabetes neuropathy, lowering empowerment scores. Our study supports other findings that smoking and poor foot care can cause peripheral diabetes neuropathy [24]. The provision of home monitoring kits, such as HbA1c residential kits, can improve routine glucose monitoring, enabling patients to assume responsibility of their diabetes care. [7, 25]. The use of advanced technology, such as the FreeStyle Libre system, has demonstrated a reduction in hypoglycemic episodes and an enhancement in overall glucose variability in persons with Type 1 and Type 2 diabetes [26]. The enhancement in HbA1c levels associated with home blood glucose monitoring corroborates the findings of FreeStyle Libre technology, indicating that consistent self-monitoring is essential for managing glucose fluctuation [14, 27]. Drawn from a single tertiary care hospital, the sample size was rather small (n=62), so restricting the generalizability of the results to the larger diabetic population. Adherence to home glucose monitoring was self-reported, which would introduce reporting bias. The lifestyle elements including diet and physical activity which can also affect glycemic control were not under control or documented during the course of the study.

CONCLUSIONS

This study shows, via a notable decrease in HbA1c levels, regular personal tracking of blood glucose levels considerably improves glycemic management in individuals with type II DM. The impact was constant across several weight ranges, genders, diabetes durations, and age groups. Highlighted during patient counselling, home glucose monitoring should be included into regular diabetes control strategies. To get better metabolic results, healthcare professionals have to make sure patients are informed, equipped, and driven to regularly undertake self-monitoring.

Acknowledgments

The researcher expresses gratitude to Department of General Medicine at Lady Reading Hospital (LRH), Peshawar and the supervisor for their assistance during the study project, as well as for providing insightful ideas that contributed to the successful execution of the complete procedure.

Authors Contribution

Conceptualization: SAS, MTHK
Methodology: SAS, SA, SU, MTHK
Formal analysis: SAS, SA, MB, YNK, SU
Writing review and editing: SAS, SA, MB, YNK, SU, MTHK

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

Source of Funding

The author received no financial support for the research, authorship and/or publication of this article.

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