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# Prevalence of Diabetes Mellitus II and Usefulness of HbA1c as a Diagnostic Criterion

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**Disclaimers**

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## ABSTRACT

**Background**: Background: Type 2 Diabetes Mellitus (T2DM) is a significant global health challenge, with rising prevalence and associated complications. Hemoglobin A1c (HbA1c) is increasingly used as a diagnostic tool for long-term glycemic control.

**Objective**: To assess the prevalence of T2DM and evaluate the efficacy of HbA1c as a diagnostic criterion, while exploring its correlation with lipid profiles.

**Methods**: This cross-sectional study included 1,054 participants aged 25 years and above at Gambat Institute of Medical Sciences. Data collection involved demographic information, BMI calculation, random blood glucose (RBS) testing, and HbA1c measurement using the Advia 1800 Siemens analyzer. Lipid profiles were assessed, and the correlation between HbA1c levels and lipid abnormalities was analyzed using Pearson's correlation coefficient. Data analysis was conducted using SPSS version 25.

**Results**: T2DM prevalence was 9.1% using HbA1c, with higher prevalence in males (4.7%) than females (4.4%). Significant correlations were observed between HbA1c levels and total cholesterol (p=0.0001), triglycerides (p=0.0057), and LDL (p=0.0012).

**Conclusion**: HbA1c is an effective diagnostic tool for T2DM and correlates significantly with lipid abnormalities, emphasizing its role in comprehensive diabetes management.

## INTRODUCTION

Diabetes Mellitus (DM) is a complex metabolic disorder marked by chronic hyperglycemia, resulting from either impaired insulin secretion, insulin action, or a combination of both. The disorder is primarily categorized into two major types: Type 1 Diabetes Mellitus (T1DM), which is characterized by the autoimmune destruction of pancreatic β-cells, leading to absolute insulin deficiency, and Type 2 Diabetes Mellitus (T2DM), which is predominantly associated with insulin resistance and a relative insulin deficiency (1). T2DM, the most prevalent form of diabetes, represents a significant public health challenge globally due to its rising incidence and the substantial burden it places on healthcare systems. The global prevalence of T2DM has escalated to alarming levels, driven by factors such as aging populations, urbanization, dietary transitions, and increasingly sedentary lifestyles (2). This condition is associated with a spectrum of metabolic disturbances, including dyslipidemia, hypertension, and obesity, all of which contribute to the high risk of cardiovascular diseases among affected individuals (3).

In recent years, the Hemoglobin A1c (HbA1c) test has gained prominence as a diagnostic tool for diabetes, particularly T2DM, due to its ability to reflect average blood glucose levels over the preceding two to three months. This long-term marker of glycemic control offers several advantages over traditional fasting blood glucose measurements, including convenience, as it does not require fasting, and its ability to minimize day-to-day variations in blood glucose levels (4). The adoption of HbA1c as a diagnostic criterion by major health organizations, such as the American Diabetes Association and the World Health Organization, underscores its utility in not only diagnosing diabetes but also in monitoring the effectiveness of therapeutic interventions aimed at maintaining glycemic control (5). However, despite its widespread use, the HbA1c test has limitations, particularly in individuals with conditions that affect hemoglobin turnover, such as anemia or hemoglobinopathies, where it may not accurately reflect glycemic status (6).

The prevalence of T2DM in Pakistan has been reported to be on the rise, with recent studies indicating a significant increase in the number of cases. Pakistan ranks among the top 10 countries with the highest burden of diabetes, with an estimated 7.5 million adults affected (7). This situation is exacerbated by the lack of national diabetes guidelines and a comprehensive diabetes registry, which hinders the effective management and control of the disease at the population level (8). Moreover, the high prevalence of risk factors such as obesity, hypertension, and a sedentary lifestyle in the Pakistani population further compounds the challenge of managing T2DM (9). These factors highlight the urgent need for effective screening, prevention, and management strategies tailored to the specific needs of the population.

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Given the rising prevalence of T2DM and the associated risk of complications, it is imperative to explore the relationship between glycemic control, as measured by HbA1c, and other metabolic parameters such as lipid profiles. The correlation between HbA1c levels and lipid abnormalities has been a subject of considerable research, with mixed results. While some studies have reported significant associations between poor glycemic control and adverse lipid profiles, others have found no such correlation, thereby warranting further investigation (10). This study aims to contribute to this body of knowledge by examining the prevalence of T2DM and evaluating the efficacy of HbA1c as a diagnostic criterion in a cohort of patients at PAQSJIMS Gambat. The study will also explore the association between HbA1c levels, glucose levels, and lipid profiles, thereby providing insights that could inform more effective management strategies for T2DM in the local context.

## MATERIAL AND METHODS

The study was conducted as a cross-sectional analysis aimed at assessing the prevalence of Type 2 Diabetes Mellitus (T2DM) and evaluating the efficacy of Hemoglobin A1c (HbA1c) as a diagnostic criterion in a cohort of patients aged 25 years and older at the Gambat Institute of Medical Sciences (PAQSJIMS). The study population comprised 1,054 patients who attended the outpatient department for various health concerns. Participants were included if they were aged 25 years or older, and those with a prior diagnosis of diabetes or currently undergoing treatment with glucocorticoids or steroids were excluded. All participants provided informed consent before being included in the study, and ethical approval was obtained from the institutional review board, ensuring that the study adhered to the principles outlined in the Declaration of Helsinki (1).

Data collection involved the systematic recording of demographic information, including age, gender, and medical history, alongside anthropometric measurements such as height and weight, which were used to calculate Body Mass Index (BMI) according to the formula BMI = $kg/m^2$ (2). Blood samples were collected using capillary blood for random blood glucose (RBS) estimation with a portable glucometer to assess the glycemic status of participants. Individuals with blood glucose levels exceeding 180 mg/dL were further tested for HbA1c to confirm and diagnose T2DM. HbA1c levels were measured using the Advia 1800 Siemens analyzer, a reliable and widely accepted method for this purpose (3).

The lipid profile of participants, including total cholesterol (TC), triglycerides (TG), high-density lipoprotein (HDL), low-density lipoprotein (LDL), and very low-density lipoprotein (VLDL), was also assessed. These biochemical parameters were analyzed to explore the correlation between glycemic control, as indicated by HbA1c levels, and lipid abnormalities commonly associated with T2DM (4). Data on possible risk factors, including obesity, hypertension, and lifestyle habits, were collected through a structured questionnaire administered to all participants. The questionnaire was designed to capture detailed information on participants' medical history, dietary habits, physical activity levels, and family history of diabetes, thereby allowing for a comprehensive assessment of risk factors associated with T2DM.

Data analysis was performed using SPSS software, version 25. Descriptive statistics were used to summarize demographic data and the prevalence of diabetes and prediabetes among the study population. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. The association between HbA1c levels and lipid profile parameters was analyzed using Pearson's correlation coefficient, and the significance of differences between groups with adequate and inadequate glycemic control was determined using independent sample t-tests (5). A p-value of less than 0.05 was considered statistically significant.

The study was designed to ensure the confidentiality and privacy of participants, with all personal data being anonymized and stored securely. Participants were informed about the purpose of the study and the potential implications of the findings, and they were assured that their participation was voluntary and that they could withdraw at any time without any consequences. The results of the study were intended to contribute to the understanding of the relationship between glycemic control, lipid profiles, and the prevalence of T2DM, thereby informing future public health strategies and clinical practices aimed at better managing this chronic condition in the local population.

## RESULTS

The study included a total of 1,054 participants, comprising 746 males and 308 females, all aged 25 years and above. The demographic and clinical characteristics of the study population are presented in Table 1..

**Table 1: Demographic and Clinical Characteristics of Study Population**

| Characteristic | Male (n=746) | Female (n=308) | Total (n=1054) |
|---|---|---|---|
| Mean Age (years) | 47.5 ± 11.8 | 48.2 ± 12.9 | 47.8 ± 12.3 |
| Mean BMI ($kg/m^2$) | 26.6 ± 4.1 | 26.0 ± 4.5 | 26.4 ± 4.2 |

The mean age of the participants was 47.8 ± 12.3 years, and the mean BMI was 26.4 ± 4.2 $kg/m^2$. A significant portion of the study population, 61.85%, had a healthy weight, while 17.83% were classified as obese, which poses a significant concern given the association between obesity and the risk of developing T2DM. The detailed distribution of BMI categories among the participants is provided in Table 2

**Table 2: Distribution of Participants by Body Mass Index (BMI)**

| Weight Status | Male (n=746) | Female (n=308) | Total (n=1054) | Percentage (%) |
|---|---|---|---|---|
| Underweight | 52 | 42 | 92 | 8.72% |
| Healthy weight | 436 | 216 | 652 | 61.85% |
| Overweight | 98 | 22 | 120 | 11.38% |
| Obese | 160 | 28 | 188 | 17.83% |

The glycemic control of the study population, as indicated by HbA1c levels, is summarized in Table 3. Adequate glycemic control (HbA1c < 7%) was observed in 64% of the participants, whereas 36% exhibited inadequate glycemic control (HbA1c > 7%).

The study also explored the correlation between HbA1c levels and lipid profile parameters, revealing significant differences between participants with adequate and inadequate glycemic control. Notably, participants with inadequate glycemic control had higher mean levels of total cholesterol, triglycerides, LDL, and VLDL, as well as higher fasting blood glucose levels compared to those with adequate glycemic control.

**Table 3: Relationship Between Lipid Profile and Glycated Hemoglobin (HbA1c) in Study Participants**

| Parameter | Adequate Glycemic Control (HbA1c < 7%) | Inadequate Glycemic Control (HbA1c > 7%) | p-value |
|---|---|---|---|
| Total Cholesterol (mg/dL) | 140.81 ± 25.01 | 159.33 ± 31.45 | 0.0001 |
| Triglycerides (mg/dL) | 137.22 ± 58.43 | 166.39 ± 68.39 | 0.0057 |
| HDL (mg/dL) | 51.98 ± 6.69 | 51.65 ± 7.4 | 0.0321 |
| LDL (mg/dL) | 64.67 ± 20.87 | 72.78 ± 21.56 | 0.0012 |
| VLDL (mg/dL) | 28.81 ± 9.84 | 32.9 ± 14.39 | 0.0216 |
| HbA1c (%) | 6.29 ± 0.55 | 8.45 ± 1.16 | 0.0001 |
| Fasting Blood Glucose (mg/dL) | 110.19 ± 21.32 | 144.55 ± 37.87 | 0.0057 |

In terms of diabetes diagnosis, glucose levels identified 62 participants (11.5%) as diabetic, with a slightly higher prevalence among males (6%) compared to females (5.5%). However, when using HbA1c as the diagnostic criterion, 59 participants (9.1%) were identified as diabetic, again with a higher prevalence in males (4.7%) compared to females (4.4%). The comparative assessment of glucose levels and HbA1c is presented in Table 4.

**Table 4: Comparative Assessment of Glucose Levels and HbA1c in Diagnosing Diabetes**

| Diagnostic Criterion | Males (n=746) | Females (n=308) | Total Positive (%) |
|---|---|---|---|
| Glucose | 41 (6%) | 21 (5.5%) | 62 (11.5%) |
| HbA1c | 32 (4.7%) | 17 (4.4%) | 59 (9.1%) |

The findings underscore the importance of using HbA1c as a reliable diagnostic tool, particularly in its ability to reflect long-term glycemic control. Additionally, the study highlights the significant correlation between poor glycemic control and adverse lipid profiles, which are known risk factors for cardiovascular complications in individuals with T2DM. Figure 1 Description: This figure illustrates the distribution of the study population based on their responses to four questions regarding current illness, knowledge about diabetes, blood sugar testing, and diabetes diagnosis, separated by gender. Notably, a higher number of males reported having knowledge about diabetes and being tested for blood sugar levels, while a larger

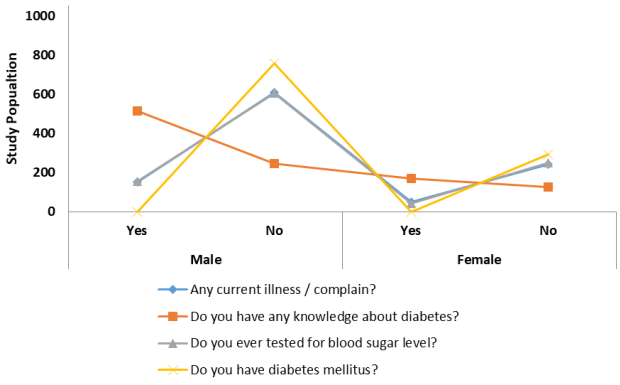


**Figure 1 Distribution of Study Population**

proportion of females reported having diabetes mellitus.

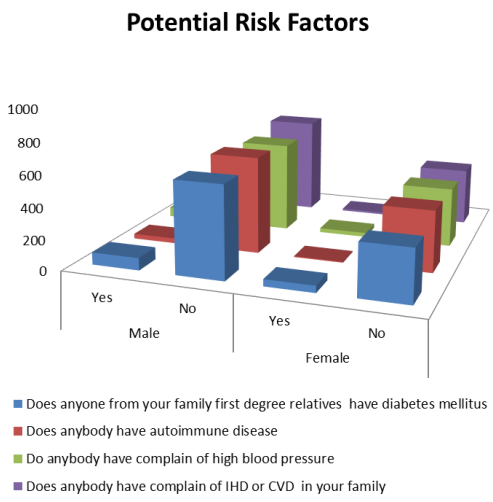


**Figure 2 Potential Risk Factors**

Figure 2 Description: This figure presents potential risk factors for diabetes mellitus among the study population, categorized by gender. It highlights the presence of first-degree relatives with diabetes, autoimmune diseases, high blood pressure, and ischemic heart disease (IHD) or cardiovascular disease (CVD) complaints within families. The figure shows that a significant number of participants, particularly females, reported family history of diabetes and high blood pressure as common risk factors.

These results emphasize the need for comprehensive management strategies that focus on both glycemic control and lipid profile optimization to reduce the risk of complications associated with T2DM.

## DISCUSSION

The findings of this study highlighted several important aspects of Type 2 Diabetes Mellitus (T2DM) prevalence and the utility of HbA1c as a diagnostic criterion, with implications for both clinical practice and public health strategies. The prevalence of T2DM observed in this study, at 9.1% when using HbA1c as the diagnostic tool, aligns with previous reports indicating a rising burden of diabetes in Pakistan. This prevalence, although consistent with some national estimates, underscores the growing challenge of T2DM in the region, particularly when considering the rapid urbanization and lifestyle changes contributing to increased risk factors such as obesity and hypertension (7). The higher prevalence observed in males compared to females also mirrors findings from other studies, suggesting potential gender differences in risk exposure and the need for tailored intervention strategies (11).

The study's results also reaffirmed the importance of HbA1c as a reliable marker for long-term glycemic control, which is crucial in the management of T2DM. The significant correlations found between HbA1c levels and lipid profile parameters, particularly with total cholesterol, triglycerides, and LDL, support the growing body of evidence linking poor glycemic control with dyslipidemia. This relationship is well-documented in the literature, where elevated HbA1c levels have been associated with an increased risk of cardiovascular diseases, a leading cause of morbidity and mortality in diabetic patients (13). The findings further underscore the utility of HbA1c not only as a diagnostic tool but also as a predictor of cardiovascular risk, reinforcing the need for its routine use in clinical settings to guide treatment decisions and monitor disease progression.

However, the study also highlighted certain limitations that should be considered when interpreting the results. The cross-sectional design, while useful for assessing prevalence, limited the ability to establish causal relationships between glycemic control and lipid abnormalities. Longitudinal studies would be required to better understand the temporal relationship and the impact of glycemic control on lipid profiles over time (9). Additionally, the exclusion of patients with known diabetes or those on glucocorticoid treatment may have resulted in an underestimation of the true prevalence of T2DM, as these individuals represent a significant portion of the diabetic population. Furthermore, the reliance on a single HbA1c measurement, without considering potential confounding factors such as hemoglobinopathies or anemia, may have introduced some degree of misclassification, although the use of a standardized analyzer (Advia 1800 Siemens) helped mitigate this risk (3).

The strengths of the study include its relatively large sample size and the comprehensive assessment of both glycemic control and lipid profiles, which allowed for a robust analysis of their interrelationship. The use of HbA1c as a diagnostic criterion, in conjunction with glucose levels, provided a more nuanced understanding of T2DM prevalence and highlighted the potential for HbA1c to serve as a superior marker in certain populations. These findings are consistent with recommendations from major health organizations advocating for the inclusion of HbA1c in diagnostic algorithms, particularly in resource-limited settings where fasting glucose testing may not always be feasible (5).

Given the study's findings, several recommendations can be made for future research and clinical practice. First, there is a need for larger, longitudinal studies that can explore the causal pathways linking poor glycemic control to dyslipidemia and cardiovascular outcomes. Such studies should also consider the role of other potential confounders, including genetic factors and lifestyle interventions, in modulating these relationships. Clinically, the routine use of HbA1c in conjunction with lipid profile assessments should be encouraged, particularly in patients with known risk factors for cardiovascular disease. This approach would facilitate early identification of individuals at high risk and enable timely interventions aimed at reducing the burden of complications associated with T2DM (14).

## CONCLUSION

In conclusion, this study provided valuable insights into the prevalence of T2DM and the efficacy of HbA1c as a

diagnostic tool in a Pakistani population. The findings underscored the significant correlation between glycemic control and lipid abnormalities, highlighting the need for comprehensive management strategies that address both aspects of the disease. Despite its limitations, the study contributes to the growing body of evidence supporting the use of HbA1c in clinical practice and offers a foundation for future research aimed at improving outcomes for patients with T2DM.

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