THE PLANET

Original Article

Prevalence and Risk Stratification of Undiagnosed Diabetes and Pre-Diabetes among Blood Donors

Rifat Hasan[1*], Anamul Haque[2], Umma Asma Saki[3], Jannatul Ferdause[4], Farhana Munmun[5], Sourav Das[6], Trishna Saha[7], Mohammad Abdul Kadir[8]

ARTICLE INFO

Received: 9 Mar 2026
Accepted: 12 Mar 2026
Published Online: 18 Mar 2026

DOI: 10.5281/zenodo.19497764

Volume: 9, Number: 2, Page: 57-61

e-ISSN: 2789-5912
ISSN: 2617-0817

*Corresponding author

ABSTRACT

Background: Diabetes and prediabetes are rapidly increasing globally and in Bangladesh, imposing a major public health burden. As many individuals remain undiagnosed during the prolonged asymptomatic phase, screening—particularly among apparently healthy groups such as blood donors—is essential for early detection and prevention. **Objective:** The aim of the study was to determine the prevalence of undiagnosed diabetes and pre-diabetes and assess associated risk factors among blood donors. **Methods & Materials:** This cross-sectional study at the Department of Transfusion Medicine, Bangladesh Medical University (BMU), Dhaka, included 135 healthy blood donors aged 18–60 years. Demographic, clinical, lifestyle, and family history data were collected, diabetes risk assessed using FINDRISC, and HbA1c measured from EDTA blood samples. Data were analyzed with SPSS v24.0 using Chi-square tests ($p < 0.05$). **Results:** Among 135 blood donors (mean age 36.2 ± 6.4 years; 91.1% male), 51.8% were overweight and 17.8% obese, with 7.4% reporting regular physical exercise and 11.9% having hypertension. A majority had a family history of diabetes (60%). FINDRISC scores indicated moderate risk in 52.6% (7–11) and 25.9% (12–14). HbA1c assessment showed 49.6% were normoglycemic, 41.5% prediabetic, and 8.9% diabetic. Higher BMI and elevated FINDRISC scores were significantly associated with increased prevalence of prediabetes and diabetes ($p = 0.030$ and <0.001). **Conclusion:** Blood donors, though seemingly healthy, may have significant undiagnosed dysglycemia, strongly influenced by BMI, family history, and risk score.

Keywords: *Undiagnosed Diabetes, Pre-Diabetes, Blood Donors.*

1. *Assistant Professor, Department of Transfusion Medicine, National Institute of Burn & Plastic Surgery, Dhaka, Bangladesh (ORCID: 0009-0003-8630-7862)*
2. *Senior Consultant, Department of Medicine, Mugda Medical College Hospital, Dhaka, Bangladesh (ORCID: 0009-0000-8256-507X)*
3. *Specialist, Department of Transfusion Medicine, KPJ Specialized Hospital, Dhaka, Bangladesh (ORCID: 0009-0006-6292-3240)*
4. *Junior Consultant, Department of Ophthalmology, Mugda Medical College Hospital, Dhaka, Bangladesh (ORCID: 0009-0009-4635-510X)*
5. *Consultant, Department of Transfusion Medicine, Green Life Hospital, Dhaka, Bangladesh (ORCID: 0009-0000-8485-0720)*
6. *Assistant Professor (In situ), Department of Transfusion Medicine, National Centre for Control of Rheumatic Fever and Heart Diseases, Dhaka, Bangladesh (ORCID: 0009-0000-6409-9394)*
7. *Medical officer, Department of Transfusion Medicine, National Institute of Kidney Diseases and Urology, Sher-E-Bangla Nagar, Dhaka, Bangladesh (ORCID: 0009-0008-0028-8530)*
8. *Senior Consultant, Department of Medicine, Mugda Medical College Hospital, Dhaka, Bangladesh (ORCID: 0009-0001-6835-0010)*

INTRODUCTION

The prevalence of diabetes has been increasing at an alarming rate across the globe [1]. Current global estimates indicate that at least 150 million individuals are living with diabetes, with nearly two-thirds residing in developing countries [2]. The growing epidemic of diabetes is a serious public health concern, affecting approximately 537 million people worldwide, including 90 million in Southeast Asia. Projections suggest that by 2045, the number of affected individuals will rise dramatically to 783 million globally and 151.5 million in Southeast Asia [3]. Prediabetes, which represents an intermediate, high-risk state in the progression toward T2DM, is associated with both microvascular and macrovascular complications [4-7]. In Bangladesh specifically, 8.4 million adults were living with diabetes in 2019, and this number is projected to nearly double to 15.0 million by 2045. Additionally, an estimated 3.8 million individuals in Bangladesh had prediabetes in 2019, posing an additional burden on the national health system alongside existing diabetes cases [8].

A substantial proportion of individuals with T2DM remain undiagnosed for several years, during which time complications may silently develop. Globally, it is estimated that approximately 50% (range: 24.1% to 75.1%) of individuals living with diabetes are unaware of their condition [9,10]. Screening plays a central role in the preventive strategy for T2DM, as it focuses on identifying undiagnosed T2DM, PDM, and individuals who are at increased risk among asymptomatic and apparently healthy populations. Early identification allows the initiation of appropriate non-pharmaceutical and/or pharmaceutical interventions aimed at delaying or preventing disease progression [11]. Individuals in the prediabetic stage are particularly vulnerable to developing T2DM, and the typically prolonged asymptomatic phase of the disease provides an opportunity for detection through structured screening programs before clinical manifestations appear [12-14].

Screening remains a fundamental component of preventive approaches for T2DM, particularly for detecting dysglycemia among asymptomatic individuals. Over time, various non-invasive risk score questionnaires have been developed and validated as practical, time-efficient, and cost-effective alternatives to conventional screening methods [15,16]. These tools offer advantages over traditional strategies that depend heavily on invasive, inconvenient, and often costly laboratory-based blood tests.

Initially, screening for DM was conducted using a single-step approach that relied directly on laboratory investigations such as the 2-hour oral glucose tolerance test (OGTT), fasting plasma glucose (FPG), or glycated hemoglobin (HbA1c), which are invasive and relatively expensive procedures. More recently, a two-step screening approach has gained worldwide acceptance. In this model, individuals are first assessed using risk scoring questionnaires to identify those at higher risk, who are then subjected to confirmatory

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laboratory testing. The Finnish Diabetes Risk Score (FINDRISC) has been extensively utilized in several European countries and has demonstrated validity as an inexpensive and practical risk assessment tool for T2DM. Glycosylated hemoglobin (HbA1c) serves as a blood biomarker reflecting persistently elevated glucose levels and is widely used to evaluate glycemic status [11]. An HbA1c value greater than 6.5% is used to diagnose diabetes, while levels between 5.7% and 6.4% indicate prediabetes.

Despite the growing burden of diabetes and prediabetes globally and in Bangladesh, evidence regarding the prevalence of undiagnosed dysglycemia among apparently healthy populations remains limited. Blood donors are generally considered healthy individuals, as they undergo routine eligibility screening prior to donation; however, metabolic disorders such as prediabetes and undiagnosed diabetes may remain unrecognized in this group due to the asymptomatic nature of early T2DM. Data on risk stratification and glycemic status among blood donors in Bangladesh are scarce, and opportunities for early detection through structured screening in this accessible population are often underutilized. Identifying undiagnosed diabetes and prediabetes among blood donors may not only enhance donor safety but also contribute to broader public health efforts aimed at early intervention and prevention. The purpose of the study is to determine the prevalence of undiagnosed diabetes and pre-diabetes and assess associated risk factors among blood donors.

OBJECTIVE

To determine the prevalence of undiagnosed diabetes and pre-diabetes and assess associated risk factors among blood donors.

METHODS & MATERIALS

This cross-sectional observational study was conducted in the Department of Transfusion Medicine, Bangladesh Medical University (BMU), Dhaka, Bangladesh over a 12-month period following protocol approval. A total of 135 healthy, non-remunerated blood donors were included in the study, who were selected based on specific inclusion and exclusion criteria for the assessment of the prevalence of undiagnosed diabetes and pre-diabetes and associated risk factors among blood donors.

Inclusion Criteria:

- Age 18–60 years, weight ≥45 kg
- Normal vital signs: temperature <99.5°F, pulse 60–100/min, BP 100–140/60–90 mmHg
- Adequate hemoglobin: ≥12.5 g/dL (male), ≥11.5 g/dL (female)
- Free from acute illness, skin infection, transfusion-transmissible diseases, or IV drug marks
- Female donors during menstruation (if healthy)
- Stable, controlled hypertension

Exclusion Criteria:

- Known diabetes mellitus
- Temporary deferral: recent surgery, infection, vaccination, childbirth/abortion, tooth extraction, tattoo, certain medications
- Permanent deferral: cancer, cardiac/liver/kidney disease, HIV/AIDS, hepatitis B/C, endocrine disorders, epilepsy, asthma, leprosy, schizophrenia, abnormal bleeding, or unexpected weight loss

Data Collection and Study Variables:

Demographic data (age, sex), clinical parameters (BMI, history of hypertension), lifestyle factors (physical activity), and family history of diabetes were recorded. The Finnish Diabetes Risk Score (FINDRISC) questionnaire was used to assess risk for type 2 diabetes. Approximately 5 mL of blood was collected in EDTA tubes during donation, and HbA1c levels were measured using an automated analyzer (Capillary 3 Octa/Variant II) at the Department of Biochemistry & Molecular Biology, BMU. Prevalence of prediabetes and diabetes was determined based on HbA1c results and risk stratification.

Data Analysis:

Data were compiled and analyzed using SPSS version 24.0. Quantitative variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages. Associations between categorical variables, such as glycemic status across BMI categories and exercise history, were assessed using the Chi-square (χ^2) test, with $p < 0.05$ considered statistically significant.

Ethical Considerations and Quality Assurance:

Written informed consent was obtained from all participants. The study was approved by the Institutional Review Board (IRB) of BMU. Data collection and laboratory analyses were performed under supervision of trained investigators, following standardized procedures to ensure accuracy and reliability. Participant confidentiality was strictly maintained throughout the study.

RESULTS

Table I presents the socio-demographic, clinical, and lifestyle characteristics of the blood donors. The mean age of the participants was 36.16 ± 6.39 years, with the majority in the 25–34 years age group (59, 43.7%) and 35–44 years (53, 39.3%). Most participants were male (123, 91.1%). The mean BMI was 26.8 ± 3.38 kg/m²; 70 donors (51.8%) were overweight, 24 (17.8%) obese, and 41 (30.4%) had normal weight. Only 10 participants (7.4%) reported regular physical exercise. A history of hypertension was observed in 16 donors (11.9%). Additionally, a positive family history of diabetes in first-degree family members was noted in 81 donors (60.0%), with 37 (27.4%) reporting a history in relatives, and 17 (12.6%) reporting no family history.

Table I

Socio-Demographic, Clinical and Lifestyle Characteristics of the Blood Donors (*n* = 135).

Variables		Frequency (n)	Percentage (%)
Age Group (years)	18–24	10	7.4
	25–34	59	43.7
	35–44	53	39.3
	45–54	12	8.9
	≥55	1	0.7
	Mean ± SD	36.16 ± 6.39	
Sex	Male	123	91.1
	Female	12	8.9
BMI (kg/m²)	Underweight	0	0.0
	Normal weight	41	30.4
	Overweight	70	51.8
	Obese	24	17.8
	Mean ± SD	26.8 ± 3.38	

Regular Physical Exercise	Yes	10	7.4
	No	125	92.6
History of Hypertension	Yes	16	11.9
	No	119	88.1
Family History of Diabetes	Family	81	60.0
	Relative	37	27.4
	None	17	12.6

Table II shows the distribution of donors based on the FINDRISC risk score categories. Most participants were in the moderate-risk groups, with 71 donors (52.6%) in the 7–11 score range, 35 (25.9%) in 12–14, and 14 (10.4%) in 15–20. Fifteen donors (11.1%) scored below 7, and none had a score above 20.

Table II
Distribution of Blood Donors According to FINDRISC Risk Score (*n* = 135).

Risk group	Number of participants	Percentage (%)
<7	15	11.1
7–11	71	52.6
12–14	35	25.9
15–20	14	10.4
>20	0	0
Total	135	100

Table III demonstrates the distribution of glycemic status among donors according to HbA1c levels. Nearly half of the participants (67, 49.6%) had normal glycemia, 56 donors (41.5%) were prediabetic, and 12 (8.9%) were diagnosed with previously undiagnosed diabetes.

Table III
Prevalence of Undiagnosed Diabetes and Prediabetes Based on HbA1c Levels Among Blood Donors (*n* = 135).

Category	Number of participants	Percentage (%)
Normal HbA1c <5.7	67	49.6
Prediabetes HbA1c 5.7–6.4	56	41.5
Diabetes HbA1c ≥6.5	12	8.9
Total	135	100.0

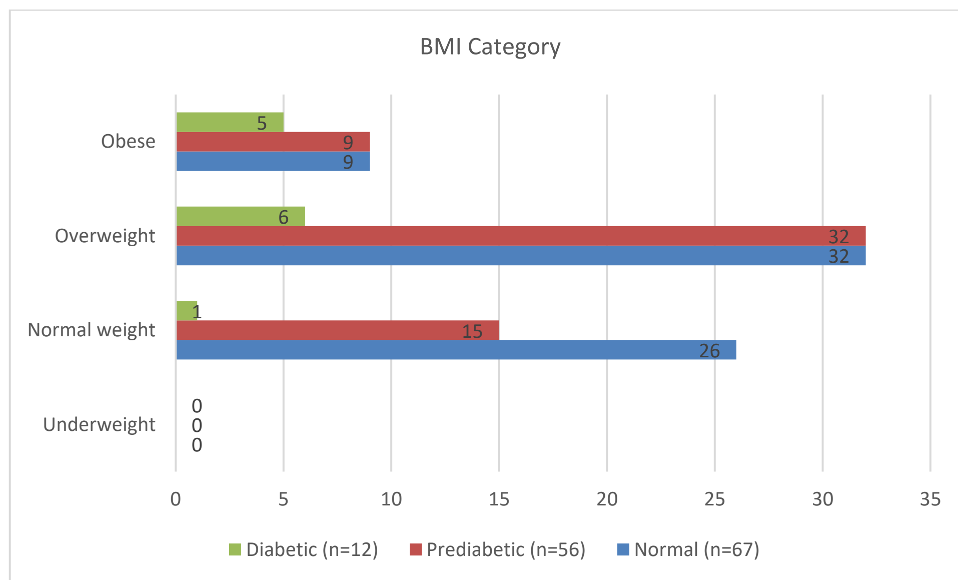

Figure 1 Distribution of Glycemic Status According to BMI Categories Among Blood Donors (*n* = 135)

The distribution of glycemic status according to BMI categories among blood donors is summarized in the table. Among normoglycemic participants, 26 donors (38.8%) had normal weight, 32 (47.8%) were overweight, and 9 (13.4%) were obese, totaling 67. In the prediabetic group, 15 donors (26.8%) had normal weight, 32 (57.1%) were overweight, and 9 (16.1%) were obese, totaling 56. Among diabetic participants, 1 donor (8.3%) had normal weight, 6 (50.0%) were overweight, and 5 (41.7%) were obese, totaling 12. Overall, the distribution across BMI categories shows that higher BMI is associated with increased prevalence of prediabetes and diabetes, with the group-wise totals summing to 135 participants ($p = 0.030$) *Figure 1*.

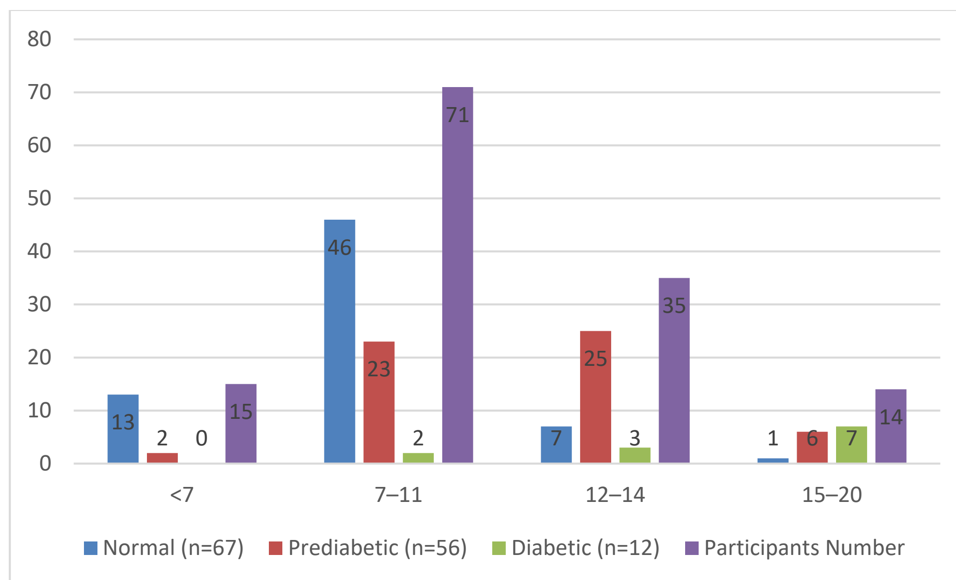

Figure 2 Association of FINDRISC Score Variation with Undiagnosed Diabetes and Prediabetes among Blood Donors (*n* = 135)

Among normoglycemic donors, most were in the 7–11 group (46, 55.2%), while prediabetic donors were mainly in the 12–14 category (25, 44.6%). Diabetic donors were predominantly in the highest risk group 15–20 (7, 58.3%). The association between increasing FINDRISC scores and higher prevalence of prediabetes and diabetes was statistically significant ($p < 0.001$) *Figure 2*.

DISCUSSION

In this cross-sectional study conducted at Bangladesh Medical University, a notable proportion of apparently healthy blood donors were found to have previously undiagnosed dysglycemia, including prediabetes and diabetes based on HbA1c levels. Most donors fell into moderate FINDRISC risk categories, and higher BMI and physical inactivity were significantly associated with dysglycemia, highlighting the importance of risk assessment and targeted screening in this accessible population.

The socio-demographic, clinical, and lifestyle characteristics of the blood donors in this study reflect patterns observed in similar populations. The majority of participants were male (123, 91.1%) and aged 25–44 years (112, 83.0%), consistent with previous reports that blood donor populations are predominantly young adults and male. The mean BMI of 26.8 ± 3.38 kg/m², with more than half of the donors classified as overweight (70, 51.8%) and 24 (17.8%) as obese, aligns with Ramasamy et al.'s findings that overweight and obese donors exhibited higher proportions of prediabetes and diabetes, highlighting BMI as an important determinant of dysglycemia even in apparently healthy individuals [17]. Furthermore, only a small proportion of donors reported engaging in regular physical exercise (10, 7.4%), while 16 (11.9%) had a history of hypertension, and 81 (60.0%) had a family history of diabetes, indicating the presence of multiple lifestyle and hereditary risk factors. These observations are supported by large-scale screening studies, such as Marx et al., which reported elevated HbA1c in a substantial proportion of blood donors, including prediabetic and diabetic ranges across age and sex categories, emphasizing that even seemingly healthy donor populations may harbor significant metabolic risk [18]. Collectively, these findings underscore the importance of systematic risk assessment among blood donors to identify undiagnosed dysglycemia and associated lifestyle and clinical risk factors.

The distribution of blood donors according to the FINDRISC risk score in this study demonstrates that the majority of participants were classified within the low to moderate risk categories, with 71 (52.6%) in the 7–11 range and 35 (25.9%) in the 12–14 range, while fewer donors were in the higher risk group of 15–20 (14, 10.4%) and none above 20. This pattern is consistent with findings from community-based studies reported by Salmerón et al., in which most adults fell into low (<7) and slightly elevated (7–11) risk categories, with smaller percentages in moderate and high-risk groups [19]. Similarly, Nnamudi et al. observed that in a young adult Nigerian cohort, the majority had low (<7) or slightly elevated (7–11) FINDRISC scores, with progressively fewer individuals in moderate (12–14) and high (15–20) risk categories [20]. These parallels suggest that even in a healthy donor population, the distribution of diabetes risk largely mirrors patterns seen in general adult populations, reinforcing the utility of the FINDRISC questionnaire in identifying individuals at elevated risk of developing type 2 diabetes and supporting targeted preventive interventions among donors.

The prevalence of undiagnosed dysglycemia among the blood donors in this study demonstrates that a substantial proportion of participants were prediabetic (56, 41.5%) and a smaller but notable number were diabetic (12, 8.9%), while nearly half had normal HbA1c levels (67, 49.6%). These findings are consistent with those reported by Ramasamy et al., who screened 210 voluntary blood donors using HbA1c and found prediabetes in 46.2% and diabetes in 15.1% of participants, indicating a similar pattern of undiagnosed glycemic abnormalities among otherwise healthy donors [17]. Additionally, Gore et al. reported that elevated HbA1c values in the prediabetes and diabetes ranges were common among 31,546 adolescent volunteer blood donors, reinforcing the notion that even ostensibly healthy donors may harbor significant rates of abnormal glycemic status [21]. Together, these studies, along with the current findings, highlight the utility of HbA1c screening in identifying prediabetes and diabetes in donor populations and suggest the need for targeted preventive measures among apparently healthy individuals.

The distribution of glycemic status according to BMI categories among the blood donors in this study demonstrates a clear trend of increasing prevalence of prediabetes and diabetes with higher BMI. Among normoglycemic participants, 38.8% had normal weight, while 47.8% of prediabetic and 50% of diabetic donors were overweight. Similarly, 16.1% of prediabetic and 41.7% of diabetic donors were obese, indicating that higher BMI is strongly associated with dysglycemia. These findings align with Gore et al., who,

although not stratified by BMI, showed that elevated HbA1c values in the prediabetes and diabetes ranges were common among 31,546 blood donors, highlighting that even healthy donors may harbor undiagnosed dysglycemia [21]. The current results support the well-established association between overweight and obesity and increased risk of impaired glucose regulation, reinforcing the importance of BMI as a key predictor of prediabetes and diabetes in blood donor populations.

The findings demonstrate a clear association between increasing FINDRISC scores and higher prevalence of dysglycemia among blood donors. Normoglycemic donors were predominantly in the lower risk categories (<7 and 7–11), while prediabetic donors were mainly in the intermediate risk group (12–14), and diabetic donors were concentrated in the highest risk group (15–20), with the association being statistically significant ($p < 0.001$). These results are consistent with the study by Ramasamy et al., in which 210 voluntary blood donors screened with the FINDRISC questionnaire showed that individuals with higher scores (≥12) had significantly higher rates of prediabetes (46.24%) and undiagnosed diabetes (15.05%) [17], reinforcing the observation that higher FINDRISC scores reliably predict increased likelihood of prediabetes and diabetes. Together, these findings underscore the utility of the FINDRISC questionnaire as a practical, non-invasive risk assessment tool for identifying blood donors at elevated risk of dysglycemia, supporting early detection and targeted preventive strategies even within ostensibly healthy populations.

LIMITATIONS

This study had some limitations:

- The study was conducted at a single center, so the results may not fully represent the national population.
- The small sample size limits the generalizability of the findings.
- Blood donors generally represent a healthier subset of the population, which may introduce selection bias and limit the applicability of the results to the broader population.

CONCLUSION

Despite being considered a healthy population, blood donors may harbor a substantial burden of undiagnosed dysglycemia. In this study, a significant proportion of participants were prediabetic, while a smaller group had previously undiagnosed diabetes. The prevalence of dysglycemia increased with higher BMI categories, with overweight and obese donors showing greater rates of prediabetes and diabetes compared to those with normal weight. Similarly, higher FINDRISC scores were strongly associated with dysglycemia, highlighting the predictive value of risk stratification tools. A positive family history of diabetes further underscored hereditary susceptibility in this population. These findings emphasize that BMI, lifestyle factors, and familial predisposition are key determinants of glycemic status, reinforcing the importance of targeted screening and preventive strategies even among apparently healthy blood donors.

ACKNOWLEDGMENT

I would like to express my sincere gratitude for the invaluable support and cooperation provided by the staff, participants and my co-authors/colleagues who contributed to this study.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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