Burden of Diabetes Mellitus and Its Determinants among Adults (≥30 Years) Residing in Urban Field Practice Area of A Tertiary Care Teaching Hospital, Uttar Dinajpur, West Bengal

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Abstract

Introduction: Diabetes mellitus (DM) poses a significant global health challenge, particularly in countries like India. Despite the multitude of studies, relatively few have assessed the burden of diabetes and its determinants in a resource-limited district in West Bengal, India, utilizing various biochemical and anthropometric parameters. **Materials and Methods:** The cross-sectional study was conducted from July to December 2023 to assess the burden of diabetes and its determinants among an estimated sample of 114 adults (≥30 years) residing in the urban field practice area of tertiary care hospital in Uttar Dinajpur, West Bengal. Sociodemographic and behavioral data were collected through household survey using a predesigned, pretested interview schedule, whereas the anthropometric and biochemical data were collected on prefixed days at the urban primary health center using standardized tools and techniques as appropriate. Data were analyzed with SPSS version 20 using descriptive and inferential statistics. Univariate and multivariable logistic regression was performed to identify associations between diabetes and its determinants. **Results:** Prevalence of DM and prediabetes was 39.47% and 31.58%, respectively. Factors significantly associated with DM were female (adjusted odd ratio [AOR] = 4.55, 95% confidence interval [CI] [1.06–19.41]), overweight participants (AOR = 6.53, 95% CI [1.02–41.85]), physical activity (AOR = 2.83, 95% CI [1.05–7.65]), and family history of diabetes (AOR = 2.74, 95% CI [1.04–7.22]). **Conclusion:** The findings underscore the urgent need for implementation of targeted public health interventions aimed at reducing the prevalence of diabetes and mitigating its associated risks at national and subnational level.

Keywords: Diabetes mellitus, prevalence, primary care, risk factors

Introduction

Diabetes mellitus (DM), a metabolic disorder characterized by elevated blood sugar levels, is a significant public health concern due to its growing prevalence worldwide.[1] Low and middle-income countries, particularly diversely populated nations with limited resources like India, disproportionately bear the brunt of the rising prevalence of DM.[2-4] Morbidity and mortality associated with diabetes are staggering, with nearly 6.7 million deaths occurring globally each year.[5] International Diabetes Federation estimate suggests, 537 million individuals were living with diabetes in 2021, and this number is projected to rise to 643 million by 2030 if effective prevention strategies are not implemented.[5] The ICMR-INDIAB population-based cross-sectional study, which utilized both the oral glucose tolerance test (OGTT) and glycated hemoglobin (HbA1c) to diagnose diabetes, reported a prevalence of 7.3% in India. The rapid socioeconomic transition, urbanization, sedentary lifestyles, and dietary changes have contributed to the rise in diabetes prevalence.[5,6,8] Furthermore, genetic predisposition and obesity play significant roles in the development of diabetes among Indians.[5] In diverse settings like India, HbA1c could be a valuable population-based screening tool to accurately assess the true prevalence of diabetes.

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HbA1c measurement is a valuable indicator of long-term blood glucose control, as it captures chronic hyperglycemia better than fasting blood glucose (FBG) and OGTT.[9] The American Diabetes Association recommends HbA1c level in blood as tool to diagnose DM if the value of HbA1c ≥6.5%.[10] HbA1c is less sensitive to acute illness and stress, has lower biological variability, and has greater preanalytical stability than FBG.[9-12] HbA1c had greater sensitivity and negative predictive value in detection of DM.[13] FBG estimation results in the underestimation of diabetes and prediabetes than HbA1c estimation.[14] A study predicted doubling of DM prevalence globally by 2030 with major increase in India.[15] There are relatively fewer studies conducted in India to assess the prevalence of diabetes using HbA1c estimation although HbA1c provides an objective and standardized assessment of glycemic status to detect DM early. The results of these studies highlight the critical need for comprehensive preventive measures and targeted interventions to combat the escalating diabetes crisis in India.

Hence, this study was planned to find out the prevalence of DM among adults (≥30 years) residing in the urban field practice area of a tertiary care teaching hospital of Uttar Dinajpur, West Bengal and also to assess relationship between DM with its potential risk factors.

Materials and Methods

Study design, study setting, and study population

The community-based observational study with cross-sectional design was conducted between July to December 2023 among adults aged 30 years and above and registered under the National Program for Prevention and Control of Non-Communicable Disease in the urban field practice area of a tertiary care teaching hospital at Raiganj, Uttar Dinajpur district**,** West Bengal, India.

The study area comprised six wards and had a total adult population (≥30 years) of 21740, of which the population in each of the six wards was 3540, 1691, 3331, 4365, 3408, and 5405, respectively, at *Sudarshanpur (Ward-2)*, *Ashokpally (Ward-3)*, *Rabindrapally (Ward-4), Milonpara (Ward-5), Kharmujaghat (Ward-6), and Milonpara (Ward-7)* as available from the population register maintained at the urban primary health center (UPHC). The sample population included individuals aged 30 years and above, who had resided in the study area continuously for at least 1 year, volunteered to participate, and provided informed consent. The participants, who were seriously ill or not present on the day of data collection or belonging to the same household were excluded from the study.

Sample size and sampling technique

Based on a study by Maiti *et al*. in 2023, the reported prevalence of people of diabetes in India was 16.1%.[7] The sample size estimated was 114, using the formula Z^2pq/L^2, where $Z = 1.96$ at 95% confidence interval (CI) and 5% level of significance, $P = 0.161$ and $(q = 1 - p)$, with an absolute error (L) margin of 10%, design effect of 2 and nonresponse rate of 10%.

The sample was selected using disproportionate stratified random sampling technique from the six wards (strata) in the study area. From each stratum, 19 participants (114/6 = 19) following the exclusion and inclusion criteria were selected using the simple random sampling method from the available line list of adults (≥30 years) maintained at the UPHC.

Data collection

Sociodemographic and behavioral data were collected by face-to-face interview of the respondents using a predesigned, pretested interview schedule at the household level after obtaining informed consent. The respondents who were interviewed were mobilized to the UPHC by field-level health workers on six prefixed days for clinical, anthropometric, and biochemical evaluation using standard operating protocol. Venous blood samples were collected aseptically by qualified phlebotomist and biochemical parameters were evaluated using standard reagents and kits with support of biochemistry department of the study hospital.

Sociodemographic and behavioral variables included age (30-44/45-59/≥60 years), gender (Male/female), education of head of participants family (illiterate/literate), economic status as per modified BG Prasad scale May 2022 (INR < 2544/2544-4239/≥4240),[15] type of family (nuclear/joint), family history of diabetes and hypertension (present/absent), substances use (present/absent) and physical activity (no activity/physically active).

Anthropometric variables such as weight (in kg), height (in cm), waist circumference (in cm), hip circumference (in cm), and neck circumference (in cm) were measured following standard procedures using standardized weighing machine and nonstretchable measuring tape, respectively, and indicators such as body mass index (BMI), conicity index, body fat percentage were calculated using standard formulas.

Systolic and diastolic blood pressure were measured and recorded twice over the left arm of the patients in resting state using aneroid sphygmomanometer as per standard protocol.

Venous blood samples were collected by the qualified phlebotomist at the UPHC following aseptic procedure and appropriate disposal of biomedical wastes.[16] The biochemical samples were analyzed for HbA1c, total cholesterol, high-density lipoprotein (HDL) cholesterol, and creatinine. Total cholesterol was measured by CHOD-PAP method,[17] HDL cholesterol was measured by PEG-precipitation method,[17] creatinine was measured by modified Jaffe's Kinetic method,[18] HbA1c was measured by particle enhanced immunoturbidometric method.[19] Semiautomated analyzer (Erba-Mannheim Chen 5X) was used for measuring these blood parameters.

Operational definitions

DM was considered if respondents had history of intake of hypoglycemic medication, having prescription proof of undergoing treatment and/or HbA1c ≥6.5.[10] HbA1c level between 5.7% and 6.4% was considered pre-diabetes, whereas below 5.7% was defined as "no diabetes."[10] If either or both of a participant's parents had DM, they were considered to have a positive family history.

Hypertension was considered if systolic BP of ≥140 mmHg or diastolic BP of ≥90 mmHg was observed as per seventh report of Joint National Committee guidelines.[20]

Substance use was considered if participants were consuming either tobacco (smoke/smokeless) or alcohol or both for at least the last 1 year. (Past tobacco users are included under "Present" category).

Physical activity was categorized as "NO Activity" and "Physically Active" (atleast 75–150 min of vigorous exercises per week or 150–300 min of moderate intensity exercises per week).[21]

Waist circumference was measured to the nearest 0.1 cm at the midpoint between the tip of the iliac crest and the last costal margin in the back and at the umbilicus in the front, using a nonstretchable tape, at the end of normal expiration, with the subject standing erect in a relaxed position.

Abdominal/central obesity was considered present when the waist circumference was ≥80 cm in women and ≥90 cm in men.[22] Waist-to-hip ratio (Normal: <0.9, High: ≥0.9 for males and Normal: <0.85, High: ≥0.85 for females).[23]

Participants were also categorized depending on serum total cholesterol (in mg/dl) (normal: ≤200, High: >200) and for HDL cholesterol (in mg/dl) (Normal: ≥40, Low: <40 for male and Normal: ≥50, Low: <50 for female).[24]

Conicity index (C_i) was constructed using the following formula: (C_i) = waist circumference (m)/(0.109×√(body weight [kg]/height[m]) where 0.109 is a constant which results from the conversion of units of volume and mass into units of length.[24-26] Cutoffs 1.18 was used to classify C_i into normal (<1.18) and high (≥1.18) categories.[24,26]

Body fat percentage (%) indicates the amount of fat present in our body and it was calculated using following formula: % body fat = $(86.01 \times \log_{10}$ [Waist Circumference–Neck Circumference] $- 70.041 \times \log_{10}$ [Height] + 36.76) for men or $(163.205 \times \log_{10}$ [Waist Circumference + Hip Circumference – Neck Circumference] $- 97.684 \times \log_{10}$ [Height] – 78.387) for women.[27-30] Body fat percentage was categorized as <25% and ≥25%.[24,27,31]

Estimated glomerular filtration rate (eGFR in mL/min/1.73 m^2) was calculated using modification of diet in renal disease formula and categorized into two groups: ≥60 and <60.[18]

Statistical analysis

Data collected were checked for completeness and consistency. Categorical data were presented in the form of frequency and percentage, whereas continuous data were presented in the form of mean (standard deviation), median (interquartile range) as appropriate. Binary logistic regression analysis was done to find out the factors associated with the presence of diabetes. Statistical significance was assessed at 5% significance level. All statistical analyses were performed using the Statistical Package for the Social Sciences (IBM SPSS, statistics for Windows, version 20.0 Armonk, New York, USA: IBM Crop. 2011).

Ethical considerations

Ethical approval was obtained from the Institutional Ethics Committee of the said teaching hospital bearing Ref. No. IEC 06/2023(09) dated 21.06.2023. Informed consent was obtained from respondents before data collection. Participants were informed about the risk–benefits of the study and their right to withdraw from the study without citing any reason to the researchers. Privacy and confidentiality of participants were maintained throughout.

Results

Out of a total of 114 participants, the point prevalence of DM was 45 (39.47%) [Figure 1]. Among these 45 diabetic participants, 16 (14.03%) were known diabetic with HbA1c <6.5, 16 (14.03%) were newly diagnosed type 2 DM and remaining 13 (11.41%) were known diabetic having poor glycemic control with HbA1c ≥6.5, 36 (31.58%) participants were prediabetic and remaining 33 (28.95%) were nondiabetic [Figure 1].

On sociodemographic profile analysis, study participants consisted of age groups 30–44 years, i.e., 44 (38.6%) and 45–59 years, i.e., 39 (34.21%) predominantly. The geriatric age group consists of 31 (27.19%) subjects. Most of the study subjects were female, i.e., 84 (73.68%). As per family profile, most of them, i.e., 73 (64.04%) belong to the nuclear family, most of the participants are illiterate, i.e., 73 (64.04%) and 45 (39.47%) participants have family history of DM. On assessing their lifestyle profile, it shows that 74 (64.91%) participants were not using any substances and 59 (51.75%) participants were involved in physical activities regularly [Table 1].

Anthropometric assessment shows that 70 (61.41%) participants were in the obese category of BMI (Asian category

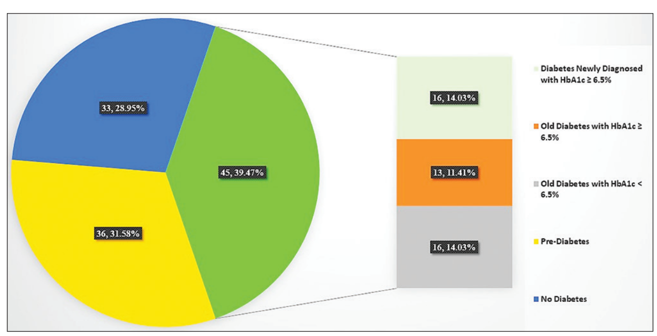

Figure 1: Bar in pie diagram showing distribution of glycemic categories among the study participants (*n* = 114)

Table 1: Frequency distribution of participants according to their sociodemographics and background characteristics (n=114)

Variables	Frequency (%)
Participant's age (completed years)	
30–44	44 (38.6)
45–59	39 (34.21)
≥60	31 (27.19)
Gender	
Male	30 (26.32)
Female	84 (73.68)
Socioeconomic status*	
<2544	56 (49.12)
2544–4239	34 (29.83)
≥4240	24 (21.05)
Family type	
Nuclear	73 (64.04)
Joint	41 (35.96)
Education	
Illiterate	73 (64.04)
Literate	41 (35.96)
Substance use	
Absent	74 (64.91)
Present	40 (35.09)
Physical activity	
No activity/sedentary	55 (48.25)
Physically active	59 (51.75)
Family history of DM	
Absent	69 (60.53)
Present	45 (39.47)

*Per capita monthly income in INR as per B G Prasad Scale May 2022. DM: Diabetes mellitus

Table 2: Distribution of participants according to their clinical, anthropometric, and serum biochemical factors (n=114)

Variables	Frequency (%)
Presence of DM	
Absent	69 (60.53)
Present	45 (39.47)
Blood pressure category	
Normotensive	24 (21.05)
Prehypertension	38 (33.33)
Hypertension	52 (45.62)
Waist-to-hip ratio	
Normal	15 (13.16)
High	99 (86.84)
BMI (Asian category)	
Normal	35 (30.70)
Overweight	9 (7.89)
Obese	70 (61.41)
Body fat percentage	
<25	9 (7.89)
≥25	105 (92.11)
Conicity index	
Normal	35 (30.70)
High	79 (69.30)
Total cholesterol (mg/dL)	
≤200	97 (85.09)
>200	17 (14.91)
HDL cholesterol	
Normal	74 (64.91)
Low	40 (35.09)
Total cholesterol-HDL ratio	
≤4.22	98 (85.96)
>4.22	16 (14.04)
eGFR (mL/min/1.73 m^2)	
≥60	92 (80.70)
<60	22 (19.30)

eGFR: Estimated glomerular filtration rate, HDL: High-density lipoprotein, BMI: Body mass index, DM: Diabetes mellitus

guideline) followed by 35 (30.7%) participants of normal BMI and 9 (7.89%) participants were overweight [Table 2]. Majority of the participants fall under high-waist-to-hip ratio category, i.e., 99 (86.84%). One hundred and five (92.11%) participants fall under body fat percentage indicator ≥25 category and 79 (69.3%) participants fall under high conicity index category. On serum evaluation, only 17 (14.91%) participants had total cholesterol level >200 and 40 (35.09%) participants had low HDL cholesterol level, although 16 (14.04%) had total cholesterol to HDL ratio >4.22. Twenty-nine (25.44%) participants show HbA1c level ≥6.5%. Twenty-two (19.3%) participants had eGFR level <60 ml/min/1.73 m^2. Fifty-two (45.62%) participants were hypertensive and 38 (33.33%) participants were prehypertensive.

Chi-square test revealed significant associations with gender (χ^2 [df], P = 4.44 [1], 0.035), type of the family (χ^2 [df], P = 5.39 [1], 0.02), BMI categories (χ^2 [df], P = 8.07 [2], 0.018), and family h/o T2DM (χ^2 [df], P = 10.43 [1], 0.001).

On binary logistic regression analysis, diabetics are significantly associated with female gender (unadjusted odd ratio [UOR] [CI], P = 2.71 [1.05–7.01], 0.039), joint family type (UOR [CI], P = 2.52 [1.14–5.53], 0.022), obese participants (UOR [CI], P = 3.78 [1.46–9.78), 0.006), hypertensive persons (UOR [CI], P = 3.52 [1.14–10.84], 0.03), and family h/o diabetes (UOR [CI], P = 3.6 [1.63–7.96], 0.002). In multivariable logistic regression analysis, independent categorical variables were included in two groups, i.e., first age groups, gender, economic status, family type, education, family h/o DM, substance use, physical activity were entered in Block 1 followed by (total: HDL) cholesterol ratio, BMI, waist–hip ratio, body fat percentage, and conicity index were entered into Block 2 (Omnibus test found significant). Such analysis reveals significant association of female gender (adjusted odd ratio [AOR] [CI], P = 4.55 [1.06–19.41], 0.041), overweight participants (AOR [CI], P = 6.53 [1.02–41.85], 0.048), physical activity (AOR [CI], P = 2.83 [1.05–7.65], 0.04), and family h/o diabetes (AOR [CI], P = 2.74 [1.04–7.22], 0.041). The adjusted regression model was of good fit as evident from Hosmer–Lemeshow test statistic (P > 0.05) and the independent variables in the model was able to explain

Table 3: Logistic regression analysis showing the prevalence of diabetes and its associated factors among the study participants (*n*=114)

Variables	DM		Bivariate analysis, UOR (95% CI)	Multivariate analysis, AOR (95% CI)
	Yes, *n* (%)	No (reference), *n* (%)		
Age group				
30–44	15 (34.09)	29 (65.91)	1	1
45–59	20 (51.28)	19 (48.72)	2.03 (0.84–4.93)	2.77 (0.9–8.53)
≥60	10 (32.26)	21 (67.74)	0.92 (0.35–2.45)	1.24 (0.36–4.32)
Gender				
Male	7 (23.33)	23 (76.67)	1	1
Female	38 (45.24)	46 (54.76)	2.71 (1.05–7.01)*	4.55 (1.06–19.41)*
Socioeconomic status 2022				
<2544	20 (35.71)	36 (64.29)	1	1
2544–4239	14 (41.18)	20 (58.82)	1.26 (0.52–3.02)	0.97 (0.31–3.06)
≥4240	11 (45.83)	13 (54.17)	1.52 (0.58–4.02)	0.99 (0.26–3.71)
Type of family				
Nuclear	23 (31.51)	50 (68.49)	1	1
Joint	22 (53.66)	19 (46.34)	2.52 (1.14–5.53)*	2.51 (0.96–6.54)
Education				
Illiterate	24 (32.88)	49 (67.12)	1	1
Literate	21 (51.22)	20 (48.78)	2.14 (0.98–4.69)	2.54 (0.78–8.33)
Substance use				
Absent	31 (41.89)	43 (58.11)	1	1
Present	14 (35)	26 (65)	0.75 (0.34–1.66)	1.25 (0.4–3.93)
Physical activity				
No activity	19 (34.55)	36 (65.45)	1	1
Physically active	26 (44.07)	33 (55.93)	1.49 (0.7–3.18)	2.83 (1.05–7.65)
Total cholesterol: HDL				
≤4.22	36 (36.73)	62 (63.27)	1	1
>4.22	9 (56.25)	7 (43.75)	2.21 (0.76–6.45)	2.67 (0.67–10.62)
Waist-to-hip ratio				
Normal	4 (26.67)	11 (73.33)	1	1
High	41 (41.41)	58 (58.59)	1.94 (0.58–6.53)	0.58 (0.1–3.28)
BMI (Asian category)				
Normal	7 (20)	28 (80)	1	1
Overweight	4 (44.44)	5 (55.56)	3.2 (0.68–15.14)	6.53 (1.02–41.85)*
Obese	34 (48.57)	36 (51.43)	3.78 (1.46–9.78)#	2.21 (0.63–7.8)
Body fat percentage				
<25	2 (22.22)	7 (77.78)	1	1
≥25	43 (40.95)	62 (59.05)	2.43 (0.48–12.25)	1.95 (0.2–18.45)
Conicity index				
Normal	14 (40)	21 (60)	1	1
High	31 (39.24)	48 (60.76)	0.97 (0.43–2.18)	0.92 (0.3–2.82)
Family history of T2DM				
Absent	19 (27.54)	50 (72.46)	1	1
Present	26 (57.78)	19 (42.22)	3.6 (1.63–7.96)#	2.74 (1.04–7.22)#

**P*-value significant <0.05, #*P*-value significant at <0.01. Cox and Snell R^2=21.5% and Nagelkerke R^2=29.1%. UOR: Unadjusted odd ratio, AOR: Adjusted odd ratio, CI: Confidence interval, DM: Diabetes mellitus, T2DM: Type 2 DM, BMI: Body mass index, HDL: High-density lipoprotein

a moderate degree of the variability in the outcome variable as demonstrated by Nagelkerke and Cox-Snell pseudo R^2 test values of 29.1% and 21.5%, respectively [Table 3].

Discussion

This study was conducted in an urban primary care setting involving various biochemical and anthropometric parameters. A high prevalence of DM (39.47%) was observed. The study identified statistically significant association between diabetes with female gender, overweight participants, physical activity, and family history of diabetes.

Similar DM prevalence of 34.6% was reported by Al Mansour in a study conducted among semi-urban Saudi population.[32] Majority of previous studies, conducted both globally and in India, have reported lower prevalence rates of diabetes.[29-31] This may be attributed to the reliance on fasting and postprandial blood glucose measurements as diagnostic criteria, rather than incorporating HbA1c assessment.

Similar to our research findings, studies conducted by Tobias in 2011 and Campesi *et al*. in 2017 demonstrated an association between female gender and a higher prevalence of diabetes.[33,34] Scott *et al*. in 2013 (HR 2.72, 95% CI 2.48, 2.99) reported similar finding of significant association between family h/o diabetes and high diabetic prevalence.[35] Studies by Jayedi *et al*. in 2022 and Teufel *et al*. in 2021 demonstrated similar association of overweight with high diabetic prevalence.[36,37] In contrast, studies by Lao *et al*. in 2019, Crump *et al*. in 2016 showed that poor physical fitness was associated with high diabetic prevalence.[38,39] As relation of physical activity was assessed with the prevalence of diabetes, there could be increase of physical activity after the identification of diabetes.

The study highlighted the high prevalence of diabetes in an estimated sample in a resource-limited primary care setting in a less developed district of West Bengal. Several sensitive biochemical markers along with anthropometric indices (both measured and calculated) have been used to observe their association with the prevalence of diabetes. However, due to cross-sectional design temporal association could not be established. Furthermore, due to resource constraints, we were unable to differentiate the type of DM we encountered. Efforts were made to minimize recall and social desirability bias, especially while collecting behavioral data using a shorter recall period.

Conclusion

The findings emphasized the need for targeted public health interventions to reduce the prevalence of diabetes and mitigate its associated risks at both national and subnational levels. This study highlighted the burden of DM among urban individuals aged 30 and older. Individuals who are overweight, physically active, female, or have a family history of diabetes are at increased risk of developing DM in their lifetime. Annual population-based screening of glycemic status with HbA1c level should be included under the national program as it will play a crucial role to identify diabetes and prediabetes at the community level with more precision. It will also help in monitoring of glycemic status in high risk and affected individuals. Besides, early identification and follow-up of high-risk groups coupled with lifestyle modification through effective social and behavior change communication in the community will help to establish necessary preventive framework to control DM and its complications.

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Conflicts of interest

There are no conflicts of interest.

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