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Original Research Article

Risk Profiling and Prevalence of Type 2 Diabetes Mellitus in a District-Level Population: A Cross-Sectional Study

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ABSTRACT

Background: India has emerged as the diabetes capital of the world, a trend largely attributed to rapid industrialization and urbanisation, which have contributed to significant lifestyle changes and an epidemiological transition.

Objective: To estimate the prevalence of Type 2 Diabetes Mellitus among people of Gandhinagar District. To identify and analyse the sociodemographic and lifestyle-related risk factors associated with Type 2 Diabetes Mellitus in the district population.

Material and methods: A cross-sectional analytical study was conducted among 600 participants selected from each of the four talukas of Gandhinagar, ensuring representation of both rural and urban populations through probability-proportional-to-size sampling. Data were collected using a pretested and predesigned proforma. Information on sociodemographic and behavioural factors, family history, and physical measurements was obtained. Random blood sugar (RBS) levels were measured for all participants; individuals with RBS >200 mg/dL underwent HbA1c testing. Data were analyzed using Excel 2019 and SPSS v27.

Results: The prevalence of T2DM was 10.66% (64/600), with 37.5% (24/64) being newly diagnosed. Significant associations were observed with increasing age, reduced physical activity, smoking, and obesity ($p<0.05$). Insignificant associations were found with gender, socioeconomic status, alcohol consumption, family history of diabetes, or frequency of eating meals outside the home. The highest prevalence was noted in the 46–55 years age group. Dehgam taluka exhibited the highest proportion of undiagnosed cases, which may be attributed to its predominantly rural population.

Conclusion: High prevalence of modifiable risk factors, targeted primary prevention strategies are essential to curb the rising burden of T2DM in the region.

Keywords: Gandhinagar, Prevalence, Risk Factors, Type 2 Diabetes Mellitus

INTRODUCTION

Non-communicable diseases (NCDs)—including diabetes mellitus, hypertension, coronary artery disease, cancer, and obesity—are leading global causes of morbidity and mortality. According to the WHO Global Health Estimates 2015, NCDs accounted for 39 million (70%) of the 56 million global deaths, with diabetes responsible for 4% and hypertensive heart disease for 2.4%. In the Southeast Asia Region, diabetes and hypertension contributed to approximately 0.4 and 0.2 million deaths, respectively. [1]

India is undergoing an epidemiological transition driven by rapid urbanisation and industrialisation, leading to reduced physical activity, unhealthy diets, and increased tobacco and alcohol use. [2] These

changes have shifted the disease burden from communicable to non-communicable diseases. As per the Global Status Report on NCDs 2015, NCDs cause over 5.8 million deaths in India annually, accounting for 61% of all deaths. The NCD burden rose from 29% in 1990 to 62% in 2016. [3]

India has the second-highest number of adults with diabetes after China, with nearly one in ten adults over 18 having elevated blood glucose.[4] Major metabolic risk factors include high blood pressure, obesity, hyperglycaemia, and hyperlipidaemia. In contrast, modifiable behavioural risks—tobacco use, poor diet, inactivity, and harmful alcohol intake—are strongly linked to disease onset. [5]

Given the rising diabetes burden, particularly among younger age groups, region-specific data are essential for targeted interventions. Despite numerous national surveys, information on the prevalence and determinants of type 2 diabetes mellitus in Gandhinagar district remains scarce. This study seeks to fill this gap by estimating prevalence and identifying associated sociodemographic, socioeconomic, and lifestyle-related risk factors in the district population.

AIM:

To evaluate the prevalence and identify the associated risk factors of Type 2 Diabetes Mellitus in Gandhinagar District.

OBJECTIVES:

-To estimate the prevalence of Type 2 Diabetes Mellitus among adults in Gandhinagar District.

-To identify and analyse the sociodemographic and lifestyle-related risk factors associated with Type 2 Diabetes Mellitus in the district population.

MATERIAL AND METHODS

Study Design and Setting- This was a community-based, cross-sectional study conducted in the Gandhinagar district of Gujarat, India. The district comprises both rural and urban populations, organized into four administrative talukas: Mansa, Kalol, Dehgam, and Gandhinagar. The study was conducted over 21 months, from March 2021 to November 2022.

Study Population- The study population included individuals aged 18 years and above residing in Gandhinagar district, which had a total population of 1,391,753 as per the 2011 Census of India.

Inclusion Criteria

- Permanent residents or those residing in the district for more than one year

Exclusion Criteria

- Individuals who did not provide consent

Sample Size Estimation

The sample size was calculated using the formula:

$n = (Z^2 \times p \times q) / l^2$

Where:

- Z = 1.96 (corresponding to 95% confidence level)

- p = 15% (estimated prevalence of Type 2 Diabetes Mellitus from previous studies)

- q = 100 - p = 85

- l = 20% of p = 3

$n = (1.96)^2 \times 15 \times 85 / (3^2) = 544$

Adjusting for a 10% non-response rate: Final sample size = 544 + 10% = 598 ≈ 600

Sampling Technique- A Probability Proportional to Size (PPS) sampling method was adopted to ensure proportional representation from all talukas and their respective rural and urban areas.

Rural Sampling- Village lists were obtained from the Census of India 2011. Four villages were randomly selected from each taluka using the lottery method. An equal number of participants were selected randomly from each selected village.

Urban Sampling- Each taluka had one designated urban center (e.g., Gandhinagar Municipal Corporation). Each urban center was divided into four zones. An equal number of participants were selected randomly from each zone.

Study Tool and Pilot Testing- A pre-designed, pre-tested, semi-structured questionnaire was administered, consisting of the following components: - Socio-demographic variables, Behavioural characteristics (e.g., smoking, alcohol consumption, physical activity, diet), Family history of diabetes and hypertension, Anthropometric measurements: Height, weight, waist and hip circumference, Biochemical measurements: - Random Blood Sugar (RBS): measured using a glucometer, HbA1c: measured using a point-of-care HbA1c meter if RBS > 200 mg/dL

A pilot study was conducted in a village in Mansa taluka with 20 participants to pre-test the tool. Necessary modifications were made based on feedback. Data from the pilot study were excluded from the final analysis.

Data Collection Procedure- Data collection was conducted from March 2021 to July 2022 through house-to-house visits. In the event of the non-availability of an eligible participant at a selected household, the adjacent household was approached as per protocol. Data Entry and Statistical Analysis- Data were entered in Microsoft Excel 2019, and analysis was conducted using SPSS Version 27.

ETHICAL CONSIDERATIONS

Approval was obtained from the Institutional Ethics Committee of B.J. Medical College and Civil Hospital, Ahmedabad, with Ref. no 146/2021 on 25/06/2021.

RESULTS AND DISCUSSION

A community-based cross-sectional study was conducted in Gandhinagar district among 600 participants (54.66% male, 45.33% female) aged 18–86 years (mean ± SD: 43.4 ± 16.7 years) to determine the prevalence of type 2 diabetes mellitus (T2DM) and associated risk factors. The largest proportion of participants belonged to the ≥55 years age group (23%), followed by 46–55 years (20.66%), 18–25 years (20.33%), 36–45 years (18.33%), and 26–35 years (17.66%). Educational attainment was as follows: primary (22.33%), secondary (20.66%), higher secondary (19.33%), graduate (13.16%), postgraduate (8.83%), and illiterate (15.66%).

Regarding occupation, 28.16% were engaged in desk-based jobs, 19% in manual labour, 17.83% in business, 12.16% were students, 11.33% housewives, and 11.5% retired or unemployed. Rural residents accounted for 56.66% and urban residents for 43.33%. Socioeconomic status (BG Prasad classification) distribution was: Class II (41.33%), Class III (23.33%), Class I (19.66%), Class IV (13.5%), and Class V (2.16%).

Most participants were married (78.83%), with 14.33% unmarried and 6.83% widowed/divorced/separated. Family history of diabetes and hypertension was reported by 21.66% and 29%, respectively.

Alcohol consumption was reported by 25% (“ever users”) and tobacco use by 38.33%, with 13.66% using both substances and 50.33% neither. Adequate physical activity (≥150 min/week) was reported by 58% of participants, whereas 42% reported inadequate activity.

Frequency of eating meals outside the home was daily (5.33%), every three days (23.83%), weekly (28.5%), monthly (32.66%), and never (9.66%). Fruit consumption ≥5 days/week was reported by 7.83% and green leafy vegetables ≥5 days/week by 45.5%.

Based on BMI, 14.33% were underweight, 37.66% normal weight, 14.33% overweight, and 33.66% obese; elevated waist circumference and waist–hip ratio were observed in 34.5% and 29.66%, respectively. Glycaemic status showed RBS ≥ 200 mg/dL in 19.33%, 140–199 mg/dL in 26.66%, and <140 mg/dL in 54%, with a mean RBS of 152 ± 66 mg/dL.

The overall prevalence of diabetes was 10.66%, with 40% of cases undiagnosed, and the highest prevalence was observed in Dehgam taluka. Statistically significant associations were found between diabetes and age, physical inactivity, smoking, obesity, elevated waist circumference, and high waist–hip ratio, whereas gender, residence, alcohol consumption, socioeconomic status, and family history of diabetes or hypertension showed no significant association.

In the present study, the prevalence of type 2 diabetes mellitus (T2DM), determined using glycated haemoglobin (HbA1c ≥6.5%), was 10.66% (n = 64), of which 37.5% were previously undiagnosed, indicating a considerable hidden burden.

Taluka-wise analysis revealed the highest prevalence in Mansa (12.35%; 36.36% undiagnosed), followed by Dehgam (12.06%; 42.85% undiagnosed), Kalol (10.38%; 31.25% undiagnosed), and Gandhinagar (9.54%; 39.13% undiagnosed). Overall, only 60% of diagnosed individuals were aware of their condition.

The prevalence observed in this study exceeds the national average reported in the Prevalence of Diabetes in India Study (PODIS) (4.3%; urban: 5.9%, rural: 2.7%) as well as figures from Punjab (8.3%), rural West Bengal (2.95%), and Switzerland (6.3%), but is comparable to rural Tamil Nadu (10.8%). The proportion of undiagnosed diabetes (40%) aligns with findings from Ravikumar P. et al., whereas Jaya Prasad Tripathy et al. reported only 18% awareness and 82% newly detected cases in Punjab. The substantial proportion of undiagnosed cases in the present study highlights persistent gaps in community-level screening and early detection. [6,7] Observed inter-taluka variations may reflect differences in lifestyle patterns, socioeconomic conditions, healthcare access, and awareness levels. These findings underscore the need for targeted, community-based screening programmes, health education interventions, and preventive strategies to facilitate early diagnosis and improved glycaemic control.

Association of Diabetes Mellitus with Socio-demographic and Family History Variables:
In the present study, out of 600 participants, the proportion of undiagnosed diabetes mellitus (DM) was 40%, a figure consistent with the findings of Ravikumar P et al. and notably higher than that reported by Jaya Prasad Tripathy et al. in Punjab (82% newly detected).[6,7] The high proportion of undiagnosed cases reflects deficiencies in community-level screening and early detection. Differences in prevalence across talukas may be attributed to variations in lifestyle, socioeconomic status, healthcare accessibility, and awareness, underscoring the need for targeted community-based screening programmes, health education, and early intervention strategies.

Table-1: Association of diabetes with age of the study participants (n=600)

Age	Diabetic	Non diabetic	Total	P-Value	Chi-Square Value
18-25	2 (1.64%)	120 (98.36%)	122	**0.001528***	**17.5251**
26-35	12 (11.32%)	94 (88.68%)	106		
36-45	14 (12.73%)	96 (87.27%)	110		
46-55	22 (17.74%)	102 (82.26%)	124		
> 55	14 (10.14%)	124 (89.86%)	138		
Total	64 (10.66%)	536 (89.33%)	600		

Age was significantly associated with DM prevalence. As depicted in Table 1 highest prevalence (17.74%) occurred in the 46–55 years age group, followed by 36–45 years (12.73%), 26–35 years (11.32%), and >55 years (10.14%), with the lowest prevalence (1.64%) in the 18–25 years group. This association was statistically significant (χ^2 = 17.5251; df = 4; p = 0.0015), confirming age as a key risk factor. These results are in line with findings from Akula Sanjeevaiah et al. (Warangal, 2019), the National Urban Diabetes Survey (2001), and Nithesh Kumar et al. (2018), all of which reported peak prevalence in middle-aged groups.[8,9]

The present study found no statistically significant gender difference in DM prevalence, with rates of 11.58% in males (n = 328) and 6.1% in females (n = 272) (χ^2 = 0.6409; df = 1; p = 0.4234). This aligns with evidence from other Indian studies, such as those by Anamitra Barik et al. (2016, rural India) and Jaya Prasad Tripathy et al. (2017, Punjab), both of which reported no gender association.[7,10] However, some studies, including those by I Meshram et al. (2016; multi-region, n = 7,531) and Ranjit Mohan Anjana et al. (multi-state survey), have documented a male preponderance as a significant risk factor for DM.[11,12]

The prevalence of DM was higher among rural residents (12.35%) compared to urban residents (8.46%), though this difference was not statistically significant ($\chi^2 = 2.3414$; df = 1; p = 0.1259).

In the present study, diabetes prevalence varied across socioeconomic strata as per the Revised BG Prasad classification, with the highest proportion observed in class V (Lower class, 15.38%) and the lowest in class I (Upper class, 7.62%). Intermediate prevalence rates were recorded in class II (12.09%), class III (9.28%), and class IV (11.11%). Although a trend toward higher prevalence in lower socioeconomic groups was noted, the association between socioeconomic class and diabetes was statistically non-significant ($\chi^2 = 2.2911$; df = 4; p = 0.6823), suggesting that socioeconomic status may not be a strong independent predictor of diabetes risk in this cohort. Nevertheless, social inequities manifest in the form of limited awareness, inadequate preventive practices, constrained healthcare resources, insufficient budget allocations, and lack of medical reimbursement. These factors collectively delay diagnosis, promote complications, and increase treatment costs, thereby perpetuating a vicious cycle of economic hardship, inadequate management, and premature mortality. While the present study did not find a significant association, contrasting evidence exists; for example, Ashis Talukder et al. (2020) reported higher diabetes prevalence among wealthier classes compared to poorer groups, indicating that the relationship between socioeconomic status and diabetes may be context-dependent and influenced by lifestyle, healthcare access, and regional differences. [13]

In the present study, neither family history of hypertension nor family history of diabetes was found to be significantly associated with diabetes mellitus. Among participants with a family history of hypertension (n = 174), 20 individuals (11.49%) had diabetes, compared to 44 (10.32%) among those without such a history (n = 426), a difference that was statistically non-significant ($\chi^2 = 0.1761$; df = 1; p = 0.6747). Similarly, diabetes prevalence was higher among those with a family history of diabetes (13.84%, 18 of 130) than among those without (9.78%, 46 of 470), but this difference was also not statistically significant ($\chi^2 = 1.7606$; df = 1; p = 0.1845). Although family history is well-established as a risk factor for type 2 diabetes mellitus (T2DM), the absence of statistical significance in the present study may reflect sample size limitations or the influence of unmeasured confounding variables. Contrasting evidence from earlier research underscores this point—Jaya Prasad Tripathy et al. (2017) identified family history of diabetes, but not hypertension, as a significant risk factor; Ranjit Mohan Anjana et al. reported family history of diabetes as an important predictor; and a 2009 study in the urban population of Chandigarh also found a positive association. [7,12] These discrepancies highlight the potential context-specific nature of familial risk influences and the need for larger, multi-centric studies to clarify these associations.

Table-2: Association of diabetes with Lifestyle and Behavioural Risk Factors (n=600)

Variables	Diabetic	Non diabetic	Total	P-Value	Chi-Square Value
Duration of physical activity					
<150min/week	48 (19.04%)	204 (80.96%)	252	0.00001*	32.0271
>150min/week	16 (4.59%)	332 (95.41%)	348		
Smoking habit					
Never smokers	26(7.02%)	344 (92.98%)	370		
Ever smokers	38 (16.52%)	192 (83.48%)	230	0.0002*	13.4184
Body mass index					
Underweight	1 (1.16%)	85 (98.84%)	86	0.00001*	37.5703
Normal	10 (4.42%)	216 (95.58%)	226		
Overweight	14 (16.27%)	72 (83.73%)	86		
Obese	40 (19.80%)	162 (80.20%)	202		
Waist circumference					
Normal	33 (8.39%)	360(91.61%)	393	0.0130*	6.1585
High	31 (14.97%)	176(85.03%)	207		
Waist hip Ratio					
Normal	30 (7.10%)	392 (92.90%)	422	0.00001*	18.8943
High	34 (19.10%)	144 (80.90%)	178		

An inverse relationship was observed between the duration of physical activity and the prevalence of diabetes mellitus shown in Table 2 and Figure 1.

Among the 252 participants who reported engaging in physical activity for less than 150 minutes per week (below WHO's recommended threshold), 19.04% were found to be diabetic.

In contrast, only 4.59% of those engaging in physical activity for more than 150 minutes per week (n = 348) were diabetic. This association was found to be highly statistically significant (χ^2 = 32.0271; df = 1; p < 0.00001), indicating that insufficient physical activity is a strong risk factor for type 2 diabetes mellitus in this population.

In the present study, alcohol consumption was not found to be significantly associated with diabetes mellitus. Among ever-users of alcohol (n = 150), the prevalence of diabetes was 9.33%, compared to 11.11% among never-users (n = 450). This difference was statistically non-significant (χ^2 = 0.3731; df = 1; p = 0.5413).

Although the prevalence was marginally higher among never-users, the association remained insignificant, aligning with the findings of Tripura K. (2019) in Tripura, who also reported no significant relationship between alcohol consumption and diabetes. [14] In contrast, a case–control study by Venkatachalam et al. involving 300 participants identified alcohol consumption as an important predictor of diabetes, suggesting possible population-specific or methodological differences. [15]

In contrast to alcohol use, smoking history demonstrated a statistically significant association with diabetes mellitus. Among ever-smokers (n = 230), 16.52% were diabetic, compared to 7.02% among never-smokers (n = 370), a highly significant difference (χ^2 = 13.4184; df = 1; p = 0.0002). This finding underscores tobacco smoking as a potential modifiable risk factor for diabetes in the study population.

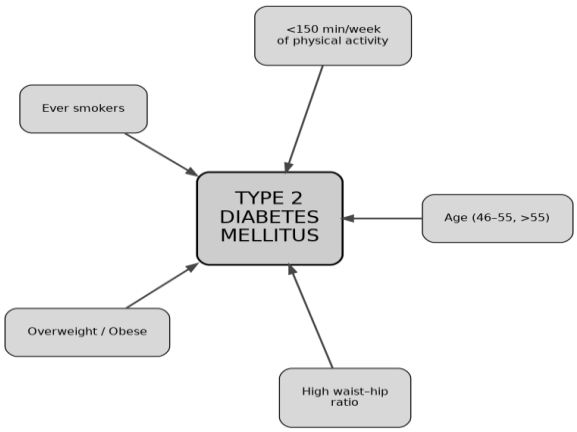

Figure-1: Web of causation model of Diabetes of studied population

Participants who reported a high frequency of eating meals outside the home (n = 346) exhibited a higher prevalence of diabetes (12.71%) compared to those with a low or no frequency (7.87%, n = 254). Although this difference approached statistical significance (χ^2 = 3.605; df = 1; p = 0.0576), it was not statistically significant, but the observed trend suggests a possible influence of dietary habits on diabetes risk, warranting further investigation.

Generalised obesity (BMI), abdominal obesity (waist circumference), elevated waist–hip ratio (WHR), smoking, and physical inactivity emerged as significant risk factors for diabetes in the present study. These associations have been consistently reported in various studies globally.[10,12,16] Notably, Indians tend to have a lower BMI than individuals of European descent; however, their diabetes risk increases at relatively lower BMI thresholds. [17] Physical activity is well established as having a protective effect against obesity, cardiovascular disease, and metabolic syndrome. [18] The associations between physical inactivity and diabetes in our study remained even after controlling for anthropometric measures, indicating that physical activity may directly influence diabetes risk beyond its role in obesity prevention. Public health strategies focusing on a healthy diet and promotion of physical activity could thus substantially reduce obesity—the single most important modifiable risk factor for type 2 diabetes. [19]

BMI showed a strong positive association with diabetes prevalence, which increased progressively with BMI category: underweight – 1.16% (n = 86), normal – 4.42% (n = 226), overweight – 16.27% (n = 86), and obese – 19.80% (n = 202). This trend was highly statistically significant (χ^2 = 37.5703; p < 0.00001), underscoring the role of higher BMI as a substantial risk factor. Similarly, among participants with high waist circumference (n = 207), the prevalence of diabetes was 14.97%, compared to 8.39% among those with normal waist circumference (n = 393), with a statistically significant association (χ^2 = 6.1585; p = 0.0130), highlighting central obesity's role in type 2 diabetes pathogenesis. Elevated WHR was also strongly associated with diabetes—19.10% prevalence among those with elevated WHR (n = 178) versus 7.10% among those with normal WHR (n = 422)—a highly significant finding (χ^2 = 18.8943; p < 0.00001), affirming WHR as an important anthropometric marker in diabetes risk assessment.

CONCLUSIONS

This community-based cross-sectional study, conducted among 600 adults in Gandhinagar district using a population proportion to size sampling method, estimated the prevalence of type 2 diabetes mellitus (T2DM) and its associated risk factors. The overall prevalence of T2DM was 10.66%, with nearly 40% of cases previously undiagnosed. The highest proportion of undiagnosed cases occurred in Dehgam taluka, potentially due to the predominance of rural populations.

Diabetes prevalence was higher among participants aged >45 years, those engaged in sedentary occupations, and individuals with obesity, high waist circumference, or elevated waist–hip ratio. Anthropometric indicators showed strong and statistically significant associations with T2DM: BMI, waist circumference, and WHR. Dietary habits also showed a suggestive, though not statistically significant, association with higher diabetes prevalence in individuals frequently consuming meals outside the home.

Other significant associations included age, reduced physical activity, and smoking status, whereas gender, residence, alcohol consumption, socioeconomic status, family history of diabetes, and hypertension were not significantly associated. These findings underscore the substantial role of obesity, both general and central, physical inactivity, and certain lifestyle behaviours in T2DM risk, highlighting the need for targeted community-based interventions to promote healthy diets, regular physical activity, and early screening, particularly in rural areas.

RECOMMENDATION

- Periodic anthropometric assessment in school- and college-going populations to enable early detection of individuals at risk for type 2 diabetes mellitus (T2DM).
- Integration of health-promotive lifestyle education into school and college curricula to encourage physical activity and balanced dietary habits from an early age.
- Promotion of healthy dietary practices, particularly increased consumption of green leafy vegetables and fruits, at both individual and community levels.
- Community awareness and sensitisation programmes focusing on non-communicable diseases (NCDs), their prevention strategies, and associated complications.
- Routine screening of individuals with established risk factors for T2DM, with emphasis on early detection of prediabetes to prevent progression.
- Expansion of screening strategies beyond health facilities to include community-based and camp-based initiatives for wider coverage.
- Strengthening tobacco and alcohol control measures, coupled with strict enforcement of related legislation.
- Institutional initiatives (schools, colleges, workplaces, healthcare facilities) to promote physical activity—e.g., "bicycle-to-work/school" days or similar campaigns—to improve population-level activity levels.

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