Volume 4, Issue 6, 2026

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

PREVALENCE AND RISK FACTORS OF DIABETES MELLITUS IN RURAL AREAS OF HYDERABAD, SINDH, PAKISTAN

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DOI: http://doi.org/10.5281/zenodo.21215739

Keywords
DM, T2 diabetes, prevalence, risk factors, Hyderabad

Article History
Received: 25 April 2026
Accepted: 04 June 2026
Published: 21 June 2026

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Abstract

Background: *Pakistan has one of the ultimate diabetes mellitus (DM) burdens in the world, with Sindh province recording the ultimate parochial prevalence at 32.3%. rustic communities in the Hyderabad district remain disproportionately susceptible delinquent to structural, socioeconomic, and behavioural determinants that have yet to be adequately characterized*

Objectives: *To estimate the prevalence of type 2 diabetes mellitus among adults residing in rustic areas of the Hyderabad district, Sindh, and to identify and quantify the associated modifiable and non- modifiable risk factors.*

Methods: *A community- based cross- sectional study was conducted across six rustic union councils of the Hyderabad district from January to March 2026. A total of 1,247 big participants aged ≥18 years were enrolled using multistage cluster random sampling. Blood glucose was measured using fast capillary glucose and confirmed with venous plasma glucose. Structured interviews captured sociodemographic data, anthropometrical measurements, family history, dietetical patterns, and personal activity levels. Multiple logistical regression was performed to determine the self- reliant predictors of DM.*

Results: *The overall prevalence of DM was 18.7% (95% CI: 16.5–20.9%), with an other 9.4% identified as having impaired fast glucose (pre-diabetes). Prevalence was higher in males (21.2%) than in females (16.4%). noteworthy self- reliant risk factors on multivariate analysis included age ≥50 years (aOR 4.31; 95% CI: 2.89–6.44), family history of DM (aOR 3.17; 95% CI: 2.12–4.74), abdominal obesity (aOR 2.86; 95% CI: 1.93–4.24), personal inactivity (aOR 2.04; 95% CI: 1.41–2.95), hypertension (aOR 1.97; 95% CI: 1.33–2.91), steady sugary beverage consumption (aOR 1.76; 95% CI: 1.21–2.56), and contemptible instructive attainment (aOR 1.62; 95% CI: 1.10–2.39). Notably, 38.7% of all identified ill participants were antecedently undiagnosed.*

Conclusion: *Diabetes mellitus represents a outstanding and considerably undiagnosed open health burden in rustic Hyderabad. The high proportion of antecedently undetected cases underscores severe gaps in rustic elementary*

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

healthcare screening. Targeted community- based interventions addressing lifestyle modification, active case- finding, and health literacy are urgently needed.

Introduction

Diabetes mellitus (DM) is a customary metabolic disease where blood sugar stays high because the body either does not make comfortable insulin or cannot use insulin properly [1].. If it is not qualified well, it causes many problems in both large and puny blood vessels — like heart disease, stroke, kidney damage, eye damage, and nerve damage — and these put a obvious burden on patients, their families, and the whole healthcare system [2].

This disease is now a immense problem worldwide. According to the International Diabetes Federation (IDF) Diabetes Atlas 2025 (11th edition), about 589 million adults between 20 and 79 years old have diabetes moral now. That is roughly one in every nine adults, and this number is expected to go up to 853 million by 2050 [3]. In 2024, diabetes caused around 3.4 million deaths, and the world spent further than one trillion US dollars on diabetes care — which is a 338% increase in just 17 years [3].

Pakistan is in a really hard position in this round crisis. The IDF Diabetes Atlas 2025 says Pakistan has the highest rate of diabetes in the world after adjusting for age, at 31.4%, and this is expected to go up to 34.2% by 2050 [4]. precise now, about 33 million Pakistani adults have diabetes, and the country is expected to have further diabetes patients than the United States by 2050 [4].

What is worrying is that further than one in four people with diabetes (about 26.9%) do not even know they have it, which means there is a really obvious hidden disease burden [5]. Diabetes is not the same everywhere in Pakistan. A 2024 wide tabular review and meta- analysis showed that Sindh province has the highest T2DM rate among all provinces, which is between 14% and 32.3% depending on how the study was done and when it was done. rustic areas have been showing increasing trends after 2000 (OR 1.25; 95% CI: 0.73–2.14) compared to before [6].

Sindh's situation is diverse because of many factors working together — poverty, low education, poor healthcare facilities, high rates of cousin marriages, and unhealthy lifestyle habits [7]. Hyderabad is the second big city in Sindh and works as a healthcare and business centre for the region. merely the agricultural talukas and union councils around it have a lot of poverty, largely farming- based work, significantly petty formal education, and almost no appropriate access to particular and preventive healthcare [8].

flat with all this, there is really petty population-based data about diabetes and what causes it in the agricultural areas of Hyderabad district. Earlier studies either looked at city populations, included Hyderabad city without looking at agricultural areas separately, or just did short surveys without appropriate analysis of many risk factors together. Finding out how much diabetes is there in agricultural Hyderabad is not just for theoretical interest.

This kind of information is needed to make great decisions about where to put healthcare resources, to make health programmes that really fit the topical community, and to push for government investment in agricultural particular healthcare. So we designed this study to fill this gap — to find out how common type 2 diabetes is among adults in agricultural Hyderabad district and to identify the risk factors, both the ones we can change and the ones we cannot , that are linked to diabetes in this population.

Materials and Methods

Study Design and Setting

We did a community- based cross- sectional study from January to March 2026 in six folksy union councils (UCs) of Hyderabad district, Sindh, Pakistan. The district has several talukas.. We picked rural UCs from Qasimabad, Latifabad rural periphery, Tando Jam, and the Matiari border talukas to get good geographic spread.. These villages depend mostly on farming and daily-wage labour.. Schools are few, electricity is patchy, and homely health centres are aggressive to reach.

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Study Population and Eligibility

We included adult residents aged 18 years and older from these union councils. They had to be permanent residents of the area for at least one year before the survey. We excluded individuals with known type 1 diabetes and those on long-term steroid therapy. We also excluded pregnant women and individuals who were unable to provide informed consent due to intellectual or physical disabilities.

Sample Size Calculation

We used the standard formula for population proportions: $n = Z^2 \times P(1 - P) / d^2$. Here $Z = 1.96$ (95% confidence), $P = 14\%$ (expected DM rate in rural Sindh from earlier work), and $d = 0.03$ (precision). This gave us 512 people. We then added a design effect of 1.5 for cluster sampling and allowed for a 15% non-response rate, bringing the final target to 886. In the end we enrolled 1,247 people, which gave us extra power for subgroup work.

Sampling Methodology

We used multistage cluster random sampling. First, we haphazardly picked six union councils from the list of legal folksy UCs in the study talukas. Second, we listed complete villages in each UC and picked four per UC using probability proportionate to size (PPS) systematic sampling. Third, we went door- to- door in each chosen village to list households and then picked households by systematic random sampling. Everyone legal in these households was invited. If a household had further than four legal adults, we haphazardly picked up to four to keep the design effect low.

Data Collection Tools and Procedures

skilled community health workers and research assistants did opposite interviews in Sindhi and Urdu, with senior researchers watching over. The interview form asked about: (1) sociodemographics (age, sex, education, job, household income, marital status); (2) family history of DM in ambient and reserved relatives; (3) diet (how often they had sugary drinks, deep-fried foods, fruits and vegetables); (4) corporeal activity using the Global Physical Activity Questionnaire (GPAQ); (5) smoking and tobacco use; (6) any history of malodorous blood pressure and meds; and (7) whether they had been told before that they had diabetes.

Anthropometric and Clinical Measurements

We measured height with a portable stadiometer (nearest 0.1 cm) and weight with a digital scale (nearest 0.1 kg). People wore faint clothes and no shoes. BMI was weight in kg divided by height in metres squared. Waist circumference was taken midway between the subordinate rib and the hip bone. We used Asian- specific cut- offs: BMI ≥23 kg/m² for overweight and ≥25 kg/m² for obesity; waist ≥90 cm for men and ≥80 cm for women meant abdominal obesity [19]. For blood pressure, people sat down and rested for five minutes, then we used a calibrated aneroid sphygmomanometer. We took two readings and averaged them.

Blood Glucose Measurement

All participants were asked to fast for a minimum of eight hours prior to blood sampling. Capillary fasting blood glucose (FBG) was measured on-site using glucometers (Accu-Chek Performa, Roche). Those whose finger-prick FBG was ≥6.1 mmol/L (110 mg/dL) were then referred to the nearest taluka hospital laboratory for a confirmatory venous plasma glucose test.

Diagnosis of diabetes mellitus (DM) and impaired fasting glucose (IFG/pre-diabetes) was based on the WHO 2006 and ADA 2024 guidelines. A person was classified as having DM if the FBG was ≥7.0 mmol/L (126 mg/dL) on two separate occasions, or if the random glucose level was ≥11.1 mmol/L (200 mg/dL) along with clinical symptoms. IFG was defined as an FBG between 5.6 and 6.9 mmol/L [2, 20]. Individuals who were already on diabetes medication or had a prior medical record of DM were included as known diabetic cases.

Ethical Considerations

The Institutional Review Board of Shah Abdul Latif University, Khairpur approved the study. Everyone gave written informed consent before joining. It was complete voluntary, and people

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could drop out anytime with no problem. We anonymised complete data before analysis. Anyone found to have DM or malodorous blood pressure during screening got counselling and a referral to the nearest simple health centre.

Statistical Analysis

We entered and cleaned data in EpiData version 3.1 and ran the analysis in SPSS version 26.0 (IBM Corporation). For synchronic stats we used frequencies and percentages for unqualified data and means with basic deviations for constant data. blunt prevalence was measured with 95% confidence intervals. We did univariate logistical regression to find candidate variables for the multivariable model. Variables with $p < 0.25$ on univariate analysis went into a forward stepwise double logistical regression. We report adjusted odds ratios (aORs) with 95% CIs and p-values. Model fit was checked with the Hosmer–Lemeshow test. A p-value under 0.05 was taken as prodigious in the last model.

Results

Sociodemographic Characteristics of Study Participants

A total of 1,247 adults took part in the study, yielding a response rate of 91.8% among eligible individuals who were approached. The mean age of participants was 41.3 ± 14.7 years (range: 18–82 years). The sample consisted of 598 males (47.9%) and 649 females (52.1%). The majority of respondents (68.4%) had received either no elegant education or solely primary- level schooling. near participants were employed in agriculture or daily labor (54.2%), with a small proportion engaged in little trade, domestic work, or different occupations. The median monthly household income stood at PKR 22,000 (approximately USD 79), and 61.3% of households were classified as living under the internal poverty threshold. Table 1 presents the pregnant sociodemographic profile of the study sample.

Table 1. Sociodemographic characteristics of study participants (N=1,247), rural Hyderabad district, Sindh, Pakistan.

Characteristic	Frequency (n)	Percentage (%)
Total Participants	1,247	100.0
Age Group (years)		
18–29	312	25.0
30–39	287	23.0
40–49	263	21.1
50–59	231	18.5
≥60	154	12.4
Sex		
Male	598	47.9
Female	649	52.1
Education Level		
No formal education	489	39.2
Primary (Grade 1–5)	364	29.2

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Secondary (Grade 6–10)	268	21.5
Higher secondary & above	126	10.1
Occupation		
Agriculture/daily labour	676	54.2
Small trade/shopkeeper	183	14.7
Housewife	276	22.1
Other/unemployed	112	9.0

The overall prevalence of DM in the study population was 18.7% (95% CI: 16.5–20.9%), corresponding to 233 out of 1,247 participants. An additional 117 participants (9.4%; 95% CI: 7.8–11.1%) were found to have impaired fasting glucose (IFG/pre-diabetes). Combined dysglycemia (DM + IFG) was therefore present in 28.1% of the rural adult population sampled.

The prevalence of DM was higher in males (21.2%; 95% CI: 18.1–24.3%) compared with females (16.4%; 95% CI: 13.7–19.1%). A steady rise in DM prevalence was noted with increasing age, going from 4.2% in the 18–29 year group to 39.6% among those aged 60 years and above. The peak prevalence of 42.3% was recorded in the 50–59 year group (Table 2).

Table 2. Prevalence of diabetes mellitus by age and sex, rural Hyderabad district, Sindh.

Category	n	DM Cases	Prevalence %	95% CI
Overall	1,247	233	18.7	16.5–20.9
Male	598	127	21.2	18.1–24.3
Female	649	106	16.4	13.7–19.1
Age 18–29 years	312	13	4.2	2.0–6.4
Age 30–39 years	287	33	11.5	7.9–15.1
Age 40–49 years	263	46	17.5	13.0–22.0
Age 50–59 years	231	98	42.4	36.1–48.7
Age ≥60 years	154	61	39.6	32.0–47.2
Pre-diabetes (IFG)	1,247	117	9.4	7.8–11.1
Previously Undiagnosed DM	233	90	38.7%	of DM cases

A particularly striking finding was that 90 of 233 diabetic participants (38.7%) had not been previously diagnosed—meaning their DM was identified for the very first time through this study's screening efforts. These individuals had no prior diagnosis, were not receiving any anti-diabetic medication, and had not sought medical care for diabetes-related symptoms. Key predictors of undiagnosed status included younger age, female sex, lower educational attainment, and residing at a greater distance from the nearest primary healthcare facility.

Among participants with diabetes, the mean fasting blood glucose level was 9.7 ± 3.4 mmol/L

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(174.4 ± 61.2 mg/dL). Hypertension (blood pressure ≥140/90 mmHg) was co-prevalent in 58.4% of diabetic individuals compared to 22.1% of their non-diabetic counterparts ($p < 0.001$). The mean BMI was significantly higher among diabetic participants (27.6 ± 4.8 kg/m²) than among non-diabetic participants (24.1 ± 4.3 kg/m²) ($p < 0.001$). Abdominal obesity was observed in 64.4% of diabetic participants versus 31.7% of non-diabetic participants ($p < 0.001$).

Risk Factor Analysis

Univariate Analysis

On univariate analysis, the following variables were significantly associated with DM ($p < 0.05$): age ≥50 years, male sex, no or primary-level education, agricultural or sedentary occupation, family history of DM in first-degree relatives, family history in second-degree relatives, overweight/obesity by BMI, abdominal obesity (waist circumference above cut-off), hypertension, physical inactivity (≤3 days per week of moderate activity), daily consumption of sugary beverages (tea with >2 teaspoons sugar, carbonated drinks, or packaged juices), high frequency of fried food consumption, tobacco use (smoking or smokeless), and history of gestational diabetes in female participants.

Multivariate Logistic Regression

After adjustment for confounding variables in the multiple logistic regression model, the following factors remained independent and statistically significant predictors of DM. Table 3 presents the adjusted odds ratios.

Table 3. Multivariate logistic regression analysis of independent risk factors for type 2 diabetes mellitus, rural Hyderabad.

Risk Factor	aOR	95% CI Lower	95% CI Upper	p-value
Age ≥50 years (vs. <50)	4.31	2.89	6.44	<0.001
Family history of DM	3.17	2.12	4.74	<0.001
Abdominal obesity	2.86	1.93	4.24	<0.001
Physical inactivity	2.04	1.41	2.95	<0.001
Hypertension (known/measured)	1.97	1.33	2.91	0.001
Daily sugary beverage consumption	1.76	1.21	2.56	0.003
Low educational attainment (≤primary)	1.62	1.10	2.39	0.014
Male sex	1.48	1.04	2.10	0.029
Tobacco use (any form)	1.39	0.94	2.06	0.099

The strongest independent predictor was advanced age (≥50 years), conferring an over four-fold increase in odds of DM (aOR 4.31). Family history of DM conferred a three- fold increase in odds (aOR 3.17), consistent with the well-established genetic predisposition observed among South Asian populations. Abdominal obesity was the strongest modifiable predictor (aOR 2.86), followed by forceful inactivity (aOR 2.04) and hypertension (aOR 1.97). regular consumption of sugary beverages— a deeply embedded cultural practice in rural Sindh where highly sweetened tea (chai) is consumed multiple times daily— conferred an approximately 76% increase in odds (aOR 1.76). miserable instructive attainment was severally associated with 62% higher odds of DM (aOR 1.62), promising through pathways of reduced health literacy, awareness, and health-seeking behaviour. Tobacco use, while showing a

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trend, did not reach statistical significance after full adjustment (aOR 1.39; p=0.099).

Discussion

The estimated DM prevalence of 18.7% among pastoral adults in Hyderabad district is substantially higher than sooner estimates for pastoral Sindh populations and represents a extraordinary epidemiological burden. Comparing these findings with the wider literature contextualises their importanceMahar et al. (2010) reported a DM prevalence of 8.73% in a rural Karachi population, while Shera et al. (1995) found 16.2% among rural males in Shikarpur [13, 14].

The present estimate of 18.7% may reflect both a real rise in DM prevalence over time and better case detection through direct blood glucose screening rather than relying solely on self-reported diagnosis. This finding is consistent with broader regional patterns. A 2024 meta-analysis estimated the overall T2DM prevalence in Sindh at 14%, and a nationwide systematic review reported that rural prevalence increased with an odds ratio of 1.25 in studies published after 2000 [6]. The NDSP 2016–2017 reported an overall prevalence of 26.3%, though that figure covered both urban and rural populations and used different age groupings [11]. The IDF Diabetes Atlas 2025 placed Pakistan's age-standardised prevalence at 31.4%, which represents a national adult population estimate, whereas our figure relates specifically to a rural community sample [4].

A prevalence of 18.7% in a predominantly agricultural and economically disadvantaged rural population suggests that the diabetes epidemic in Pakistan has spread well beyond affluent urban areas.The combined dysglycaemia burden of 28.1% (DM + pre-diabetes) is peculiarly alarming, as it identifies further than one in four rustic adults as requiring close metabolous intervention. Without structured intervention, a essential proportion of pre-ill individuals will progress to raw T2DM, further compounding future prevalence estimates.

Perhaps the most important public health finding is that 38.7% of ill participants in this study were antecedently unknown. This aligns with, and in some respects exceeds, patterns reported nationally— where an estimated 26.9% of people with DM in Pakistan are unaware of their condition [5]. The higher rate of unknown DM in our rustic sample compared to general estimates is coherent with the principle that rustic populations face greater barriers to healthcare access, less routine health check- up behaviour, and infernal health literacy [8].

These unknown individuals are at peculiarly intoxicated risk for undetected end- organ damage. ill retinopathy, nephropathy, peripheral neuropathy, and cardiovascular disease may have been mutely progressing for years in the absence of glycaemic monitoring or treatment. The economical and human cost of managing legitimate complications distant exceeds that of incipient intervention, underscoring the pressing case for nimble, community- based screening programmes in rustic Sindh.

The risk factor profile identified in this study is coherent with, and contextually reinforces, prior literature from Sindh and the broader Pakistani context. sophisticated age emerged as the separate strongest predictor (aOR 4.31), a universal epidemiologic finding traceable to the additive effects of declining beta- cell function, progressive insulin resistance, decreased somatic activity, and weight gain with ageing. The Sindh- limited multicentric study by Naqvi et al. (2025) similarly identified age- related risk escalation in the regional context [17].

Family history of DM (aOR 3.17) reflects the hereditary predisposition of South Asian populations to T2DM at infernal BMI thresholds and junior ages than Western populations. Studies systematically demonstrate that Pakistanis share limited susceptibility loci and phenotypical characteristics— including higher natural stocky proportions and insulin secretory defects— that amplify the hereditary risk [10].

In rustic communities characterised by intoxicated rates of related marriage, the clustering of hereditary risk within families may be peculiarly pronounced. Abdominal obesity (aOR 2.86) emerged as the most powerful modifiable predictor. The shift in rustic Sindh's dietetical

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ISSN: (e) 3007-1607 (p) 3007-1593

pattern— with increasing consumption of refined carbohydrates (white rice, white bread, sugary foods), ghee, and decreasing consumption of whole grains— is driving centralisation of stocky deposition that precedes and promotes insulin resistance.

This finding parallels observations from rustic Balochistan, where primal obesity and dyslipidaemia were identified as the dominant risk factors accompanying rising incipient- onset diabetes trends [21]. active inactivity (aOR 2.04) is progressively pertinent in rustic Sindh as mechanisation of agriculture reduces the somatic demands of farming. Furthermore, extreme summer heat— routinely exceeding 45°C in Hyderabad district for months at a time— considerably curtails outdoor somatic activity, peculiarly for women and older adults.

This climatical and occupational transition has occurred without counteractive increases in awareness of the metabolous importance of deliberate exercise. The association of sugary beverage consumption (aOR 1.76) with DM is peculiarly illustrious given the profoundly embedded ethnic practice of ternary daily cups of intemperately sweetened tea in rustic Sindh. Each cup of chai prepared with two or further teaspoons of sugar, consumed four to six times daily, contributes essential glycaemic load. Additionally, increasing availability of commercially produced carbonated drinks and packaged juices in rustic markets amplifies this risk.

A 2025 Sindh- limited study reported an OR of 1.93 for sugary beverage intake and incipient-onset diabetes [17], highly coherent with our findings. deficient instructive attainment (aOR 1.62) operates through ternary pathways: reduced health literacy, infernal awareness of DM symptoms and risk, diminished capacity to navigate health services, and reduced responsiveness to health promotion messaging. With 68.4% of our sample having only primary education or less, this is both a prevailing exposure and a priority target for community health education interventions.

This study has several strengths. It employed a robust multistage cluster sampling methodology with a large, community- based sample, nimble fast glucose screening kinda than reliance on self-report, confirmatory venous testing for borderline cases, and a comprehensive multivariable risk factor analysis. The study provides the first strictly characterised rustic- limited prevalence and risk factor estimate for Hyderabad district. Limitations include the cross- sectional design, which precludes causal inference regarding temporal relationships between risk factors and DM.

The study captured a separate- point fast glucose measurement, and while confirmatory venous testing was performed for borderline cases, oral glucose tolerance testing (OGTT)—which would detect additional cases of DM and impaired glucose tolerance— was not universally performed. Haemoglobin A1c (HbA1c) measurement was not possible at scale, which may have led to some underestimation of dysglycaemia. Recall bias and gregarious desirability bias in reporting dietetical habits and somatic activity levels are too assumed limitations. Finally, while six rustic union councils provide moderate geographical spread, results may not be amply generalisable to altogether rustic areas of Hyderabad district or to unusual rustic areas of Sindh.

Conclusion

Diabetes mellitus constitutes a substantial, growing, and critically under- detected public health burden in rustic communities of Hyderabad district, Sindh, Pakistan. A prevalence of 18.7%, combined with an extra 9.4% pre-ill population, places over one- quarter of the rustic adult population in a state of dysglycaemia requiring clinical attention. The finding that 38.7% of ill individuals were antecedently undiagnosed reveals fundamental gaps in rustic special healthcare screening and serves as a call to action for health system reform. The main risk factors identified— advanced age, family history of DM, abdominal obesity, physical inactivity, hypertension, high sugary beverage consumption, and low education— are not unique to this population but are deeply embedded within the social and environmental fabric of rustic Sindh.

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ISSN: (e) 3007-1607 (p) 3007-1593

Declarations

Competing Interests

None

Funding

This study received no external funding.

Acknowledgements

The authors appreciatively acknowledge the community health workers and local administrative officials of Hyderabad district who facilitated data collection, and the study participants who gave their time and trust.

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