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**Original Research Article**

# Assessing the Prevalence of Type 2 Diabetes Mellitus and Impaired Glucose Tolerance in the Adult Urban Population of Katihar, North Bihar: A Cross-Sectional Study

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**Abstract:**

**Background:** Diabetes Mellitus, with a history tracing back to 1500 BC, has evolved into a global epidemic, particularly impacting low and middle-income countries. The chronic condition, characterized by the body's inability to produce or properly use insulin, leads to elevated glucose levels in the blood. Type 2 Diabetes Mellitus (T2DM), the most prevalent form, is significantly influenced by urbanization, diet, and lifestyle changes. This study aims to explore the prevalence and risk factors of T2DM and Impaired Glucose Tolerance (IGT) in the urban setting of Katihar City, Bihar, to provide insights into the scope of these conditions and their association with various socio-demographic and lifestyle factors.

**Methods:** Conducted in Sharifganj, Katihar, this community-based cross-sectional observational study involved 1050 adults aged 20 years and above, selected through systematic random sampling. Data were collected via interviews and physical measurements, with statistical analysis performed using MS Office Excel 2016 and SPSS-20.

**Results:** The study found a T2DM prevalence of 9.24% and an IGT prevalence of 12.48%, with notable risk factors including age, family history, dietary habits, tobacco use, hypertension, and obesity markers such as high BMI and increased waist-hip ratio. The majority of participants were in the 51-60 age group, with a slight male predominance.

**Conclusion:** The high prevalence of T2DM and IGT in Katihar City underscores the urgent need for public health interventions focusing on awareness, early screening, and the promotion of healthier lifestyles.

Recommendation: Strategies should target improving dietary habits, increasing physical activity, and providing targeted interventions across different socio-economic groups to effectively manage and prevent T2DM and IGT.

**Keywords:** Diabetes Mellitus, Type 2 Diabetes Mellitus, Impaired Glucose Tolerance, Risk Factors,Bihar



## Introduction

Diabetes mellitus, a condition documented as early as 1500 BC in an Egyptian manuscript, has been a part of human history for thousands of years, with its distinct symptom of excessive urination noted by civilizations from ancient Greece to India [1]. The term "diabetes," derived from Greek, meaning "siphon," and the addition of "mellitus" by Thomas Willis in 1675 due to the sweet taste of diabetic urine, highlights the long-standing recognition of this disease's characteristics [2]. The distinction between types of diabetes, including the condition "Madhumeha" described in ancient Indian texts by Sushruta and Charaka, marks the early understanding of the disease's complexity. Currently, diabetes is recognized as a long-term condition that results from the body's inability to produce or effectively utilize insulin, resulting in increased glucose levels in the bloodstream. This metabolic disorder has a major impact on global health, causing a significant burden on low and middle-income countries in terms of illness and death [3,4].

In 2016, non-communicable diseases (NCDs), with diabetes being a major component, were responsible for a substantial proportion of global deaths, underscoring the pressing need to address this escalating health crisis [5,6]. Diabetes is classified by the World Health Organisation into different types, such as Type 1, Type 2, and gestational diabetes. Each type has its unique characteristics and presents its own set of management challenges. The

prevalence of Type 2 diabetes has become a global epidemic, with factors such as rapid urbanization, unhealthy diets, and sedentary lifestyles driving its widespread occurrence [7]. With over 425 million people affected worldwide, the urgency to curb the diabetes epidemic is more pressing than ever, necessitating comprehensive efforts to improve early diagnosis, treatment, and prevention strategies to mitigate the disease's impact on individuals and healthcare systems globally [8].

This study investigates the occurrence and potential factors linked to Type 2 Diabetes Mellitus (T2DM) and Impaired Glucose Tolerance (IGT) in adults aged 20 years and above residing in the urban area of Katihar City, in North Bihar. The goal is to accurately assess the prevalence rates of T2DM and IGT in this population, shedding light on the extent of these health issues in an urban setting. In addition, the study aims to explore the correlation between various risk factors and the occurrence of T2DM and IGT in the population. The goal is to gain an in-depth knowledge of the factors that contribute to these circumstances in the urban environment of Katihar.

## Material and Methodology

### Study Location

The research was carried out in Sharifganj, an urban locality within Katihar, situated along the Katihar-Manihari State Highway. The population of Sharifganj is approximately 12,000.

### Study Approach

This was a community-based cross-sectional observational study spanning one year, from January to December 2018.

### Participants

Adult residents of Sharifganj, Katihar, aged 20 years and above, were included, with specific inclusion and exclusion criteria to refine participant selection. People with a known case of Type 2 Diabetes Mellitus (T2DM) were specifically included, while those with secondary causes of hyperglycemia or Type 1 Diabetes were excluded.

### Sample Size Calculation

Based on WHO's reported diabetes prevalence of 8.7% in India in 2015, the study's sample size was calculated to be approximately 1050 individuals.

$$\eta = \frac{Z^2 X pq}{L^2}$$

Where $\eta$ =sample size

p = prevalence rate of disease,

here p=8.7% = 0.087

q= 1-p = complement of p

here q=1-0.087 = 0.913

L= permissible error (Beta error) = 20% of p

20% of 0.087= 0.0174

Z= alpha error (level of significance)

5% error with a probability of 0-0.5

=1.96=2

$=Z^2 = 2^2 = 4$

and $L^2 = (0.0174)^2 = 0.0003028$

$$\therefore \eta = \frac{4 \text{ X } 0.087 \text{ X } 0.913}{0.0003028} = 1049.28$$

So, the sample size of this study was rounded to1050

### Sampling Technique

The study randomly selected households among the estimated 2500 homes in Sharifganj with eligible participants, using systematic random sampling. Ultimately, 1050 individuals were included, comprising 537 males and 513 females.

### Data Collection

Data were collected through personal interviews using a predesigned questionnaire, which included socio-demographic characteristics and other factors related to diabetes. Measurements such as height, weight, Body Mass Index (BMI), waist and hip circumferences, and blood pressure were taken following standard procedures.

### Study Variables

Variables included age, education, occupation, physical activity levels, socio-economic status, family history of diabetes, and tobacco use. Specific instruments and scales, like the Modified Kuppuswamy Socioeconomic Status Scale, were employed to categorize various socio-economic and lifestyle factors.

Body Mass Index(BMI) was calculated using formula:

$$BMI = \frac{\text{Weight (Kg)}}{\text{Height (m}^2\text{)}}$$

Waist Hip Ratio(WHR) was calculated using formula of :

Waist circumference/Hip circumference

The categorization of BMI and WHR is

| Classification | BMI (kg/m²) |
|---|---|
| Underweight | <18.5 |
| Normal range | 18.5-24.9 |
| Over weight | >25 |
| Pre-obese | >25-29.9 |
| Obese Class I | 30-34.9 |
| Obese Class II | 35-39.9 |
| Obese Class III | >40 |

| Waist to Hip Ratio Chart (WHO) Criteria | | |
|---|---|---|
| **Waist Hip Ratio** | **Male** | **Female** |
| High | > 0.90 | > 0.85 |
| Normal | Below 0.90 | Below 0.85 |

**Blood Pressure and Sugar Estimation**

Blood pressure was measured using standard procedures, and blood sugar levels were assessed through fasting and post-glucose tests following WHO and IDF recommendations.

**BLOOD SUGAR ESTIMATION:**

After the interview, participants were informed about procedural details of the blood sugar investigation. Objective of the study was clearly explained in local language to the subjects. Participants were motivated to fast overnight and its importance was stressed for correct blood sugar recording.

In the next morning subjects screened for fasting and post glucose as recommended by WHO and IDF.

Early morning in full aseptic condition the blood sample was drawn and kept in Sodium flouride containing containers after taking early morning fasting sample, Subjects were given 75 grams of anhydrous glucose in 200ml of water to drink in 5 minutes. Exactly after 2 hours the post glucose sample was taken to estimate the oral glucose tolerance. Samples were tested in the laboratory on the same day by using GOD/POD method for blood glucose estimation.

**GOD/POD Reaction**:

$$\text{Glucose} + O_2 + H_2O_2 \xrightarrow{\text{Glucose Oxidase}} \text{Gluconic Acid} + H_2O$$

$$H_2O_2 + \text{Phenol} + 4\ \text{aminoantipyrine} \xrightarrow{\text{Peroxidase}} \text{quinonimine} + H_2O$$

Glucose concentration in the sample is calculated using the following formula:

$$\text{Glucose mg/dl} = \frac{\text{Absorbance of Test Sample}}{\text{Absorbance of Standard}} \times 100$$

The participants were informed about the result of the blood sugar estimation done and necessary advice was given and referral was done for further management, if needed.

Results analyzed as per recommended diagnostic criteria for Diabetes and Intermediate Hyperglycemia[4]as:

**1. Diabetes should be diagnosed if ONE OR MORE of the following criteria are met:**

- Fasting Plasma Glucose $\geq$ 7.0 mmol/L (126mg/dl)
- Two Hour Plasma glucose $\geq$ 11.1 mmol/L(200mg/dl) following a 75grams oral glucose load.

**2. Impaired Glucose Tolerance (IGT) should be diagnosed if BOTH of the following criteria are met:**

- Fasting Plasma Glucose $\leq$ 7.0mmol/L(126 mg/dl)
- Two Hour Plasma Glucose 7.8-11.1 mmol/L (140-200mg/dl) following a 75 grams oral glucose load.
-

**3. Impaired Fasting Glucose (IFG) should be diagnosed if BOTH of the following criteria are met:**

- Fasting Plasma Glucose 6.1-6.9 mmol/L (110-125mg/dl)
- Two hour plasma glucose < 7.8mmol/L (140mg/dl) following 75grams oral glucose load.

**Data Analysis**

Data were analyzed using MS Office Excel 2016 and SPSS-20 software. Statistical significance was determined at a p-value of <0.05, with chi-square tests and graphic presentations used for data interpretation.

**Results**

The study provides a comprehensive overview of various factors influencing the prevalence of Type 2 Diabetes Mellitus (T2DM) and Impaired Glucose Tolerance (IGT) among participants. The age and gender distribution showed a majority of participants were between the ages of 51-60, with a slight male predominance across the sample. In terms of conditions, T2DM was present in 9.24% of participants, whereas IGT was more common at 12.48%, though a significant 78.28% of the population was considered normal.

Regarding religious affiliation, 63.24% of the population identified as Muslims, while 36.76% identified as Hindu. The impact of age on these conditions was evident, with the highest prevalence of T2DM and IGT observed in the 61-70 age group. Gender differences were also noted, with males slightly more affected by T2DM and IGT than females, though the differences were not statistically significant.

The study further highlighted the influence of family structure, showing that individuals from nuclear families had a higher prevalence of both conditions compared to those from joint families. A positive family history of diabetes was a significant risk factor, increasing the likelihood of developing T2DM and IGT. Occupational impact was noted as well, with semi-skilled and unskilled workers exhibiting the highest prevalence of T2DM, and variations in IGT prevalence across different job types.

Educational qualifications did not significantly affect the prevalence of T2DM and IGT, while socio-economic status showed that individuals from the lower middle class had the highest prevalence of T2DM. The study also found that tobacco use and non-vegetarian dietary habits were associated with a slightly higher prevalence of these conditions.

Furthermore, hypertensive individuals and those with sedentary lifestyles had significantly higher rates of T2DM and IGT, underscoring the importance of managing blood pressure and engaging in physical activity. Overweight and obese individuals, as well as those with a higher Waist-Hip Ratio (WHR), especially noted significant differences between genders, and had an increased prevalence of T2DM and IGT, highlighting the impact of body composition on these conditions

**Table 1: A comprehensive summary of the distribution and prevalence of T2DM and IGT in the study population, highlighting the significant factors associated with these conditions.**

| Category | Detail | T2DM Prevalence | IGT Prevalence | Normal Prevalence | Total Sample Size | Significance |
|---|---|---|---|---|---|---|
| **Overall Prevalence** | - | 9.24% | 12.48% | 78.28% | 1050 | - |
| **By Age Group** | 20-30 years | 3.70% | 9.26% | 87.04% | 108 | Significant |
| | 31-40 years | 6.04% | 13.74% | 80.22% | 182 | |
| | 41-50 years | 8.36% | 11.50% | 80.14% | 287 | |
| | 51-60 years | 7.96% | 10.19% | 81.85% | 314 | |
| | 61-70 years | 20.86% | 21.58% | 57.56% | 139 | |
| | >70 years | 20.00% | 5.00% | 75.00% | 20 | |
| **By Gender** | Male | 9.87% | 12.66% | 77.47% | 537 | Not significant |
| | Female | 8.58% | 12.28% | 79.14% | 513 | |
| **By Family Type** | Nuclear | 10.75% | 13.80% | 75.45% | 558 | Significant |
| | Joint | 7.52% | 10.98% | 81.50% | 492 | |
| **By Family History** | Present | 21.84% | 36.78% | 41.38% | 174 | Significant |
| | Absent | 6.74% | 7.64% | 85.62% | 876 | |
| **By Occupation** | Various Categories | Varied | Varied | Varied | 1050 | Significant |
| **By Education** | Various Levels | Varied | Varied | Varied | 1050 | Not significant |
| **By Socio-Economic Status** | Various Classes | Varied | Varied | Varied | 1050 | Significant |
| **By Tobacco Use** | Yes | 9.37% | 10.27% | 80.36% | 662 | Significant |
| | No | 9.02% | 16.24% | 74.74% | 388 | |
| **By Diet** | Veg | 6.25% | 8.85% | 84.90% | 192 | Significant |
| | Non-Veg | 9.90% | 13.28% | 76.82% | 858 | |
| **By Blood Pressure** | >140/90 | 21.30% | 26.33% | 52.37% | 338 | Significant |
| | <140/90 | 3.51% | 5.90% | 90.59% | 712 | |
| **By Physical Activity** | Various Levels | Varied | Varied | Varied | 1050 | Significant |
| **By BMI** | Various Categories | Varied | Varied | Varied | 1050 | Significant |
| **By WHR (Male)** | Various Levels | Varied | Varied | Varied | 537 | Significant |
| **By WHR (Female)** | Various Levels | Varied | Varied | Varied | 513 | Significant |

Note: The specific values for categories marked as "Varied" in the table reflect diverse outcomes across different sub-categories within those sections, as detailed in the full document. The prevalence rates and significance are interpreted based on statistical analysis, with "Significant" indicating a p-value of <0.05, suggesting a statistically significant difference or association.

## Discussion

The study carefully examines the many factors that affect T2DM and IGT in individuals, who were mostly 51-60 years old and slightly male. Notably, T2DM was found in 9.24% of participants, IGT in 12.48%, while a substantial 78.28% were normal. A significant portion of the sample identified as Muslim (63.24%), with the rest Hindu (36.76%), and the highest prevalence of T2DM and IGT was in those aged 61-70, regardless of the minor gender differences. The study also emphasized the role of family structure, indicating that individuals from nuclear families were more prone to both conditions, and a positive family history of diabetes markedly increased risk. Occupational roles, particularly among semi-skilled and unskilled workers, showed a higher incidence of T2DM, whereas educational qualifications had a negligible impact. Socio-economic factors revealed that the lower middle class was most affected by T2DM. Lifestyle factors, including tobacco use and non-vegetarian diets, were linked to a modest increase in prevalence, while hypertension, sedentary lifestyles, overweight, obesity, and higher Waist-Hip Ratios, particularly with notable gender differences, were significantly associated with elevated rates of T2DM and IGT, underscoring the critical influence of health management and physical activity.

The present study revealed a prevalence of T2DM at 9.24%, slightly exceeding the figures reported by the World Health Organization (WHO) in 2015 (8.7%) and the International Diabetes Federation (IDF) in 2017 (8.8%). When compared to regional data, the prevalence aligns closely with Maharashtra's 10.9% as reported by Anjana RM et al. [9] in the ICMR INDIAB Phase-I study, but remains lower than Jharkhand's 13.5% and significantly less than urban areas in Tamil Nadu and Chandigarh with prevalences reaching up to 14.2%. Similarly, Tripathy JP et al. (2017) [10] found a prevalence of 9.4% in urban Punjab, closely mirroring our findings. The study also reported an Impaired Glucose Tolerance (IGT) prevalence of 12.48%, comparable to Maharashtra's 12.8% and significantly higher than Jharkhand's 8.1%, according to the same ICMR INDIAB study. The National Urban Disease Survey (NUDS) [11] and the Chandigarh Urban Diabetes Survey (CUDS) [12] in 2011 cited prevalences of 14% and 13.2% for IGT respectively, closely aligning with the current study, while Poornima MP et al. (2018) [13] reported a slightly lower prevalence of 10.8%.

The demographic analysis of the study subjects indicated a majority within the 41–60-year age range, making up 57.24% of the total. The prevalence of diabetes and IGT was highest among those aged 61-70, underscoring a clear trend of increasing prevalence with age. This is in line with findings from Devi R et al. (2016) [14] and Mohan et al. [15] in the Chennai Urban Population Study (CUPS), which observed a similar age-related increase in diabetes prevalence. Singh PS et al. (2017) [16] further supported these observations, highlighting the highest T2DM prevalence in the 50-59- and 60-69-year age groups. These collective findings underline a critical need for targeted interventions in older populations to manage and prevent the progression of T2DM and IGT.

## Conclusion

In a community-based cross-sectional study of 1050 people in Sharifganj, Katihar, Bihar, researchers examined the prevalence and risk factors of Type 2 Diabetes Mellitus (T2DM) and Impaired Glucose Tolerance. The participant pool, which included 537 males and 513 females, showed a T2DM prevalence of 9.24% and an IGT prevalence of 12.48%, aligning with the national averages reported by the WHO and IDF. These statistics highlight the significant health challenges posed by T2DM and IGT amidst socio-economic and lifestyle transitions in both urban and rural settings. The study identified key risk factors for the development of these conditions, including age, family history, dietary habits, tobacco use, hypertension, occupation, physical inactivity, socioeconomic status, and obesity indicators such as a high Body Mass Index (BMI) and waist-hip ratio. Notably, the study underscored the impacts of sedentary lifestyles, dietary choices, and genetic predispositions on diabetes prevalence, with lower education levels linked to higher diabetes rates due to likely reduced health awareness and poor dietary choices. The research underscores the urgent need for increased awareness and education regarding T2DM risk factors, advocating for early screening, lifestyle changes, and targeted interventions across socio-economic groups to mitigate the diabetes epidemic in India.

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