# Identifying knowledge of Diabetes Mellitus – Type 2 in Rural Population using Data Mining

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## ABSTRACT

Diabetes Mellitus (DM) is one of the fastest-growing public health challenges of the 21st century. Limited socioeconomic resources and inadequate awareness significantly contribute to poor disease recognition, particularly in rural populations. Untreated DM can lead to serious complications, necessitating regular check-ups and continuous monitoring of blood glucose levels. This study aimed to estimate the prevalence and Anatomical Therapeutic Chemical (ATC) classification of diabetes across various socio-demographic categories in India, using data from the fifth National Family Health Survey (NFHS-5, 2019–2021), which covered all Indian states. The dataset included 2,078,315 individuals aged 15 years and above, with prevalence and ATC statistics adjusted for age and sex, and stratified by wealth quintile, age, education, and gender. Additionally, 974 participants from a clinical survey in rural Tamil Nadu were assessed using a modified Michigan Diabetes Awareness Questionnaire. Results indicated no statistically significant difference in DM knowledge by gender, occupation, or education level (p = 0.4721), but a significant difference by age group (p = 0.0062). Overall, 66.72% of respondents demonstrated basic knowledge of DM, 54.18% identified the optimal method for home glucose monitoring, and 53.8% recognized major complications. Knowledge levels were distributed as average (46.37%), good (40.92%), low (7.71%), and excellent (5.00%). These findings highlight the need for targeted educational interventions to improve diabetes awareness and management, especially among younger and socioeconomically disadvantaged groups.

**Keywords:** Awareness, Blood glucose, Diabetes Mellitus, Knowledge, Rural population

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## INTRODUCTION

Diabetes is a group of metabolic disorders characterized by persistent hyperglycaemia, leading to both microvascular and macrovascular complications that significantly impair quality of life and reduce life expectancy (Pang et al., 2021). According to the World Health Organization (WHO), the global prevalence of Diabetes Mellitus (DM) has increased from 4.70% in 1980 to

8.50%, with an estimated 422 million people affected worldwide. The disease is particularly prevalent in Asian countries, with India and Pakistan reporting rates of 8.50% and 6.70%, respectively (Sun et al., 2022). Effective DM management requires not only the use of appropriate medication but also patient awareness and daily self-care practices. As a major noncommunicable disease (NCD), DM represents a substantial threat to global health, often progressing to a chronic condition that elevates morbidity and mortality rates, reduces quality of life, and imposes a significant financial burden on healthcare systems (Moraes et al., 2020).

Type 2 Diabetes Mellitus (T2DM) is regarded as a major public health crisis globally due to the high rates of premature death, severe complications, and significant morbidity and mortality associated with the disease (Shawahna et al., 2021). DM currently ranks as the ninth leading cause of death worldwide and is projected to become the seventh by 2030 (Sun et al., 2022). While T2DM affects populations globally, its burden is particularly high in Asian countries. Nations with large populations—such as China, India, the United States, and Pakistan—contribute disproportionately to the global prevalence of diabetes (Azeem et al., 2022). Pakistan ranks third after China and India in T2DM prevalence and is expected to overtake fourth place if current trends persist, with reported rates of 28.3% in urban areas and 25.3% in rural areas. Common risk factors include advanced age, family history of diabetes, obesity, and impaired glucose metabolism, often linked to poor diet and inadequate physical activity (Mekonnen et al., 2020). Previous studies have indicated that patients with T2DM often have limited awareness regarding essential aspects of their condition, including diet, exercise, and medication use (Sami et al., 2020).

Early diagnosis can substantially reduce the burden of DM and improve quality of life. Given the irreversible nature of the disease, enhancing Awareness, Treatment, and Control (ATC) is essential in mitigating its impact, particularly as ATC outcomes often show significant socioeconomic disparities. Hart's inverse care law highlights that individuals with the greatest healthcare needs often have the least access to care (Khodakarami et al., 2022). Patients from lower socioeconomic strata typically demonstrate poorer ATC of their diabetes. Studies worldwide have consistently reported low ATC rates among populations in low-income households. For example, in South Africa, 80.60% of adults with DM did not receive adequate healthcare between 2011 and 2012. Similarly, in Bangladesh, awareness, treatment, and control rates were 41.20%, 36.90%, and 14.20%, respectively. In northeast China, a 2012 cross-sectional survey found ATC rates of 64.10%, 52.94%, and 44.26%, respectively, among adults aged 18–79 years. A 2016–2017 study in semi-urban Nepal reported ATC rates of 65.02%, 93.08%, and 21.00% among individuals aged 25 years and above.

In Latin America, DM prevalence continues to rise, with only 50% of individuals aware of their condition (Avilés-Santa et al., 2020). India bears the second largest burden of DM globally, with an estimated 74.9 million adults aged 20–79 years living with the disease in 2021—a figure projected to reach 124.9 million by 2045 (Sun et al., 2022). According to the International Diabetes Federation (IDF), one in every seven adults in India has diabetes, with one-third of households affected. Despite this, nationally representative studies on DM prevalence and ATC in India remain scarce (Mathur et al., 2022; Claypool et al., 2020). A population-based study involving 1.3 million adults estimated a national DM prevalence of 7.5% between 2012 and 2014. The Indian Council of Medical Research–India Diabetes (ICMR–INDIAB) study, conducted between 2008 and 2015 across 15 states, reported substantial inter-state variation and increasing prevalence among low-SES groups in urban areas (Ranasinghe et al., 2021). Between 1990 and 2016,

DM prevalence among adults aged 20 years and above in India rose from 5.5% to 7.7% (Anjana et al., 2022). The National NCD Monitoring Survey (NNMS) in 2018 reported a prevalence of 9.30%, closely aligning with IDF estimates of 9.60% in 2021, projected to increase to 10.40% by 2030.

Against this backdrop, the present study utilizes data from the nationally representative NFHS-5 (2019–2021) to estimate the prevalence and ATC of DM at both national and state levels, and to explore socioeconomic disparities in diabetes care in India.

## LITERATURE REVIEW

A cross-sectional, population-based study conducted among adults aged 65 years and above in Wuhan, China, highlights the burden of diabetes in elderly populations. In 2018, Wuhan had approximately 1,278,902 elderly residents (Wuhan Municipal Bureau of Statistics, 2021). Between January and December 2018, the Wuhan Center for Disease Control and Prevention carried out health screenings for 388,403 (30.37%) senior citizens from 11 urban and six suburban districts under a municipal government initiative. All participants provided informed consent. Inclusion criteria required participants to be at least 65 years old and permanent residents of Wuhan. After excluding 11,701 cases with incomplete or erroneous data, 376,702 respondents (96.99%) completed the study. Glycaemic control was defined as fasting plasma glucose (FPG) <7.0 mmol/L. Participants self-reporting a diabetes diagnosis and meeting the FPG threshold during the medical check-up were considered to have controlled blood glucose levels. Overweight status was defined as a body mass index (BMI) between 24.0 and 27.9, while obesity was defined as BMI ≥28.0. Central obesity was defined by waist circumference ≥85 cm for women and ≥90 cm for men, based on the Healthy Adult Weight Determination in China (WS/T428-2013) (Sun et al., 2020).

Given the severity of diabetes in China, Type 2 Diabetes Mellitus (T2DM) is expected to impose substantial healthcare costs on elderly individuals, making the improvement of DM knowledge and management rates imperative (Bai et al., 2021). The study reported that 77.14% of patients were aware of DM, and 41.33% maintained glycaemic control. In contrast, in many European countries and the United States—regions with greater healthcare resources—DM awareness and control rates reach approximately 70% and 50%, respectively (Bikbov et al., 2021). These findings suggest improvements in both knowledge and control of DM in China, supported by the advancement of diabetes health education programmes. The study also observed a higher prevalence of T2DM among women compared to men, consistent with results from other Asian investigations. Previous research has linked smoking, alcohol consumption, and physical inactivity to T2DM development (Qiu et al., 2021). However, these associations were not observed in this study, possibly because current rather than past behaviours were assessed, and lifestyle changes following diagnosis may have influenced the outcomes.

Socioeconomic and cultural factors, literacy levels, healthcare policies, and access to quality diabetic care are known to influence patient knowledge regarding diabetes complications. The study found that males had a greater awareness of all diabetic complications compared to females, aligning with findings from Africa, where male patients were 4.6 times more likely to be aware of complications than female patients (Belsti et al., 2019).

In another investigation conducted at the Department of Medicine, Medical College, Kottayam, 150 adult T2DM patients aged between 18 and 77 years were surveyed (Kumar, 2021). The majority of participants were aged between 38 and 57 years, with 56% male and 44% female. Of these, 80% were aware of DM complications, with 83.33% of men and 75.75% of women

demonstrating such awareness. Specific complication knowledge included awareness of foot problems (92 respondents), renal complications (120), eye complications (91), hypertension (38), heart attack (62), stroke (42), and recurrent infections (78).

Collectively, these studies emphasise the variability of DM knowledge across populations and highlight the influence of demographic and socioeconomic factors. They underscore the need for targeted, context-specific education strategies to improve awareness, prevention, and management of diabetes complications globally.

## RESEARCH METHODOLOGY

This cross-sectional study was conducted among rural residents of the Erode district, Tamil Nadu, India. Using a convenience sampling method, 974 patients aged 18 years and above—who had provided prior written informed consent—were selected for participation (Table 1). Individuals with mental disabilities or cognitive impairments were excluded from the study.

A modified version of the Michigan Diabetes Awareness Questionnaire was employed to assess participants' knowledge of diabetes. The instrument covered ten key domains: basic awareness of Diabetes Mellitus (DM), knowledge of DM complications, prevention and control measures, and socio-demographic information. The questionnaire was administered to the diabetic community within the designated rural area through face-to-face interviews, each lasting approximately 15–20 minutes. Before the interviews, participants were briefed about the objectives and scope of the study, and opportunities were provided to share their views upon completion of the discussion.

Data were analysed using Python 3.0. Descriptive statistics were used to summarise demographic characteristics. For inferential analysis, a t-test was applied to compare two groups, while one-way ANOVA was used for comparisons involving more than two groups.The

demographic profile revealed that the majority of respondents (31.52%) were aged between 51–60 years, while the smallest group (2.67%) comprised individuals aged 30 years or younger. The second largest age group was 61–70 years (23.00%), followed by 41–50 years (21.56%), >70 years (11.40%), and 31–40 years (9.86%). In terms of education, the highest proportion had completed higher secondary education (35.01%), followed by illiterate participants (27.52%), those with primary education (20.94%), and secondary education (16.53%). Occupationally, the majority were unemployed (52.46%), followed by employed individuals (28.23%) and those engaged in business (19.30%). Female respondents (55.70%) outnumbered male respondents (44.30%).

**Table 1 Demographic characteristics of respondent sample for the survey questionnaires**

| Sl. No | Demographic variable | Number of individuals (N) | Percentage of individuals (%) |
|---|---|---|---|
| **AGE (Years)** | | | |
| 1 | Up to 30 | 26 | 2.67 |
| 2 | 31 to 40 | 96 | 9.86 |
| 3 | 41 to 50 | 210 | 21.56 |
| 4 | 51 to 60 | 307 | 31.52 |
| 5 | 61 to 70 | 224 | 23.00 |
| 6 | >70 | 111 | 11.40 |
| **GENDER** | | | |
| 1 | Female | 543 | 55.7 |
| 2 | Male | 431 | 44.3 |
| **EDUCATION** | | | |
| 1 | Illiterate | 268 | 27.52 |
| 2 | Higher Secondary | 341 | 35.01 |
| 3 | Secondary | 161 | 16.53 |
| 4 | Primary | 204 | 20.94 |
| **OCCUPATION** | | | |
| 1 | Unemployed | 511 | 52.46 |
| 2 | Business | 188 | 19.30 |
| 3 | Employed | 275 | 28.23 |

**Table 2 Gender based respondent sample participant for the survey questionnaires**

| Sl. No | Demographic Characteristics | Number of individuals | | Percentage of individuals | |
|---|---|---|---|---|---|
| | | Male | Female | Male | Female |
| AGE (Years) | | | | | |
| 1 | Up to 30 | 14 | 11 | 3.2 | 2.0 |
| 2 | 31 to 40 | 48 | 48 | 11.1 | 8.8 |
| 3 | 41 to 50 | 104 | 107 | 24.1 | 19.7 |
| 4 | 51 to 60 | 130 | 178 | 30.2 | 32.8 |
| 5 | 61 to 70 | 89 | 135 | 20.6 | 24.9 |
| 6 | >70 | 46 | 64 | 10.7 | 11.8 |
| EDUCATION | | | | | |
| 1 | Illiterate | 121 | 148 | 28.1 | 27.3 |
| 2 | Primary | 96 | 107 | 22.3 | 19.7 |
| 3 | Secondary | 88 | 74 | 20.4 | 13.6 |
| 4 | Higher Secondary | 126 | 214 | 29.2 | 39.4 |
| OCCUPATION | | | | | |
| 1 | Business | 141 | 48 | 32.7 | 8.8 |
| 2 | Employed | 151 | 123 | 35.0 | 22.7 |
| 3 | Unemployed | 139 | 372 | 32.3 | 68.5 |

The analysis indicated a higher proportion of female participants across most demographic categories.

Participants' knowledge was assessed using ten questions from the adapted Michigan Diabetes Awareness Questionnaire, covering disease definition, complications, prevention, and treatment (Table 3).

The overall results indicated that 66.63% of respondents correctly identified DM as an increase in blood glucose levels, 54.09% recognised blood testing as the best method for glucose monitoring, and 53.8% identified kidney, eye, and heart damage as major complications. Knowledge distribution revealed that 46.30% had average knowledge, 40.90% had good knowledge, 7.80% had poor knowledge, and only 5.00% had excellent knowledge.

## RESULT AND DISCUSSION

The study examined the level of Type 2 Diabetes Mellitus (T2DM) awareness among the rural population of the Erode district. Statistical analysis revealed a significant difference in the mean knowledge scores across different age groups ($p = 0.0058$) (Table 4). However, no statistically significant differences in knowledge were observed with respect to gender ($p = 0.7256$), education level ($p = 0.1258$), or occupation ($p = 0.4704$).The findings suggest that older respondents possessed greater awareness of DM compared to younger respondents, indicating an age-related variation in diabetes knowledge. Similar patterns were reported by Palanisamy et al., who found significant differences in knowledge levels by age, with younger respondents demonstrating higher mean values ($\mu = 58.92$). Other studies have shown mixed results regarding the relationship between age and DM awareness.

In terms of gender, this study found no significant differences in knowledge levels, aligning with findings from previous research indicating that gender does not play a decisive role in DM awareness (Bharath et al.). While Bharath et al. observed higher knowledge levels among males, the difference was significant only for one specific question ($p < 0.0300$).

Educational attainment, often cited as a major factor influencing health knowledge, did not significantly affect DM awareness in this study ($p = 0.126$). This result contrasts with findings by Konduru et al., who reported that graduates exhibited higher knowledge levels. The absence of significant differences in the present study suggests that, within this rural population, individuals of varying education levels possessed relatively similar knowledge about DM.

| | Survey Questions | Survey Response | Total Samples | Percentage sample (%) |
|---|---|---|---|---|
| 1 | What is DM? | Weight Increase | 73 | 7.5 |
| | | Weight Decrease | 154 | 15.8 |
| | | Increase in blood glucose level | 649 | 66.6 |
| | | None of the above | 98 | 10.1 |
| 2 | Which organ gets affected by high fat diet? | Kidney | 189 | 19.4 |
| | | Heart | 574 | 58.9 |
| | | Lungs | 105 | 10.8 |
| | | Eye | 106 | 10.9 |
| 3 | If you take your morning insulin but skip breakfast, blood glucose level will? | Increase | 138 | 14.2 |
| | | Decrease | 570 | 58.5 |
| | | Remain the same | 266 | 27.3 |
| 4 | Best method for home glucose testing | Urine test | 147 | 15.1 |
| | | Blood test | 527 | 54.1 |
| | | Both is equally good | 300 | 30.8 |
| 5 | Best manner to take care of feet is to | Wash and take care in each day | 212 | 21.8 |
| | | Protect from injuries | 213 | 21.9 |
| | | Both | 549 | 56.4 |
| 6 | What are the complications of DM? | Kidney damage | 218 | 22.4 |
| | | Heart damage | 106 | 10.9 |
| | | Eye damage | 126 | 12.9 |
| | | All | 524 | 53.8 |
| 7 | Symptoms of Numbness and tingling represent | Kidney disease | 120 | 12.3 |
| | | Nerve disease | 479 | 49.2 |
| | | Liver disease | 261 | 26.8 |
| | | Eye disease | 114 | 11.7 |
| 8 | Following issue not associated with DM | Vision Problem | 428 | 43.9 |
| | | Kidney Problem | 143 | 14.7 |
| | | Lung Problem | 261 | 26.8 |
| | | Nerve Problem | 142 | 14.6 |
| 9 | Need to avoid the following food is | Carbohydrate Rich Food | 452 | 46.4 |
| | | Protein rich food | 127 | 13.0 |
| | | Fiber rich food | 228 | 23.4 |
| | | Vitamin rich food | 167 | 17.1 |
| 10 | Patient Knowledgeable Status | Poor | 76 | 7.8 |
| | | Average | 451 | 46.3 |
| | | Good | 398 | 40.9 |
| | | Excellent | 49 | 5.0 |

**Table 3 Respondent sample participant answer for the survey questionnaire**

**Table 4 Analysis of significant variable about knowledge of DM for demographic characteristics**

| Sl. No | Variables | Sample No | Sample Mean | Sample SD | Sig |
|---|---|---|---|---|---|
| Age (Years) | | | | | |
| 1 | Up to 30 | 26 | 2.13 | 0.68 | 0.0058 |
| 2 | 31 to 40 | 96 | 2.31 | 0.74 | |
| 3 | 41 to 50 | 210 | 2.38 | 0.72 | |
| 4 | 51 to 60 | 307 | 2.54 | 0.64 | |
| 5 | 61 to 70 | 224 | 2.48 | 0.73 | |
| 6 | >70 | 111 | 2.36 | 0.73 | |
| Education | | | | | |
| 1 | Illiterate | 268 | 2.38 | 0.69 | 0.1258 |
| 2 | Primary | 204 | 2.46 | 0.73 | |
| 3 | Secondary | 161 | 2.53 | 0.71 | |
| 4 | Higher Secondary | 341 | 2.41 | 0.72 | |
| Occupation | | | | | |
| 1 | Business | 188 | 2.48 | 0.73 | 0.4704 |
| 2 | Employed | 275 | 2.44 | 0.76 | |
| 3 | Unemployed | 511 | 2.41 | 0.67 | |

When analysed by occupation, no significant differences in DM knowledge were observed, consistent with findings from Daniel Asmelash et al., who noted that occupation and education level were not significantly associated with glycaemic control practices. Given the rapid rise of DM in developing countries and the continuing lack of knowledge among affected populations, these findings underscore the need for targeted awareness programmes. Such interventions can empower patients to better manage their condition, improve health literacy, and enhance self-care skills

**Table 5 T-Test analysis about knowledge of DM for demographic characteristics**

| Gender | Total Sample Number | Sample Mean | Sample SD | T-TEST Value | Sig. |
|---|---|---|---|---|---|
| Female | 543 | 2.44 | 0.688 | 0.3497 | 0.7256 |
| Male | 431 | 2.43 | 0.718 | | |

These results indicate that gender-based differences in knowledge were negligible. This is noteworthy given prior studies suggesting that demographic factors such as gender can sometimes influence awareness of health conditions.

The study also highlights the broader implications for rural healthcare delivery. Medical professionals should prioritise educating rural populations on the importance of maintaining healthy lifestyles, regular glucose monitoring, and awareness of potential complications. Factors such as diabetes status, the presence of comorbid chronic diseases, physical activity levels, and prior exposure to diabetes-related information may all influence patient understanding of DM risk factors and management practices.

It is important to note that this study may underestimate the actual level of DM knowledge among the rural population in Erode district. Without structured and continuous guidance from healthcare providers, patient understanding may remain superficial. Therefore, community-based educational initiatives, supported by health workers and local authorities, are essential for improving disease management outcomes.

## CONCLUSION

This study identified a statistically significant variation in diabetes awareness across different age groups (p = 0.0058), while no significant differences were found based on gender (p =

0.7256), education (p = 0.1258), or occupational status (p = 0.4704). The findings suggest that DM patients remain vulnerable to complications due to educational gaps and limited disease knowledge.

To mitigate the burden of DM and its associated complications, targeted awareness campaigns are essential, particularly for disadvantaged, rural, and less-educated populations. These efforts should be complemented by lifestyle interventions aimed at improving self-care behaviours. Strengthening integrated diabetes management strategies can enhance glycaemic control and reduce comorbidities in such communities.

Improved understanding of DM is directly associated with better health outcomes and quality-adjusted life years. Therefore, the development of structured, comprehensive educational programmes addressing knowledge gaps and risk factors is strongly recommended to empower individuals and support effective long-term diabetes management.

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