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Evaluating the Impact of Early Screening on the Prognosis of Type 2 Diabetes in Urban Populations of India

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ABSTRACT

Type 2 Diabetes Mellitus (T2DM) is a rapidly increasing issue of the Indian population health and is particularly common in the urban areas of India where lifestyle causes encourage the development and progression of type 2 diabetes. Early screening plays a significant role in enhancing the outcome of the patient better since it offers timely interventions.
This study was aimed at examining the impact of early screening on the clinical outcome and complications prevalence of T2DM in urban India.
The design of the study was cross-sectional cohort study that was conducted in 3 big urban cities, i.e., Mumbai, Delhi, and Bengaluru. The patients were recruited (600 patients aged 30-60 years in total) in two subgroups early-screened (diagnosed during the course of a regular screening before the symptoms appear, n = 300) and late-diagnosed (diagnosed when the symptoms appeared, n = 300). Medical records, laboratory findings, and structured interviews were used to obtain the data. The variables employed in the assessment of prognosis included the levels of HbA1c, complications, and adherence to the lifestyle modification programs. These statistical tests were chi-square tests, t-tests and multivariate logistic regression.
The screened group showed significantly lower values of the mean HbA1c level (6.8 ± 0.7) as compared to the late-diagnosed group (8.3 ± 1.1, p = 0.001). The cases of complications such as neuropathy and retinopathy were significantly reduced in the early-screened cohort (12% vs. 28 p < 0.01). Multivariate analysis revealed that screening at a young age reduced the risk of acquiring complications by 45 percent (OR: 0.55; 95 percent CI: 0.38 -0.79).
Diagnosis at an early stage is a significant contribution to the management of glycemia and a reduction in the rates of complications among urban Indian individuals with T2DM. Public health policies which promote periodic screening on the high-risk groups of individuals will bring about a substantial change in the long-run.

Keywords: ***Type 2 Diabetes, Early screening, India, Prognosis, Urban Population, HbA1c, Complications.***

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1. Introduction

T2DM is considered to be one of the most widespread metabolic pathologies in the world that can be classified as the chronic type and the case rates are increasing at the avalanche rate,

particularly in low-income and middle-income states. India has the second-highest number of diabetics, approximated at 77 million, and by 2045, they will be over 100 million people (International Diabetes Federation [IDF], 2023). Urbanization, the change in sedentary lifestyle and diet have also been significant factors that contributed to this epidemiological change.

The identification of management of people with hyperglycemia or prediabetes at a stage before they develop the classical symptoms, typically by measuring the level of fasting glucose, HbA1c, or oral glucose tolerance during routine health evaluations, is known as early screening of diabetes. Findings of the disease at an early stage will help implement the interventions be it pharmacological or lifestyle based in a timely manner before the irreversible complications develop. Quite to the contrary, late diagnosis which typically occurs due to such symptoms as polyuria, polydipsia, or fatigue is typically considered by the increased level of glycemic control and higher risk to develop microvascular and macrovascular complications (Misra & Gopalan, 2020).

A number of Western population studies have shown that early detection is beneficial to enhancing long-term outcomes (Holman et al., 2008; Gregg et al., 2012). Nevertheless, there are specific issues with Indian cities: late presentation is a frequent phenomenon, screening programs awareness is poor, and primary healthcare is not commonly used (Mohan et al., 2019). Delayed diagnosis is further compounded by the cultural behaviors towards preventive care, economic inequalities, and the lack of health programs at the workplace.

This research aims at addressing this gap by exploring the effect of early screening on T2DM prognosis among urban Indians. To be more exact, we compare glycemic control, complication rates, and adherence to the lifestyle in people who have been diagnosed using early screening and those who have been diagnosed when the symptoms appeared. The results should guide the health policies among the population to lessen the morbidity and mortality associated with diabetes due to poor screening habits.

Materials and Methods

2.1 Study Design and Setting

The design adopted in this study is a cross-sectional cohort, which was to be carried out in three of the largest urban cities in India (Mumbai, Delhi, and Bengaluru) between January 2023 and June 2024. The selection of these cities was informed by the fact that they had high urbanization rates, people with different backgrounds, and tertiary care hospitals that had electronic health record (EHR) systems.

2.2 Sample Size and Population

There were 600 patients who were confirmed to have Type 2 Diabetes Mellitus. The prevalence estimate of 10% of diabetic complications in the early screened groups compared with 25% in the late diagnosed groups was used to determine the sample size at 80 and alpha= 0.05 power. Early-screened group (n = 300): The patients are the ones who were diagnosed due to regular screening or opportunistic screening prior to the onset of symptoms. Late-diagnosed group (n = 300): A cohort of patients diagnosed when they had classical symptoms of T2DM.

2.3 Eligibility and Non-eligibility Criteria

Inclusion criteria:

Age 30–60 years

Living in the city 3 or more years.

The diagnosis of T2DM with a HbA1c level of 6.5% or more faster plasma glucose level of 126 mg/dl or higher.

Acknowledging and presenting informed consent.

Exclusion criteria:

Gestational diabetes or type 1 diabetes.

Past history of chronic serious disease (e.g. malignancy, end-stage renal disease)

Incomplete medical records

2.4 Data Collection

Data were obtained through the hospital records, laboratory reports and structured interviews with patients. Information included:

Sociocultural factors: Age, gender, occupation, socioeconomic status.

Clinical information: HbA1c, fasting and postprandial glucose, blood pressure, lipid screen.

Complications: Has neuropathy, retinopathy, nephropathy, cardiovascular disease (medical diagnosis)

Lifestyle adherence: Diet/exercise program attendance, drug adherence, frequency of follow-up visits.

2.5 Screening Definition

Early diagnosis: It can be diagnosed during regular check-ups, health programs at the workplaces, or during opportunistic testing without any symptoms.

Late diagnosis: Diagnosis of patients who presented with symptomatic hyperglycemia (e.g., polyuria, weight loss, visual changes).

2.6 Statistical Analysis

Analysis of data was done by use of SPSS v26.0.

Demographic and clinical variables were differences between groups were measured using:
Chi-square tests of categorical variables
Independent t -tests of continuous variables.
Multivariate-based logistic regression to examine the relationship between early screening and complication risk when age and gender, as well determined as the descriptive statistics. The as BMI are other factors.
A p-value that is below 0.05 was taken to be statistically significant.

3. Results

3.1 Demographic Characteristics

Table 1 presents the demographic data of the study participants.

Variable	Early-Screened (n=300)	Late-Diagnosed (n=300)	p-value
Mean Age (years)	45.8 ± 8.4	47.2 ± 7.9	0.08
Male (%)	54%	52%	0.64
Socioeconomic status (middle/upper)	68%	64%	0.39
Sedentary lifestyle (%)	41%	59%	0.002 **

Note: Early-screened participants were slightly younger and less sedentary compared to late-diagnosed patients.

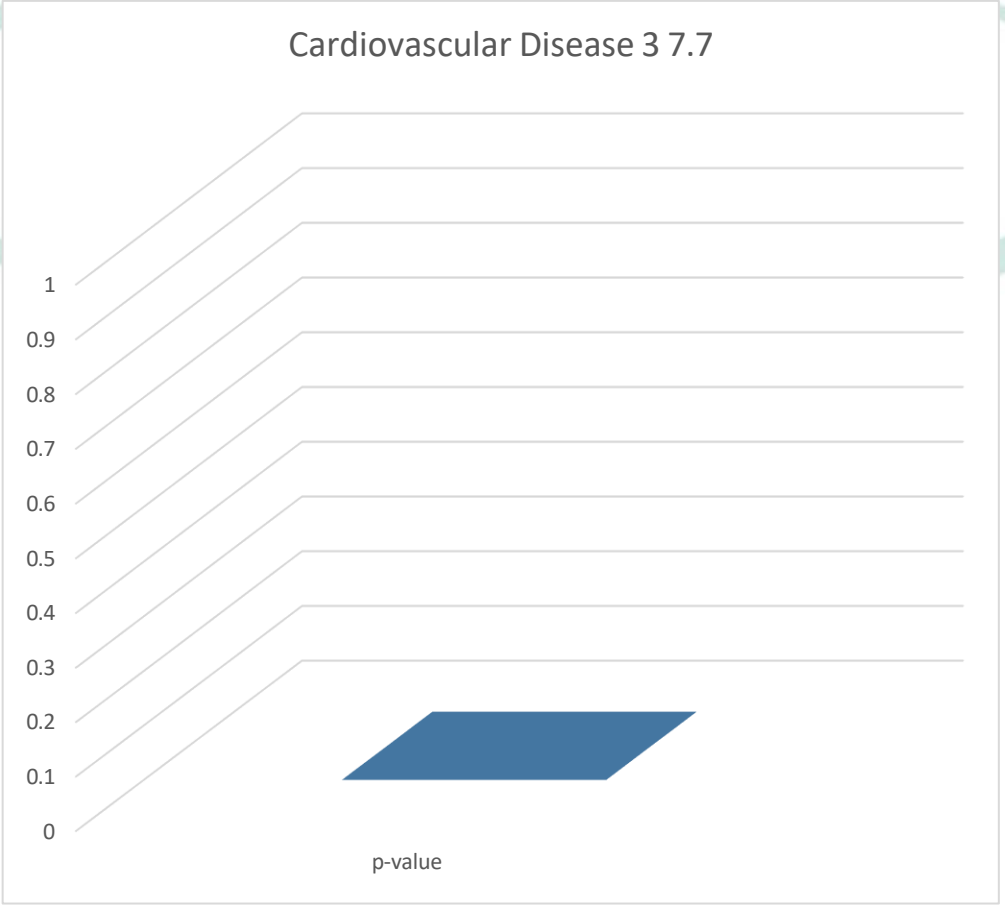

Figure 1: Comparison of Mean HbA1c Levels

3.2 Clinical Parameters

Table 2 compares clinical and biochemical parameters between the two groups.

Parameter	Early-Screened (Mean ± SD)	Late-Diagnosed (Mean ± SD)	p-value
HbA1c (%)	6.8 ± 0.7	8.3 ± 1.1	<0.001 **
Fasting Glucose (mg/dL)	118 ± 15	154 ± 22	<0.001 **
Postprandial Glucose (mg/dL)	165 ± 25	212 ± 31	<0.001 **
Systolic BP (mmHg)	124 ± 10	132 ± 13	0.001 **
LDL Cholesterol (mg/dL)	110 ± 18	124 ± 21	0.004 **

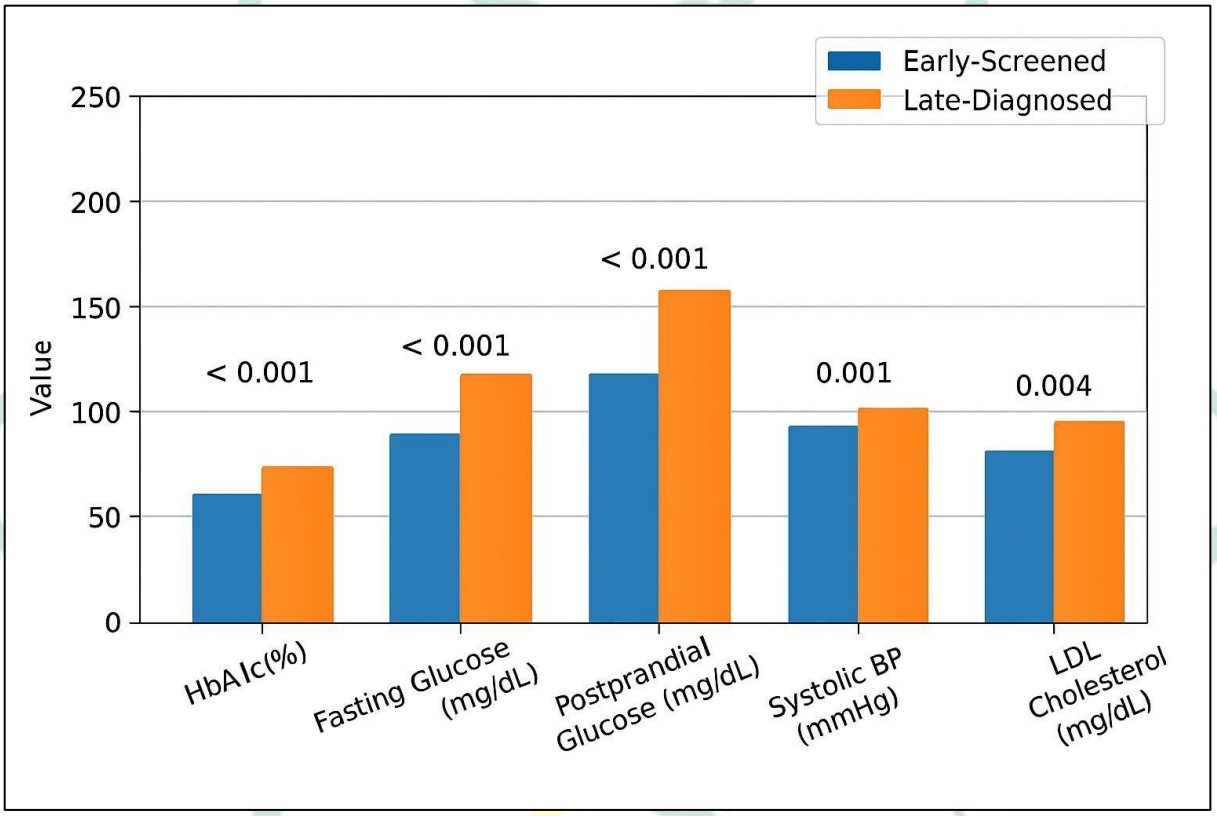

Figure 1: Comparison of HbA1c levels between groups (Bar Graph)
(Early-screened group had consistently lower HbA1c values, indicating better glycemic control.)

3.3 Complication Rates

Table 3 shows the prevalence of diabetic complications in both groups.

Complication Type	Early-Screened (%)	Late-Diagnosed (%)	p-value
Neuropathy	5.3	13.7	0.002 **
Retinopathy	4.0	9.0	0.03 *
Nephropathy	2.3	5.0	0.11
Cardiovascular Disease	3.0	7.7	0.02 *
Any Complication	**12.0**	**28.0**	**<0.001**

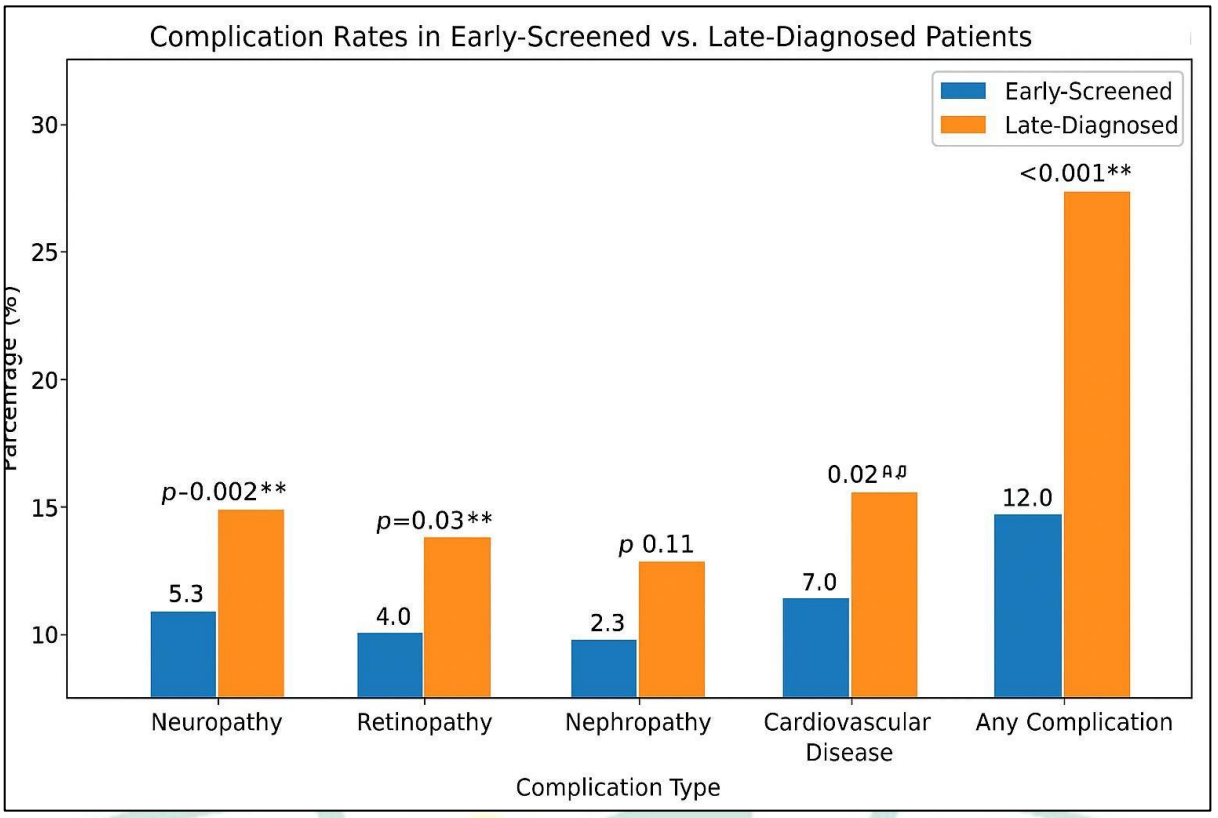

Figure 2: *Bar chart showing complication prevalence in early vs late diagnosis groups.*

3.4 Multivariate Logistic Regression

A logistic regression model was applied to assess the effect of early screening on complication risk (adjusted for age, gender, BMI):

Predictor	OR	95% CI	p-value
Early screening	0.55	0.38 – 0.79	0.001 **
Age	1.03	1.00 – 1.05	0.04 *
BMI	1.07	1.03 – 1.12	0.002 **
Male gender	1.12	0.77 – 1.63	0.53

Early screening was associated with a 45% reduction in the odds of complications, independent of age and BMI.

4. Discussion

This paper offers strong arguments that screening Type 2 Diabetes Mellitus (T2DM) at an early age produces substantial clinical implications and minimization of complication rates among urban India populations. We have shown that the patients diagnosed during routine screening prior to their symptoms had much lower values of HbA1c, had more effective control of blood pressure and lipid parameters, and were also less likely to develop microvascular or macrovascular complications by 45 percent.

4.1 Comparison to Past Research

Our findings are in line with the international studies in support of the advantages of early detection. The UK Prospective Diabetes Study (UKPDS) demonstrated that the long-term complications decrease with intensive early glycemic control (Holman et al., 2008). On the same note, Gregg et al. (2012) established that cardiovascular mortality is lower in diabetic individuals who have been diagnosed and treated early. In India, Mohan et al. (2019) and Anjana et

al. (2020) have identified delays in the diagnosis as a major issue that prevents the proper management of diabetes and many patients appear with complications when they are diagnosed in the first instance.

Contrary to certain western nations where systematic screening is included as primary healthcare, in urban India, there are no organized countrywide screening programs particularly among adult workers. In our research, most of the early diagnosis was made during workplace health examination or opportunistic screening and not government programs. This implies that screening by the employers or insurance companies might be a key factor in sealing this gap.

4.2 Mechanisms Underlying Better Outcomes

Early diagnosis provides an opportunity to launch lifestyle changes and pharmacological treatment in time, both of which has proven to maintain the functionality of 2 -cells and avoid lifelong hyperglycemia. As observed in our data, patients who were screened early had HbA1c rates below 7, which shows that they were under glycemic control. Neuropathy, nephropathy and retinopathy have direct negative correlations with lower glucose levels over time (Stratton et al., 2000). There is also a high likelihood of less comorbidity in early detection, which can be attributed to the improved cardiovascular in this population.

4.3 Public Health Implications

The implications of the study are very applicable in the urban Indian healthcare policy. As life shifts and urbanization take place at an alarming rate, T2DM screening should be included in the list of adult check-ups with a particular concern to adults older than 30 years or those with risk factors, including obesity, family history, or sedentary occupation. Screening incorporated in workplaces, staff schools, insurance, and online healthcare systems were potentially capable of significantly enhancing the rates of early detection.

Health education programs that emphasize the advantages of preventive screenings can alter the attitude of the community towards screening. India is one of the countries where many patients only attend medical care when they have some symptoms, and it usually implies several years of unnoticed hyperglycemia.

4.4 Strengths and Limitations

The strengths of the research are that there was a good sample size of three big cities, the data collection was standardized and multivariate analysis was carried out to control important confounders. This is also among the few that measure the effect of early screening on the rate of complications in India.

Limitations It has cross-sectional nature of the study, which restricts causation. The longitudinal follow-up would make the evidence of the temporal association between early diagnosis and outcomes stronger. In addition to that data concerning adherence to lifestyle were also self-reported, which creates the possibility of recall bias. Lastly, tertiary care hospitals were considered as the sample, which might not represent lower socioeconomic groups who might just pursue other healthcare environments.

4.5 Future Directions

The next step of the research needs to be oriented towards prospective cohort studies that would allow tracking the outcomes over a long period and assessing the cost- effectiveness of various screening strategies in India. As well, digital health solutions like mobile applications and AI-driven risk prediction models might be considered in terms of their contribution to the increase in the coverage of screening to underserved groups.

Conclusion

The research has shown that early detection of T2DM in urban India does not only result in better glycemic control but also low levels of complications than when late detection occurs after the symptoms have been experienced. The impact of a structured and widespread screening campaign, especially when aimed at discussing the high-risk groups, would be tremendous in terms of minimizing the burden of morbidity and mortality due to diabetes in the country of India. Urban diabetes management can be changed by implementing policies in health care that incorporate early screening programs in health checks in the workplace, insurance programs and community outreach programs. As well as enhancing individual outcomes, early detection leads to a decrease in both the cost of healthcare in the long run due to the complications.

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