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Original Research Article

Prevalence of complications and comorbidities among adults with type 2 diabetes mellitus and their association with glycemic control and duration of diabetes: a cross-sectional study from Kerala, India

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ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder associated with microvascular and macrovascular complications that significantly increase morbidity and mortality. Understanding the prevalence of these complications and their association with glycemic control and duration of diabetes is essential for improving long-term outcomes.
Methods: A cross-sectional study was conducted among 70 adults aged 35–65 years with T2DM attending a tertiary care outpatient clinic in Kerala, India. Data on demographic, anthropometric, clinical, and laboratory parameters were collected using a structured proforma. Glycemic status was assessed using fasting blood sugar, postprandial blood sugar, and HbA1c. Diabetic neuropathy was evaluated using vibration perception threshold, peripheral arterial disease using ankle-brachial index, and diabetic retinopathy by fundoscopic examination. Associations between complications, comorbidities, glycemic control, and duration of diabetes were analyzed using chi-square tests.
Results: The mean age of participants was 53.6±8.4 years, with males comprising 82.9%. The prevalence of diabetic neuropathy, retinopathy, and peripheral arterial disease was 71.4%, 30%, and 7.1%, respectively. Obesity, hypertension, and dyslipidemia were present in 65.7%, 48.6%, and 64.3% of participants, respectively. Poor glycemic control (HbA1c≥7%) was observed in 75.7%. A significant association was noted between duration of diabetes and retinopathy (p=0.003), while glycemic control showed no significant association with most variables.
Conclusions: A high burden of microvascular complications and cardiometabolic comorbidities was observed among adults with T2DM. Longer duration of diabetes was significantly associated with retinopathy, emphasizing the need for early screening, optimal glycemic control, and comprehensive risk factor management.

Keywords: Type 2 diabetes mellitus, Neuropathy, Retinopathy, Peripheral arterial disease, Glycemic control, comorbidities

INTRODUCTION

T2DM has emerged as a global health crisis, with over 800 million individuals affected worldwide, a number that has doubled over the past three decades.[1] In India, the prevalence is particularly alarming, with approximately 212 million cases reported in 2022. This escalating burden underscores the urgent need for comprehensive strategies to manage and mitigate the disease's impact. Beyond hyperglycemia, T2DM is associated with a spectrum of complications and comorbidities that significantly impair quality of life and increase mortality risk. Diabetic neuropathy, retinopathy, and peripheral arterial disease are among the most prevalent

complications, affecting a substantial proportion of patients.[2] Concurrently, comorbidities such as hypertension, dyslipidaemia, and obesity are commonly observed in patients with T2DM, further complicating disease management.[3] Glycemic control, as measured by parameters such as HbA1c, fasting blood sugar, and postprandial blood sugar, plays a pivotal role in the onset and progression of these complications. Studies have consistently shown that sustained glycaemic control is associated with a significant reduction in the risk of developing diabetes-related complications.[4] Conversely, poor glycaemic control increases the risk of both microvascular and macrovascular complications.[5] The duration of diabetes is another critical factor influencing the prevalence of complications and comorbidities. Longer disease duration has been shown to correlate with an increased likelihood of developing these adverse health outcomes.[6]

Despite the established associations between glycemic control, disease duration, and the prevalence of complications and comorbidities, there remains a paucity of comprehensive data from Indian populations. This study aims to address this gap by assessing the prevalence of diabetes-related complications and comorbidities among adults with T2DM and examining their association with glycemic control and duration of diabetes.

METHODS

This cross-sectional study was conducted from July 2018 to March 2019 at a tertiary care centre in Kerala, South India. Ethical clearance was obtained from the Institutional Ethics Committee prior to the initiation of the study. A total of 70 patients attending the diabetes outpatient department were recruited using purposive sampling after obtaining written informed consent.

Adults aged 30 years and above with a diagnosis of type 2 diabetes mellitus (T2DM) for at least one year were included in the study. Patients with acute illness, major psychiatric disorders, stroke, epilepsy, Alzheimer's disease, or sensory impairments such as blindness or deafness were excluded.

Sociodemographic details were collected using a semi-structured questionnaire. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters (kg/m²) and classified according to the WHO Asia-Pacific guidelines for South Asian populations as normal (18.5–22.9 kg/m²), overweight (23.0–24.9 kg/m²), and obese (≥25.0 kg/m²). Glycaemic control was assessed using recent laboratory reports of fasting blood sugar (FBS), postprandial blood sugar (PPBS), and glycated haemoglobin (HbA1c) obtained from electronic medical records. HbA1c was categorized based on American diabetes association guidelines into good control (<7%), moderate control (7–8%), and poor control (>8%). Blood pressure was measured in the sitting position using a mercury sphygmomanometer with an appropriately sized cuff and classified according to the joint national committee 8 (JNC 8) guidelines. Lipid profiles, including total cholesterol, triglycerides, low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), and very-low-density lipoprotein cholesterol (VLDL-C), were obtained from same-day laboratory reports. Dyslipidaemia was defined according to the national cholesterol education program adult treatment panel III criteria, and the presence of one or more abnormal lipid parameters was considered diagnostic.

Diabetic complications were assessed systematically. Peripheral neuropathy was evaluated using a biothesiometer to measure vibration perception threshold (VPT) at the great toes and medial malleoli of both feet, with the mean of four readings used for analysis; a VPT value >25 volts was considered indicative of neuropathy.[10] Peripheral arterial disease was assessed using the ankle-brachial index (ABI) in both lower limbs, with the lower of the two values used for analysis; an ABI ≤0.90 was considered diagnostic.[11] Diabetic retinopathy was assessed by a trained ophthalmologist through fundus examination and recorded as present or absent based on clinical findings.

RESULTS

A total of 70 adults with type 2 diabetes mellitus (T2DM) were included in the study. The median age of the participants was 54.5 years (IQR: 48–59), with a mean age of 53.3±7.69 years. The majority were male (81.4%), while females constituted 18.6% of the study population. Most participants were non-smokers (94.3%), and nearly two-thirds reported no alcohol consumption (64.3%) (Table 1).

Table 1: Demographic and lifestyle characteristics of adults with type 2 diabetes mellitus (n=70).

Variable	Category	Frequency	%
Age (in years)	≤53	32	45.7
	>53	38	54.3
Gender	Male	57	81.4
	Female	13	18.6
Smoking	Non-smoker	66	94.3
	Smoker	4	5.7
Alcohol use	Non-drinker	45	64.3
	Drinker	25	35.7

Table 2. Prevalence of comorbidities and glycemic control (n=70).

Variable	Category	Frequency	%
Diabetes control (based on HbA1c values)	Good	17	24.3
	Moderate	17	24.3
	Poor	36	51.4
Duration of diabetes	<10	25	35.7
	10–20	40	57.1
	>20	5	7.1
BMI category	Underweight	1	1.4
	Normal	11	15.7
	Overweight	12	17.1
	Obese	46	65.7
Blood pressure category	Normal	36	51.4
	Hypertension	34	48.6
Lipid status	Normal	25	35.7
	High (Dyslipidaemia)	45	64.3

Table 3: Prevalence of diabetes-related complications (n=70).

Variable	Category	Frequency	%
Diabetic neuropathy	Normal	19	27.1
	Mild neuropathy	41	58.6
	Definite neuropathy	10	14.3
Peripheral arterial disease	Normal	65	92.9
	PAD present	2	2.9
	Non-compressible	3	4.3
Diabetic Retinopathy	Absent	49	70
	present	21	30

Table 4: Association between glycemic control and participant characteristics, lifestyle, comorbidities, and complications (n=70).

Variable	Category	Good control N (%)	Poor control N (%)	P value
Age (in years)	<53	7 (21.9)	25 (78.1)	0.666
	≥53	10 (26.3)	28 (73.7)	
Gender	Male	15 (26.3)	42 (73.7)	0.407
	Female	2 (15.4)	11 (84.6)	
Smoking	Non-smoker	15 (22.7)	51 (77.3)	0.217
	Smoker	2 (50.0)	2 (50.0)	
Alcohol use	Non-drinker	7 (15.6)	38 (84.4)	0.022
	Drinker	10 (40.0)	15 (60.0)	
BMI category	Obese	13 (28.3)	33 (71.7)	0.562
	Normal	2 (16.7)	10 (83.3)	
	Overweight	2 (16.7)	10 (83.3)	
Blood pressure	Normal	8 (22.2)	28 (77.8)	0.679
	Hypertension	9 (26.5)	25 (73.5)	
Lipid status	Normal	5 (20.0)	20 (80.0)	0.533
	High	12 (26.7)	33 (73.3)	
Peripheral neuropathy (VPT)	Normal	6 (31.6)	13 (68.4)	0.436
	Mild	10 (24.4)	31 (75.6)	
	Definite	1 (10.0)	9 (90.0)	
Retinopathy	Absent	15 (30.6)	34 (69.4)	0.059
	Present	2 (9.5)	19 (90.5)	
Peripheral arterial disease (ABI)	Normal	17 (26.2)	48 (73.8)	0.422
	Non-compressible	0 (0.0)	3 (100.0)	

Continued.

Variable	Category	Good control N (%)	Poor control N (%)	P value
	PAD Present	0 (0.0)	2 (100.0)	

Table 5: Association between duration of diabetes and complications/comorbidities (n=70).

Variable	Category	>10 years n (%)	<10 years n (%)	P value
Blood pressure	Normal	24 (66.7)	12 (33.3)	0.669
	Hypertension	21 (61.8)	13 (38.2)	
Peripheral neuropathy (VPT)	Definite	7 (70.0)	3 (30.0)	0.501
	Mild	24 (58.5)	17 (41.5)	
	Normal	14 (73.7)	5 (26.3)	
Peripheral arterial disease (ABI)	Non-compressible	2 (66.7)	1 (33.3)	1
	PAD present	1 (50.0)	1 (50.0)	
	Normal	42 (64.6)	23 (35.4)	
Lipid status	High	26 (57.8)	19 (42.2)	0.193
	Normal	19 (76.0)	6 (24.0)	
Retinopathy	Present	19 (90.5)	2 (9.5)	0.003

More than half of the participants (51.4%) had poor glycaemic control based on HbA1c values, while 24.3% each had good and moderate control. With respect to disease duration, 57.1% had been living with diabetes for 10–20 years, and 7.1% for more than 20 years. Obesity was highly prevalent, affecting 65.7% of participants. Dyslipidaemia was present in 64.3%, and 48.6% were hypertensive, while the remaining 51.4% had normal blood pressure readings (Table 2). Among diabetes-related complications, diabetic neuropathy was the most common, affecting 73% of participants; of these, 58.6% had mild neuropathy and 14.3% had definite neuropathy. Diabetic retinopathy was identified in 30% of participants. Peripheral arterial disease (PAD) was detected in 2.9%, while 4.3% had non-compressible arteries based on ankle–brachial index measurements (Table 3).

No statistically significant associations were observed between glycaemic control and most demographic or clinical variables, including age, sex, BMI, blood pressure, lipid status, or neuropathy status ($p>0.05$). Alcohol consumption showed a statistically significant association with glycaemic control ($\chi^2=5.22$, $p=0.022$) (Table 4). A statistically significant association was found between duration of diabetes and the presence of diabetic retinopathy ($p=0.003$). Participants with a diabetes duration exceeding 10 years had a markedly higher prevalence of retinopathy (90.5%) compared to those with a shorter duration (9.5%). No significant associations were observed between duration of diabetes and neuropathy, PAD, dyslipidaemia, or hypertension ($p>0.05$) (Table 5). Overall, microvascular complications were common in this cohort, with neuropathy being the most prevalent, followed by retinopathy. Obesity and dyslipidaemia were the most frequent comorbid conditions. The findings highlight a high burden of complications among adults with long-standing T2DM.

DISCUSSION

In this cross-sectional study of 70 adults with T2DM, we observed a notably high burden of complications and comorbidities. Specifically, diabetic neuropathy (73%) was the most prevalent complication, followed by retinopathy (30%) and peripheral arterial disease (PAD; 2.9%). Among comorbidities, obesity (65.7%), dyslipidaemia (64.3%), and hypertension (48.6%) were prominent. The majority (>50%) of participants had poor glycaemic control, and more than half had a diabetes duration of 10–20 years.

The neuropathy prevalence (73%) appears higher than that reported in many previously published cohorts. For example, a meta-analysis from Iran reported a pooled neuropathy prevalence of 56.5% (95% CI: 42.8–69.3) among patients with T2DM.[7] A narrative review noted prevalence estimates ranging from 6% to 60%, depending on the screening method and population studied.[8] The higher prevalence in our sample may reflect selection bias inherent to a tertiary care setting, longer diabetes duration (with most participants having >10 years of disease), or the methods used for neuropathy assessment (VPT and ABI). This finding underscores that diabetic neuropathy remains a major clinical challenge in Indian T2DM populations.

Regarding retinopathy (30%), our estimate lies within the range reported for middle-income countries but is higher than some community-based studies. The high prevalence of obesity, dyslipidaemia, and long-standing diabetes in our cohort likely contributes to this finding. The very low prevalence of PAD (2.9%) may reflect under-detection, including the presence of non-compressible arteries (4.3%), or earlier stages of disease. Nonetheless, it highlights the comparatively greater burden of microvascular than macrovascular complications in this cohort. Comorbidities such as obesity, hypertension, and

dyslipidaemia were highly prevalent. These findings are consistent with the clustering of cardiometabolic risk factors in T2DM and highlight the need for comprehensive risk-factor management beyond glycaemic control alone. In univariate analysis, no statistically significant associations were observed between glycaemic control and most demographic or clinical variables, including age, sex, BMI, blood pressure, lipid status, and neuropathy. An exception was alcohol use, which showed a significant association with better glycaemic control (χ^2=5.22, p=0.022). This finding should be interpreted cautiously, as it may reflect underlying behavioural factors, such as better treatment adherence among moderate alcohol users, rather than a causal relationship.

With respect to duration of diabetes, a strong positive association was observed with retinopathy (p=0.003), whereas other complications and comorbidities did not show statistically significant associations. This aligns with established evidence that prolonged exposure to hyperglycaemia and metabolic stress increases the risk of microvascular damage, particularly diabetic retinopathy.[9] Interestingly, recent evidence from a prospective cohort study reported that intensive glycaemic control over one year did not significantly alter retinopathy outcomes in T2DM, highlighting the complexity of microvascular disease progression.[10] The high prevalence of neuropathy among relatively younger patients (mean age ≈53 years) raises important clinical concerns, as neuropathy contributes substantially to morbidity, including foot ulceration, falls, and increased healthcare utilisation.[11] Early screening using tools such as VPT or monofilament testing, along with aggressive management of modifiable risk factors, is therefore essential.

The strong association between longer diabetes duration and retinopathy reinforces the importance of timely ophthalmological screening, particularly after 10 years of disease. Meanwhile, the lack of significant associations between glycaemic control and most complications in this study should not be interpreted as diminishing the importance of glycaemic control. Instead, it highlights the multifactorial aetiology of diabetic complications, involving glycaemic variability, coexisting hypertension, dyslipidaemia, obesity, and genetic susceptibility.[9] The clustering of cardiometabolic comorbidities further supports the need for an integrated, comprehensive management approach rather than a glycaemia-centric strategy alone.

However, this study has certain limitations. The cross-sectional design precludes causal inference, the sample size was relatively small and drawn from a tertiary care centre (limiting generalizability), and some variables including alcohol consumption, smoking, medication adherence, and duration of poor glycaemic control-may be subject to recall or measurement bias.

CONCLUSION

This study highlights a high prevalence of microvascular complications, particularly neuropathy and retinopathy, among patients with type 2 diabetes mellitus in a South Indian tertiary care setting. Obesity, dyslipidaemia, and hypertension were also common, reflecting the clustering of cardio metabolic risk factors in this population. Although glycaemic control did not show a significant association with most complications, the duration of diabetes was strongly related to retinopathy, reaffirming the progressive nature of microvascular damage with chronic hyperglycemia.

These findings underscore the need for early, routine screening for neuropathy and retinopathy especially among individuals with a longer duration of diabetes and comprehensive management addressing not only glycaemia but also obesity, dyslipidaemia, and blood pressure. Future longitudinal studies with larger, community-based samples and multivariate analyses are warranted to identify independent predictors and guide region-specific preventive strategies.

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