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Research Article

Comparative Assessment of Cardiovascular Risk Factors in Patients with Type 2 Diabetes Mellitus and Non-Diabetic Individuals: A Cross-Sectional Study

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ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) is associated with an increased risk of cardiovascular disease due to the coexistence of multiple metabolic and clinical risk factors. Comparative assessment of these risk factors between diabetic and non-diabetic individuals is essential for early identification and implementation of preventive strategies. **Aim:** To comparatively assess cardiovascular risk factors among patients with type 2 diabetes mellitus and non-diabetic individuals. **Materials and Methods:** This hospital-based comparative cross-sectional study included 160 participants, comprising 80 patients with type 2 diabetes mellitus and 80 age- and sex-matched non-diabetic individuals. Demographic characteristics, anthropometric measurements, blood pressure, fasting plasma glucose, HbA1c, and lipid profile were assessed. The prevalence of major cardiovascular risk factors and overall cardiovascular risk profiles were compared between the two groups. Statistical analysis was performed using the independent Student's t-test or Welch's t-test for continuous variables and the Chi-square test for categorical variables. Odds ratios with 95% confidence intervals were calculated, and a p-value <0.05 was considered statistically significant. **Results:** The mean age and sex distribution were comparable between the groups (p>0.05). Patients with T2DM had significantly higher BMI (27.40±3.60 vs. 24.80±3.20 kg/m²), waist circumference (94.60±10.10 vs. 86.90±9.80 cm), systolic and diastolic blood pressure, fasting plasma glucose (156.80±42.70 vs. 91.60±8.90 mg/dL), HbA1c (8.10±1.60% vs.

5.40±0.40%), total cholesterol, triglycerides, and LDL cholesterol, while HDL cholesterol was significantly lower (all p≤0.001). Hypertension (63.8%), dyslipidemia (71.3%), central obesity (66.3%), low HDL cholesterol (61.3%), elevated LDL cholesterol (57.5%), hypertriglyceridemia (55.0%), physical inactivity (70.0%), and family history of cardiovascular disease (42.5%) were significantly more prevalent among diabetic participants. Dyslipidemia demonstrated the strongest association with diabetes (OR=4.36, 95% CI: 2.24–8.47). Diabetic participants had a significantly higher mean number of cardiovascular risk factors (4.80±1.70 vs. 2.70±1.50, p<0.001), greater estimated 10-year cardiovascular risk (17.60±8.40% vs. 8.90±5.70%, p<0.001), and higher odds of belonging to the high cardiovascular risk category (OR=5.48, 95% CI: 2.65–11.31). **Conclusion:** Patients with type 2 diabetes mellitus exhibited a significantly greater burden of cardiovascular risk factors and substantially higher estimated cardiovascular risk than non-diabetic individuals. Comprehensive cardiovascular risk assessment, early lifestyle intervention, and aggressive management of modifiable risk factors should be incorporated into routine diabetes care to reduce future cardiovascular morbidity and mortality.

KEYWORDS: Type 2 diabetes mellitus. Cardiovascular risk factors. Dyslipidemia.

INTRODUCTION

Cardiovascular disease (CVD) remains the leading cause of morbidity and mortality worldwide and is particularly prevalent among individuals with type 2 diabetes mellitus (T2DM). The coexistence of diabetes with traditional cardiovascular risk factors such as hypertension, dyslipidemia, obesity, smoking, and sedentary lifestyle substantially increases the risk of adverse cardiovascular outcomes. T2DM contributes to accelerated atherosclerosis through multiple mechanisms including chronic hyperglycemia, insulin resistance, oxidative stress, endothelial dysfunction, systemic inflammation, and abnormalities in lipid metabolism. These pathophysiological changes promote vascular injury, plaque formation, and thrombosis, resulting in an increased incidence of coronary artery disease, cerebrovascular accidents, and peripheral arterial disease. Consequently, early identification and management of cardiovascular risk factors in patients with T2DM have become an essential component of diabetes care.[1]

The prevalence of type 2 diabetes has increased dramatically over the past few decades owing to rapid urbanization, changing dietary habits, physical inactivity, obesity, and population aging. India has emerged as one of the countries with the highest burden of diabetes, posing significant public health and economic challenges. Individuals with T2DM are estimated to have a two- to four-fold higher risk of developing cardiovascular disease compared with non-diabetic individuals. Furthermore, cardiovascular complications often develop silently before the diagnosis of diabetes and may remain asymptomatic until advanced stages. Therefore, assessment of cardiovascular risk factors in diabetic patients is important not only for preventing cardiovascular events but also for improving long-term survival and quality of life.[2]

Traditional cardiovascular risk factors such as elevated blood pressure, abnormal lipid profile, increased body mass index (BMI), central obesity, smoking, alcohol consumption, and family history of cardiovascular disease frequently coexist in patients with T2DM. In addition, diabetes-specific factors including duration of diabetes, poor glycemic control, and insulin resistance further amplify cardiovascular risk. Comparative evaluation of these risk

factors between diabetic and non-diabetic individuals provides valuable insights into the magnitude of excess cardiovascular risk attributable to diabetes. Such comparisons also help identify modifiable risk factors that can be targeted through lifestyle modification, pharmacotherapy, and regular screening.[3]

Several national and international guidelines recommend comprehensive cardiovascular risk assessment in individuals with diabetes, emphasizing aggressive control of blood glucose, blood pressure, serum lipids, body weight, and other modifiable risk factors. However, despite advances in preventive strategies, cardiovascular disease continues to account for the majority of deaths among diabetic patients. This highlights the need for continuous evaluation of cardiovascular risk profiles in different populations, especially in developing countries where demographic characteristics, healthcare access, and lifestyle patterns differ considerably.[4]

AIM

To comparatively assess cardiovascular risk factors among patients with type 2 diabetes mellitus and non-diabetic individuals.

OBJECTIVES

1. To compare the prevalence of major cardiovascular risk factors between patients with type 2 diabetes mellitus and non-diabetic individuals.
2. To evaluate the association of anthropometric, clinical, and biochemical cardiovascular risk factors with type 2 diabetes mellitus.
3. To identify the overall cardiovascular risk profile among diabetic and non-diabetic study participants.

MATERIALS AND METHODOLOGY

Source of Data

The data were collected from patients diagnosed with type 2 diabetes mellitus attending the Department of General Medicine and age- and sex-matched non-diabetic individuals attending the outpatient department or accompanying patients at the same tertiary care hospital during the study period. Clinical, anthropometric, laboratory, and demographic data were obtained after obtaining written informed consent.

Study Design

A hospital-based comparative cross-sectional study was conducted.

Study Location

The study was conducted in the Department of General Medicine at a tertiary care teaching hospital.

Study Duration

The study was conducted over a period of 18 months.

Sample Size

A total of 160 participants were included in the study.

- **Group A:** 80 patients diagnosed with Type 2 Diabetes Mellitus.
- **Group B:** 80 age- and sex-matched non-diabetic individuals.

Inclusion Criteria

Group A (Type 2 Diabetes Mellitus)

- Patients aged ≥18 years.
- Diagnosed cases of Type 2 Diabetes Mellitus according to American Diabetes Association (ADA) diagnostic criteria.
- Patients willing to provide written informed consent.

Group B (Non-Diabetic Controls)

- Individuals aged ≥18 years.
- No previous diagnosis of diabetes mellitus.
- Fasting plasma glucose and/or HbA1c within the normal range.
- Individuals willing to participate and provide written informed consent.

Exclusion Criteria

- Type 1 diabetes mellitus.
- Gestational diabetes mellitus.
- Pregnant or lactating women.

- Patients with acute infections or inflammatory diseases.
- Patients with chronic liver disease.
- Patients with chronic kidney disease requiring dialysis.
- Patients with malignancy.
- Patients with known congenital heart disease.
- Individuals unwilling to participate.

Procedure and Methodology

After obtaining approval from the Institutional Ethics Committee, eligible participants were recruited consecutively according to the predefined inclusion and exclusion criteria. Written informed consent was obtained before enrollment. A detailed clinical history including age, sex, duration of diabetes, smoking status, alcohol consumption, family history of diabetes and cardiovascular disease, physical activity, dietary habits, and medication history was recorded using a structured case record form. A comprehensive physical examination was performed. Anthropometric measurements including height, weight, body mass index (BMI), waist circumference, and hip circumference were measured using standardized techniques. Waist-to-hip ratio was calculated. Blood pressure was recorded using a calibrated sphygmomanometer after the participant had rested for at least five minutes, and the average of two readings was considered for analysis.

Participants underwent laboratory investigations including fasting blood glucose, postprandial blood glucose, glycated hemoglobin (HbA1c), serum total cholesterol, triglycerides, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), very-low-density lipoprotein cholesterol (VLDL-C), serum creatinine, and other routine investigations whenever indicated. Cardiovascular risk factors were assessed and compared between diabetic and non-diabetic participants.

Sample Processing

Venous blood samples were collected under aseptic precautions after an overnight fast of 8-12 hours. Approximately 5-7 mL of venous blood was obtained from each participant. Blood samples for fasting glucose and lipid profile were collected in plain tubes, while HbA1c estimation was performed using EDTA blood samples. Serum was separated by centrifugation at approximately 3000 rpm for 10 minutes and analyzed on an automated biochemistry analyzer using standardized laboratory protocols. Internal and external quality control procedures were followed throughout the study.

Statistical Methods

The collected data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) software version 26.0.

Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were expressed as frequencies and percentages. Comparison of continuous variables between diabetic and non-diabetic groups was performed using the independent Student's *t*-test or Mann-Whitney U test depending on data distribution. Categorical variables were compared using the Chi-square test or Fisher's exact test whenever appropriate. Odds ratios (OR) with 95% confidence intervals (CI) were calculated for important cardiovascular risk factors. A p-value <0.05 was considered statistically significant.

Data Collection

Data were collected using a predesigned and pretested case record form. Information regarding demographic characteristics, clinical history, lifestyle habits, anthropometric measurements, blood pressure, laboratory investigations, and cardiovascular risk factors was recorded systematically for every participant. All collected data were verified for completeness, coded, and entered into a

computerized database before statistical analysis.

OBSERVATION AND RESULTS

Table 1: Comparative assessment of demographic, anthropometric, clinical, and biochemical cardiovascular risk parameters among diabetic and non-diabetic participants (N=160)

Variable	Total (N=160), n (%) or Mean±SD	Type 2 diabetes mellitus (n=80)	Non-diabetic individuals (n=80)	Test of significance	95% CI of difference	p-value
Age, years	52.85±10.08	53.80±9.70	51.90±10.40	Welch's t=1.19	−1.24 to 5.04	0.234
Male sex	90 (56.3)	47 (58.8)	43 (53.8)	χ^2=0.41	−10.4% to 20.4%	0.524
Female sex	70 (43.8)	33 (41.3)	37 (46.3)			
BMI, kg/m²	26.10±3.64	27.40±3.60	24.80±3.20	Welch's t=4.83	1.54 to 3.66	<0.001 *
Waist circumference, cm	90.75±10.65	94.60±10.10	86.90±9.80	Welch's t=4.89	4.59 to 10.81	<0.001 *
Systolic blood pressure, mmHg	132.80±17.03	139.20±16.80	126.40±14.70	Welch's t=5.13	7.87 to 17.73	<0.001 *
Diastolic blood pressure, mmHg	82.00±9.62	84.90±9.60	79.10±8.80	Welch's t=3.98	2.92 to 8.68	<0.001 *
Fasting plasma glucose, mg/dL	124.20±44.93	156.80±42.70	91.60±8.90	Welch's t=13.37	55.51 to 74.89	<0.001 *
HbA1c, %	6.75±1.79	8.10±1.60	5.40±0.40	Welch's t=14.64	2.33 to 3.07	<0.001 *
Total cholesterol, mg/dL	192.15±36.47	202.60±38.40	181.70±31.50	Welch's t=3.76	9.93 to 31.87	<0.001 *
Triglycerides, mg/dL	154.55±58.33	176.40±61.80	132.70±46.20	Welch's t=5.07	26.65 to 60.75	<0.001 *
LDL-C, mg/dL	116.85±31.02	124.80±32.60	108.90±27.40	Welch's t=3.34	6.49 to 25.31	0.001*

HDL-C, mg/dL	43.00±9.22	39.70±8.20	46.30±9.10	Welch's t=−4.82	−9.31 to −3.89	<0.001 *

Table 1 compares the demographic, anthropometric, clinical, and biochemical cardiovascular risk parameters between patients with type 2 diabetes mellitus (T2DM) and non-diabetic individuals. The mean age of the study participants was 52.85±10.08 years, with comparable ages between the diabetic (53.80±9.70 years) and non-diabetic groups (51.90±10.40 years), and the difference was not statistically significant (Welch's t=1.19, 95% CI: −1.24 to 5.04, p=0.234). Similarly, the gender distribution was comparable, with males constituting 58.8% of the diabetic group and 53.8% of the non-diabetic group (χ^2=0.41, p=0.524). However, diabetic participants had significantly higher mean BMI (27.40±3.60 vs. 24.80±3.20 kg/m², p<0.001), waist circumference (94.60±10.10 vs. 86.90±9.80 cm, p<0.001), systolic blood pressure (139.20±16.80 vs. 126.40±14.70 mmHg, p<0.001), and diastolic blood pressure (84.90±9.60 vs. 79.10±8.80 mmHg, p<0.001) than non-diabetic individuals. Glycemic parameters showed marked differences, with significantly higher fasting plasma glucose (156.80±42.70 vs. 91.60±8.90 mg/dL, p<0.001) and HbA1c levels (8.10±1.60% vs. 5.40±0.40%, p<0.001) among diabetic participants. Furthermore, diabetic individuals exhibited significantly higher total cholesterol (202.60±38.40 vs. 181.70±31.50 mg/dL, p<0.001), triglycerides (176.40±61.80 vs. 132.70±46.20 mg/dL, p<0.001), and LDL cholesterol (124.80±32.60 vs. 108.90±27.40 mg/dL, p=0.001), whereas HDL cholesterol was significantly lower (39.70±8.20 vs. 46.30±9.10 mg/dL, p<0.001).

Table 2: Prevalence of major cardiovascular risk factors among diabetic and non-diabetic participants (N=160)

Cardiovascular risk factor	Total (N=160), n (%)	Type 2 diabetes mellitus (n=80), n (%)	Non-diabetic individuals (n=80), n (%)	Test of significance	Difference in prevalence, 95% CI	p-value
Hypertension	78 (48.8)	51 (63.8)	27 (33.8)	χ^2=14.41	15.2% to 44.8%	<0.001 *
Dyslipidemia	86 (53.8)	57 (71.3)	29 (36.3)	χ^2=19.71	20.5% to 49.5%	<0.001 *
General obesity	57 (35.6)	39 (48.8)	18 (22.5)	χ^2=12.02	12.0% to 40.5%	0.001*
Central obesity	84 (52.5)	53 (66.3)	31 (38.8)	χ^2=12.13	12.6% to 42.4%	<0.001 *
Low HDL-C	75 (46.9)	49 (61.3)	26 (32.5)	χ^2=13.28	13.9% to 43.6%	<0.001 *
Elevated LDL-C	70 (43.8)	46 (57.5)	24 (30.0)	χ^2=12.29	12.7% to 42.3%	<0.001 *
Hypertriglyceridemia	65 (40.6)	44 (55.0)	21 (26.3)	χ^2=13.71	14.2% to 43.3%	<0.001 *

Current smoking	37 (23.1)	23 (28.8)	14 (17.5)	χ^2=2.85	−1.7% to 24.2%	0.092
Physical inactivity	89 (55.6)	56 (70.0)	33 (41.3)	χ^2=13.39	14.0% to 43.5%	<0.001 *
Family history of cardiovascular disease	51 (31.9)	34 (42.5)	17 (21.3)	χ^2=8.32	7.2% to 35.3%	0.004*

Table 2 compares the prevalence of major cardiovascular risk factors between diabetic and non-diabetic participants. Overall, hypertension was present in 48.8% of participants and was significantly more common among diabetic individuals (63.8%) than non-diabetic individuals (33.8%) (χ^2=14.41, p<0.001). Dyslipidemia was the most prevalent cardiovascular risk factor, affecting 53.8% of participants overall, with a significantly higher prevalence among diabetics (71.3%) compared with non-diabetics (36.3%) (χ^2=19.71, p<0.001). General obesity and central obesity were also significantly more frequent in diabetic participants, occurring in 48.8% and 66.3%, respectively, compared with 22.5% and 38.8% among non-diabetic individuals (p≤0.001). Similarly, low HDL cholesterol (61.3% vs. 32.5%), elevated LDL cholesterol (57.5% vs. 30.0%), and hypertriglyceridemia (55.0% vs. 26.3%) were significantly more prevalent among diabetic participants (all p<0.001). Physical inactivity was observed in 70.0% of diabetics compared with 41.3% of non-diabetics (χ^2=13.39, p<0.001), while a positive family history of cardiovascular disease was significantly more frequent among diabetic individuals (42.5% vs. 21.3%, p=0.004). Although current smoking was more common among diabetic participants (28.8%) than non-diabetic individuals (17.5%), this difference did not reach statistical significance (χ^2=2.85, p=0.092).

Table 3: Association of anthropometric, clinical, and biochemical cardiovascular risk factors with type 2 diabetes mellitus (N=160)

Risk factor	**Diabetic participants with risk factor, n/N (%)**	**Non-diabetic participants with risk factor, n/N (%)**	**Unadjusted odds ratio**	**95 % CI for odds ratio**	**Test of significance**	**p-value**
Hypertension	51/80 (63.8)	27/80 (33.8)	3.45	1.80 - 6.61	χ^2=14.41	<0.001 *
Dyslipidemia	57/80 (71.3)	29/80 (36.3)	4.36	2.24 - 8.47	χ^2=19.71	<0.001 *
General obesity	39/80 (48.8)	18/80 (22.5)	3.28	1.65 - 6.49	χ^2=12.02	0.001*

Central obesity	53/80 (66.3)	31/80 (38.8)	3.10	1.63 - 5.92	χ^2=12.13	<0.001 *
Low HDL-C	49/80 (61.3)	26/80 (32.5)	3.28	1.72 - 6.28	χ^2=13.28	<0.001 *
Elevated LDL-C	46/80 (57.5)	24/80 (30.0)	3.16	1.64 - 6.06	χ^2=12.29	<0.001 *
Hypertriglyceridemia	44/80 (55.0)	21/80 (26.3)	3.43	1.77 - 6.68	χ^2=13.71	<0.001 *
Current smoking	23/80 (28.8)	14/80 (17.5)	1.90	0.90 - 4.04	χ^2=2.85	0.092
Physical inactivity	56/80 (70.0)	33/80 (41.3)	3.32	1.73 - 6.39	χ^2=13.39	<0.001 *
Family history of cardiovascular disease	34/80 (42.5)	17/80 (21.3)	2.74	1.37 - 5.49	χ^2=8.32	0.004*

Table 3 presents the association between cardiovascular risk factors and type 2 diabetes mellitus using unadjusted odds ratios. Dyslipidemia showed the strongest association with diabetes, with diabetic participants having 4.36 times higher odds of dyslipidemia compared with non-diabetic individuals (95% CI: 2.24–8.47, p<0.001). Hypertension was also strongly associated with diabetes (OR=3.45, 95% CI: 1.80–6.61, p<0.001). Hypertriglyceridemia demonstrated a significant association (OR=3.43, 95% CI: 1.77–6.68, p<0.001), followed by general obesity (OR=3.28, 95% CI: 1.65–6.49, p=0.001), low HDL cholesterol (OR=3.28, 95% CI: 1.72–6.28, p<0.001), physical inactivity (OR=3.32, 95% CI: 1.73–6.39, p<0.001), central obesity (OR=3.10, 95% CI: 1.63–5.92, p<0.001), and elevated LDL cholesterol (OR=3.16, 95% CI: 1.64–6.06, p<0.001). A positive family history of cardiovascular disease was associated with approximately 2.74-fold higher odds of diabetes (95% CI: 1.37–5.49, p=0.004). Although current smoking was associated with an OR of 1.90, the confidence interval included unity (95% CI: 0.90–4.04), and the association was not statistically significant (p=0.092).

Table 4: Overall cardiovascular risk profile among diabetic and non-diabetic study participants (N=160)

Cardiovascular risk parameter	Total (N=160), n (%) or Mean±SD	Type 2 diabetes mellitus (n=80)	Non-diabetic individuals (n=80)	Test of significance	95% CI	p-value

Number of cardiovascular risk factors	3.75±1.92	4.80±1.70	2.70±1.50	Welch's t=8.28	1.60 to 2.60	<0.001*
Estimated 10-year cardiovascular risk, %	13.25±8.39	17.60±8.40	8.90±5.70	Welch's t=7.67	6.46 to 10.94	<0.001*
Overall risk category				**χ^2=31.82**		**<0.001***
Low risk, <10%	46 (28.8)	9 (11.3)	37 (46.3)			
Intermediate risk, 10-19.9%	57 (35.6)	28 (35.0)	29 (36.3)			
High risk, ≥20%	57 (35.6)	43 (53.8)	14 (17.5)			
High cardiovascular risk, ≥20%	57 (35.6)	43 (53.8)	14 (17.5)	χ^2=22.92	Difference: 22.5% to 50.0%	<0.001*
Odds of high cardiovascular risk		43/37	14/66	OR=5.48	OR: 2.65-11.31	<0.001*

Table 4 summarizes the overall cardiovascular risk profile among diabetic and non-diabetic participants. Patients with type 2 diabetes mellitus had a significantly greater mean number of cardiovascular risk factors than non-diabetic individuals (4.80±1.70 vs. 2.70±1.50, Welch's t=8.28, 95% CI: 1.60–2.60, p<0.001). Likewise, the estimated 10-year cardiovascular risk was significantly higher among diabetic participants (17.60±8.40%) compared with non-diabetic individuals (8.90±5.70%) (Welch's t=7.67, 95% CI: 6.46–10.94, p<0.001). The distribution of overall cardiovascular risk categories also differed significantly between the groups (χ^2=31.82, p<0.001). Nearly half of the non-diabetic participants (46.3%) were classified as low cardiovascular risk compared with only 11.3% of diabetic participants. In contrast, more than half of diabetic participants (53.8%) belonged to the high-risk category (≥20% estimated 10-year cardiovascular risk), whereas only 17.5% of non-diabetic individuals were classified as high risk. The prevalence of high cardiovascular risk was therefore significantly greater among diabetic participants (χ^2=22.92, p<0.001), with an odds ratio of 5.48 (95% CI: 2.65–11.31), indicating that patients with type 2 diabetes mellitus had more than fivefold higher odds of being categorized as having high cardiovascular risk.

DISCUSSION

The present comparative cross-sectional study evaluated cardiovascular risk factors among 160 participants, comprising 80 patients with type 2 diabetes mellitus (T2DM) and 80 non-diabetic individuals. The principal finding was that participants with T2DM had a significantly less favourable cardiovascular risk profile, characterized by greater adiposity, higher blood pressure, poor glycaemic indices, atherogenic dyslipidemia, physical inactivity, clustering of multiple risk factors, and a higher estimated 10-year cardiovascular risk. These findings reinforce

the close interrelationship between T2DM and cardiovascular disease and indicate that cardiovascular risk assessment should form an integral part of routine diabetes management.

The mean age of diabetic participants was 53.80±9.70 years compared with 51.90±10.40 years among non-diabetic individuals, with no statistically significant difference. Similarly, the sex distribution was comparable between the groups. This demographic comparability was important because it reduced the likelihood that differences in cardiovascular risk parameters were merely attributable to age or sex. Anjana et al. (2017)[1], in the ICMR–INDIAB population-based study, demonstrated that diabetes was strongly associated with increasing age, male sex, obesity, hypertension, and family history. However, because age and sex were comparable in the present study, the observed differences in anthropometric, metabolic, and clinical risk factors were more likely to be associated with diabetic status itself. Dalal et al. (2024)[2] similarly reported that most Indian patients with coexistent diabetes, hypertension, and dyslipidemia were middle-aged and that males constituted 57% of their study population.

Diabetic participants had significantly higher mean BMI and waist circumference than non-diabetic individuals. The mean BMI was 27.40±3.60 kg/m² in the diabetic group compared with 24.80±3.20 kg/m² in the non-diabetic group, while the corresponding waist circumferences were 94.60±10.10 cm and 86.90±9.80 cm. General obesity was present in 48.8% of diabetic participants compared with 22.5% of non-diabetic individuals, and central obesity was observed in 66.3% and 38.8%, respectively. General obesity increased the unadjusted odds of T2DM by 3.28 times, whereas central obesity was associated with 3.10 times higher odds. These results are consistent with Powell-Wiley et al. (2021)[3], who emphasized that excess adiposity directly contributes to the development of insulin resistance, diabetes, hypertension, and dyslipidemia. Central adiposity may be particularly relevant because visceral adipose tissue is metabolically active and promotes inflammation, insulin resistance, and atherogenic lipid abnormalities. The findings are also supported by Puri et al. (2023)[4], who described the characteristic Asian Indian phenotype as increased abdominal and visceral fat, greater insulin resistance, higher waist circumference, hypertriglyceridemia, and low HDL-C, even at comparatively modest BMI values.

The diabetic group had significantly higher systolic and diastolic blood pressure. Mean systolic blood pressure was 139.20±16.80 mmHg among diabetic participants compared with 126.40±14.70 mmHg among non-diabetic individuals, while mean diastolic blood pressure was 84.90±9.60 mmHg and 79.10±8.80 mmHg, respectively. Hypertension was present in 63.8% of diabetic participants compared with 33.8% of non-diabetic participants and was associated with 3.45 times higher odds of T2DM. Petrie et al. (2018)[5] explained that diabetes and hypertension frequently coexist because they share pathophysiological mechanisms, including insulin resistance, endothelial dysfunction, vascular inflammation, oxidative stress, arterial stiffness, and activation of the renin–angiotensin–aldosterone system. Dalal et al. (2024)[2] also reported a mean systolic blood pressure of 138.81±19.59 mmHg and a mean diastolic blood pressure of 82.17±10.35 mmHg among Indian patients with coexistent T2DM, hypertension, and dyslipidemia, values closely resembling those observed in the present diabetic group.

As expected, glycaemic parameters differed markedly between the groups. Diabetic participants had a mean fasting plasma

glucose of 156.80±42.70 mg/dL and mean HbA1c of 8.10±1.60%, compared with 91.60±8.90 mg/dL and 5.40±0.40%, respectively, among non-diabetic individuals. The mean HbA1c in the present diabetic group suggested suboptimal glycaemic control. Dalal et al. (2024)[2] reported a comparable mean HbA1c of 8.35±1.96% among Indian patients with diabetes, hypertension, and dyslipidemia, indicating that inadequate glycaemic control remains common in routine clinical practice. Wan et al. (2020)[6], in a 10-year cohort study, found that higher and more variable HbA1c levels were associated with increased cardiovascular disease and mortality in patients with T2DM. Chronic hyperglycaemia may promote cardiovascular injury through advanced glycation end-product formation, oxidative stress, endothelial dysfunction, vascular inflammation, and accelerated atherosclerosis.

The lipid profile of diabetic participants was significantly more atherogenic. Mean total cholesterol, triglycerides, and LDL-C were significantly higher, while mean HDL-C was significantly lower in the diabetic group. Dyslipidemia was present in 71.3% of diabetic participants compared with 36.3% of non-diabetic individuals and showed the strongest unadjusted association with T2DM, with an odds ratio of 4.36. Das et al. (2021)[7], in a real-world multicentre Indian study, reported that diabetic dyslipidemia was common and that substantial gaps remained in attaining guideline-recommended lipid targets. Puri et al. (2023)[4] further described diabetic dyslipidemia among Indians as an atherogenic pattern consisting predominantly of elevated triglycerides, low HDL-C, and increased concentrations of small dense LDL particles. This pattern is strongly associated with residual cardiovascular risk even when total LDL-C concentrations are not markedly elevated.

Low HDL-C was observed in 61.3% of diabetic participants compared with 32.5% of controls and was associated with 3.28 times higher odds of diabetes. Elevated LDL-C was present in 57.5% and 30.0%, respectively, while hypertriglyceridemia occurred in 55.0% of diabetic participants compared with 26.3% of non-diabetic individuals. Das et al. (2021)[7] identified inadequate control of LDL-C and other lipid abnormalities among Indian patients with T2DM despite lipid-lowering treatment. Puri et al. (2023)[4] noted that Asian Indians have a particularly high prevalence of hypertriglyceridemia, low HDL-C, visceral adiposity, and insulin resistance, which together contribute to premature atherosclerotic cardiovascular disease. The higher total cholesterol, LDL-C and triglyceride levels and lower HDL-C observed in the present study therefore reflect the characteristic lipid abnormalities associated with insulin resistance and T2DM.

Physical inactivity was reported in 70.0% of diabetic participants compared with 41.3% of non-diabetic individuals and was associated with 3.32 times higher odds of T2DM. This finding indicates that sedentary behaviour may have contributed to both excess body weight and the clustering of metabolic risk factors. Powell-Wiley et al. (2021)[3] identified physical inactivity as an important behavioural determinant of obesity and cardiovascular disease, while Anjana et al. (2017)[1] demonstrated the importance of lifestyle and metabolic risk factors in the growing Indian diabetes epidemic. Regular physical activity improves insulin sensitivity, assists weight and blood pressure control, increases HDL-C, lowers triglycerides, and reduces overall cardiovascular risk.

A family history of cardiovascular disease was significantly more frequent in diabetic participants than in non-diabetic individuals (42.5% vs. 21.3%) and was associated with 2.74 times higher odds of diabetes. This may reflect shared genetic susceptibility and

common familial exposure to unhealthy dietary patterns, physical inactivity, obesity, hypertension, and dyslipidemia. Anjana et al. (2017)[1] identified family history as an important risk factor for diabetes in both urban and rural Indian populations. However, because the present study was cross-sectional, it could not distinguish the independent genetic effect from shared environmental and behavioural influences.

Current smoking was more common among diabetic participants than non-diabetic individuals (28.8% vs. 17.5%), but the difference was not statistically significant. The corresponding odds ratio was 1.90, but its 95% confidence interval crossed unity. The lack of statistical significance may have resulted from the relatively small number of smokers or differences in sex distribution, duration, intensity, and reporting of tobacco exposure. Nevertheless, smoking remains an established cardiovascular risk factor and may interact with diabetes to accelerate endothelial injury, thrombosis, inflammation, and atherosclerosis. Wong and Sattar (2023)[8] emphasized that smoking cessation remains a central component of comprehensive cardiovascular risk reduction in patients with diabetes.

The present study demonstrated considerable clustering of cardiovascular risk factors among diabetic participants. The mean number of risk factors was 4.80±1.70 in the diabetic group compared with 2.70±1.50 among non-diabetic individuals. Wright et al. (2020)[9] showed that cardiovascular outcomes among individuals with T2DM were strongly related to the number and degree of control of major risk factors, including glycaemia, blood pressure, lipids, smoking, and renal function. Their study indicated that individuals with better simultaneous control of multiple risk factors had substantially lower cardiovascular event and mortality risks. Thus, evaluating isolated risk factors may underestimate the actual cardiovascular burden, whereas assessment of cumulative risk provides a more clinically meaningful picture.

The estimated mean 10-year cardiovascular risk was almost twice as high among diabetic participants as among non-diabetic individuals (17.60±8.40% vs. 8.90±5.70%). Furthermore, 53.8% of diabetic participants were classified as being at high cardiovascular risk compared with only 17.5% of non-diabetic individuals. Conversely, low cardiovascular risk was observed in 46.3% of non-diabetic participants but only 11.3% of diabetic participants. The odds of being categorized as high cardiovascular risk were 5.48 times greater among patients with T2DM. Calvo-Hueros et al. (2021)[10], in a cohort of patients with T2DM followed for 10 years, demonstrated a substantial burden of predicted and observed cardiovascular risk and highlighted the importance of validating risk prediction tools specifically in diabetic populations. Wong and Sattar (2023)[8] similarly emphasized that diabetes markedly increases lifetime cardiovascular risk, although the magnitude varies according to age, diabetes duration, target-organ damage, and control of accompanying risk factors.

The finding that more than half of the diabetic group belonged to the high-risk category is also consistent with contemporary Indian evidence. Verma et al. (2023)[11] reported a substantial prevalence of established atherosclerotic cardiovascular disease and high or very high predicted cardiovascular risk among Indian patients with T2DM. Dalal et al. (2024)[2] demonstrated that the coexistence of diabetes, hypertension, dyslipidemia, and excess body weight remained common and frequently uncontrolled in real-world Indian practice. These observations suggest that a large proportion of patients with T2DM require intensive, multifactorial cardiovascular

prevention rather than glucose-centred management alone.

The higher cardiovascular risk observed in patients with T2DM can be explained by the combined influence of hyperglycaemia, hypertension, central obesity, atherogenic dyslipidemia, insulin resistance, inflammation, endothelial dysfunction, oxidative stress, and prothrombotic alterations. Reddy et al. (2022)[12] documented a high and heterogeneous burden of diabetes, hypertension, obesity, and dyslipidemia across North and South Indian populations, highlighting the need for region-specific cardiovascular prevention. The significant associations observed in the present study are therefore clinically plausible and consistent with both Indian and international evidence.

Overall, the present study demonstrated that patients with T2DM carried a substantially greater cardiovascular risk burden than non-diabetic individuals despite comparable age and sex distributions. Dyslipidemia showed the strongest association with diabetes, while hypertension, obesity, central obesity, low HDL-C, elevated LDL-C, hypertriglyceridemia, physical inactivity, and family history of cardiovascular disease were also significantly associated. The accumulation of these risk factors resulted in a markedly higher estimated 10-year cardiovascular risk among diabetic participants.

CONCLUSION

The present cross-sectional study demonstrated that patients with type 2 diabetes mellitus had a significantly higher burden of cardiovascular risk factors than non-diabetic individuals. Diabetic participants exhibited greater body mass index, waist circumference, blood pressure, fasting plasma glucose, HbA1c, total cholesterol, triglycerides, and LDL cholesterol, along with significantly lower HDL cholesterol. Hypertension, dyslipidemia, obesity, central obesity, hypertriglyceridemia, physical inactivity, and a positive family history of cardiovascular disease were significantly more prevalent among patients with type 2 diabetes mellitus, while dyslipidemia showed the strongest association with diabetic status. Furthermore, diabetic participants had a significantly higher cumulative number of cardiovascular risk factors and a markedly greater estimated 10-year cardiovascular risk, with more than half being categorized as high-risk individuals. These findings emphasize that type 2 diabetes mellitus is associated with a substantial increase in modifiable cardiovascular risk factors, highlighting the need for comprehensive cardiovascular risk assessment, early lifestyle modification, aggressive management of metabolic abnormalities, and regular follow-up to reduce future cardiovascular morbidity and mortality.

LIMITATIONS OF THE STUDY

1. The study employed a cross-sectional design, which limits the ability to establish causal relationships between type 2 diabetes mellitus and cardiovascular risk factors.
2. The study was conducted at a single tertiary care centre; therefore, the findings may not be fully generalizable to the wider community or different healthcare settings.
3. The sample size was relatively modest (160 participants), which may have limited the power to detect associations for less common risk factors such as smoking.
4. Lifestyle-related variables including dietary habits, physical activity, smoking, and alcohol consumption were partly based on self-reported information and were therefore susceptible to recall and reporting bias.
5. The study did not assess the duration of diabetes, antidiabetic medications, medication adherence, or long-term

glycaemic control, all of which may influence cardiovascular risk.

6. Novel cardiovascular biomarkers, inflammatory markers, imaging-based assessment of subclinical atherosclerosis, and long-term cardiovascular outcomes were not evaluated.
7. The cardiovascular risk assessment was based on predicted risk scores rather than prospective follow-up for actual cardiovascular events.

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