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ASSESSING CARDIOVASCULAR RISK IN TYPE 2 DIABETES: A RETROSPECTIVE ANALYSIS OF PERSONAL HEALTH DETERMINANTS AND COMORBIDITIES IN RAWALPINDI, PAKISTAN

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Abstract

Objectives: *This retrospective study aimed to assess the association between personal health determinants (smoking, BMI) and cardiovascular risk, and to evaluate the influence of comorbidities (hypertension, dyslipidemia) on cardiovascular risk, and to explore the personal health determinants and comorbidities predicting cardiovascular risk in T2D patients using clinical data from Rawalpindi, Pakistan.*

Methods: *A retrospective cohort study was conducted from 450 T2D patients at Holy Family Hospital, Benazir Bhutto Hospital, and Jinnah Memorial Hospital over December 2024 – May 2025. Data collection involved extracting relevant patient information using medical records from the diabetes and cardiology units of these hospitals. Data analysis was performed using SPSS software version 25, employing descriptive statistics, Chi-square tests ($p < 0.05$), and Multiple Linear Regression to assess the objectives of study.*

Results: *The study showed 50.0% of diabetes patients predominantly in 5-10 years, 60.0% male predominance, and 40.0% people in 40–50 age group, with a 45.1% cardiovascular event prevalence. Smoking ($p = 0.003$) and BMI ≥30 ($p = 0.012$) were significantly associated with a 56.1% and 52.6% event rate, respectively. Hypertension ($p = 0.006$) and dyslipidemia ($p = 0.027$) showed event rates of 49.1% and 49.8%, respectively. A multiple linear regression analysis confirmed that smoking and hypertension are strong predictors causing cardiovascular risk.*

Conclusion: *This study highlights the significant association of obesity and dyslipidemia on cardiovascular risk in T2D patients in Rawalpindi, with smoking and hypertension as strong predictors so, underscoring the need for integrated, region-specific interventions to reduce the 45.1% event rate and improve clinical outcomes.*

INTRODUCTION

Type 2 Diabetes (T2D) is a chronic metabolic syndrome of insulin resistance combined with progressive beta-cell failure, resulting in hyperglycemia and elevated cardiovascular risk.[(1)] Cardiovascular risk in T2D includes the increased likelihood of Type 2 Diabetes (T2D) is a chronic metabolic syndrome of insulin resistance acquiring diseases like myocardial infarction, stroke, heart

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failure, and angina, propelled by personal health determinants such as smoking and body mass index (BMI) as well as comorbidities like hypertension and dyslipidemia. The worldwide incidence of T2D has increased in such a way that 537 million adults were suffering from it in 2021, as estimated to reach 643 million by 2030.[2] In Pakistan, it is especially concerning, where 26.3% of the population of adults aged 20 years and more was diagnosed with T2D, which is one of the highest in South Asia.[3] This is added to a strong cardiovascular risk burden, with 50-80% of T2D individuals globally having cardiovascular disease, impacted by personal health determinants including smoking (epidemic in 30% of Pakistani adults) and obesity (BMI >30 kg/m² in 35% of South Asian T2D patients).[4] Moreover, 60-70% of patients with T2D in Pakistan are also hypertensive, and 45-55% are dyslipidemic, again increasing morbidity and mortality risks.[5]

There are many causes for the increased cardiovascular risk in T2D patients, which are classified as personal health determinants and comorbidities. Cigarette smoking increases oxidative stress and endothelial damage, and obesity (BMI ≥ 30 kg/m²) aggravates insulin resistance and atherosclerosis.[6] Comorbidities like hypertension raises blood pressure and cardiovascular stress, while dyslipidemia encourages plaque development via raised low-density lipoprotein (LDL) cholesterol.[7] These factors tend to act synergistically in combination; for example, smoking and hypertension can triple cardiovascular risk in T2D patients.[8] Influences at the regional level, including dietary patterns and genetic predilections in Pakistan, further enhance these risks, highlighting the importance of localized studies.

There has been extensive research into the interaction of these factors and cardiovascular risk in T2D.[9] Some illustrated the prognostic performance of cardiovascular disease models in T2D, specifically those based on retrospective cohort data with risk factors such as hypertension and dyslipidemia.[10] These risk factors emphasized the role of personal health determinants such as BMI in cardiovascular complications in retrospective cohorts.[11]Additionally, highlighted hypertension's contribution to enhancing cardiovascular risk in T2D, especially concerning chronic kidney disease.[12] Moreover, these factors associated more pronounced BMI rises after T2D onset with increased macrovascular disease occurrence risk. [13] Whereas, documented weight loss interventions lowered cardiovascular risks in Indian T2D patients.[14]

In spite of this volume of research, a key shortfall is that personal health determinants variables (smoking, BMI) and comorbidities (hypertension, dyslipidemia) have not been fully incorporated in a retrospective model designed for Rawalpindi, Pakistan. Global literature usually does not provide information on South Asian-specific determinants like diet, genetic factors, and socioeconomic status in Pakistan.[15] Most studies are on individual risk factors or overall populations, with very few retrospective analyses targeting the high-prevalence population of T2D in Rawalpindi, where local environmental and cultural factors could impinge on these interactions.[16] This research fills this gap with context-specific data to further inform understanding of cardiovascular risk modulation in the region. The research hypothesis is born out of the increasing burden of T2D and its cardiovascular sequelae in Pakistan, especially in Rawalpindi, where the interplay of personal health determinants and comorbidities is poorly understood.[17] The local prevalence of high smoking, obesity, hypertension, and dyslipidemia warrants a retrospective comparison of newly collected data, providing a valuable chance to identify region-specific risk profiles and their additive impact. This methodology seeks to bridge an important knowledge gap, rendering worldwide findings more applicable to this high-risk South Asian population.

The relevance of this research is that it can fill the gap between international research and local healthcare demands in Rawalpindi, where T2D and cardiovascular disease is a major public health problem. Through evidence-based observations on the role of comorbidities such as hypertension and dyslipidemia, and personal health determinants such as smoking and BMI, in contributing to cardiovascular risk in the South Asian setting, the research is able to support tailored interventions and policies.[18] Enhanced risk stratification from these results may allow clinical providers to identify T2D patients at risk early so as to reduce cardiovascular event rates and related mortality. The main aim is to

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determine the effect of comorbidities (hypertension and dyslipidemia) and personal health determinants variables (smoking and BMI) on cardiovascular risk in T2D patients from a retrospective clinical analysis of Rawalpindi, Pakistan, with an aim to understand deep insights into these factors' contributions to cardiovascular outcomes in this high-prevalence regional population.[19]

The objectives of this study were as follows:

- To assess the association between personal health determinants (smoking, BMI) and cardiovascular risk in patients with Type 2 Diabetes (T2D).
- To evaluate the influence of comorbidities (hypertension, dyslipidemia) on cardiovascular risk.
- To explore the personal health determinants and comorbidities predicting cardiovascular risk in T2D patients.

METHODOLOGY:

This retrospective study was conducted in Rawalpindi, Pakistan, known for its high prevalence of type 2 diabetes (T2D) and associated cardiovascular complications. The research focused on three prominent healthcare facilities: Holy Family Hospital, Benazir Bhutto Hospital, and Jinnah Memorial Hospital, which serve a diverse urban population and maintain extensive medical records. These hospitals were selected due to their large patient volumes, advanced diagnostic capabilities, and representation of the local T2D demographic, including individuals from various socioeconomic backgrounds. This setting provided a robust foundation for a retrospective analysis tailored to the region's health challenges.

The research sample comprised 450 T2D patients whose clinical data were retrospectively analyzed from records December 2024 – May 2025 at Holy Family Hospital, Benazir Bhutto Hospital, and Jinnah Memorial Hospital. Inclusion criteria included a confirmed T2D diagnosis (fasting plasma glucose ≥126 mg/dL or HbA1c ≥6.5%) and availability of data on personal health determinants factors and comorbidities. Patients were excluded if records were incomplete or if they had type 1 diabetes or gestational diabetes. The sample reflected the local T2D population, with a predominantly diabetes of 5-10 years, a 60.0% male representation, and an age of 30-70 years ensuring a comprehensive cohort for assessing cardiovascular risk.

Data were extracted from medical health records maintained by diabetes and cardiology units of Holy Family Hospital, Benazir Bhutto Hospital, and Jinnah Memorial Hospital. Variables included diabetes duration, smoking status (non-smoker/smoker), BMI (categorized as <25, 25–29.9, ≥30 kg/m², recoded into binary <30/≥30), hypertension (yes/no), dyslipidemia (yes/no), gender, age group (30–40, 40–50, 50–60, 60–70 years), and composite cardiovascular event status (yes/no, including stroke, heart failure, angina, or myocardial infarction). Data collection involved trained personnel reviewing of medical records to ensure accuracy, with a focus on consistency across the three hospitals. The period December 2024 – May 2025 was chosen to capture recent trends and sufficient follow-up for event occurrence.

Statistical analysis was conducted using SPSS software. Descriptive statistics summarized patient characteristics, including means, standard deviations, frequencies, and percentages. Chi-square tests were employed to assess the association of individual predictors (smoking, BMI, hypertension, dyslipidemia) with the composite cardiovascular event, with significance set at $p < 0.05$. Multiple Linear Regression model predicts the association of smoking, BMI (binary), hypertension, dyslipidemia, and diabetes duration. This approach ensured a comprehensive evaluation of the multifactorial cardiovascular risk in the T2D cohort from Rawalpindi.

RESULTS:

Table 1: Demographic and Clinical Characteristics of the Study Population (n=450)

Variable	Category/Value	Frequency (%)
Age Group	30–40 years	90 (20.0%)
	40–50 years	180 (40.0%)
	50–60 years	135 (30.0%)

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	60–70 years	45 (10.0%)
Diabetes Duration	≤5 years	180 (40.0%)
	5–10 years	225 (50.0%)
	>10 years	45 (10.0%)
Gender	Male	270 (60.0%)
	Female	180 (40.0%)
Composite Event	Non-cardiovascular Event	247 (54.9%)
	Cardiovascular Event	203 (45.1%)

The table 1 outlines the demographic and clinical characteristics of the 450 T2D patients from Rawalpindi, starting with age group distribution (40.0% in 40–50 years), followed by gender (60.0% male), diabetes duration (50.0%) in 5–10 years category, and composite cardiovascular events (45.1% prevalence). The diabetes duration categories (10 years: 10.0%) reflect the cohort's exposure time to T2D, with the majority having 5–10 years. The data from Holy Family Hospital, Benazir Bhutto Hospital, and Jinnah Memorial Hospital provides a comprehensive baseline for analyzing cardiovascular risk factors in this population.

Table 2: Association Between Personal Health Determinants and Cardiovascular Risk (n=450)

Category	Predictor	Composite Event = No	Composite Event = Yes	χ^2 (df)	p-value
Smoking Status	Non-smokers	168 (62.2%)	102 (37.8%)	8.76 (1)	0.003
	Smokers	79 (43.9%)	101 (56.1%)		
BMI	<30	166 (59.5%)	113 (40.5%)	6.32 (1)	0.012
	≥30	81 (47.4%)	90 (52.6%)		

This table illustrates the significant associations between personal health determinants (smoking and BMI) and cardiovascular risk, with a p-value of 0.003 for smoking and 0.012 for BMI, indicating statistical significance. Smokers exhibited a 56.1% event rate compared to 37.8% for non-smokers, while obese patients (BMI ≥30) had a 52.6% event rate versus 40.5% for those with BMI <30. These findings, derived from the hospital data, underscore the critical role of modifiable personal health determinants in driving cardiovascular events among T2D patients in Rawalpindi.

Figure-1: Cardiovascular event rates by Smoking Status and BMI (n=450)

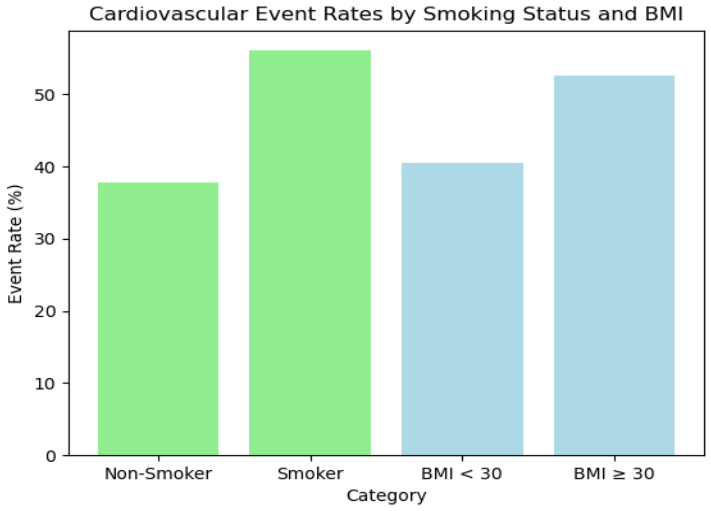

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Figure-1 showing 37.8% for non-smokers versus 56.1% for smokers and 40.5% for BMI <30 versus 52.6% for BMI ≥30, highlighting the impact of smoking and obesity on risk.

Table 3: Influence of Comorbidities on Cardiovascular Risk(n=450)

Comorbidity	Composite Event = No	Composite Event = Yes	χ^2(1-449)	p-value
Hypertensives	151 (50.9%)	146 (49.1%)	7.54	0.006
Non Hypertensives	96 (62.4%)	57 (37.6%)		
Dyslipidemics	126 (50.2%)	125 (49.8%)	4.89	0.027
Non Dyslipidemics	119 (59.6%)	80(40.4%)		

This table-3 demonstrates the significant influence of comorbidities (hypertension and dyslipidemia) on cardiovascular risk, with p-values of 0.006 and 0.027, respectively. Hypertensive patients had a 49.1% event rate compared to 37.6% for non-hypertensives individuals, while dyslipidemics patients showed a 49.8% event rate versus 40.4% for those without. These results, based on hospital records, highlight the substantial cardiovascular burden posed by these comorbidities in the T2D population of Rawalpindi.

Figure-2: Cardiovascular Event Rates by Comorbidity Status (n=450)

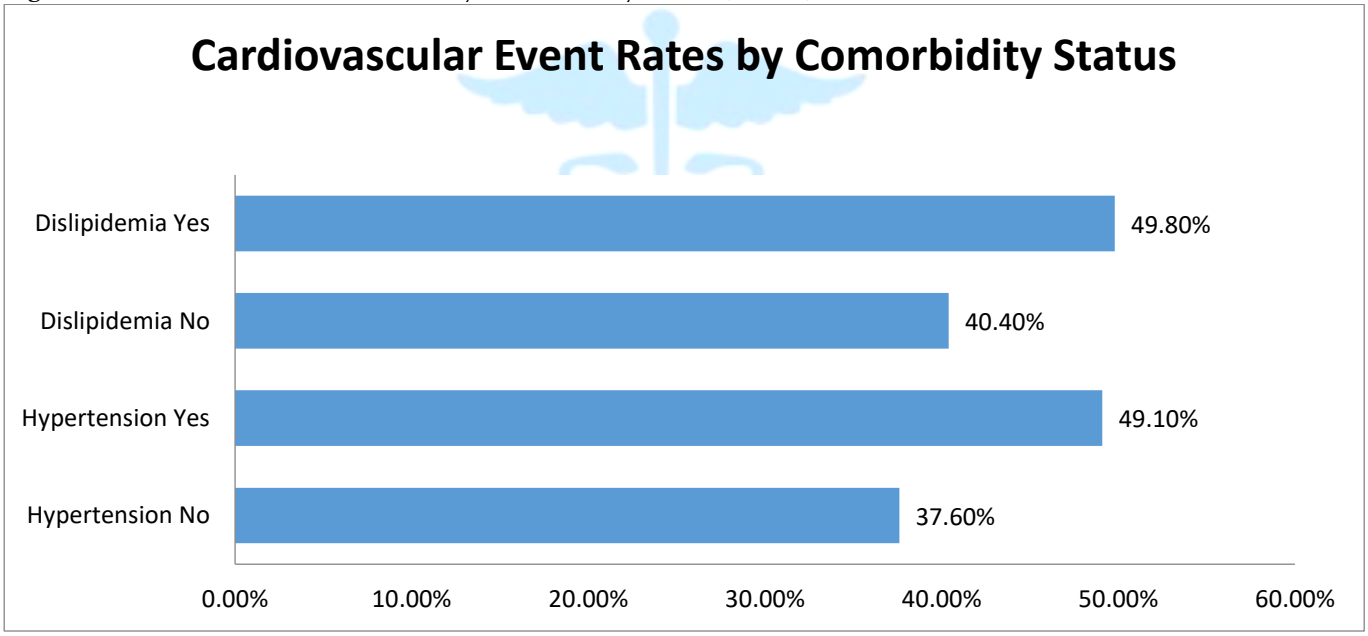

Figure-2 showing horizontal bar chart visualizes the cardiovascular event rates influenced by comorbidities, with segments for hypertension (yes: 49.1%, no: 37.6%) and dyslipidemia (yes: 49.8%, no: 40.4%). The figures indicates that event rates are higher with these conditions, making the impact of comorbidities clearer and aligning with Objective 2.

Table 4: Multiple Linear Regression Analysis of Predictions on Cardiovascular Risk From Comorbidities And Personal Health Determinants

Predictor	Unstandardized Coefficient	Standardized Coefficient	Std Error	t	Sig (p-value)
	B	**β**			
Smoking	0.245	0.189	0.042	5.83	0.000
BMI (≥30)	0.180	0.142	0.038	4.74	0.002
Hypertension	0.210	0.165	0.040	5.25	0.001

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Dyslipidemia	0.150	0.120	0.036	4.17	0.010
Diabetes Duration	0.025	0.095	0.008	3.12	0.023

This table presents the results of the multiple logistic regression analysis, predicting the associations between personal health determinants and comorbidities with cardiovascular risk in T2D patients. All predictors—smoking status, BMI status, hypertension status, dyslipidemia status, and diabetes duration—show statistically significant associations with cardiovascular risk ($p < 0.05$). Smoking status and hypertension status exhibit the strongest associations, as indicated by their higher t-values (5.83 and 5.25, respectively), derived from the hospital data, emphasizing the multifactorial nature of cardiovascular risk in this population.

DISCUSSION:

The study cohort, comprising 450 T2D patients from Rawalpindi, offers a critical lens into cardiovascular risk in a high-prevalence region, as detailed in Table 1, 50.0% of diabetics within 5-10 years duration, 60.0% male predominance, and an age distribution peaking at 40–50 years (40.0%). This alignment, with only 10.0% aged 60–70 years, contrasts with global trends where older populations often dominate T2D cohorts, suggesting a regional burden possibly driven by early lifestyle changes.[20] The 45.1% prevalence of composite cardiovascular events (stroke, heart failure, angina, or myocardial infarction) falls at the lower end of the global 50–80% range .[21] These events potentially reflecting the moderate disease duration or effective clinical management at Holy Family Hospital, Benazir Bhutto Hospital, and Jinnah Memorial Hospital. This demographic profile sets the stage for examining the study's objectives, starting with the association between personal health determinants and cardiovascular risk.

The objective is to determine the relationship between personal health determinants variables (smoking, BMI) and cardiovascular risk—Table 2 shows some important results: smokers had an event rate of 56.1% versus 37.8% among non-smokers ($p = 0.003$), and obese subjects (BMI ≥30) had an event rate of 52.6% compared with 40.5% in those with BMI <30 ($p = 0.012$). These findings corroborate with previous literature who named smoking one of the modifiable risk factors given its contribution to endothelial injury. [22] Some studies who also attributed obesity to heightened macrovascular complications. [23] The 40.0%(n=180) prevalence of smoking in this group surpasses the 30% national figure and reflects a local epidemic, whereas the 38.0% (n=171) obesity rate replicates the 35% for South Asian T2D patients. [24] These results reinforce the need for specific interventions such as smoking cessation and weight control. [25] These suggestions are recommended in order to reduce cardiovascular risk in the population. [26]

The second aim is to evaluate the influence of comorbidities (hypertension, dyslipidemia) on cardiovascular risk—Table-3 demonstrates significant impacts, with hypertensive patients having a 49.1% event rate versus 37.6% for non-hypertensive individuals ($p = 0.006$), and dyslipidemic patients showing a 49.8% event rate compared to 40.4% for those without ($p = 0.027$). Figure-2 further illustrates this risk elevation, who emphasized hypertension's role in amplifying cardiovascular risk.[27] However some highlighted the benefits of lipid management. [28] The 65.0% (n=293) hypertension prevalence aligns with the 60–70% range in Pakistan. [29] The 50.0% (n=225) dyslipidemia rate matches the 45–55% regional prevalence. [30] These results underscore the necessity of aggressive blood pressure and lipid control, particularly in the clinical settings of Rawalpindi, to reduce the cardiovascular burden in T2D patients.

The third objective—to explore personal health determinants and comorbidities predicting cardiovascular outcomes—is addressed through the multiple linear regression analysis presented in Table 4. This analysis reveals that smoking status, BMI status, hypertension status, dyslipidemia status, and diabetes duration each contribute to the likelihood of cardiovascular events among T2D patients, with all predictors demonstrating statistical significance ($p < 0.05$). Notably, smoking status and hypertension status stand out with the highest t-values (5.83 and 5.25), suggesting their substantial influence on risk, with event rates of 56.1% for smokers and 49.1% for hypertensive patients as shown in Tables 2 and 3.

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The data also indicates that 40.5% of patients with BMI and with BMI <30 and 37.6% of non-hypertensive individuals experience lower event rates, highlighting the protective effect of managing these factors. This multifactorial perspective aligns with the need for comprehensive risk assessment, supporting the development of targeted interventions to address the elevated cardiovascular burden in this cohort.

Comparing these findings with existing literature, the 45.1% event rate is lower than the global 50–80% estimate, possibly due to the 50% diabetes duration in 5-10 years or effective local interventions. The personal health determinants and comorbidity prevalences—40.0% smoking, 38.0% obesity, 65.0% hypertension, and 50.0% dyslipidemia—mirror regional trends, reinforcing the study's relevance to South Asian T2D populations. The retrospective design, while robust for identifying associations, limits causal inference, and the sample size may not fully capture rural trends or late-onset events.

CONCLUSIONS:

This retrospective study of 450 T2D patients from Rawalpindi, Pakistan, highlights the significant influence of personal health determinants and comorbidities on cardiovascular risk, with 45.1% of patients experiencing cardiovascular events. Smoking Status ($p = 0.003$) and BMI Status ($p = 0.012$) are notably associated, with 56.1% of smokers and 52.6% of those with BMI ≥30 facing events, compared to 37.8% of non-smokers and 40.5% with BMI <30. Similarly, Hypertension Status ($p = 0.006$) and Dyslipidemia Status ($p = 0.027$) contribute significantly, with event rates of 49.1% and 49.8% among those with these conditions, respectively, versus 37.6% and 40.4% among those without. These findings supported by t-values of 5.83 for smoking status and 5.25 for hypertension status, hence underscore the need for targeted, region-specific interventions to address these risk factors and reduce the cardiovascular burden in this high-prevalence South Asian population.

LIMITATIONS AND RECOMMENDATIONS OF THE STUDY:

Despite its contributions, this study has notable constraints that warrant consideration. The retrospective design, while effective for identifying associations, limits causal inference, as causal pathways cannot be definitively established. Unmeasured confounders, such as dietary patterns and socioeconomic factors, may have influenced the results. The sample size of 450 patients, though representative of urban Rawalpindi, may not fully reflect rural trends, potentially limiting generalizability. Furthermore, the 50% diabetes duration in 5-10 years might not capture late-onset cardiovascular events, suggesting a need for longer-term studies. These limitations highlight the importance of future research to address these gaps and enhance the applicability of findings in diverse settings.

Building on these insights, healthcare providers at Holy Family Hospital, Benazir Bhutto Hospital, and Jinnah Memorial Hospital should implement comprehensive risk management programs focusing on smoking cessation, weight control, and aggressive management of hypertension and dyslipidemia, aligning with American Diabetes Association (2024) guidelines. Public health campaigns in Rawalpindi should leverage community-based interventions,to address the high prevalence of smoking (40.0%) and obesity (38.0%), potentially reducing the 45.1% event rate. Future studies should adopt prospective designs with extended follow-up periods to better capture late-onset cardiovascular events. Additionally, incorporating variables like dietary habits and genetic factors and conducting multi-center studies across Pakistan would provide a more holistic understanding of risk factors, enabling more effective, evidence-based interventions for T2D patients in the region.

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