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Association Between Diabetes-Related Distress and Predicted 10-Year Cardiovascular Risk in Type 2 Diabetes Mellitus: A Cross-Sectional Study Using PAID Score and UKPDS Risk Engine

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Abstract*— Type 2 diabetes mellitus (T2DM) is a rapidly growing global health problem, and cardiovascular disease remains the leading cause of morbidity and mortality in people living with diabetes. Alongside metabolic dysregulation, diabetes-related distress (DRD) is a common psychosocial burden arising from the continuous demands of diabetes self-management and has been associated with adverse clinical behaviours and outcomes. This observational cross-sectional study assessed the association between DRD and predicted 10-year cardiovascular risk among adults with T2DM attending a tertiary care medicine setting in New Delhi, India. DRD was measured using the Problem Areas in Diabetes (PAID) questionnaire, a validated 20-item scale that quantifies diabetes-specific emotional burden. Predicted 10-year risks for coronary heart disease, fatal coronary heart disease, stroke, and fatal stroke were estimated using the United Kingdom Prospective Diabetes Study (UKPDS) Risk Engine 2.0. Statistical analysis evaluated correlations between PAID scores and UKPDS-predicted cardiovascular risk estimates and compared distress levels across cardiovascular risk strata. The findings indicate that higher DRD is strongly associated with higher predicted cardiovascular risk across multiple outcomes, underscoring the importance of integrating psychosocial screening into routine diabetes care. Incorporating DRD assessment may strengthen comprehensive cardiovascular risk stratification and guide targeted interventions in individuals with T2DM.

***Index Terms*— Cardiovascular Risk; Diabetes-Related Distress; PAID Score; Type 2 Diabetes Mellitus; UKPDS Risk Engine**

I. INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder that occurs when the pancreas produces insufficient insulin or when the body cannot effectively utilize the insulin it produces, resulting in sustained hyperglycemia. The global burden of diabetes continues to rise, with current estimates indicating hundreds of millions of affected adults worldwide. This increase is particularly pronounced in developing regions, including South-East Asia and India, where rapid urbanization, sedentary lifestyles, overweight and obesity, and unhealthy dietary patterns have contributed to a substantial rise in prevalence.[1]

Diabetes mellitus is commonly categorized as type 1 diabetes, type 2 diabetes mellitus (T2DM), and gestational diabetes mellitus. Among these, T2DM constitutes the predominant subtype and is characterized primarily by insulin resistance with progressive β-cell dysfunction. Contemporary pathophysiologic models emphasize multi-organ contributions to dysglycemia, including adipose tissue lipolysis, impaired incretin effect, hyperglucagonemia, increased renal glucose reabsorption, and central mechanisms, interacting with genetic susceptibility to influence disease development and progression.[2]

In addition to its physical complications, T2DM imposes a substantial psychological burden. Diabetes-related distress (DRD) refers to diabetes-specific emotional distress arising from the daily demands of self-management, fear of complications, and perceived lack of support. DRD is conceptually distinct from clinical depression and has been increasingly recognized as an important determinant of diabetes outcomes. Evidence suggests that DRD is frequently under-recognized in routine clinical practice, despite its association with poorer self-care behaviours, suboptimal glycemic control, and adverse clinical outcomes.[3,4] Professional recommendations therefore support structured psychosocial screening in diabetes care, and validated instruments such as the Problem Areas in Diabetes (PAID) questionnaire are widely used to quantify diabetes-related distress in both clinical and research settings.[3]

Cardiovascular disease remains the leading cause of morbidity and mortality among individuals with T2DM. The elevated cardiovascular risk in this population results from clustering of traditional risk factors such as obesity, hypertension, and dyslipidaemia, as well as diabetes-specific mechanisms including endothelial dysfunction, oxidative stress, chronic inflammation, autonomic dysfunction, accelerated atherosclerosis, and a pro-thrombotic state.[5] Given the heterogeneity of cardiovascular risk among individuals with T2DM, validated risk prediction models are commonly used to estimate future risk and guide preventive strategies. The United Kingdom Prospective Diabetes Study

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(UKPDS) Risk Engine is a diabetes-specific tool that predicts 10-year risk for coronary heart disease and cerebrovascular events using clinical and biochemical parameters such as age, sex, duration of diabetes, glycated haemoglobin, blood pressure, lipid profile, smoking status, and atrial fibrillation.[6]

There is growing evidence that psychosocial factors such as diabetes-related distress may influence cardiovascular risk through both behavioural and biological pathways. DRD has been linked to reduced medication adherence, unhealthy dietary patterns, decreased physical activity, and sleep disturbances, as well as stress-related inflammatory activation and endothelial dysfunction.[4,5] Despite this, data examining the association between diabetes-related distress and predicted future cardiovascular risk particularly using diabetes-specific risk models and within Indian populations remain limited. Therefore, the present study aimed to assess the association between diabetes-related distress measured by the PAID questionnaire and predicted 10-year cardiovascular risk estimated using the UKPDS Risk Engine among adults with type 2 diabetes mellitus.

II. MATERIALS AND METHODS

A. Study Design and Setting

This was an observational, cross-sectional study conducted in the Department of Medicine at the Employees' State Insurance Post Graduate Institute of Medical Science and Research (ESI PGIMSR) and ESIC Model Hospital, Basaidarapur, New Delhi, India. The institute is a tertiary care referral centre catering to a large urban population with diverse socioeconomic backgrounds.

B. Study Duration

The study was carried out over a period of approximately 15 months, from "April 24, 2024 **to** July 25, 2025".

C. Study Population

The study population consisted of adult patients diagnosed with type 2 diabetes mellitus (T2DM) who attended the outpatient and inpatient services of the Department of Medicine during the study period. Eligible participants were consecutively recruited after screening for inclusion and exclusion criteria.

D. Sample Size Calculation

Sample size was calculated based on previously published literature that demonstrated a positive correlation between diabetes-related distress, assessed using the Problem Areas in Diabetes (PAID) scale, and predicted 10-year cardiovascular risk estimated using the UKPDS Risk Engine in patients with type 2 diabetes mellitus. Assuming a correlation coefficient (r) of 0.24, with a confidence level of 95% and a statistical power of 80%, the minimum required sample size was calculated as 134 participants. After accounting for an anticipated non-response rate of 10%, a total of 148 patients were enrolled in the study.

E. Eligibility Criteria

1) Inclusion Criteria:

Patients fulfilling all of the following criteria were included in the study: a) Age ≥ 40 years

b) Diagnosed with type 2 diabetes mellitus based on at least one of the American Diabetes Association diagnostic criteria, including glycated haemoglobin (HbA1c) ≥ 6.5%, fasting plasma glucose ≥ 126 mg/dL, 2-hour plasma glucose ≥ 200 mg/dL during oral glucose tolerance testing, or random plasma glucose ≥ 200 mg/dL with classical symptoms of hyperglycaemia.

2) Exclusion Criteria:

Patients were excluded if they met any of the following criteria:

a) Presence of a known psychiatric illness

b) Use of corticosteroids or psychotropic medications, including antipsychotics, antidepressants, anxiolytics, hypnotics, or mood stabilizers

c) Terminal illness

d) Prior documented history of coronary heart disease or cerebrovascular accident

F. Data Collection Procedure

After obtaining written informed consent, eligible participants underwent a standardized assessment performed by the investigator. Data were collected using a structured case record form and included demographic, clinical, biochemical, psychosocial, and cardiovascular risk parameters.

G. Clinical and Demographic Assessment

Demographic variables recorded included age and sex. Clinical details included duration of diabetes, current treatment regimen, presence of comorbidities such as hypertension or dyslipidaemia, smoking status (current or former smoker versus non-smoker), and history of atrial fibrillation.

H. Anthropometric and Blood Pressure Measurements

Anthropometric measurements included body weight and height, recorded using standard calibrated instruments. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Blood pressure was measured in the sitting position after adequate rest using a calibrated sphygmomanometer, and systolic blood pressure values were recorded for analysis.

I. Biochemical Parameters

Venous blood samples were collected under standard conditions for laboratory analysis. The following biochemical parameters were recorded:

a) Glycated haemoglobin (HbA1c)

b) Lipid profile, including total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, and triglycerides

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All laboratory investigations were performed in the hospital's central laboratory following standard quality control protocols.

J. Assessment of Diabetes-Related Distress

Diabetes-related distress was assessed using the Problem Areas in Diabetes (PAID) questionnaire, a validated 20-item instrument designed to measure emotional distress specific to living with diabetes. Each item was scored on a 5-point Likert scale ranging from 0 (not a problem) to 4 (serious problem). The total raw score was summed and multiplied by 1.25 to obtain a final score ranging from 0 to 100, with higher scores indicating greater levels of diabetes-related distress. The questionnaire was administered in the presence of the investigator to ensure uniform understanding and completeness.

K. Cardiovascular Risk Assessment

Predicted 10-year cardiovascular risk was estimated for each participant using the United Kingdom Prospective Diabetes Study (UKPDS) Risk Engine 2.0. The tool incorporates patient-specific variables including age, sex, duration of diabetes, glycated haemoglobin, systolic blood pressure, lipid parameters, smoking status, and presence of atrial fibrillation to generate predicted risks for coronary heart disease, fatal coronary heart disease, stroke, and fatal stroke. The UKPDS Risk Engine 2.0 is a validated diabetes-specific cardiovascular risk prediction model derived from the United Kingdom Perspective Diabetes Study cohort.

L. Ethical Considerations

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and the Indian Council of Medical Research guidelines. Approval was obtained from the Institutional Ethics Committee prior to commencement of the study. Written informed consent was obtained from all participants. Participant confidentiality was maintained throughout the study, and all collected data were anonymized and securely stored.

M. Statistical Analysis

Collected data were entered into Microsoft Excel and analysed using Statistical Package for the Social Sciences (SPSS) software, version 27. Normality of continuous variables was assessed using the Kolmogorov–Smirnov test. Quantitative variables were expressed as mean with standard deviation or median with interquartile range, depending on data distribution. Comparisons of PAID scores across UKPDS cardiovascular risk categories were performed using the Kruskal–Walli's test, followed by pairwise comparisons using the Mann–Whitney U test. Categorical variables were expressed as percentages and compared using the chi-square test. Correlation between PAID scores and UKPDS risk estimates was assessed using Spearman's correlation coefficient. A p-value of less than 0.05 was considered statistically significant.

III. RESULTS

A. Baseline Demographic and Clinical Characteristics

A total of 148 patients with type 2 diabetes mellitus were included in the study. The baseline demographic and clinical characteristics of the study population are summarized in **Table I**. The mean age of the participants was 56.35 ± 7.78 years, with a range of 40 to 75 years. Females constituted 54.1% of the cohort, while males accounted for 45.9%.

Comorbid conditions were present in 58.1% of patients. A history of smoking (current or former) was reported by 27% of participants. Atrial fibrillation was uncommon and was observed in only 2% of the study population. The mean duration of diabetes was 8.94 ± 5.34 years, indicating a mixed cohort of recently diagnosed and long-standing diabetic patients.

Anthropometric assessment showed a mean body mass index of 29.01 ± 4.83 kg/m². The mean systolic blood pressure was 135.03 ± 13.48 mmHg. Glycaemic control was suboptimal, with a mean HbA1c of 8.99 ± 1.78%. Lipid parameters demonstrated a mean total cholesterol of 180.88 ± 43.18 mg/dL, LDL-cholesterol of 100.78 ± 45.63 mg/dL, HDL-cholesterol of 43.67 ± 12.86 mg/dL, and triglycerides of 179.33 ± 93.29 mg/dL.

Table 1: Baseline demographic and clinical characteristics

	Mean	Std. Deviation	Median	Mode	Range	Minimum	Maximum
AGE	56.35	7.78	56	52	35	40	75
BMI	29.01	4.83	29.9	32.2	17	20.2	37.2
HBA1c	8.99	1.78	9	7.1	8.2	5.7	13.9
Duration of years	8.94	5.34	8.15	1	25	1	26
SBP	135.03	13.48	135.35	117	72.7	91.4	164.1
TG (mg/dl)	179.33	93.29	172.25	49	395.4	49	444.4
LDL-C (mg/dl)	100.78	45.63	105.35	18	252.4	18	270.4
TC (mg/dl)	180.88	43.18	180.7	79	201.9	79	280.9
HDL-C	43.67	12.86	43.7	33.8	70	15	85

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		Frequency
GENDER	Female	80
	Male	68
COMORBIDITY	No	62
	Yes	86
ATRIAL FIBRILLATION	No	145
	Yes	3
SMOKING STATUS	No	108
	Yes	40

B. Diabetes-Related Distress (PAID Scores)

The distribution of diabetes-related distress as measured by the PAID questionnaire is presented in **Table II**. The mean PAID score was 25.77 ± 11.89, with a median value of 23.64. Scores ranged from 8.5 to 63.14, indicating a wide variability in emotional distress among the participants. Overall, the findings suggest a moderate level of diabetes-related distress in the study population.

Table II. Distribution of Diabetes-Related Distress (PAID Scores)

	Mean	Std. Deviation	Median	Mode	Range	Minimum	Maximum
PAID SCORE	25.77	11.89	23.64	10.25[a]	54.64	8.5	63.14

C. Predicted 10-Year Cardiovascular Risk (UKPDS Risk Engine)

The predicted 10-year cardiovascular risk estimates calculated using the UKPDS Risk Engine are shown in **Table III**. The mean predicted risk for coronary heart disease (CHD) was 20.65 ± 15.81%, while the mean predicted risk for fatal CHD was 14.71 ± 13.66%.

The mean predicted risk for stroke was 9.08 ± 12.98%, and the mean predicted risk for fatal stroke was 1.34 ± 1.95%. The wide range of predicted risk values indicates considerable heterogeneity in cardiovascular risk among patients with type 2 diabetes mellitus.

Table III. Predicted 10-Year Cardiovascular Risk Using UKPDS Risk Engine

	Mean	Std. Deviation	Median	Mode	Range	Minimum	Maximum
CHD	20.65	15.81	15.75	8.8	79.3	1.7	81
Fatal CHD	14.71	13.66	10.1	2.4	66	0.5	66.5
Stroke	9.08	12.98	5.3	1.1	96.2	0.5	96.7
Fatal Stroke	1.34	1.95	0.75	0.5	12.9	0.1	13

D. Association Between PAID Scores and UKPDS-Predicted Cardiovascular Risk

A strong and statistically significant positive correlation was observed between diabetes-related distress and predicted cardiovascular risk, as shown in **Table IV**. PAID scores demonstrated significant positive correlations with predicted 10-year risks of CHD ($r = 0.610$, $p < 0.001$), fatal CHD ($r = 0.643$, $p < 0.001$), stroke ($r = 0.628$, $p < 0.001$), and fatal stroke ($r = 0.623$, $p < 0.001$).

These findings indicate that higher levels of diabetes-related emotional distress were consistently associated with higher predicted cardiovascular and cerebrovascular risk across all assessed domains.

Table IV. Association Between PAID Score and UKPDS-Predicted Cardiovascular Risk

		CHD	Fatal CHD	Stroke	Fatal Stroke
PAIDSCORE	Spearman's correlation	.610	.643	.628	.623
	Sig. (2-tailed)	.001 sig	.001, sig	.001 sig	.001, sig
	N	148	148	148	148

E. PAID Scores Across Cardiovascular Risk Categories

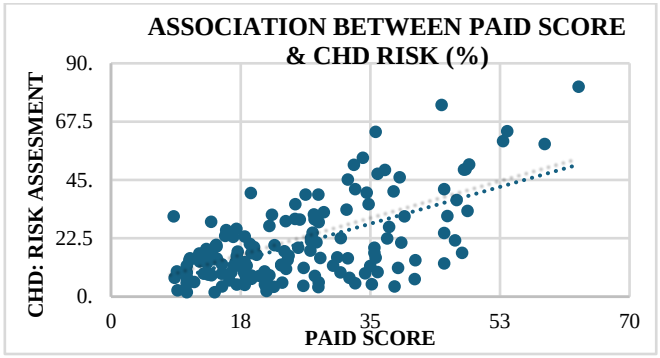
When participants were stratified into low, moderate, and high cardiovascular risk categories based on UKPDS-predicted CHD risk, a progressive increase in PAID scores was observed across risk strata. Mean PAID scores were lowest in the low-risk group and highest in the high-risk group. The difference in PAID Score across CHD risk categories was statistically significant ($p = 0.001$).

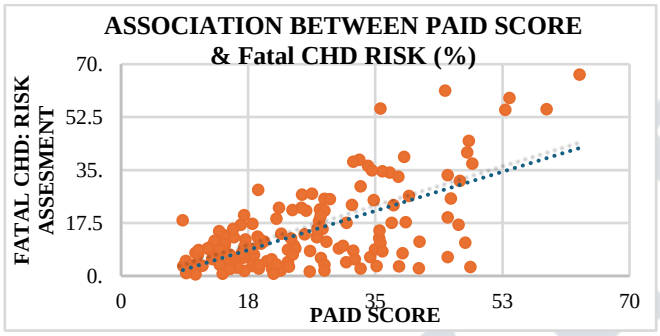
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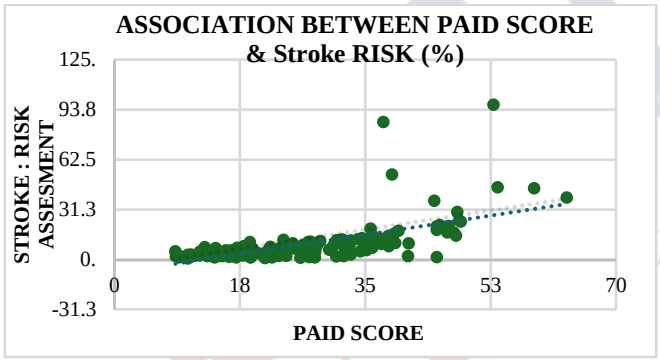
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Similar trends were observed for fatal CHD and stroke risk categories, with significantly higher PAID scores among patients classified into higher cardiovascular risk groups. The comparison of PAID scores across risk categories is illustrated in **Fig. 1**, demonstrating a clear upward trend in emotional distress with increasing predicted cardiovascular risk.







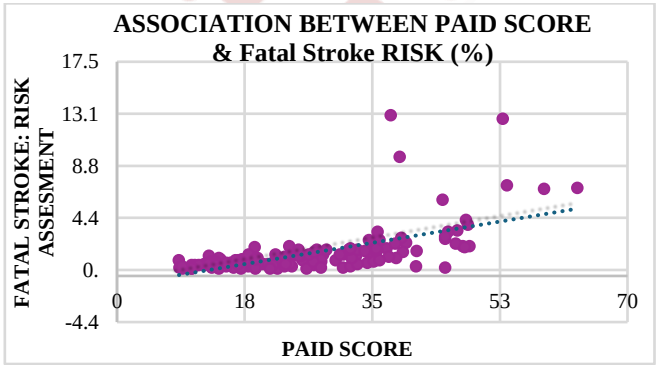
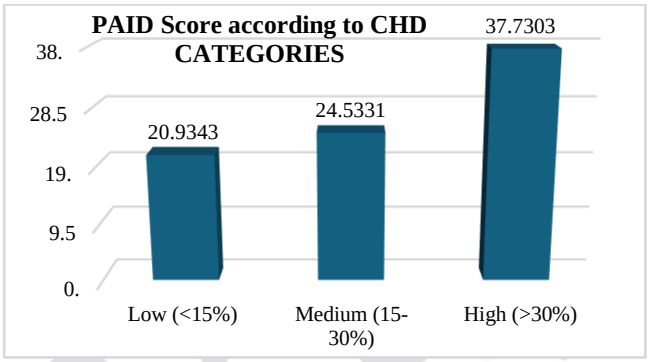
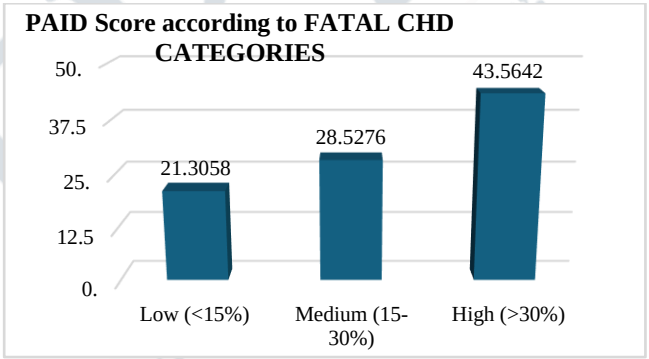


Fig1: Correlation Between PAID Score and Predicted 10-Year Coronary Heart Disease Risk

F. Graphical Representation of the Association Between PAID and Cardiovascular Risk

The relationship between PAID scores and predicted cardiovascular risk is graphically depicted in **Fig. 2**. Scatter plot analysis demonstrated a strong positive linear association between PAID scores and predicted 10-year CHD risk, reinforcing the findings of the correlation analysis.





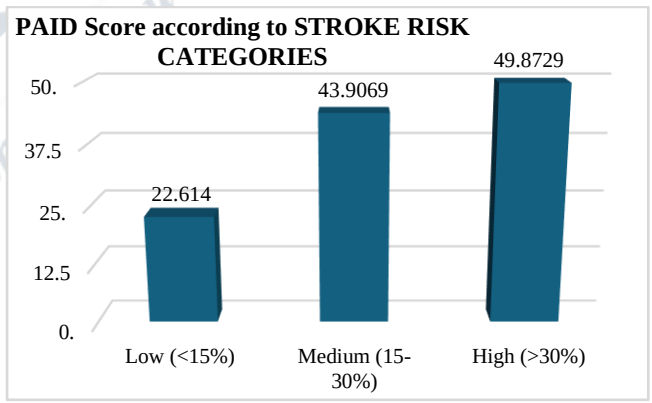


Fig2: Comparison of PAID Scores Across UKPDS Cardiovascular Risk Categories

IV. DISCUSSION

This study aimed to assess the association between diabetes-related distress (DRD), assessed using the Problem Areas in Diabetes (PAID) questionnaire, and predicted 10-year cardiovascular risk estimated by the UKPDS Risk Engine among adults with type 2 diabetes mellitus. The principal finding of this study is the presence of a strong and statistically significant positive association between higher

levels of diabetes-related distress and higher predicted risks of coronary heart disease, fatal coronary heart disease, stroke, and fatal stroke.

The study population predominantly comprised middle-aged individuals with long-standing type 2 diabetes mellitus, suboptimal glycemic control, and a high prevalence of overweight and obesity. These baseline characteristics are consistent with epidemiological patterns reported in Indian and other developing-country settings, where rapid lifestyle transitions have contributed to both metabolic and cardiovascular disease burden.[1] Poor glycaemic control, as reflected by elevated mean HbA1c levels in the present study, has previously been associated with increased emotional burden and difficulty in sustaining effective self-management.

The mean PAID score observed in this cohort indicates a moderate degree of diabetes-related distress overall, with a wide range of scores reflecting substantial inter-individual variability. This finding aligns with existing literature emphasizing that diabetes-related distress is a heterogeneous construct influenced by disease duration, treatment complexity, perceived disease burden, and psychosocial support. Importantly, DRD is conceptually distinct from clinical depression and represents a diabetes-specific emotional response that directly impacts self-care behaviours and disease outcomes.[3,4]

Predicted 10-year cardiovascular risk estimates generated using the UKPDS Risk Engine demonstrated considerable heterogeneity across participants. The relatively high mean predicted risks for coronary heart disease and fatal coronary heart disease highlight the persistent burden of macrovascular complications in patients with type 2 diabetes mellitus. Cardiovascular disease continues to be the leading cause of morbidity and mortality in this population, driven by both traditional risk factors and diabetes-specific pathophysiological mechanisms such as endothelial dysfunction, oxidative stress, inflammation, and accelerated atherosclerosis.[5]

The most clinically relevant observation of this study is the strong positive association between diabetes-related distress and predicted cardiovascular risk across all assessed outcomes. Participants with higher PAID scores consistently demonstrated higher predicted risks of coronary and cerebrovascular events. This association was further supported by the graded increase in PAID scores across cardiovascular risk categories, suggesting that diabetes-related distress may serve as a marker of overall disease severity and cardiovascular vulnerability.

Several plausible mechanisms may explain this relationship. Diabetes-related distress has been shown to adversely affect adherence to medications, dietary regulation, physical activity, and glucose monitoring, all of which are key determinants of glycaemic control, blood pressure, and lipid levels. In addition, chronic psychological stress may activate neuroendocrine and inflammatory pathways, contributing to endothelial dysfunction, insulin resistance, and progression of atherosclerosis.[4,5] Through these behavioural and biological pathways, DRD may indirectly but meaningfully contribute to increased cardiovascular risk in individuals with type 2 diabetes mellitus.

The findings of this study reinforce the importance of incorporating psychosocial assessment into routine diabetes care. While cardiovascular risk stratification traditionally focuses on biomedical parameters, the present results suggest that psychosocial factors such as diabetes-related distress provide additional clinically relevant information. Simple, validated tools such as the PAID questionnaire can be feasibly integrated into routine clinical practice and may help identify individuals who could benefit from targeted psychological support alongside conventional cardiovascular risk reduction strategies. The use of diabetes-specific risk prediction tools such as the UKPDS Risk Engine further strengthens individualized risk assessment in this population.[6]

The study has certain limitations. The cross-sectional design limits the ability to infer causality between diabetes-related distress and cardiovascular risk. The single-centre 36setting may affect generalizability to broader populations, particularly those in primary care or rural settings. Additionally, certain lifestyle and behavioural variables were not quantified in detail and may have contributed to residual confounding. Despite these limitations, the study is strengthened by the use of validated instruments for both distress assessment and cardiovascular risk prediction, as well as an adequate sample size.

V. CONCLUSION

This study demonstrates a strong and consistent association between diabetes-related distress and predicted 10-year cardiovascular risk among adults with type 2 diabetes mellitus. Higher levels of emotional distress, as measured by the PAID questionnaire, were associated with higher predicted risks of coronary heart disease, fatal coronary heart disease, stroke, and fatal stroke using the UKPDS Risk Engine. These findings highlight the clinical relevance of diabetes-related distress beyond psychological well-being, suggesting that it may serve as an important marker of overall cardiovascular risk. Routine assessment of diabetes-related distress using simple, validated tools may enhance comprehensive risk stratification and support holistic management strategies aimed at reducing long-term cardiovascular complications in patients with type 2 diabetes mellitus.

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