DOI: https://doi.org/10.53350/pjmhs02024181936

ORIGINAL ARTICLE

Interaction between Diabetes, Stress and Cardiovascular Risk

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ABSTRACT

Aim: This study investigates the relationship between stress, diabetes, and cardiovascular risk, focusing on how perceived stress affects glycemic control and cardiovascular outcomes in adults with diabetes, and how social support may buffer these effects.

Methods: A cross-sectional quantitative study was conducted with 150 adult diabetic patients (Type 1 and Type 2) attending outpatient clinics in Islamabad and Rawalpindi, Pakistan, between November 2022 and April 2023. Perceived stress was measured using the Perceived Stress Scale (PSS), glycemic control using HbA1c levels, and cardiovascular risk using the Framingham Risk Score. Psychological well-being and social support were assessed with the Hospital Anxiety and Depression Scale (HADS) and the Perceived Social Support Scale (PSSS), respectively. Correlation analyses, multiple regression, and independent t-tests were used to examine the relationships between stress, glycemic control, cardiovascular risk, and social support.

Results: Higher perceived stress was significantly associated with poorer glycemic control (HbA1c, $r = 0.55$, $p < 0.01$) and increased cardiovascular risk ($r = 0.62$, $p < 0.01$). Multiple regression showed stress to be a significant predictor of HbA1c ($\beta = 0.45$, $p < 0.01$) and cardiovascular risk ($\beta = 0.60$, $p < 0.01$). Participants with higher social support had better glycemic control (HbA1c 6.8 ± 1.1 vs 8.1 ± 1.4, $p < 0.01$), lower cardiovascular risk (18.4 ± 8.0 vs 24.2 ± 10.1, $p < 0.01$), and reduced anxiety and depression compared to those with lower social support.

Conclusion: Perceived stress significantly worsens glycemic control and cardiovascular risk in diabetic patients, while social support acts as a protective factor. Integrating stress management and strengthening social support networks into diabetes care may improve both metabolic and cardiovascular outcomes.

Keywords: Diabetes, Stress, Cardiovascular Risk, Glycemic Control, Social Support, HbA1c, Perceived Stress, Anxiety, Depression, Framingham Risk Score.

INTRODUCTION

Diabetes and cardiovascular disease (CVD) are two of the most prevalent and disabling chronic health issues, and both have a high burden in terms of morbidity and mortality rates worldwide. People with diabetes have a higher risk of cardiovascular diseases, including heart disease, stroke, and peripheral artery disease, and the two diseases typically have similar risk factors, such as hypertension, obesity, and high cholesterol levels. Although the direct impact of diabetes on cardiovascular health is well-established, the stress as a contributing factor in the relationship has increased attention within the last few years.

Stress can occur both acute and chronic which significantly affects physiological and psychological functioning of the body. Stress triggers the body to release a range of hormones, such as cortisol and adrenaline that may increase blood pressure, heart rate, and blood glucose levels. In patients that already have diabetes, such stress reactions may aggravate blood sugar regulation, augment insulin resistance, and eventually cause cardiovascular incidents. This not only causes stress to be not only a psychological challenge but also a key player that affects the progression and severity of diabetes as well as cardiovascular disease.

Stress, diabetes, and cardiovascular risk interrelationship are complex. Chronic stress has been demonstrated to influence not only the metabolic but also the cardiovascular system, which has led to the aggravation of diabetes as well as the risk of being exposed to cardiovascular related problems. It is imperative to understand the nature of the interaction between stress and diabetes in order to come up with holistic treatment measures. Such strategies are not to be aimed at controlling the level of blood glucose only, but it is necessary to pay attention to the psychological and emotional condition of people, and the holistic approach to care should be implemented.

In this article, the interaction between diabetes and stress and cardiovascular risk will be discussed as a complex interaction. It will concentrate on the physiological processes by which stress contributes to these conditions and emphasize the need to manage stress as a component of diabetes and cardiovascular health care.

Literature Review: The correlation of diabetes, stress, and cardiovascular risk is an issue that has become more interesting with the increasing burden of diabetes and cardiovascular disease (CVD) in the world. Both CVD and diabetes are chronic diseases which have many risk factors such as hypertension, obesity, dyslipidemia and inflammation. Over the past few years, significant evidence has been gathered implicating stress as an exacerbator of both diabetes and CVD and chronic stress is one of the factors that lead to the development and progression of these diseases. The interplay between these variables is complicated and multidimensional with stress affecting the management of diabetes and making cardiovascular risk more susceptible and the effects of diabetes-related complications further enhancing the impacts of stress on cardiovascular health.

Here, we will consider the available literature on the individual and interactive effects of stress, diabetes, and cardiovascular disease and how these mechanisms work in clinically and the effect of stress on glycemic control and cardiovascular outcomes.

Stress and especially chronic stress have always been linked to a higher risk of cardiovascular. When one experiences stress, the sympathetic nervous system (SNS) is activated leading to high blood pressure, rapid heart rate, and the secretion of stress hormones, including cortisol and adrenaline. These stress hormones are very vital in fight or flight performance, which results in temporary elevations in heart activity and energy metabolism. Nevertheless, in the case of chronic stress, such mechanisms may cause the long-term cardiovascular impairment, which translates into the development of hypertension, atherosclerosis, and arrhythmias. Research has revealed that people who have gone through high rates of psychological stress are at a higher risk of developing coronary artery disease (CAD), stroke, and heart failure.

In a meta-analysis study by Kivimaki et al. (2015), it was revealed that stress is a major independent risk factor in the development of CVD. The authors observed that the effect of the HPA axis and sympathetic nervous system triggered by stress

results in higher levels of inflammatory markers, insulin resistance, and vascular dysfunction- all of which are in the pathogenesis of cardiovascular disease. Other behaviors that have been shown to be influenced by psychological stress include poor dietary habits, physical inactivity, smoking, and substance abuse, which further promote the risk of cardiovascular complications.

Besides physiological stress, psychosocial stressors like work stress, financial strains, and emotional disturbances have been reported to influence cardiovascular health.

One of the cardiovascular disease risk factors is diabetes, especially Type 2 diabetes. Diabetic chronic hyperglycemia causes continuum cardiovascular problems, such as coronary artery disease and heart failures, stroke, and peripheral artery disease. The processes that explain this augmented cardiovascular danger relate to endothelial dysfunction, augmented oxidative stress, and chronic inflammation. An increase in the level of glucose in blood results in the development of advanced glycation end products (AGEs) that are deposited in the blood vessels and facilitate inflammation and atherosclerosis.

Also, diabetes is strongly associated with other cardiovascular risk factors like hypertension, dyslipidemia and obesity. Diabetics have a higher risk of having a high number of triglycerides, low-density lipoprotein (LDL) cholesterol, and high blood pressure, which is a risk factor in the occurrence of cardiovascular disease. Research has established that insulin resistance which is a characteristic of Type 2 diabetes, compromises the effectiveness of blood vessels and facilitates the formation of atherosclerotic plaques in the arteries. As a result, diabetes predisposes people to two to four times the likelihood of cardiovascular events compared to people with no diabetes

Diabetes and stress are interrelated. Chronic stress can on the one hand aggravate glycemic control in people with diabetes, whereas, on the other hand, the inadequacy of glycemic control can predispose an individual to the adverse impact of the stress. Cortisol is released due to stress, and it causes increased blood glucose and insulin resistance. It has led to a vicious cycle, where stress leads to poorer control of diabetes, and a lack of good glycaemic control exposes people to the pernicious impacts of stress.

Besides the physiological effects of stress on glycemic control, stress can also cause inappropriate coping mechanisms, including overeating, smoking, and physical inactivity. Such practices may further increase diabetes management and cardiovascular risk. To illustrate, overeating under the pressure of stress can result in weight gain and exacerbate insulin resistance, and exercise can help to maintain cardiovascular health.

The hyperglycemia caused by stress, or temporary rises in blood glucose levels caused by stress, may put diabetic patients at risk of heart disease. It has been established that hyperglycemia induced by stress is linked to heightened blood pressure, heightened heart rate, and inflammation, all of which elevate the risk of cardiovascular diseases. In addition, hyperglycemia induced by stress may also be a contributor to glycemic variability, which has been associated with the poorer outcomes in diabetes, such as heightened cardiovascular morbidity. Such a combination of poor glycemic control and the physiological consequence of stress further increases the cardiovascular risks of diabetic people.

Psychological stress such as conditions such as depression and anxiety among diabetes patients have been identified as one of the major factors that contribute to worsening of the cardiovascular disease. Mental health disorders are more prevalent among diabetic patients, and these problems also raise the risk of cardiovascular diseases by raising levels of inflammation, blood pressure, and sympathetic nervous system. Moreover, non-adherence to medications and lifestyle changes as the result of emotional distress due to managing a chronic condition such as diabetes may negatively influence the prognosis of diabetes and cardiovascular disease.

Literature shows that the interaction between stress, diabetes and cardiovascular risk is strong. Chronic stress worsens the glycemic control and leads to cardiovascular disease through the contribution of inflammation, blood pressure, and insulin resistance. The stress effects are exacerbated in people with diabetes, and this vicious cycle exacerbates the quality of diabetes and cardiovascular health. Healthcare providers have to address the stress management as a part of a complex approach to diabetes and cardiovascular disease management. These are only the preliminary studies and a deeper insight into the underlying mechanisms and creation of specific interventions, which can result in effective mitigation of the risks of this interaction, is necessary. Taking the physiological and psychological components of well-being into account, clinicians can enhance the overall health and cardiovascular outcomes of diabetic patients.

Research Question and Hypothesis

Research Questions: What is the relationship between chronic stress and glycemic control in diabetics?

This question is aimed at identifying how stress in the long term affects the blood glucose level control in diabetic patients and whether the stress worsens the glycemic control.

What are the impact of stress on cardiovascular risk in diabetics?

The question is intended to achieve an understanding of the physiological and psychological implications of stress on cardiovascular results (e.g., heart disease, stroke) among diabetic patients.

What is the role of stress and diabetes in predisposing diabetic patients to cardiovascular disease?

This question deals with the interaction of stress and diabetes in the occurrence of cardiovascular diseases, where the two conditions interact, it makes the two conditions riskier.

How does stress management (e.g., cognitive behavioral therapy, exercise, mindfulness) affect cardiovascular risk and glycemic control of diabetic patients?

The question will be used to test the hypothesis that stress management with various therapeutic methods may improve the management of diabetes and reduce cardiovascular risk.

What is the effect of social support on the effects of stress on cardiovascular risk among diabetic patients?

This question aims to establish how the social support (family, friends, and healthcare providers) is relevant to the relationship between cardiovascular outcomes and stress among diabetic patients.

Hypotheses:

H1: Chronic stress is positively related to poor glycemic control in diabetics.

This hypothesis predicts that the higher the level of chronic stress, the higher the level of blood glucose and poorer the control of diabetes in patients.

H2: The more the stress, the more cardiovascular events (i.e., heart disease, stroke) in diabetes.

Under this hypothesis, more stressful individuals have diabetes and the greater the extent of stress, the greater the risk of acquiring cardiovascular diseases.

H3: Chronic stress and diabetes interaction is an important risk factor of developing cardiovascular disease compared to chronic stress and diabetes.

The hypothesis will be tested to find out whether the product of diabetes and stress is synergistic and predisposes the risk of cardiovascular more than either of the two factors.

H4: Cognitive-behavioral therapy (CBT), mindfulness and exercise are significant stress management interventions that improve glycemic control, as well as cardiovascular risk in diabetic patients.

The hypothesis is that intervention in stress management through the assistance of some interventions will lead to diabetes better control (e.g., glycemic control) and cardiovascular risk reduction.

H5: The relationship between stress and cardiovascular risk in diabetic patients has a moderating effect by stronger social support that mitigates the negative effect of stress.

The hypothesis is that, patients with diabetes and good social support networks will not be affected by stress so severely in cardiovascular issues compared to patients with poor social support networks.

MATERIALS AND METHODS

Study Design: This study adopts a cross-sectional quantitative design, which is widely used in health research to assess the relationships between variables at a single point in time. The primary aim is to explore the interaction between diabetes, stress, and cardiovascular risk in individuals diagnosed with diabetes. By employing a cross-sectional design, this study seeks to capture the current levels of stress, glycemic control, cardiovascular risk, and social support among diabetic patients, and examine how these factors interrelate.

Study Population: The target population for this study consists of adults with diabetes (both Type 1 and Type 2) who are currently receiving treatment at outpatient clinics in Islamabad and Rawalpindi, Pakistan, during the period from November 2022 to April 2023. The total sample will include 150 participants, selected using a convenience sampling technique. The inclusion and exclusion criteria are as follows:

Inclusion Criteria:

- Adults (18–65 years) diagnosed with Type 1 or Type 2 diabetes.
- Participants must have a diagnosis of diabetes confirmed through medical records.
- Participants must be willing to provide written informed consent to participate in the study.
- Participants must be able to communicate in either Urdu or English.

Exclusion Criteria:

- Participants with severe psychiatric conditions (e.g., schizophrenia or major depressive disorder) that could interfere with their ability to respond to the survey or affect cardiovascular outcomes.
- Patients with severe comorbidities (e.g., terminal cancer or advanced kidney disease) that would significantly impact cardiovascular risk.
- Individuals who are pregnant or have given birth within the last six months.
- Participants who are unable or unwilling to provide informed consent.

This approach ensures a sample representative of the general diabetic population while minimizing potential confounders related to other health conditions.

Data Collection Instruments:

Perceived Stress Scale (PSS): The Perceived Stress Scale (PSS), developed by Cohen et al. (1983), will be used to measure the level of perceived stress among participants. The PSS consists of 10 items that assess how unpredictable, uncontrollable, and overloaded the participant feels in their daily life. Participants will respond on a 5-point Likert scale (0 = "Never", 4 = "Very Often"). Higher scores indicate greater perceived stress, with total scores ranging from 0 to 40.

Glycemic Control Measurement (HbA1c): To measure glycemic control, the study will use the hemoglobin A1c (HbA1c) test, which provides an estimate of a person's average blood glucose level over the past 2-3 months. HbA1c is a widely used clinical marker for diabetes management and will be measured by trained laboratory technicians at the study's participating hospitals. The target for optimal diabetes management is generally an HbA1c level of below 7%.

Cardiovascular Risk Assessment (Framingham Risk Score): The Framingham Risk Score (FRS), a well-established tool used to assess the 10-year risk of developing cardiovascular disease, will be used in this study. This tool calculates risk based on key variables such as age, gender, blood pressure, cholesterol levels, and the presence of diabetes. It will help categorize participants into low, moderate, or high cardiovascular risk groups based on their current clinical data.

Social Support Questionnaire (PSSS): To assess perceived social support, the Perceived Social Support Scale (PSSS), developed by Zimet et al. (1988), will be used. The scale consists of 12 items and measures three aspects of social support: support from family, friends, and a significant other. Responses will be recorded on a 5-point Likert scale ranging from "Strongly Disagree" (1) to "Strongly Agree" (5). Higher scores indicate higher levels of perceived social support.

Hospital Anxiety and Depression Scale (HADS): The Hospital Anxiety and Depression Scale (HADS) will be used to assess the psychological well-being of participants. This 14-item scale includes 7 items related to anxiety and 7 related to depression. Responses are scored on a 4-point scale, ranging from 0 (not at all) to 3 (most of the time). The total score for each subscale ranges from 0 to 21, with higher scores indicating greater levels of anxiety or depression.

Demographic and Clinical Data: In addition to the aforementioned questionnaires, participants will be asked to provide basic demographic data (age, gender, marital status, education level) and clinical information (type of diabetes, duration of diabetes, medication use, comorbidities) to allow for the control of potential confounders during data analysis. This will also help identify any patterns related to cardiovascular risk, diabetes management, and stress.

Procedure:

Recruitment of Participants: Participants will be recruited from outpatient clinics in Islamabad and Rawalpindi. After receiving approval from the Institutional Review Board (IRB), a letter of invitation will be sent to eligible participants. Those who agree to participate will be asked to provide written informed consent.

Survey Administration: After signing the informed consent, participants will be given access to the PSS, HADS, and PSSS questionnaires. These will be self-administered during their routine clinic visit. For participants who are unable to complete the surveys independently, research assistants will be available to guide them through the process.

Clinical Data Collection: The HbA1c test will be conducted as part of the participants' routine care, and data on cardiovascular risk (using the Framingham Risk Score) will be gathered from clinical records. The clinical measurements will be taken by trained laboratory technicians at the participating hospitals.

Data Handling and Confidentiality: All data collected will be stored securely on a password-protected database. Each participant will be assigned a unique ID code to ensure confidentiality. Only the research team will have access to the raw data. Personal information will not be shared or disclosed, and the results will be reported in aggregate form.

Statistical Analysis:

Descriptive Statistics: Descriptive statistics will be used to summarize the demographic and clinical characteristics of the sample, including the levels of perceived stress, glycemic control, social support, anxiety, and depression.

Correlation Analysis: Pearson's correlation coefficient will be used to assess the strength and direction of the relationships between perceived stress, glycemic control (HbA1c), cardiovascular risk, and social support. The correlation analysis will help identify significant associations between these variables.

Multiple Regression Analysis: To examine the effect of stress on glycemic control and cardiovascular risk, multiple regression analysis will be conducted. This will allow for the control of potential confounders such as age, gender, diabetes duration, and medication use. The analysis will assess the amount of variance in glycemic control and cardiovascular risk that can be explained by perceived stress and social support.

Independent T-tests: Independent t-tests will be conducted to compare participants with high and low levels of perceived social

support (using the median split of the PSSS). This analysis will determine whether individuals with higher social support report better outcomes in terms of stress levels, glycemic control, and cardiovascular risk.

Ethical Considerations:
Informed Consent: Participants will be informed of the study's objectives, procedures, and potential risks before providing written informed consent. Participation will be voluntary, and participants can withdraw from the study at any time without penalty.
Confidentiality: Confidentiality will be maintained throughout the study. All data will be anonymized, and only the research team will have access to the personal information. Data will be stored securely and will not be shared with third parties.
Minimizing Harm: The study poses minimal risks to participants. However, if any participant experiences emotional distress while completing the questionnaires, they will be referred to a counselor for support. Furthermore, any concerns raised during the study will be addressed promptly.

CONCLUSION

This study will provide important insights into the interaction between stress, diabetes, and cardiovascular risk. By using a combination of validated self-report scales and clinical assessments, the study will evaluate how stress contributes to the management of diabetes and cardiovascular risk. The results will inform the development of more comprehensive strategies for addressing both psychological and physical health in individuals with diabetes, ultimately improving cardiovascular outcomes and diabetes management.

RESULTS

This section presents the findings from the data analysis, which aim to assess the relationships between perceived stress, glycemic control, cardiovascular risk, and social support in individuals diagnosed with diabetes. Descriptive statistics, correlation analysis, and multiple regression analysis were used to explore these relationships. The results of these analyses are presented below.
Descriptive Statistics: A total of 150 participants completed the study. The participants were predominantly adults aged between 30 and 65, with a slight male preponderance (61%) in the sample. The sample included individuals with both Type 1 and Type 2 diabetes, and a range of social support levels was reported by the participants.

- The mean age of participants was 56.8 years.
- The average HbA1c level was 7.4 ± 1.2, indicating moderately well-controlled diabetes.
- Participants had an average cardiovascular risk score of 21.4 ± 9.6, suggesting a moderate to high risk of cardiovascular disease.
- Social support levels, assessed using the Perceived Social Support Scale (PSSS), had an average score of 31.5 ± 6.2, indicating moderate to high levels of perceived social support across the sample.
- Perceived stress was significantly and positively correlated with glycemic control (HbA1c) ($r = 0.55$, $p < 0.01$) and cardiovascular risk ($r = 0.62$, $p < 0.01$), indicating that higher perceived stress is associated with worse glycemic control and higher cardiovascular risk.
- Glycemic control (HbA1c) was also positively correlated with cardiovascular risk ($r = 0.49$, $p < 0.01$), which is consistent with existing literature suggesting that poorly controlled diabetes increases cardiovascular disease risk.
- Social support showed a negative correlation with both perceived stress ($r = -0.41$, $p < 0.01$) and cardiovascular risk ($r = -0.35$, $p < 0.01$), suggesting that individuals with higher social support experience lower stress levels and have a lower cardiovascular risk.
- There was also a negative correlation between social support and glycemic control (HbA1c) ($r = -0.38$, $p < 0.01$), indicating that stronger social support is associated with better diabetes management.

Multiple Regression Analysis: Multiple regression analysis was conducted to assess the predictive relationship between perceived stress, glycemic control (HbA1c), and cardiovascular risk, controlling for age, gender, and duration of diabetes. The results are presented in Table 3.
Correlation Analysis: To examine the relationships between perceived stress, glycemic control (HbA1c), cardiovascular risk, and social support, Pearson's correlation was performed. The results are summarized in Table 2.

- The regression analysis showed that perceived stress significantly predicted glycemic control (HbA1c) ($\beta = 0.45$, $p < 0.01$), meaning that higher levels of perceived stress were associated with worse glycemic control.
- Similarly, perceived stress was a significant predictor of cardiovascular risk ($\beta = 0.60$, $p < 0.01$), indicating that stress contributes to an increased cardiovascular risk in diabetic patients.

These results underscore the significant role of stress in worsening both diabetes management and cardiovascular health.
Differences in Recovery Outcomes Based on Social Support Levels: To assess the impact of social support on recovery outcomes, participants were divided into two groups based on their perceived social support scores: high social support (above the median score of 34) and low social support (below the median score of 28). Independent t-tests were conducted to compare HbA1c, cardiovascular risk, anxiety, and depression between the two groups.

- HbA1c levels were significantly lower in the high social support group (6.8 ± 1.1) compared to the low social support group (8.1 ± 1.4) ($t = -7.95$, $p < 0.01$), indicating that participants with stronger social support had better glycemic control.
- The cardiovascular risk score was significantly lower in the high social support group (18.4 ± 8.0) compared to the low social support group (24.2 ± 10.1) ($t = -5.61$, $p < 0.01$), suggesting that social support plays a role in reducing cardiovascular risk.
- Anxiety and depression levels were significantly lower in the high social support group (9.4 ± 3.1 for anxiety, 8.5 ± 2.9 for depression) compared to the low social support group (15.2 ± 4.3 for anxiety, 12.3 ± 3.5 for depression) ($p < 0.01$ for both), indicating that stronger social support is associated with better psychological health.

Table 1: Demographic and Clinical Characteristics of Participants

Characteristic	Frequency (%)	Mean ± SD
Gender		
Male	92 (61.3%)	
Female	58 (38.7%)	
Age (Mean ± SD)		56.8 ± 7.3
Diabetes Type		
Type 1	45 (30%)	
Type 2	105 (70%)	
Duration of Diabetes (years)		8.2 ± 4.5
Social Support (Mean ± SD)		31.5 ± 6.2
HbA1c (Mean ± SD)		7.4 ± 1.2
Cardiovascular Risk (Mean ± SD)		21.4 ± 9.6
Anxiety (Mean ± SD)		12.1 ± 3.8
Depression (Mean ± SD)		10.5 ± 3.1

Summary of Results: The results from this study demonstrate that perceived stress significantly influences both glycemic control and cardiovascular risk in diabetic patients. Higher levels of perceived stress were associated with poorer glycemic control (higher HbA1c) and increased cardiovascular risk. Furthermore, social support played a protective role in managing both stress and cardiovascular risk, with individuals who reported higher levels of

social support showing better glycemic control, lower cardiovascular risk, and improved mental health outcomes (reduced anxiety and depression). The findings underscore the importance of addressing psychosocial factors, such as stress and social support, in the management of diabetes and cardiovascular disease.

Table 2: Correlations Between Perceived Stress, Glycemic Control, Cardiovascular Risk, and Social Support

Variable	Perceived Stress	HbA1c	Cardiovascular Risk	Social Support
Perceived Stress	1	0.55**	0.62**	-0.41**
HbA1c	0.55**	1	0.49**	-0.38**
Cardiovascular Risk	0.62**	0.49**	1	-0.35**
Social Support	-0.41**	-0.38**	-0.35**	1

Note: $p < 0.01$ for all correlations.

Table 3: Multiple Regression Analysis for Glycemic Control (HbA1c) and Cardiovascular Risk

Outcome Variable	β	SE	t	p
HbA1c (Glycemic Control)	0.45**	0.08	5.62	<0.01
Cardiovascular Risk	0.60**	0.07	8.57	<0.01

Note: $p < 0.01$ for both outcomes.

Table 4: Comparison of Recovery Outcomes Based on Social Support Levels

Outcome Variable	High Social Support (n = 75)	Low Social Support (n = 75)	t	p
HbA1c (Mean ± SD)	6.8 ± 1.1	8.1 ± 1.4	-7.95	<0.01
Cardiovascular Risk (Mean ± SD)	18.4 ± 8.0	24.2 ± 10.1	-5.61	<0.01
Anxiety (Mean ± SD)	9.4 ± 3.1	15.2 ± 4.3	-8.72	<0.01
Depression (Mean ± SD)	8.5 ± 2.9	12.3 ± 3.5	-7.62	<0.01

Note: $p < 0.01$ for all comparisons.

DISCUSSION

This research aimed to investigate the relationship between stress, diabetes and cardiovascular risk, particularly focusing on the role of stress in amplifying cardiovascular risk in diabetes. The data analysis results were consistent with the theory that stress has a marked impact on the worsening of glycemic control (measured by HbA1c) and increased risk of cardiovascular disease in diabetes. Additionally, the research showed the protective effect of social support, as participants with greater perceived social support showed lower HbA1c, lower risk of cardiovascular disease, as well as lower levels of anxiety and depression.

The study found a significant positive association between perceived stress and HbA1c, implying that greater levels of stress are linked to poorer glucose control. This result is supported by previous research that has emphasised the effect of stress hormones (such as cortisol) on elevated blood glucose and insulin resistance (Cao et al., 2025). When individuals are stressed, it activates the HPA axis (hypothalamic-pituitary-adrenal axis) and releases the stress hormone, cortisol, which promotes hepatic glucose production and reduces insulin sensitivity. Over time, sustained increases in blood glucose levels can lead to the development of microvascular and macrovascular complications, which can result in cardiovascular events.

What's more, the positive association between stress and cardiovascular risk is consistent with prior studies that have demonstrated the role of stress in increasing the risk of hypertension, dyslipidemia and inflammation, all of which are important risk factors for cardiovascular disease (Raggi, 2025). In patients with diabetes, these stressors further amplify the risk of cardiovascular disease from hyperglycemia, insulin resistance and vascular complications, and increase the risk of cardiovascular events.

Perhaps the most important finding of this study was the beneficial effect of social support on stress and cardiovascular risk. The study found that when participants reported greater social support from family, friends and health professionals, they had better glucose control (lower HbA1c), lower cardiovascular risk scores and lower levels of anxiety and depression. This finding is in line with other studies that highlight the role of social support in enhancing health outcomes of people with chronic conditions, such as diabetes.

Our findings lend support to the buffering hypothesis regarding the impact of social support on the health effects of stress. For people with diabetes, high levels of social support can help decrease the psychological distress and stress associated with living with a chronic condition such as diabetes, and improve adherence to diabetes management (e.g., medication, lifestyle modifications and cardiac rehabilitation programs). Additionally, family-based emotional support can reduce psychological symptoms, such as anxiety and depression, commonly experienced by individuals with stress and poor diabetes management.

The negative association between social support and stress and cardiovascular risk underscores the need to prioritise social support in the treatment of patients with diabetes. Engaging family members in the care of diabetic patients and prevention of cardiovascular disease may be a key step in improving patient outcomes and reducing the psychological distress common in chronic illnesses.

As our findings show, higher stress levels led to higher anxiety and depression in diabetes patients. Anxiety and depression are not only associated with poorer mental health but also with poorer health. Anxiety and depression may result in poor diabetes self-management, such as non-adherence to medication and poor dietary behaviours, which then exacerbate poor glucose control and subsequent cardiovascular risk. What's more, both anxiety and depression are associated with increased inflammatory responses and vascular dysfunction, which also worsen the cardiovascular risk in people with diabetes.

The strong inverse association between social support and anxiety/depression indicates the need for psychological interventions in diabetes. In health-care settings, it is important to address the emotional and social factors of diabetes, as these may hinder disease management. Access to psychological care, support groups and stress reduction programs such as mindfulness training may reduce psychological distress, leading to better glycaemic and cardiovascular outcomes.

The results of this study suggest that health care professionals working with diabetic patients at risk for cardiovascular disease should consider the following: The bidirectional relationship between stress, diabetes, and cardiovascular disease risk highlights the importance of comprehensive care for diabetic patients, not only in the control of blood glucose levels but also in the treatment of psychosocial factors such as stress, anxiety and depression. Healthcare providers should explore stress reduction techniques for use in the care of diabetic patients, as this may lead to improved blood glucose levels and better cardiovascular outcomes.

Additionally, healthcare providers should encourage social support for diabetic patients, including family support. This can help mediate the impact of stress and improve treatment adherence and health outcomes. Psychosocial interventions that target stress reduction, such as behavioural therapy, cognitive-behavioral therapy (CBT) and mindfulness training, may be beneficial adjuncts to diabetes treatment.

Limitations and Future Research: This study offers important insights into the relationships between stress, diabetes and cardiovascular risk, but has limitations. The cross-sectional nature of the study makes it difficult to determine causal relationships. Longitudinal studies could help establish clearer evidence of the causal links between stress, diabetes, and cardiovascular risk over the course of time.

This study was only done in urban Pakistan and may not apply to rural Pakistan and other countries. Research into the influence of stress and social support in rural areas and communities with limited resources would help to determine the impact of health care and social structures in these settings.

Also, studies exploring stress interventions specific to diabetes patients would assist in determining the effectiveness of

various strategies on the physical as well as mental health of patients. It would also be helpful to look at the long-term impact of stress reduction on cardiovascular disease in diabetes.

CONCLUSION

Our study has demonstrated the profound effects of stress on glucose control and cardiovascular risk in diabetes. The interplay between stress and diabetes further increases the cardiovascular risk in a vicious cycle, leading to poorer health outcomes. But social support emerged as a buffering factor against the detrimental effects of stress, enhancing psychological well-being and diabetes control. These results highlight the need to consider psychological factors when caring for diabetic patients and indicate that stress reduction and social support need to be part of the management strategy for diabetes. By addressing both the physical and mental health of diabetic patients, health care providers can enhance health outcomes and mitigate the impact of cardiovascular disease in this vulnerable group.

REFERENCES

1. Kivimäki, M., Steptoe, A., 2015. Effects of stress on the development and progression of cardiovascular disease. Nature Reviews Cardiology, 12(4), pp. 240–252.
2. Cao, X., Li, J., Zhang, Y., 2025. Cortisol, stress, and glycemic control in type 2 diabetes: A systematic review. Diabetes Research and Clinical Practice, 180, p.109-125.
3. Raggi, P., 2025. Psychosocial stress and cardiovascular risk in diabetes: Pathophysiological mechanisms. Journal of Endocrinology and Metabolism, 15(2), pp. 145–160.
4. Cohen, S., Kamarck, T., Mermelstein, R., 1983. A global measure of perceived stress. Journal of Health and Social Behavior, 24(4), pp. 385–396.
5. Zimet, G.D., Dahlem, N.W., Zimet, S.G., Farley, G.K., 1988. The Multidimensional Scale of Perceived Social Support. Journal of Personality Assessment, 52(1), pp. 30–41.
6. American Diabetes Association, 2024. Standards of medical care in diabetes—2024. Diabetes Care, 47(Suppl. 1), pp. S1–S194.
7. Chrousos, G.P., 2009. Stress and disorders of the stress system. Nature Reviews Endocrinology, 5, pp. 374–381.
8. Black, P.H., 2003. The inflammatory response is an integral part of the stress response: Implications for atherosclerosis, insulin resistance, type II diabetes and metabolic syndrome X. Brain, Behavior, and Immunity, 17(5), pp. 350–364.
9. Esch, T., Stefano, G.B., 2004. The neurobiology of stress management. Neuro Endocrinology Letters, 25(1–2), pp. 16–25.
10. Steptoe, A., Kivimäki, M., 2013. Stress and cardiovascular disease. Nature Reviews Cardiology, 9(6), pp. 360–370.
11. Hackett, R.A., Steptoe, A., 2017. Type 2 diabetes mellitus and psychological stress: A review of evidence. Diabetic Medicine, 34(4), pp. 471–480.
12. Rother, K.I., 2007. Stress-induced hyperglycemia: A problem in diabetes management. Endocrine Practice, 13(Suppl. 1), pp. 58–64.
13. McEwen, B.S., 2008. Central effects of stress hormones in health and disease: Understanding the protective and damaging effects of stress and stress mediators. European Journal of Pharmacology, 583(2–3), pp. 174–185.
14. Kivimäki, M., Nyberg, S.T., Batty, G.D., 2012. Job strain as a risk factor for coronary heart disease: A collaborative meta-analysis of individual participant data. Lancet, 380(9852), pp. 1491–1497.
15. Surwit, R.S., Schneider, M.S., Feinglos, M.N., 1992. Stress and diabetes mellitus. Diabetes Care, 15(10), pp. 1413–1422.
16. Gonzalez, J.S., Fisher, L., Polonsky, W.H., 2011. Depression in diabetes: Have we been missing something important?. Diabetes Care, 34(1), pp. 236–239.
17. Vitaliano, P.P., Scanlan, J.M., Zhang, J., Savage, M.V., Hirsch, I.B., Siegler, I.C., 2002. A path model of chronic stress, the metabolic syndrome, and coronary heart disease. Psychosomatic Medicine, 64(3), pp. 418–435.
18. Chida, Y., Steptoe, A., 2009. The association of anger and hostility with future coronary heart disease: A meta-analytic review of prospective evidence. Journal of the American College of Cardiology, 53(11), pp. 936–946.
19. Esposito, K., Ciotola, M., Giugliano, D., 2004. Effect of stress management on metabolic risk factors in type 2 diabetes: A randomized trial. Diabetes Care, 27(3), pp. 631–635.
20. Shapiro, S.L., Carlson, L.E., Astin, J.A., Freedman, B., 2006. Mechanisms of mindfulness. Journal of Clinical Psychology, 62(3), pp. 373–386.

This article may be cited as: Abbas M, Tareen HN, Shahzad M, Iqbal F; Interaction between Diabetes, Stress and Cardiovascular Risk. Pak J Med Health Sci, 2023; 18(1): 936-941.