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Structural Relationships between Anxiety and Diabetes Self-Management in Adolescents with Type 1 Diabetes: The Mediating Role of Perceived Stress

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Abstract

Objective: Adolescents with type 1 diabetes often face psychological challenges that may interfere with effective disease management. This study aimed to examine the structural links between anxiety and diabetes self-management, with perceived stress tested as a potential mediator.

Materials and Methods: This descriptive correlational study was conducted among adolescents with type 1 diabetes attending diabetes treatment centers in Tehran, Iran, in 2024. A convenience sample of 310 participants completed the Diabetes Self-Management Questionnaire, the Perceived Stress Scale, and the Beck Anxiety Inventory. Path analysis was conducted using AMOS version 24. The adequacy of the proposed model was evaluated through standard goodness-of-fit indices, and the mediating effect of perceived stress was tested using bootstrap confidence intervals.

Results: The structural model showed an acceptable fit to the observed data. Anxiety had a significant positive effect on perceived stress, β= .33, t= 4.61,P< 0.001, and a significant negative effect on diabetes self-management, β= −0.28, t= −3.90, P< 0.001. Perceived stress was also negatively associated with diabetes self-management, β= −0.46, t= −6.20, P< 0.001. Bootstrap analysis confirmed the significant indirect effect of anxiety on diabetes self-management via perceived stress, 95% CI [-0.28, -0.11]. The final model explained 48% of the variance in diabetes self-management.

Conclusion: Anxiety appears to compromise diabetes self-management among adolescents with type 1 diabetes, partly through heightened perceived stress. Integrating anxiety- and stress-focused psychological interventions into routine diabetes care may improve self-management outcomes in this vulnerable population.

Keywords: Anxiety; Perceived stress; Diabetes self-management; Type 1 diabetes; Adolescents

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Introduction

Adolescence, commonly defined as the developmental stage between 10 and 19 years of age, represents a transitional period marked by significant biological, psychological, and social transformations. This stage is often considered particularly sensitive for the development of mental health problems, as emotional fluctuations and exposure to psychosocial stressors tend to increase during puberty (1,2). Concurrently, adolescents encounter various health-related challenges, among which overweight and obesity have become major public health concerns. Recent global estimates suggest that approximately 10-30% of adolescents experience obesity, a condition that substantially elevates the risk of chronic illnesses, including diabetes, cardiovascular disease, and certain types of cancer (3,4).

Alongside rising obesity rates, the incidence of diabetes among children and adolescents has increased worldwide. Although type 1 diabetes remains the predominant form in this age group, the prevalence of type 2 diabetes has also risen, largely due to lifestyle changes and excess weight (5,6). Diabetes is among the most common chronic diseases globally, with projections suggesting that nearly 600 million individuals will be living with diabetes by 2035 (7-9). Beyond its metabolic burden, diabetes is closely linked to psychological problems; individuals with anxiety and other psychiatric disorders exhibit higher rates of diabetes compared with the general population (10).

Anxiety is one of the most prevalent psychological difficulties among adolescents with diabetes and has been consistently associated with poorer disease outcomes. Elevated anxiety levels are linked to inadequate self-management behaviors and suboptimal glycemic control (11,12). Anxiety may impair perceived control over the illness, reduce motivation, and interfere with adherence to treatment regimens. When persistent and excessive, anxiety can disrupt daily functioning and the effective management of chronic diseases such as diabetes (13,14).

Diabetes self-management constitutes a cornerstone of effective diabetes care and requires active engagement in behaviors such as medication adherence, dietary regulation, physical activity, and regular blood glucose monitoring (15). Adequate self-management improves metabolic control and reduces the risk of complications, whereas poor self-management is associated with psychological distress and adverse health outcomes. Accumulating evidence suggests an inverse relationship between anxiety and diabetes self-management, indicating that adolescents who manage their condition more effectively tend to report lower anxiety levels (16-18).

In addition to anxiety, perceived stress plays a pivotal role in shaping psychological and behavioral responses to diabetes. Perceived stress refers to individuals' cognitive appraisal of situations as overwhelming or uncontrollable and has been associated with emotional distress, depression, and maladaptive health behaviors (19,20). While moderate stress may be adaptive, sustained high levels of perceived stress can undermine coping capacity and reduce engagement in self-management behaviors (21). Previous research indicates that perceived stress is a significant predictor of negative mental health outcomes and may represent a key mechanism through which anxiety influences health-related behaviors (22,23). Despite extensive research on anxiety, perceived stress, and diabetes self-management, these variables have often been examined independently. Limited attention has been given to their simultaneous interaction within an integrated structural framework,

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particularly among adolescents with diabetes. Therefore, the present study aims to examine the structural relationship between anxiety and diabetes self-management, considering the mediating role of perceived stress. Clarifying these pathways may provide evidence to support psychologically oriented interventions aimed at improving diabetes self-management in adolescents.

Materials and methods

Study design and participants

The present study adopted a descriptive correlational design and employed path analysis modeling to examine the structural relationships among the study variables. The statistical population comprised all adolescents diagnosed with type 1 diabetes mellitus (T1D) in Tehran during the 2024-2025 period. Using a convenience sampling method, a total of 310 adolescents were recruited as the study sample.

Sample size adequacy was determined in accordance with recommendations for structural and path modeling. As suggested by Klein, an appropriate sample size in path analysis may be estimated based on the number of free parameters in the model, with 10 to 20 participants per parameter considered sufficient. Given the number of free parameters specified in the proposed model, the minimum required sample size was estimated to be 200 participants (24). To enhance statistical power and ensure a more robust model fit, a larger sample of 310 participants was ultimately included in the analysis.

Inclusion and exclusion criteria

Inclusion criteria were as follows:

(1) a confirmed diagnosis of type 1 diabetes by a specialist physician, supported by clinical laboratory evidence;
(2) age between 12 and 18 years;
(3) absence of severe psychiatric disorders; and
(4) no history of substance dependence.

Procedure

All ethical guidelines related to research involving human participants were carefully followed during the course of this study. These principles included obtaining written informed consent, ensuring that participation was entirely voluntary, informing participants of their right to withdraw from the study at any time without any negative consequences, protecting the confidentiality and privacy of personal information, and preventing any form of physical or psychological harm to the participants.

Data collection was carried out over a seven-month period, from December 2024 to July 2025. After receiving approval from the university's research office and coordinating with the administrators of adolescent diabetes treatment centers, the data were gathered from three centers in Tehran: Taban Diabetes Clinic, Diabetos Clinic, and Royan Diabetes Center.

Prior to participation, adolescents and their parents received a clear explanation of the study's purpose, procedures, and assurances regarding confidentiality. Written informed consent was obtained from all participants. On scheduled days, the researchers met with the adolescents and their parents at each center, distributed the questionnaires, and supervised the completion process in a quiet and designated area within the clinics. The completed questionnaires were reviewed immediately to ensure that all items had been answered and participants were asked to complete any missing responses when necessary. All stages of data collection were conducted under the supervision of the researchers and in accordance with established ethical standards for studies involving human participants.

Instruments

Diabetes Self-Management Questionnaire (DSMQ):

Diabetes self-management was measured using the Diabetes Self-Management

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Questionnaire (DSMQ) developed by Author (25). This instrument contains 16 items assessing five key aspects of diabetes self-management, including glucose management, dietary regulation, physical activity, use of health care services, and overall self-care practices. The items are presented as behavioral statements and are rated on a 4 point Likert scale from 0 (does not apply to me) to 3 (applies to me very much), based on the respondent's behaviors during the previous eight weeks. Higher scores reflect better diabetes self-management.

In the original validation study, the DSMQ showed satisfactory internal consistency, with a Cronbach's alpha coefficient of .84, and its construct validity was supported through confirmatory factor analysis (25). The Persian version of the questionnaire was also found to be reliable in an Iranian study by Afkhami Ardakani et al., who reported a Cronbach's alpha of 0.81 (26). In the present study, the internal consistency of the DSMQ was acceptable, with a Cronbach's alpha of 0.83.

Beck Anxiety Inventory (BAI):

Anxiety symptoms were assessed using the Beck Anxiety Inventory (BAI), originally developed by Beck et al. (27). The BAI is a 21-item self-report scale designed to evaluate the severity of anxiety symptoms across cognitive, emotional, and physical domains. Each item is scored on a 4-point scale ranging from 0 (*not at all*) to 3 (*severely*), producing a total score between 0 and 63. Based on the total score, anxiety severity can be classified into four levels: minimal (0–7), mild (8–15), moderate (16–25) and severe (26-63).

The original psychometric evaluation of the BAI demonstrated excellent internal consistency (Cronbach's alpha= .92) and adequate test–retest reliability (*r*= .75)(27). Studies conducted in Iran have likewise supported the reliability and validity of this instrument, with Cronbach's alpha coefficients above .90 and strong convergent validity with clinician-rated anxiety measures (28). In the current study, the Cronbach's alpha coefficient for the BAI was 0.74, indicating acceptable reliability.

Perceived Stress Scale (PSS):

Perceived stress was assessed using the Perceived Stress Scale (PSS), developed by Cohen et al. (29). The scale includes 14 items that measure the extent to which individuals appraise situations in their lives as stressful, uncontrollable, and unpredictable. Responses are rated on a 5-point Likert scale ranging from 0 (never) to 4 (very often), with higher scores indicating greater perceived stress.

The original version of the PSS demonstrated satisfactory internal consistency, with Cronbach's alpha values ranging from 0.84 to 0.86 and evidence of construct validity was established through its associations with life events, depressive symptoms, and health-related indicators (29). Iranian validation studies have also confirmed the acceptable psychometric properties of the Persian version, reporting Cronbach's alpha coefficients ranging from .71 to .84 (30). In the present study, the Cronbach's alpha coefficient for the PSS total score was .74.

Statistical analysis

Data were analyzed using AMOS version 24 through simultaneous path analysis modeling. Prior to model estimation, the assumptions of normality, multicollinearity, and the presence of outliers were examined.

Univariate normality was assessed by evaluating skewness and kurtosis indices. Based on conventional criteria, values within the range of −2 to +2 indicate acceptable normality. As presented in table 1, all variables in the present study met this criterion, indicating approximately normal distributions. Multivariate normality was examined using Mardia's multivariate kurtosis coefficient, which yielded a value of 3.17, supporting the assumption of multivariate normality.

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To identify potential multivariate outliers, the Mahalanobis distance (D^2) statistic was computed. No cases exceeded the critical chi-square value at the 0.05 significance level, indicating the absence of problematic outliers. Multicollinearity among predictor variables was evaluated using tolerance and variance inflation factor (VIF) indices. Tolerance values were close to 1 and all VIF values were below 2, suggesting that multicollinearity was not a concern in the present model.

Model parameters were estimated using the maximum likelihood method, and statistical significance was evaluated at a *P*-value< 0.05. Indirect effects were tested using the bootstrap resampling method to examine mediation effects. Model fit was assessed using standard goodness-of-fit indices, including the chi-square statistic divided by degrees of freedom (χ^2/df), the comparative fit index (CFI), the incremental fit index (IFI), and the root mean square error of approximation (RMSEA).

Ethical considerations

The present study was conducted in accordance with the ethical standards of research involving human participants. Ethical approval for this study was obtained from the Ethics Committee of Islamic Azad University, Chalus Branch, under the approval code IR.IAU.CHALUS.REC.1404.105. Written informed consent was obtained from all participants and their parents prior to participation. Participants were assured of the confidentiality of their information and their right to withdraw from the study at any stage without any consequences.

Results

The sample consisted of 310 adolescents with diabetes, with a mean (SD) age of 16.50 (± 1.06) years. Among them, 54.8% were female and 45.2% were male. Additionally, 51.3% were diagnosed with type 1 diabetes and 48.7% with type 2 diabetes (Table 1).

Table 2 presents the relationships among the study variables, all of which were statistically significant at the 95% confidence level (*P*< 0.05).

The goodness-of-fit results for the proposed model are summarized in table 3. To determine whether the model adequately represented the observed data, multiple fit indices were considered, including χ^2/df, RMSEA, GFI, IFI, CFI, PCFI, and PNFI. The values obtained for these indices were within the commonly accepted ranges, supporting the satisfactory fit of the proposed structural model.

The explanatory power of the model was further assessed using the coefficient of determination (R^2). The model explained 48% of the variance in diabetes self-management (R^2= 0.48), suggesting that anxiety, both directly and through perceived stress, plays an important role in predicting diabetes self-management among adolescents with diabetes. According to the results presented in table 4, anxiety significantly and negatively predicted diabetes self-management (*t*= −3.90, β= −0.28). Perceived stress likewise emerged as a significant negative predictor of diabetes self-management (*t*= −6.20, β= −0.46). In addition, anxiety was positively and significantly associated with perceived stress (*t*= 4.61, β= 0.33).

The results presented in table 5 indicate that the lower bound of the 95% bootstrap confidence interval for perceived stress, as a mediating variable in the relationship between anxiety and diabetes self-management, was −0.28, while the upper bound was −0.11. The confidence level for this interval was set at 95%, and the number of bootstrap resamples was 2,000. Because zero does not fall within this confidence interval, the indirect effect is statistically significant. Accordingly, perceived stress plays a mediating role in the relationship between anxiety and diabetes self-management among adolescents with diabetes.

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Table 1. Descriptive statistics of the study scales

Scale	Mean ± SD	Skewness	Kurtosis
Anxiety	16.50 (± 8.31)	-0.14	0.12
Perceived stress	27.62 (± 4.35)	0.70	-0.53
Diabetes self-management	68.30 (± 11.17)	0.64	-0.91

Table 2. Correlation matrix of the study variables

Variable	1	2	3
1. Anxiety	1		
2. Perceived stress	0.35**	1	
3. Diabetes self-management	-0.29**	-0.46**	1

Table 3. Model fit indices of the proposed structural model

Fit index	χ^2/df	GFI	PCFI	PNFI	CFI	IFI	RMSEA
Proposed model	2.61	0.93	0.80	0.79	0.95	0.93	0.066

Acceptable thresholds: PCFI, PNFI > 0.50, GFI, CFI, IFI > 0.90, RMSEA < 0.08, χ^2/df < 3

Table 4. Standardized and unstandardized direct effects of the study variables

Dependent variable	Predictor	Effect type	Unstandardized coefficient	Standardized β	*P*-value
Diabetes self-management	Anxiety	Direct	-0.26	-0.28	0.001
Diabetes self-management	Perceived stress	Direct	-0.65	-0.46	0.001
Perceived stress	Anxiety	Direct	0.46	0.33	0.001

Table 5. Indirect effect of anxiety on diabetes self-management via perceived stress

Dependent variable	Predictor	Indirect path	Effect	SE	Lower CI	Upper CI	*P*-value
Diabetes self-management	Anxiety	Via perceived stress	-0.17	0.04	-0.28	-0.11	0.001

Discussion

The present study examined the structural relationships between anxiety and diabetes self-management in adolescents and explored the mediating role of perceived stress. Findings confirmed the hypothesized model anxiety negatively influenced diabetes self-management, both directly and indirectly through perceived stress. These outcomes align with recent advances in health psychology and diabetes research, which emphasize the role of psychological stress processes in chronic illness (1,6,8).

Consistent with established literature, higher anxiety levels were associated with poorer self-management among adolescents with diabetes (12,13). Adolescents who experience anxiety tend to interpret diabetes-related routines such as glucose monitoring, insulin administration, and dietary control as more effortful and threatening. Such maladaptive interpretations heighten perceived stress, diminish motivation, and disrupt adherence to essential self-care behaviors. Our findings extend existing models by illustrating that the detrimental effects of anxiety operate primarily through an indirect cognitive emotional pathway via perceived stress, rather than through a direct behavioral mechanism.

Perceived stress represents an individual's appraisal that environmental demands exceed available coping resources (28). Adolescents with diabetes who exhibit high anxiety are more likely to interpret illness-related demands as uncontrollable and overwhelming, producing a cascade of physiological and cognitive stress responses. This elevated stress perception weakens executive functioning and self-regulation capacities central to health-related goal maintenance. Thus, although anxiety alone may not directly deteriorate self-management, when cognitively transformed into perceived stress it indirectly

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undermines behavioral consistency and treatment adherence (14-16,31).

The role of perceived stress observed here corresponds with modern theoretical models of self-regulation, suggesting that emotional appraisal processes mediate the translation of affective states into behavioral outcomes (7). Adolescents under high perceived stress may display fatigue, irritability, and cognitive overload that compromise routine planning and problem-solving. Prior findings confirm that stress-related impairments in executive function predict lapses in diet, activity, and insulin regulation (31). Moreover, teens with limited emotion-regulation skills such as cognitive reappraisal or mindfulness are more vulnerable to avoidance, suppression, or disengagement behaviors under stress (32). These mechanisms explain why perceived stress amplifies the detrimental cascade linking anxiety to poor adherence.

Adolescence itself magnifies these effects. It is a developmental stage distinguished by emotional lability, identity exploration, and heightened sensitivity to social evaluation. Managing a chronic condition within this psychosocial context places adolescents at elevated risk for stress-related maladaptation (7,12). When anxiety is cognitively interpreted as perceived stress, it alters health beliefs particularly perceived vulnerability and self-efficacy regarding illness control. This cognitive recoding of anxiety into stress perceptions can trigger feelings of helplessness and low confidence, leading to withdrawal from diabetes management responsibilities (33). These findings substantiate the conceptualization of perceived stress as a “psychological filter” modulating anxiety’s behavioral effects.

From a clinical standpoint, this mediating mechanism highlights critical intervention priorities. Psychological programs that merely target symptom reduction in anxiety may overlook the central role of cognitive stress appraisal. Interventions such as stress-management training, cognitive-behavioral therapy (CBT), and emotion-regulation skill enhancement for instance, mindfulness and cognitive reappraisal can help adolescents reinterpret diabetes stressors as manageable challenges rather than uncontrollable burdens (33). Health practitioners, therefore, should move beyond anxiety mitigation toward reshaping stress perception and strengthening adaptive coping capacities.

Furthermore, a developmentally informed care model is recommended. Empowering adolescents to gradually assume responsibility for diabetes management while maintaining structured professional and familial support can enhance self-efficacy and buffer stress (8,15). Programs promoting autonomy coupled with emotional skills training have shown notable improvements in adolescents’ adherence and metabolic control (32,33). In summary, this study extends the literature by empirically validating perceived stress as a mediating mechanism in the link between anxiety and diabetes self-management. Addressing perceived stress appraisal appears fundamental in refining psychosocial interventions for youth living with diabetes. Targeting stress perception not anxiety alone may foster more sustainable improvements in psychological well-being and disease self-management throughout adolescence. This research was limited by its regional sample and cross-sectional design, relying solely on self-report measures which might be influenced by response bias. Hence, generalization should be made cautiously. Future studies are encouraged to employ longitudinal designs and larger, more diverse samples, to test targeted psychological interventions aimed at reducing anxiety and perceived stress, and to evaluate their effects on strengthening self-management and self-care behaviors. Incorporating multimethod assessments behavioral as well as clinical would also enhance reliability.

Conclusions

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Findings demonstrate that both anxiety and perceived stress significantly affect diabetes self-management in adolescents. In other words, reducing anxiety can enhance adolescents' self-management abilities, while perceived stress plays an important mediating role in this process. The results underline the critical need to reinforce self-management skills and to mitigate both anxiety and perceived stress to promote better self-care behaviors and improve quality of life among adolescents living with diabetes.

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Conflict of Interest

The authors declare no conflicts of interest related to this research.

Author contributions

F.A , M.J: writing-original draft and analyzing data. E.P: supervision and conceptualization, SL.A . M.J: collecting the data and Conceptualization, F.A.: Supervision and methodological contributions. All the authors critically revised the manuscript, agree to be fully accountable for the integrity and accuracy of the study, and read and approved the final manuscript.

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