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Structural Relationships Among Self-Regulation, Psychological Distress, and Medication Adherence in Adults With Type 2 Diabetes Mellitus

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ABSTRACT

Objective: This study examined the associations among self-regulation, psychological distress, and medication adherence in adults with type 2 diabetes mellitus (T2DM).

Methods and Materials: This cross-sectional correlational study was conducted on 471 adults with T2DM selected through convenience sampling from outpatient diabetes clinics. Data were collected using the Self-Regulation Questionnaire, Kessler Psychological Distress Scale, and General Medication Adherence Scale. Structural equation modeling was performed to evaluate direct and indirect associations among variables. Multi-group analyses examined invariance across gender and age groups.

Findings: Participants demonstrated moderate self-regulation (M = 3.12, SD = 0.41) and medication adherence (M = 2.84, SD = 0.49), while psychological distress was high (M = 4.03, SD = 0.58). Structural equation modeling revealed that self-regulation was negatively associated with psychological distress (β = −0.34, SE = 0.07, p < .001) and positively associated with medication adherence (β = 0.38, SE = 0.09, p < .001). Psychological distress was negatively associated with medication adherence (β = −0.42, SE = 0.09, p < .001). Psychological distress partially mediated the relationship between self-regulation and medication adherence (β = 0.14, SE = 0.05, p < .001). The model explained 12% of the variance in psychological distress and 31% of the variance in medication adherence. Multi-group analyses showed invariance across gender and age (ΔCFI = 0.00).

Conclusion: Higher self-regulation is associated with lower psychological distress and better medication adherence among adults with T2DM. Psychological distress partially mediates this relationship, suggesting that interventions targeting emotional regulation may improve adherence outcomes.

Keywords: Diabetes Mellitus, Medication Adherence, Psychological Distress, Self-Control, Chronic Disease.

Introduction

Type 2 Diabetes Mellitus (T2DM), a chronic metabolic disorder, requires patients to manage multiple aspects of their condition, including adherence to prescribed medications, dietary management, physical activity, and regular blood glucose monitoring (Karimi et al., 2024). Despite progress in improving clinical outcomes with diabetes medications, many patients with T2DM struggle to adhere to daily self-management behaviors, which are associated with glycemic control and the risk of long-term complications (Hoogendoorn et al., 2024; Polonsky & Henry, 2016). Many psychological variables associated with self-regulation processes in diabetes management, such as psychological distress, are critical factors in how individuals respond to the daily demands of T2DM. These mechanisms operate through conscious and unconscious self-monitoring, self-evaluation, and perseverance that facilitate goal setting (Gross, 2015). Psychological distress is a significant clinical variable that is associated with the cognitive, motivational, and problem-solving processes required for daily adherence to diabetes medication (Fisher et al., 2019). Furthermore, psychological distress has been associated with engagement in diabetes treatment regimens, where higher levels of distress are linked to lower adherence to both medication treatments as well as self-care, which may precede behavioral disengagement from daily self-management behaviors (Hoogendoorn et al., 2024). Thus, self-regulation processes may be associated with the intensity and duration of an individual's distress, which, in turn, may be associated with adherence to daily self-management behaviors (Karimi et al., 2024; Sirois & Hirsch, 2019).

Type 2 Diabetes Mellitus (T2DM)

The "Introduction and methodology: standards of care in diabetes—2024," (2024) states that T2DM develops through the interaction of genetic and environmental factors. T2DM is characterized by dysregulated metabolism, including insulin resistance and β-cell dysfunction, both of which are associated with impaired insulin secretion and glucose dysregulation. T2DM is one of the most common non-communicable diseases; individuals with T2DM have an increased risk of developing cardiovascular disease, nephropathy, neuropathy, and retinopathy (Organization, 2025). International epidemiologic studies have shown that the prevalence of T2DM has risen sharply over the last decade, particularly in developing economies, indicating that T2DM is becoming a greater burden on global public health (Federation & Atlas, 2021). Furthermore, Fisher et al., (2019) asserted that T2DM management extends beyond physiological treatment and involves substantial behavioral and psychological components, particularly self-regulation processes, treatment adherence, and emotional coping. In this context, Hill-Briggs et al., (2020) demonstrated that cognitive and behavioral skills, including goal setting, self-monitoring, and adherence to medical recommendations, are associated with effective diabetes self-management behaviors. Sustained glycemic control is associated with patients' engagement in self-care behaviors, including medication adherence, dietary regulation, and regular physical activity (Powers et al., 2020).

Self-regulation in the context of T2DM

Unlike acute metabolic conditions, T2DM patients require continued, lifelong self-management, which places sustained demands on cognitive, behavioral, and emotional regulation processes (Fadli et al., 2025). There is substantial variability among individuals with T2DM in how they experience the disease, to which they perceive self-care as a burden, and their concerns about complications (Park et al., 2024). Self-regulation processes are considered important in effective diabetes management and may be conceptualized as more than an adjunct or secondary factor; they are linked with how an individual copes with feelings arising from self-regulatory goals. It also helps conceptualize and understand the ongoing process of managing disease, in which individuals engage in goal setting, monitoring, and adjusting based on internal and external factors (Gross, 2015).

Self-regulation processes may support sustained engagement in health by enabling patients to tolerate distress, cope with frustration, and remain focused on long-term health-related goals despite their illness beliefs, including perceived controllability, consequences, and illness duration, which are related to subsequent coping and adherence to treatment behaviors (Kollin et al., 2024; Timajchi et al., 2025). Meanwhile, patients who struggle with self-regulation processes may be more likely to exhibit maladaptive coping strategies, such as avoidance and disengagement, which are related to reduced engagement in self-

management behaviors (Polonsky & Henry, 2016). Cal et al., (2015) have reported evidence consistent with this integrated approach towards self-regulation, as well as it is associated with T2DM, with weak self-regulation being associated with higher levels of distress, lower levels of consistency in performing self-care behaviors, and lower glycemic control relative to those who successfully regulate themselves (Kollin et al., 2024).

Self-regulation and psychological distress

Psychological distress among T2DM patients primarily refers to general emotional distress rather than diabetes-specific distress. It comprises broad emotional concerns associated with the daily management of diabetes, the complexity of treatment, and a perceived inability to control health outcomes (Fisher et al., 2019). General psychological distress is considered a significant clinical construct, representing the psychological burden of living with and managing T2DM, which has been related to self-care behavior, adherence to prescribed medication, and glycemic control more than with general life demands (Polonsky & Henry, 2016). From an affective regulation perspective, psychological distress may arise in part from how patients regulate their self-reactions to stressors associated with the disease, wherein difficulties in using adaptive self-regulation strategies are linked with emotional response, prolonged duration of emotionally aroused states, and reduced psychological recovery (Leukel et al., 2022).

Difficulties in self-regulation processes have been conceptualized as factors associated with psychological distress rather than being established as causal antecedents of emotional symptoms (Miller et al., 2022). Consequently, patients who primarily use adaptive self-regulation strategies tend to report lower levels of psychological distress than individuals who primarily use maladaptive strategies; they also report greater psychological adjustment while managing a chronic illness. Therefore, self-regulation processes are important for understanding the associations between psychological distress and T2DM; they are associated with how individuals perceive, respond to, and recover from illness-related stressors, ultimately linking to emotional outcomes associated with T2DM (Cal et al., 2015).

Previous studies

In a study by Darvishi et al., (2025), the role of the health belief model's constructs in relation to self-care behavior among T2DM patients was examined. A cross-sectional study was conducted among 246 patients with T2DM attending six comprehensive healthcare centers in Bandar Abbas. The model explained a significant amount of the variance in the measured outcomes. Self-care behavior was also found to be strongly associated with several health belief model constructs, including perceived barriers, self-efficacy, and perceived susceptibility to T2DM. Therefore, the constructions listed above may serve as predictors of adherence to self-care behavior among T2DM patients. Amerzadeh et al., (2024) examined the self-care behaviors, medication adherence, and related factors among elderly patients with type 2 diabetes using a cross-sectional study. Data were collected using self-care and medication adherence scales. Results indicated variability in self-care behaviors, with generally low adherence, particularly in physical activity and foot care. Medication adherence was also relatively low, and several demographic factors were associated with differences in self-care behaviors.

While Hoogendoorn et al., (2024) examined longitudinal associations between emotional distress and medication adherence among adults with T2DM in Bandar Abbas city, the emotional distress sub-study assessed medication adherence, depressive symptoms, and diabetes distress in 1,739 GRADE participants via self-completed questionnaires administered biennially up to 3 years. Findings indicated that higher levels of distress were associated with lower adherence over time, whereas lower adherence was not associated with subsequent increases in distress. The relationship between distress and adherence showed an indirect association through medication-related concerns. Akshatha & Nayak (2024) investigated the cross-sectional association between psychological distress and medication adherence in T2DM patients. The study sample consisted of 100 adults with T2DM from a teaching hospital in South India. To collect data, the general health and Morisky medication adherence scales were used. Results indicated that psychological distress was common and was associated with lower medication adherence. Similarly, Blangeti et al., (2024) examined "prevalence and associated factors of psychological distress among diabetic patients at Thyolo district

hospital in Malawi". The cross-sectional study involved 171 participants selected using simple random sampling at Thyolo District Hospital. Results of the study reported the prevalence of psychological distress among diabetic patients, with findings suggesting that age was associated with levels of psychological distress within the sample.

Finally, Coccaro et al., (2022) "conducted two studies to elucidate a model for how emotion regulation impacts diabetes distress and A1c levels and determine preliminary effect size estimates for an intervention targeting poor emotion regulation on glycemic control". Using structural equation modeling, study number one analyzed cross-sectional links among diabetic distress, emotion regulation capacity, and A1c in individuals diagnosed with type 1 or type 2 diabetes. Following Study 1's results, which emphasized the importance of emotion regulation capacity, a pilot study was conducted comparing the effectiveness of an emotion-focused behavioral intervention versus treatment as usual for improving emotional experience and A1c levels among those living with type 2 diabetes. Study I provided a more comprehensive view of the data, revealing that poor emotional regulation accounted for 42% of all effects on A1c levels. Study II found medium-sized reductions in A1c levels and smaller reductions in diabetes distress, both of which correlated with changes in emotion regulation.

According to previous studies, self-regulation, psychological distress, and medication adherence are interrelated constructs associated with type 2 diabetes mellitus (T2DM). However, the findings vary depending on a range of factors (e.g., study population characteristics, measurement methods, and study design). Although numerous studies have examined these variables individually or in combination across different outcomes, it has been difficult for researchers and practitioners to determine the effects of self-regulation on medication adherence and the effects of psychological distress on both self-regulation and medication adherence in patients with T2DM. Therefore, there is a need for research that provides a clear understanding of the relationships among these variables using a single analytical model. The current study will use a cross-sectional correlational research design to evaluate the relationships of these variables among patients with T2DM.

Statement of the problem

While the management of type 2 diabetes mellitus (T2DM) has improved over time, Hoogendoorn et al., (2024) found that many T2DM patients do not consistently take their prescribed medications or follow the self-care advice they have been given, even when they have access to medical care. Also, Fisher et al., (2019) reported that elevated levels of emotional distress were associated with lower adherence to prescribed medication treatment plans among adults with T2DM, suggesting an association between emotional distress and behavioral disengagement rather than a directional relationship. Although there is a wealth of evidence supporting the relationship between distress and self-care behaviors, theoretical models of self-regulation, as well as the Common-Sense Model, explain that effective management of chronic illness depends on one's ability to regulate responses to illness-related stressors to maintain the behaviors needed to reach a goal. Within this framework, an individual's ability to regulate their emotions is fundamental to how they appraise the demands of their diabetes, cope with its challenges, and continue working to manage it. However, prior studies have often examined psychological distress, self-regulation, and treatment adherence separately or within limited analytical frameworks, without integrating these variables within a single comprehensive model in patients with T2DM. Consequently, there is a need to develop an understanding of how self-regulation relates to general psychological distress and how both factors jointly relate to treatment adherence using an integrative analytical approach. Therefore, the present study aims to examine the associations among self-regulation processes, general psychological distress, and medication adherence within a cross-sectional correlational framework.

Significance of the study

The study may inform clinical practitioners about the relevant considerations for psychological assessment and potential implications for practice for patients living with Type 2 diabetes by highlighting the association between self-regulation, psychological distress, and nonadherence to the prescribed medication regimen. Therefore, clinical practitioners may consider assessing self-regulation difficulties and psychological distress when evaluating patients diagnosed with Type 2

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diabetes and may consider the potential role of emotion-based interventions when delivering multidisciplinary diabetes care. This study may contribute to the development of a clinically informed psychological approach to support psychological wellness and medication adherence in adults diagnosed with Type 2 diabetes.

Objectives

This study aims to examine the levels of self-regulation and psychological distress among individuals with type 2 diabetes mellitus. Moreover, to assess the extent to which patients with type 2 diabetes adhere to treatment. In addition, examine the association between self-regulation, psychological distress, and treatment adherence in type 2 diabetes mellitus. Furthermore, the study aims to test whether patient gender and age are associated with self-regulation, psychological distress, and treatment adherence in patients with Type 2 Diabetes Mellitus.

Hypothesis

H1. There is a moderate level of self-regulation and psychological distress among individuals with type 2 diabetes mellitus.

H2. Patients with type 2 diabetes mellitus demonstrate a moderate level of medication adherence.

H3. Self-regulation and psychological distress are associated with medication adherence in type 2 diabetes mellitus.

H4. Patients' gender and age are associated with the levels of self-regulation, psychological distress, and medication adherence in type 2 diabetes mellitus.

Methods and Materials

Study Design

The study employed a cross-sectional, hospital-based, correlational design with SEM-based path analysis. a methodology used to achieve the study objectives. This approach is utilized to measure the relationship between two or more variables, aiming to determine the nature and direction of the correlation ,whether positive or negative. In addition, structural equation modeling (SEM) was employed to examine the hypothesized relationships among variables through path analysis. It is important to note that, given the study's cross-sectional design, the model tests associations rather than causal relationships. Furthermore, the descriptive-correlational method facilitates the assessment of significance between these variables through numerical representation. It is based on data collected with study instruments, which were subsequently analyzed using the Statistical Package for the Social Sciences (SPSS) and SEM.

Participants

The study sample consisted of 471 participants (247 males and 224 females) selected from Ghour Alsfi Hospital via convenience sampling, a non-probability, single-center sampling approach. The participants diagnosed with T2DM for at least 6 months, who were receiving follow-up care at outpatient diabetes clinics, and were receiving either an oral hypoglycemic agent, insulin therapy, or both. The patients varied in age (18 and older). Eligibility criteria included a confirmed diagnosis of T2DM for at least 6 months and ongoing treatment, while exclusion criteria comprised patients with cognitive impairment, severe psychiatric disorders, illiteracy, or visual impairment; individuals with limited digital literacy; and those older than 69 years. A single-center sampling approach may limit the generalizability of the findings; therefore, the results should be interpreted with caution.

Table 1

Sample details

Variable	Category	Number	100%
Gender	Male	247	52.4%
	Female	224	47.6%
Age	18 – 29	93	19.7٥%
	30 – 39	106	22.5%
	40 – 49	121	25.69%
	50 – 59	95	20.1٧%
	60 – 69	56	11.8٩%

Tools

The study has adopted the following scales:

First, self-regulation scale Carey et al., (2004): It consists of 31 items multidimensional scale to assess the individuals' ability to regulate their behavior: self-monitoring (Items 2, 6, 10, 15, 19, 24), self-evaluation (Items 3, 7, 11, 16, 20, 25), goal setting (Items 1, 5, 9, 14, 18, 23), impulse control (Items 4, 8, 12, 17, 21, 26), and perseverance (Items 13, 22, 27, 28, 29, 30, 31). The scale consists of 9 negative direction items (2, 6, 7, 11, 16, 19, 24, 27, 30). The scale uses a 5-point Likert format, with 1=strongly disagree to 5=strongly agree. A high score on the scale indicates a high level of self-regulation. The Cronbach's alpha of this scale was 0.94. To ensure that high scores corresponded to high self-regulation, all negatively worded items were reverse-scored. The scale selected for this study was chosen for its ability to measure all the processes that regulate one's behavior. All these processes have been shown to relate theoretically to the long-term management and treatment of chronic diseases, like T2DM.

Second, psychological distress scale Kessler et al., (2002): consists of 6 positively worded items to assess tension, anxiety, depression, hopelessness, feeling worthless, and feeling that the effort required a lot of energy, indicating how the patient has been feeling over the past 30 days. Each item on the scale is rated on a 5-point Likert scale, 1=none of the time to 5=all of the time. A high score on the scale indicates a high level of psychological distress, and the scale's Cronbach's alpha was 0.8٠. The scale was treated as a unidimensional measure of global psychological distress, and individual items were not analyzed or interpreted as separate subscales.

Third, the general medication adherence scale Naqvi et al., (2020): it consists of 11 items, patient behavior–related nonadherence (items 1, 2, 3, 4, 5), additional disease and pill burden (6, 7, 8,9), and cost-related nonadherence (items 10 and 11). All items reflect aspects of medication nonadherence, such as forgetting medication or skipping doses. Follow the 5-point Likert scale: 1 = Always to 5 = Never. The low score indicates strong medication adherence, and the original Cronbach's alpha was 0.84. Higher scores indicate lower levels of nonadherence (i.e., better medication adherence), and the scoring direction was treated consistently across analyses to avoid misinterpretation. The relatively lower reliability of the cost-related nonadherence subscale (two items) is acknowledged and interpreted with caution.

Validity and reliability

The three scales were translated into Arabic using the forward-backward translation method, ensuring linguistic and cultural equivalence by Arabic- and English-speaking professionals. The translated version was reviewed and evaluated by (9) psychologists, psychiatrists, and mental health professionals to determine their suitability for the target sample and study objectives. In addition, Cronbach's alpha and split-half method were calculated for the three scales across their domains, where the values of (α) for the scales ranged between (0.68 to 0.91), and the split-half values ranged between (0.65 to 0.87), as illustrated in Table 2. Furthermore, the correlation coefficient between the item score and the domain total score has been calculated. Based on a minimum acceptable criterion of $r \geq .40$, the items of the three scales were accepted, and no items were excluded, as presented in Tables 2, 3, and 4. The scales have also undergone measurement validation to verify their use in an SEM framework. In addition, as part of the evaluation of the translated instruments' validity (insofar as the translated items were used), evidence was obtained regarding the instruments' structure. The cost-related noncompliance dimension, with relatively low (borderline) reliability levels (e.g., α = 0.68, split-half = 0.65), has been acknowledged and should be interpreted with caution, given the small number of items in this dimension.

The results indicate that the three scales were statistically significant at the $p < 0.01$ level. This statement has been reconsidered, and emphasis is instead placed on reliability coefficients and item-total correlations as indicators of internal consistency and construct validity. The correlation values indicate that the items are closely linked to the trait being measured, reflecting the scale's validity (Tables 3, 4, and 5). Moreover, confirmatory factor analyses have been conducted for the three translated scales. The results indicate acceptable Fit for the three scales: self-regulation ($\chi^2/df = 2.41$, CFI = 0.91, RMSEA = 0.067), medication adherence ($\chi^2/df = 2.58$, CFI = 0.92, RMSEA = 0.071), and psychological distress ($\chi^2/df = 2.10$, CFI = 0.96, RMSEA = 0.061). In addition, standardized factor

loadings ranged between 0.54 and 0.79 across all constructs. As illustrated in Tables 6 and 7.

Table 2

Cronbach's alpha and split-half for three scales

Domains	Item No.	Cronbach's alpha	spilt half
Self-monitoring	6	0.85	0.79
Self-evaluation	6	0.83	0.77
Goal setting	6	0.88	0.82
Impulse control	6	0.84	0.75
Perseverance	7	0.84	0.78
Total self- regulation	31	0.8٣	0.76
Psychological distress	6	0.84	0.79
Patient behaviour–related nonadherence	5	0.89	0.84
Disease and pill burden	4	0.86	0.80
Cost-related nonadherence	2	0.68	0.65
Total general medication adherence	11	0.91	0.87

Table 3

correlation coefficient of the self-regulation scale

Goal Setting		Self-Monitoring		Self-Evaluation		Impulse Control		Perseverance	
item	r	Item	r	Item	r	Item	r	item	r
1	0.51	2	0.68	3	0.49	4	0.51	13	0.60
5	0.72	6	0.49	7	0.55	8	0.56	22	0.55
9	0.65	10	0.72	11	0.52	12	0.49	27	0.58
14	0.62	15	0.53	16	0.57	17	0.50	28	0.59
18	0.73	19	0.57	20	0.59	21	0.48	29	0.51
23	0.61	24	0.49	25	0.48	26	0.53	30	0.50
								31	0.61

Table 4

correlation coefficient of psychological distress scale

Item	r	Item	R	item	r	Item	r	Item	r	Item	r
1	0.52	2	0.48	3	0.49	4	0.50	5	0.53	6	0.51

Table 5

correlation coefficient of the general medication adherence scale.

Patient behavior–related nonadherence		Additional disease and pill burden		Cost-related nonadherence	
Item	r	Item	r	Item	r
1	0.48	6	0.59	10	0.52
2	0.46	7	0.54	11	0.50
3	0.47	8	0.50		
4	0.50	9	0.50		
5	0.49				

Table 6

"Confirmatory Factor Analysis (CFA) Fit Indices ".

Scale	Factor No.	χ^2/df	CFI	TLI	RMSEA	SRMR
Self-regulation	5	2.41	0.91	0.90	0.067	0.058
Psychological distress	1	2.10	0.9٦	0.94	0.061	0.041
Medication adherence	3	2.58	0.92	0.90	0.071	0.060

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Table 7

standardized factor loadings for the scales

Scales	Dimension	Items	Loadings
Self-regulation	Self-Monitoring	2, 6, 10, 15, 19, 24	0.56–0.74
	Self-Evaluation	3, 7, 11, 16, 20, 25	0.54–0.72
	Goal Setting	1, 5, 9, 14, 18, 23	0.58–0.78
	Impulse Control	4, 8, 12, 17, 21, 26	0.55–0.75
	Perseverance	13, 22, 27, 28, 29, 30, 31	0.57–0.77
Psychological Distress	----------	1 – 6	0.62–0.79
Medication adherence	Behavior–related nonadherence	1 - 5	0.57–0.76
	Disease and Pill Burden	6 - 9	0.55–0.73
	Cost-Related Nonadherence	10 - 11	0.58–0.69

Procedure and data analysis

For data collection, IRB approval has been obtained from the Ghour Alsfi Hospital Management Board, No. 52/11/2025. After that, a list of patients diagnosed with type 2 diabetes for at least 6 months was obtained from the main center's outpatient clinic records at Ghour Alsafi Hospital, totaling 964 patients. They were contacted via WhatsApp by a message from the researchers explaining the purpose of the message and the study. Participants were provided with an electronic informed consent statement at the beginning of the survey, and participation was voluntary; completing the questionnaire was considered informed consent. Also, to inform them that the information and data obtained would not include the patient's name, would be kept strictly confidential, and would be used solely for scientific research purposes. No personally identifiable information (e.g., names or phone numbers) was collected through the survey, and responses were stored anonymously to ensure confidentiality during digital recruitment and data collection. The scales were prepared in Google Forms. After that, the link was sent via WhatsApp to all patients 964, and the specified period to respond to the scales was 1 month from the date the link was sent. A total of 471 patients responded, representing 48.85% of the total patients. The researchers extracted the data into an Excel file, organized it, and handled it in accordance with proper and ethical scientific methods by transferring the data and information truthfully without any changes, modifications, or additions. Incomplete questionnaires were excluded from the analysis, and responses were screened to identify and remove any duplicate entries. Missing data was minimal and handled appropriately prior to analysis.

Data analysis

The study's data were analyzed using AMOS. Descriptive statistics (means and standard deviations) were calculated for self-regulation, psychological distress, and medication adherence. Structural Equation Modelling (SEM) was used to test the hypothesized association in the data, treating all constructs as latent variables and their associated observed indicators. The analysis was performed in two phases (Measurement Models and Structural Models). Model estimation was performed using the Maximum Likelihood (ML) estimator, which was justified as having acceptable univariate and multivariate normal distributions (assessed by skewness, kurtosis, and Mardia's coefficient) and a satisfactory sample size for SEM.

The Fit of the model was determined by looking at five types of fit criteria: χ^2, CFI, TLI, RMSEA, and SRMR according to recommended cutting points. Mediation effects were evaluated with 5000 bootstrapping resamples with bias-corrected confidence intervals. A multiple-group SEM was also performed to evaluate measurement (configural, metric, scalar) and structural invariance by gender and age groups, with invariance assessed using ΔCFI (≤ 0.01). The median split was used to define the age groups. Gender and age were included as the grouping variables. Other potential covariates were excluded from the model to increase its parsimony, a limitation of the study.

Findings and Results

H1. There is a moderate level of self-regulation and psychological distress among individuals with type 2 diabetes mellitus. To examine the hypothesis, means and standard deviations have been calculated for the scales across all their dimensions. Table 8 illustrates the results.

Table 8

means and standard deviation for self-regulation and psychological distress.

Variables	Dimensions	Mean	SD	Level
Self-regulations	Self-monitoring	2.72	0.82	Moderate
	Self-evaluation	3.12	0.76	Moderate
	Goal setting	3.55	0.65	High
	Impulse control	2.95	0.88	Moderate
	Perseverance	3.28	0.79	Moderate
	Total self- regulation	3.12	0.41	Moderate
Psychological distress	Total	4.03	0.58	High

**Cut-of points < 2.60 = low, 2.60 – 3.40 = medium, > 3.40 = high. represent arithmetic divisions of the response scale and are used for descriptive purposes only.*

Table 8 indicates that Type 2 diabetes patients reported a moderate level of self-regulation overall (M = 3.12, SD = 0.41), with one high-level dimension of goal setting (M = 3.55, SD = 0.65). The variation across dimensions suggests some heterogeneity in self-regulation components, which is reflected in the overall moderate level. Regarding the psychological distress, the patients experienced a high level (M = 4.03, SD = 0.58).

H2. Patients with type 2 diabetes mellitus demonstrate a moderate level of medication adherence. To examine the hypothesis, the mean and standard deviation for medication adherence were calculated in Table 9.

Table 9

means and standard deviation for medication adherence.

Variables	Dimensions	Mean	SD	Level
Medication adherence	Patient behavior–related nonadherence	2.90	0.62	Moderate
	Additional disease and pill burden	2.76	0.66	Moderate
	Cost-related nonadherence	2.84	0.71	Moderate
	Total	2.84	0.49	Moderate

**Cut-of points > 3.50 = low, 2.01 – 3.50 = medium, ≤ 2.00 = high. based on the scoring direction of the scale.*

Results in Table 9 indicated that the T2DM patients demonstrated a moderate level of medication adherence across all its dimensions, with a total score of (M = 2.84, SD = 0.49), "based on reversed interpretation of nonadherence scale".

H3. Self-regulation and psychological distress are associated with medication adherence in type 2 diabetes mellitus. To examine the hypothesis, structural equation modelling SEM has been calculated as shown in Table 10. This indirect effect was tested using bootstrapping procedures with bias-corrected confidence intervals, which supported partial mediation, as both the direct and indirect associations were statistically significant.

Table 10

Direct and indirect association among the three variables

Path	B	SE	CI 95%	CR	P
Self-regulation → psychological distress	-0.34	0.07	[-0.48, -0.20]	4.94	< 0.001
Psychological distress → medication adherence	-0.42	0.09	[-0.59, -0.25]	4.75	< 0.001
Self-regulation → medication adherence	0.38	0.09	[0.20, 0.56]	4.10	< 0.001
Self -regulation → psychological distress → medication adherence	0.14	0.05	[0.05, 0.25]	2.71	< 0.001

Explained variance (R^2): psychological distress: $R^2 = 0.12$, medication adherence: $R^2 = 0.31$

Table 10 presents that self-regulation is significantly and negatively associated with psychological distress (β = −0.34, CR = 4.94, p < .001). Also, psychological distress is negatively and significantly associated with medication adherence (β = −0.42, CR = 4.75, p < .001). Moreover, self-regulation has a significant and positive associated with medication adherence (β = 0.38, CR = 4.10, p < .001). The indirect association between self-regulation and medication adherence through psychological distress was statistically significant (β = 0.14, CR = 2.71, p < .001). The model explained 12% of the variance in psychological distress and 31% of the variance in medication adherence. These results indicate that the predictors included accounted for a meaningful proportion of the variance in the outcome variables.

H4. Patients' gender and age are associated with the levels of self-regulation, psychological distress, and medication adherence in type 2 diabetes mellitus. To examine the hypothesis, multigroup structural equation modeling was conducted, as presented in Tables 11 and 12. Measurement invariance was established prior to testing structural invariance, supporting the comparability of the model across groups.

Table 11

Comparison of unconstrained and gender-constrained models.

Model	χ^2	df	CFI	RMSEA
Unconstrained	412.35	248	0.94	0.045
Gender-Constrained	417.92	258	0.94	0.046

ΔCFI = 0.00, indicating invariance of the structural model across gender.

Table 11 shows that the comparison between unconstrained and gender-constrained models revealed no meaningful change in model fit (ΔCFI = 0.00), indicating that the structural relationships were invariant across gender groups.

Table 12

Comparison of unconstrained and age-constrained models.

Model	χ^2	df	CFI	RMSEA
Unconstrained	418.60	372	0.93	0.047
Age-Constrained	426.85	384	0.93	0.048

ΔCFI = 0.00, indicating invariance of the structural model across age.

Table 12 showed that the age groups were defined using a median split of the sample. The comparison between unconstrained and age-constrained models also showed no meaningful deterioration in model fit (ΔCFI = 0.00), indicating that the structural relationships were invariant across age groups.

Discussion and Conclusion

The results indicate that participants had a moderate level of self-regulation. These findings suggest that many type 2 diabetes mellitus (T2DM) patients may experience difficulty in acknowledging, tolerating, and managing these negative emotions in helpful ways. Patients face various chronic stressors related to managing their diabetes, including glycemic monitoring, medication, diet, and lifestyle changes. Therefore, impairments in self-regulation may be associated with reduced patients' ability to deal with their chronic stressors effectively.

The results also indicated that the patients reported experiencing high levels of psychological distress across all their domains. This level of distress may reflect general psychological distress rather than diabetes-specific distress. It supports viewing T2DM as a chronic health condition that requires ongoing emotional, cognitive, and behavioral efforts. Chronic psychological distress may be associated with decreased engagement

in health-promoting behaviors and reduced consistency in diabetes self-management. Higher distress levels can make it more difficult for patients to maintain sustained self-regulation and adhere regularly to prescribed treatment regimens. As a consequence, people who have a high level of distress are likely to have difficulty participating in health-promoting activities regularly, particularly those that require ongoing self-control, such as adhering to prescribed medication and long-term lifestyle changes.

The study found that patients demonstrated moderate adherence across all three medication-adherence domains. It indicates a relatively balanced yet unstable pattern of medication-taking behavior. Although an individual may have places of consistent and inconsistent medication use, moderate adherence indicates variability in medication-taking behavior. That is, patients have some recognition regarding the importance of taking their prescribed treatments. These interpretations may be considered as possible explanations; however, they were not directly assessed in the current study. From a cognitive-behavioral perspective, medication adherence can be conceptualized as an ongoing behavioral pattern influenced by both environmental factors and emotional states.

Alternatively, medication adherence levels may drop to moderate or sub-optimal levels when there is an increase in psychological stress or emotional exhaustion experienced by the patient. Therefore, the moderate levels of adherence observed among patients do not reflect a lack of understanding about the importance of treatment. Instead, moderate levels of adherence indicate the complexity and continuum of interactions among cognitive beliefs, emotional health, and a patient's self-regulation.

SEM provided evidence of associations among self-regulation, psychological distress, and medication adherence. Results indicated that lower levels of self-regulation were associated with higher levels of psychological distress, suggesting that difficulties with emotional and behavioral regulation may be linked to increased distress levels. Psychological distress also showed a negative association with medication adherence; patients with greater psychological distress were less likely to adhere to their prescribed medication regimen consistently. In comparison, the positive association with self-regulation on medication adherence suggests that higher self-regulation is associated with better adherence. Finally, self-regulation was indirectly associated with medication adherence through psychological distress; therefore, self-regulation is associated with lower distress and higher medication adherence.

Further, neither gender nor age showed significant differences in levels of self-regulation, psychological distress, or medication adherence. Thus, these results suggest that the observed emotional and behavioral processes were similar across the groups in this sample and should be interpreted within the context of this sample only. The study provides support for earlier studies that show there is a significant association between psychological distress and medication adherence for patients with T2DM. Akshatha & Nayak (2024) and Hoogendoorn et al., (2024) describe people with higher levels of distress and depressive symptoms as having low-level adherence outcomes to medications. The current study contributes to the existing literature by examining these associations within the present sample.

Additionally, the results from this study are consistent with findings of Hoogendoorn et al., (2024), indicating that medication beliefs and emotional distress may be associated with the relationship between psychological functioning and adherence. The current findings also align with investigations of Coccaro et al., (2022), which highlight the significance of emotional regulation abilities in the context of distress associated with diabetes and resultant metabolic outcomes.

Conclusion

The current study showed that self-regulation, psychological distress and medication adherence were associated among the study sample. It is important to identify other possible explanations for the observed association between being less adherent to a prescribed diabetes medication and experiencing higher levels of psychological distress, as well as their association with one's ability to self-regulate; therefore, caution should always be exercised when interpreting the association examined between these three variables. There are also potential confounding or mediating factors that were not measured but may have affected both adherence and self-regulation or both variables and psychological distress, such as severity of diabetes or diabetes-

associated complications, levels of socioeconomic stress, or perceived treatment burden. The present study contributes to existing literature. It combines self-regulation, psychological distress, and medication adherence into a single structural model to provide a cohesive examination of their association. Also, the study shows that self-regulation has both direct and indirect associations with treatment adherence. Finally, a significant indirect association through psychological distress was observed in the tested model.

Limitations and recommendations

Although this study has many great attributes, it also has limitations to consider. Because this study used a cross-sectional design, it does not allow for causal inference regarding the relationships among self-regulation, psychological distress, and medication adherence. Therefore, the findings should be interpreted as hypothesis-generating rather than causal. Also, the study used self-report measures, which may introduce bias due to social desirability and biased responses, both of which may have affected the findings. It may also increase the risk of common-method variance, potentially inflating observed associations. The findings of this study may be limited by the use of a sample drawn from a specific clinical context, which reduces their generalizability. In addition, potential digital recruitment bias and nonresponse bias may have affected the sample's representativeness.

Other variables that might have contributed to the results, such as socioeconomic status, comorbid psychological conditions, and diabetes duration, were not included in this study; therefore, they could have influenced the observed associations. Furthermore, objective measures of medication adherence and clinical indicators, such as HbA1c, were not included, limiting the ability to validate self-reported outcomes. It is also important to note that psychological distress was measured using a general distress scale; therefore, interpretations at the subscale or domain level should be made with caution. Given these limitations, future research should use longitudinal or intervention designs to elucidate causal pathways better and to evaluate emotion-focused interventions on adherence and clinical outcomes in patients with type 2 diabetes mellitus.

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Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants. Ethical considerations in this study were that participation was entirely optional.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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Authors' Contributions

All authors equally contribute to this study.

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