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Structural Effect of Informational-Motivational-Behavioral Skills and Acceptance-Commitment in Self-Management, Adherence, and HbA1c in Diabetes: The Mediating Role of Distress

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Abstract

Objective: Psychological and behavioral factors play a critical role in diabetes management. This study investigates the structural relationships among the informational-motivational-behavioral skills (IMB) and acceptance and commitment processes with self-management, treatment adherence, and Glycated hemoglobin (HbA1c) levels in diabetic patients, with distress as a mediator.

Method: A cross-sectional study was conducted with 321 patients with type 2 diabetes patients referred to health centers in Jiroft, Iran. Data were collected using the Diabetes Self-Management Questionnaire-Revised (DSMQ-R), the IMB-based Diabetic Self-Management Scale (IMB-DSMS), the Diabetes Distress Scale (DDS-17), the Diabetes Acceptance and Action Scale-Revised (DAAS-R), and the Diabetes Mellitus Treatment Adherence Scale (DMTAS). Structural equation modeling (SEM) was employed using LISREL-8.8 for analysis.

Results: Acceptance and commitment were positively associated with IMB skills ($\beta = 0.34$, $P < 0.001$), self-management ($\beta = 0.51$, $P < 0.001$), and treatment adherence ($t = 8.19$, $\beta = 0.55$), while negatively associated with distress ($\beta = -0.24$, $P < 0.001$). IMB skills were associated with increased self-management ($\beta = 0.43$, $P < 0.001$) and adherence ($\beta = 0.46$, $P < 0.001$), and also negatively associated with distress ($\beta = -0.40$, $P < 0.001$). Distress was also negatively associated with self-management ($\beta = -0.22$, $P < 0.001$) and adherence ($\beta = -0.29$, $P < 0.001$), and positively associated with HbA1c levels ($\beta = 0.19$, $P < 0.001$). Bootstrap results confirmed distress as a mediator between IMB skills, acceptance, and commitment, and self-management/adherence ($P < 0.05$). The model showed excellent fit (RMSEA = 0.046, $\chi^2/df = 2.51$).

Conclusion: This cross-sectional study tested a structural model integrating acceptance-commitment and IMB frameworks. Findings highlight associations among psychological flexibility, IMB skills, reduced distress, and improved self-management. These relationships inform potential intervention targets. Longitudinal and experimental studies are required to evaluate causal effects and clinical implementation.

Key words: *Acceptance; Diabetes; Glycated Hemoglobin; Information Motivation Behavioral Skills Model; Self-Management*

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Diabetes is a major global health challenge with significant physical, psychological, and social consequences (1). According to the latest estimates, approximately 589 million adults (20–79 years of age) worldwide will have diabetes in 2024, representing 11.1% of the global adult population in this age group (2). The rapid increase in diabetes cases, largely driven by urbanization and unhealthy lifestyles, has complicated the management of the disease (3, 4). Effective control, primarily through glycemic regulation, depends on a complex interaction of individual, environmental, cognitive, and emotional factors (5, 6). Self-management is a cornerstone of diabetes care, linked to adherence to treatment, lifestyle changes, and glycemic control. Research highlights its critical role, and studies show that adherence and lifestyle factors contribute significantly to successful management (7). However, effective self-management requires acceptance of the illness, emotional regulation, and psychological flexibility, and informational-motivational-behavioral skills (8, 9).

Theoretically, acceptance and commitment processes are based on functional contextualism and Relational Frame Theory, which posit that behavior arises from contextual control and learned relational networks among stimuli, thoughts, and emotions, and that change occurs by altering the context of thoughts rather than their content (10). In the context of diabetes, acceptance and commitment processes promote acceptance of illness-related negative emotions (rather than avoidance of them), increase psychological flexibility, reduce distress, and are associated with health behaviors such as self-management, treatment adherence, and glycemic control (11, 12). Complementarily, the Information-Motivation-Behavioral Skills (IMB) model emphasizes that complex health behaviors like self-management and adherence require adequate information, motivation, behavioral skills, and self-efficacy (13).

In recent years, several randomized controlled trials (RCTs) and meta-analyses have demonstrated the effectiveness of both IMB skills and acceptance and commitment processes in improving self-management and reducing distress in individuals with diabetes (12, 14). IMB interventions have been shown to enhance self-regulation, adherence to treatment, and overall diabetes management through the provision of knowledge, motivation, and behavioral skills (13). Similarly, ACT has been found to improve psychological flexibility, helping individuals to accept distressing emotions and commit to behaviors aligned with their values, even in the presence of diabetes-related challenges (12). The integration of IMB and ACT may offer a synergistic approach by combining the strengths of both frameworks. The theoretical rationale for combining these approaches lies in their complementary nature. IMB equips individuals with the necessary tools to manage their condition effectively, while ACT enhances emotional regulation and psychological flexibility, thus fostering sustainable behavioral change (11, 15). The key mechanism of synergy lies in how ACT's focus on emotional acceptance and mindfulness could reinforce the behavioral skills emphasized in the IMB model, thereby leading to improved self-management and reduced distress. This integrated approach has the potential to optimize self-management behaviors and reduce Glycated hemoglobin (HbA1c) levels, presenting a holistic solution to diabetes care.

Diabetes distress (DD)-a common emotional response to the burdens of living with diabetes-significantly disrupts psychosocial adaptation, negatively affecting motivation, self-efficacy, and self-confidence. These emotional barriers impair patients' perceived capabilities and hinder self-management behaviors and treatment adherence, ultimately contributing to elevated HbA1c levels and poorer health outcomes (16-19). Given its detrimental impact, identifying factors that mitigate DD is critical for improving glycemic control and overall well-being. Recent evidence positions DD as a key mediator in the relationship between educational-behavioral interventions such as IMB skills and acceptance-commitment processes with subsequent improvements in self-management and adherence (12, 14, 20). Interventions that enhance these psychological skills have been shown to reduce DD, thereby facilitating better self-care and glycemic outcomes. Thus, addressing both emotional and cognitive dimensions of diabetes care is essential. Understanding DD's mediating role offers a pathway for developing targeted interventions to optimize clinical outcomes in type 2 diabetes (20).

This study aims to explore the structural impact of informational, motivational, and behavioral skills, along with acceptance-commitment strategies, on self-management, treatment adherence, and HbA1c levels in diabetes, with DD serving as a mediating factor. It proposes an integrated acceptance-commitment-IMB model incorporating cognitive, emotional, and behavioral dimensions in diabetic patients, exploring how these factors predict adherence and self-management and untimatly glycemic control (HbA1c). Prior studies have primarily examined acceptance and commitment and the IMB model separately and have originated from Western contexts, overlooking cultural and social factors relevant to Asian populations like Iran. These gaps are clinically significant, as chronic diabetes underscores the need for comprehensive models that simultaneously address contextual, cognitive, emotional, and behavioral dimensions to optimize long-term self-management and adherence outcomes.

Moreover, given the growing prevalence of diabetes and its associated psychological burden, understanding how these skills are associated with clinical outcomes is crucial. DD often hinders effective diabetes management, leading to poor health outcomes. By

examining the mediating role of DD, this research will provide valuable insights into how integrated acceptance-commitment and IMB skills are associated with self-care behaviors, treatment adherence, and ultimately glycemic control. The hypotheses were: (A) Acceptance and commitment are associated with IMB skills, self-management, adherence and decreased distress, (B) IMB skills are associated with self-management and adherence through reduced distress, and (C) Distress mediates the relationships between acceptance and commitment/IMB skills and self-management, adherence, and HbA1c levels.

Materials and Methods

Participants

This study has a cross-sectional descriptive-correlational design and uses structural equation modeling (SEM) to examine the relationships between variables. The study population included all individuals aged 20 to 90 years with type 2 diabetes who visited health centers in Jiroft, Iran, in November and December 2024. Wolf *et al.* (21) and Priyanath *et al.* (22) recommend at least 100 to 200 participants or a ratio of 10 to 20 participants per estimated parameter for SEM analysis. The initial sample size was calculated as 310 based on power analysis assuming 12 parameters, but was increased to 321 participants selected through convenience sampling to ensure a sufficient sample size. Inclusion criteria included a confirmed diagnosis of type 2 diabetes with an active medical record, HbA1c levels > 6% (normal range < 5.7%), at least one year since diagnosis, according to medical records and laboratory results and reading and writing literacy for study participation. Exclusion criteria included chronic conditions unrelated to diabetes (except diabetes-related complications such as nephropathy, neuropathy, retinopathy, or cardiovascular issues confirmed by a physician), severe psychiatric disorders (e.g., schizophrenia or major cognitive deficits), and failure to complete the instruments. Inclusion and exclusion criteria were assessed via medical records, patient/caregiver reports, and clinical evaluations, consistent with routine outpatient screening. Although structured interviews (e.g., MINI, SCID) were not feasible for exclusion of severe psychiatric disorders due to time and resource constraints, this pragmatic approach minimized participant burden while ensuring clinically meaningful exclusions.

Measures

Diabetes Self-Management Questionnaire-Revised (DSMQ-R)

This questionnaire was developed by Schmitt *et al.* (23) as an update to the 2013 DSMQ. This 27-item tool assesses self-management across five subscales: dietary control, glucose monitoring, medication adherence, physical activity, and healthcare collaboration. It uses a 4-point Likert scale (0–3), with higher scores indicating better self-management. The DSMQ-R showed excellent internal consistency (Cronbach's $\alpha = 0.92$) and strong test-retest reliability in this study, with established validity through correlations with glycemic outcomes. The psychometric properties of the Persian version of this questionnaire were also examined in 2021 by Hosseinzadegan *et al.* (24) and the results indicated satisfactory internal consistency (Cronbach's alpha = 0.88) and high content validity (CVI = 0.9).

Informational-motivational-behavioral skills-based Diabetic Self-Management Scale (IMB-based DSMS)

The Diabetic Self-Management Scale based on Information, Motivation, and Behavioral Skills (IMB-based DSMS), developed by Dai *et al.* (25), is a 22-item instrument that consists of three subscales: information, motivation, and behavioral skills. The information and behavioral skills subscales use a dichotomous (yes/no) response format, while the motivation subscale employs a 5-point Likert scale (1 to 5). Higher scores indicate greater diabetes self-management ability. The DSMS was translated into Persian using the standard forward-backward method and culturally adapted. Face validity of this scale was confirmed by five experts in psychometry and health psychology. Additionally, to ensure comprehensibility and cultural appropriateness, the questionnaire was pilot-tested on 30 Iranian patients with type 2 diabetes. In the current study, the DSMS demonstrated acceptable internal consistency (Cronbach's alpha = 0.70).

Diabetes Distress Scale (DDS-17)

The DDS-17 was developed by Fisher *et al.* (26). This 17-item scale measures emotional distress related to diabetes (e.g., emotional burden, regimen distress) on a 6-point Likert scale (1–6). Scores range from 17 to 102, with averages < 3 indicating low distress and ≥ 3 moderate-to-high distress. It demonstrated high reliability (Cronbach's $\alpha = 0.90$) in this study. The Persian version of this scale was also examined in 2021 by Niroomand *et al.* (27) and the results indicated excellent internal consistency (Cronbach's alpha = 0.924) and strong convergent validity with depression (BDI-II), glycemic control (HbA1c), diabetes complications, and self-care behaviors (measured by SDSCA).

Diabetes Acceptance and Action Scale-Revised (DAAS-R)

The DAAS-R was developed by Gillanders and Barker (28,29). This 9-item scale assesses acceptance and psychological flexibility using a 5-point Likert scale (0–4). Higher scores indicate greater acceptance. In the current study, to ensure comprehensibility and cultural appropriateness, the DAAS-R administered to Iranian patients with type 2 diabetes demonstrated very high internal consistency (Cronbach's $\alpha = 0.95$). Rajaeiramsheh *et al.* (30), in study of the original 42-item DAAS in 2021, demonstrated satisfactory internal consistency (overall Cronbach's alpha = 0.87), strong test-retest reliability (ICC = 0.93), good construct

validity (confirmation of the three-factor model via confirmatory and exploratory factor analysis), and good content validity (appropriate correlations with related measures such as CAMM, ERQ-CA, and AFQ-Y8).

Diabetes Mellitus Treatment Adherence Scale (DMTAS)

This scale was developed by Hou *et al.* (31) for type 2 diabetes. This 19-item scale evaluates adherence across six subscales (e.g., medication, diet, physical activity) on a 4-point Likert scale (0–3). Scores range from 0 to 57, with higher scores indicating better adherence. The psychometric properties of the Persian version of the DMTAS were previously evaluated in another study (32) involving 473 Iranian patients with diabetes, demonstrating satisfactory internal consistency (Cronbach's alpha = 0.88) and good construct validity, as confirmed by confirmatory factor analysis (CFI = 0.99, RMSEA = 0.077, χ^2/df = 3.63). In the current study, the scale also exhibited high reliability (Cronbach's alpha = 0.95).

Procedure

Data were collected over one month by trained health center staff. Questionnaires were read aloud and completed in the presence of an evaluator to ensure comprehension, particularly for participants with lower literacy, though this may have introduced response bias. Participants were selected based on recent medical records and examination results, verified by staff. The research instruments were completed individually and on a case-by-case basis by the participants.

Data Analysis

Data were analyzed descriptively (means, standard deviations, and bivariate correlations) using SPSS-23. Statistical assumptions (normality, linearity, and multicollinearity) were examined and confirmed before inferential analyses. At the inferential level, structural equation modeling (SEM) was performed using LISREL 8.8 to test and estimate direct and indirect effects. Following the recommendations of Tabachnick and Fidell (33), the model parameters were estimated using the Maximum Likelihood (ML) method. Direct effects were considered significant based on t-values ($|t| > 1.96$, $P < 0.05$). For indirect effects, bootstrapping with 95% bias-corrected confidence intervals (default in LISREL 8.8) was applied; indirect effects were significant if zero was excluded from the bootstrap confidence interval and $P < 0.05$.

Ethical Considerations

This study was conducted by obtaining written informed consent, adhering to ethical guidelines, protecting the rights of participants, ensuring confidentiality and voluntary participation, allowing participants to withdraw from the study upon request, and providing access to the results. This study was also approved by Semnan University of Medical Sciences (Ethics code: IR.SEMUMS.REC.1403.193).

Results

The study sample consisted of 321 patients with type 2 diabetes. The mean age of participants was 51.3 ± 13.2 years. Women comprised 63.9% of the sample (n = 205), while 36.1% were men (n = 116). Most participants were married (88.5%, n = 284). More than half were unemployed (55.5%, n = 178), and 47.0% (n = 151) had less than a high school education. Regarding socioeconomic indicators, 52.6% (n = 169) reported a moderate socioeconomic status, and 49.8% (n = 160) reported moderate social support. In terms of medical history, 65.7% of participants (n = 211) reported no comorbid medical conditions other than diabetes, and 71.7% (n = 230) reported no diabetes-related complications. HbA1c levels ranged from 6 to 11. Only one participant (0.3%) achieved optimal glycemic control (HbA1c < 6), whereas 91.9% (n = 295) demonstrated moderate control (HbA1c = 6–9), and 7.5% (n = 25) showed poor control (HbA1c > 9). Descriptive statistics (means ± SD and Pearson correlation coefficients) among the study variables are presented in Table 1.

Table 1. Mean ± SD and Correlation Matrix of Acceptance and Commitment, IMB Skills, Self-Management, Treatment Adherence and Diabetes Distress (N = 321)

Variable	Mean ± SD	Correlation Coefficient				
		1	2	3	4	5
1. Acceptance and commitment	21.57 ± 9.02	1.00				
2. IMB skills	40.74 ± 5.46	0.41**	1.00			
3. Self- management	45.59 ± 11.93	0.56**	0.67**	1.00		
4. Treatment adherence	30.80 ± 12.80	0.67**	0.60**	0.65**	1.00	
5. Diabetes distress	36.35 ± 15.49	-0.32**	-0.56**	-0.28**	-0.38**	1.00

Diabetes distress was significantly and negatively correlated with acceptance and commitment ($r = -0.32$, $P < 0.01$), IMB skills ($r = -0.56$, $P < 0.01$), self-management ($r = -0.28$, $P < 0.01$), and treatment adherence ($r = -0.38$, $P < 0.01$). Acceptance and commitment were positively correlated with IMB skills ($r = 0.41$, $P < 0.01$), self-management ($r = 0.56$, $P < 0.01$), and treatment adherence ($r = 0.67$, $P < 0.01$). IMB skills demonstrated strong positive associations with both self-management ($r = 0.67$, $P < 0.01$) and adherence

(r = 0.60, P < 0.01). In addition, self-management and adherence were strongly correlated (r = 0.65, P < 0.01).
Prior to hypothesis testing, the dataset was rigorously screened for compliance with key statistical assumptions underlying SEM. No missing data were identified. Univariate normality was confirmed, with skewness and kurtosis values for all observed variables falling within the acceptable range of –1 to +1. Multivariate normality was supported by Mardia's coefficient of multivariate skewness (4.32; critical ratio = 2.99), which remained below the recommended threshold of 5. Mahalanobis distance calculations revealed no multivariate outliers (all p > 0.05). Multicollinearity was not a concern, as bivariate correlations among latent constructs ranged from r = 0.28 to 0.67, all below the problematic threshold of 0.85. The sample size (N = 321) exceeded the minimum recommended requirement for SEM based on an anticipated medium effect size (power > 0.80, α = 0.05), yielding an acceptable cases-to-parameters ratio. Measurement model adequacy was established through confirmatory factor analysis, with all standardized factor loadings exceeding 0.50 (range: 0.61–0.89, P < 0.001) and standard errors ranging from 0.03 to 0.11, indicating precise estimation. Modification indices were all below 5.00, supporting model specification without substantial cross-loadings or correlated error residuals. Collectively, these diagnostics confirmed that all a priori statistical assumptions were satisfied, justifying the application of maximum likelihood estimation in SEM. Structural equation modeling (SEM) was used to test hypothesized relationships among acceptance and commitment processes, IMB skills, diabetes distress, self-management, treatment adherence, and glycemic control. To improve model fit, items with factor loadings below 0.40 were removed from the self-management construct (items 5, 7, 10, 11, 12, 13, 15, 18, and 20). In addition, the information component of the IMB model was excluded due to high covariance with the motivational and behavioral skills components. The final standardized model is shown in Figure 1.

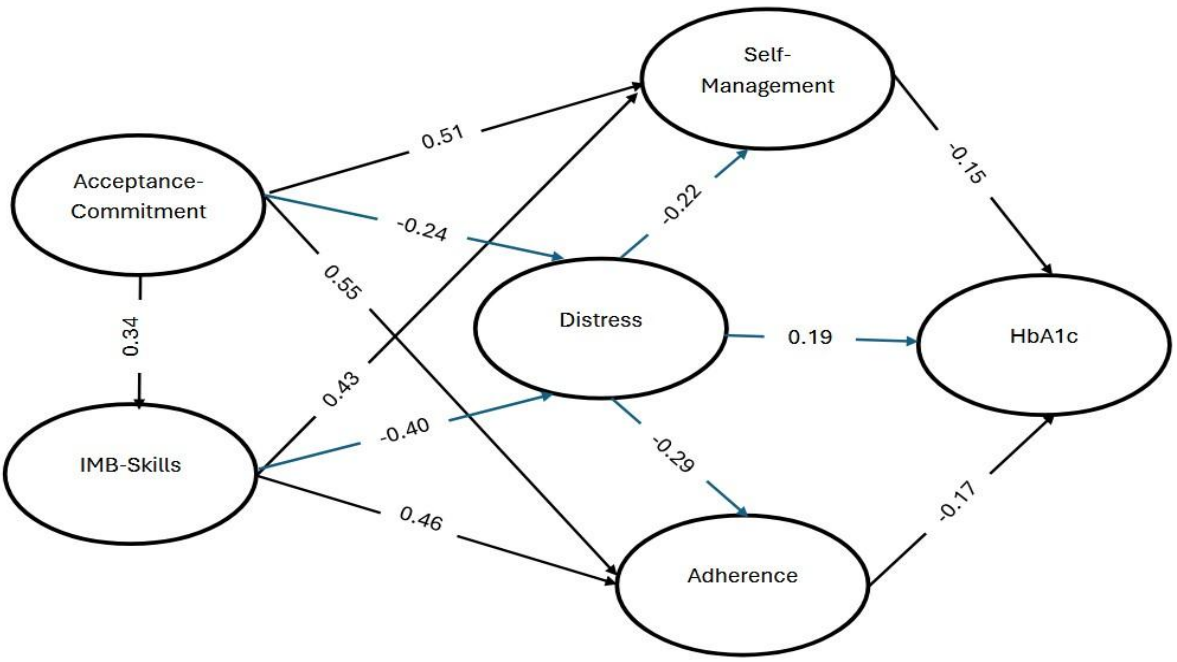

Figure 1. Final Structural Effect of Informational-Motivational-Behavioral Skills and Acceptance-Commitment in Self-Management, Adherence, And Hba1c in Diabetes with Mediating Role of Distress

The model demonstrated good fit to the data (χ^2/df = 2.51, RMSEA = 0.046, CFI = 0.98, IFI = 0.99, NFI = 0.98, GFI = 0.98, AGFI = 0.97; Table 2). Standardized factor loadings for all indicators in the measurement model, all of which were statistically significant (P < 0.001) and exceeded the acceptable threshold of 0.50, ranging from 0.61 to 0.89, indicating satisfactory convergent validity. Standard errors for all parameter estimates, which ranged from 0.03 to 0.11, suggesting adequate precision and no evidence of model misspecification or estimation instability. Modification indices, all of which were below the critical value of 5.00, indicated no substantial cross-loadings or correlated error terms requiring model re-specification. These additional diagnostics confirm that the measurement model is well-specified and that the reported fit indices are both statistically robust and theoretically plausible.

Table 2. Fit Indices for Structural Effects of IMB Skills and Acceptance-Commitment on Diabetes Outcomes with Mediating Role of Distress

Indices	Chi-square/df	RMSEA	CFI	IFI	NFI	GFI	AGFI
Obtained Values	2.51	0.046	0.98	0.99	0.98	0.98	0.97
Acceptable values	< 5	< 0.8	> 0.9	> 0.9	> 0.9	> 0.9	> 0.8

Path analysis indicated that acceptance and commitment processes were positively associated with IMB skills (β = 0.34, P < 0.001), self-management (β = 0.51, P < 0.001), and treatment adherence (β = 0.55, P < 0.001), and negatively associated with diabetes distress (β = −0.24, P < 0.001). IMB skills were positively associated with self-management (β = 0.43, P < 0.001) and treatment adherence (β = 0.46, P < 0.001), and negatively associated with diabetes distress (β = −0.40, P < 0.001). Diabetes distress showed negative associations with self-management (β = −0.22, P < 0.001) and adherence to treatment (β = −0.29, P < 0.001), and a positive association with HbA1c (β = 0.19, P < 0.01). Self-management (β = −0.15, P < 0.01) and treatment adherence (β = −0.17, P < 0.01) were negatively associated with HbA1c.

Indirect effects were examined using bootstrap analysis with bias-corrected confidence intervals. As shown in Table 3, all hypothesized indirect paths were statistically significant, with zero excluded from the 95% confidence intervals (P < 0.05). Acceptance and commitment processes had a significant positive indirect association with self-management (β = 0.07, 95% BC CI [0.04, 0.10]) and treatment adherence (β = 0.14, 95% BC CI [0.10, 0.18]) via diabetes distress. Moreover, acceptance and commitment processes showed a significant negative indirect association with diabetes distress through IMB skills (β = −0.05, 95% BC CI [−0.09, −0.03]). IMB skills also demonstrated significant positive indirect associations with self-management (β = 0.10, 95% BC CI [0.06, 0.13]) and adherence (β = 0.12, 95% BC CI [0.08, 0.17]) through diabetes distress.

Table 3. Bootstrap for Indirect Structural Effects of IMB Skills and Acceptance-Commitment on Diabetes Outcomes with Mediating Role of Distress

Path	Bootstrap			
	β (standardized Indirect Effects)	95% CI (Lower Limit)	95% CI (Upper Limit)	p-value
Acceptance and Commitment → Self-Management via Distress	0.07	0.04	0.10	0.012
Acceptance and Commitment → Adherence via Distress	0.14	0.10	0.18	0.004
Acceptance and Commitment → Distress via IMB Skills	-0.05	-0.09	-0.03	0.004
IMB Skills → Self-management via Distress	0.10	0.06	0.13	0.008
IMB Skills → Adherence via Distress	0.12	0.08	0.17	0.011

Discussion

The study findings align with the theoretical underpinnings of acceptance and commitment processes (10,12, 34), which posit that increasing psychological flexibility is central to managing chronic illness, including diabetes. Acceptance and commitment processes, as conceptualized by Hayes *et al.* (10), cultivate psychological flexibility by promoting acceptance of disease-related negative affective states, thereby enabling individuals with type 2 diabetes to pursue value-congruent actions despite persistent emotional distress. Bistara *et al.* (9) identified mindfulness and cognitive defusion as principal mechanisms through which these processes attenuate diabetes distress, permitting patients to observe cognitions and emotions without experiencing overwhelm. Sakamoto *et al.* (12) and Ngan *et al.* (34) have substantiated the utility of acceptance and commitment processes in enhancing psychological and behavioral outcomes in diabetes care. However, Ngan *et al.* (34) further observed that cumulative physiological burden compromises psychological flexibility, thereby impairing adaptive coping capacity. Critically, Hajati *et al.* (35) reported that emotion regulation interventions surpassed acceptance and commitment therapy alone in reducing HbA1c and improving self-care, suggesting that although acceptance and commitment processes enhance psychological flexibility and mitigate distress, their translational impact on glycemic outcomes may be contingent upon the availability of complementary behavioral frameworks.

Within this conceptual gap, the IMB model assumes a complementary translational function. Consistent with prior investigations (6,14, 36, 37), it demonstrates significant associations with reduced diabetes distress, enhanced self-management, and improved adherence. Kurtanty *et al.* (6) observed that IMB augments self-efficacy through information, motivational reinforcement, and behavioral skill acquisition. Kılınç İşleyen and Kartal (36) reported positive links between IMB skills and dietary adherence and medication compliance. Chen *et al.* (37) found IMB skills enhanced

health beliefs and self-efficacy but not HbA1c-a pattern replicated herein, with distress mediating IMB skills and self-management. Subramaniam *et al.* (38) similarly reported no direct IMB effects on clinical endpoints, reinforcing that behavioral change constitutes the IMB model's principal contribution. Crucially, convergent evidence indicates that IMB skills exert optimal influence only when individuals possess sufficient psychological flexibility and emotional acceptance. Acceptance and commitment processes operate proximally, restructuring relationships with aversive internal experiences to buffer emotional barriers. This infrastructure-reduced experiential avoidance and enhanced values clarity-creates receptive conditions for IMB skills to translate psychological readiness into actionable self-care behaviors, including medication adherence, dietary regulation, and glycemic monitoring.

This study's core contribution lies in specifying how acceptance and commitment processes and the IMB model interact synergistically within an integrated framework. Rather than operating as parallel pathways, the relationship is sequential and hierarchical: psychological flexibility and emotional acceptance—cultivated through acceptance and commitment processes—constitute necessary preconditions that potentiate IMB skills, which subsequently translate acceptance into behavioral execution. This configuration resolves discrepant findings reported by Hajati *et al.* (35). In fact, isolated acceptance-based interventions enhance distress tolerance but lack glycemic impact without behavioral scaffolding, while IMB interventions alone yield attenuated effects when psychological inflexibility predominates. By positioning distress reduction as a shared transdiagnostic target addressed through complementary mechanisms at distinct behavioral change levels, the integrated model achieves unique explanatory parsimony.

This study identifies diabetes-related distress as the central integrative mechanism linking both theoretical frameworks to self-management, adherence, and glycemic control (19,34). Consistent with prior research, distress actively shapes self-care behaviors rather than merely accompanying emotional responses to diabetes. IMB skills attenuate distress through enhanced self-efficacy, motivation, and accurate information, while acceptance and commitment processes address distress more directly by restructuring cognitive fusion and facilitating non-judgmental acceptance of aversive states. By targeting distress reduction through distinct yet complementary pathways, the integrated model achieves superior parsimony and explanatory power. Nonetheless, consonant with Subramaniam *et al.* (38), psychological mechanisms alone are insufficient; multifaceted interventions integrating behavioral skills training, psychological support, and medical follow-up remain essential for optimal clinical outcomes, as emphasized by Scarton *et al*. (39) and Elayyan *et al.* (40).

Although statistically significant pathways from diabetes distress, self-management, and treatment adherence to HbA1c were observed, the modest coefficient magnitudes indicate limited direct clinical impact. Campbell *et al.* (41) noted that non-glycemic factors—including complications, renal or hepatic pathology, and hemoglobinopathies—may influence HbA1c independently of true glycemic status. Thus, the integrated model's principal value lies not in immediate HbA1c reduction but in enhancing psychological well-being and fostering sustained behavioral engagement. Riangkam *et al.* (42) demonstrated that sustained self-management reduced HbA1c from 7.8% to 7.17%, underscoring the importance of consistent adherence. Polonsky *et al.* (43) affirmed treatment adherence's significant association with glycemic control. These indirect, cumulative mechanisms constitute the model's authentic clinical contribution.

Within the Iranian sociocultural context, familism reinforces IMB motivational pathways through collective family involvement in diabetes management, yet may concurrently constrain individual autonomy in health-related decision-making processes. Stigma surrounding chronic illness impedes emotional disclosure and psychological acceptance, particularly among male patients, thereby moderating the effectiveness of acceptance and commitment processes. Gender norms further circumscribe women's self-care behaviors, with domestic role expectations constraining health prioritization. By explicitly articulating how these cultural dynamics condition the observed sequential relationships, the model achieves enhanced ecological validity and translational relevance for Iranian and culturally contiguous Middle Eastern populations.

Limitation

This study has several limitations. First, data were collected from a single geographic region (Jiroft city) using convenience sampling, limiting generalizability to populations with differing cultural characteristics. Second, the absence of short, culturally validated instruments for Iranian populations may have compromised measurement accuracy. Third, budget constraints necessitated reliance on previously recorded HbA1c values rather than new laboratory assessments, potentially reducing glycemic control precision. Fourth, the cross-sectional design precludes causal inference; given HbA1c's dynamic nature, longitudinal designs are warranted. Fifth, potential confounders were not fully addressed, and covariates were not simultaneously modeled within the structural equation framework, introducing residual confounding risk. Future research should employ random sampling across diverse regions, allocate resources for comprehensive concurrent data collection, and develop culturally relevant validated instruments. Examining moderating effects of illness severity and cultural context may further enhance interpretability. Lastly, standardized diagnostic

instruments (e.g., MINI, SCID) should be utilized to improve diagnostic precision and minimize bias in exclusion criteria application.

Conclusion

This study provides novel evidence integrating acceptance and commitment processes with the IMB model in Iranian adults with type 2 diabetes, offering three key contributions. First, it identifies diabetes distress as a transdiagnostic mediator linking psychological flexibility and behavioral skills to self-management and adherence. Second, while pathways to HbA1c were significant, modest effect sizes suggest that the model's primary value lies in improving psychological well-being and sustained behavioral engagement-supporting glycemic control through indirect, cumulative mechanisms. Third, it articulates culturally specific mechanisms: familial cohesion reinforcing IMB skills, stigma impeding acceptance, and gender norms constraining self-care. These contextual dynamics enhance ecological validity for Middle Eastern populations. These insights support a paradigm shift from generic, skill-based interventions toward integrative, culturally grounded approaches that jointly target emotional and cognitive determinants of self-care. Future longitudinal and experimental studies are needed to establish causal effects on glycemic outcomes.

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Conflict of Interest

None.

Author's Contributions

Zahra Heidari Archandani and Isaac Rahimian-Boogar conceptualized the study and developed the methodology. Zahra Heidari Archandani collected the data, and both authors performed the formal analysis. Isaac Rahimian-Boogar provided supervision and project administration. The original draft was written by Zahra Heidari Archandani and Isaac Rahimian-Boogar, and both authors reviewed, edited and approved the manuscript.

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