The Effect of Depression on Poor Glycemic Control in Adults with Type 2 Diabetes: The Mediating Roles of Self-Efficacy and Self-Management Behaviors

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Keywords
Type 2 diabetes · Depression · Self-management · Self-efficacy · Hemoglobin A1c · Mediation

Abstract
Background: High levels of depression and poor self-efficacy and self-management are associated with worse glycemic control, but the linkage and pathway between these variables are poorly understood. We conducted this study to investigate the hypothesis that self-efficacy and self-management mediate the influence of depression on poor glycemic control. Methods: We studied a purposive sample of 142 adults with type 2 diabetes attending a public clinic in Ilam, Iran. Hierarchical linear regression analysis and structural equation modeling were used to explore the relationships among the variables of interest. Result: Depression directly and negatively affects self-efficacy and indirectly affects self-management behaviors, which in turn have direct effects on hemoglobin A1c (HbA1c). Self-efficacy mediates the relationship between depression and self-management behaviors. Self-efficacy and self-management behaviors partially mediate the effect of depression on HbA1c. These results confirmed that the data fit the hypothesized model very well. Conclusion: Careful monitoring of glycemic control might be important in those individuals who exhibit clinical signs of depression. Effective treatment programs should probably pay close attention to not only screening and treatment of depression but also skills training to enhance patient self-efficacy and self-management of diabetes to improve HbA1c.

Introduction
Type 2 diabetes mellitus (T2DM) is one of the most common endocrine disorders, which affects almost 6% of the adult population worldwide [1]. According to recent estimates, the total number of patients living with diabetes expected to rise significantly from 176 million in 2000 to 370 million in 2030, with more than four-fifths of them living in developing countries [2]. Diabetes is a costly dis-

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ease to manage because of the chronic nature and its complications [3]. In 2013, the global healthcare expenditure for managing diabetes and its complications was estimated to total at least USD 548 billion. This number is projected to exceed USD 627 billion by the year 2035 [4].

Glycemic control is considered as the main therapeutic goal for management of diabetes [5]. The standard measurement of glycemic control is glycated hemoglobin A1c (HbA1c), which provides an accurate measure of average glycemic control over the past 12 weeks [6]. HbA1c values <7% considered indicator of good glycemic control; otherwise the patient’s diabetes is not well controlled. Optimizing glycemic control significantly reduces the risk of both micro- and macrovascular complications [7]. Suboptimal glycemic control is a major concern for the patient with diabetes, regardless of the wide range of drugs available to reach glycemic targets [8]. Previous studies have indicated that longer duration of diabetes [9], lower education level [10], younger age [10], and emotional distress such as anxiety and depression [10, 11] are the main risk factors for poor glycemic control.

In the past decades, several studies have shown that depression is common among patients with T2DM, affecting 30% of cases. Depressed patients with T2DM are at an increased risk for cardiovascular morbidity and mortality [12]. The underlying biological mechanisms linking depression to adverse health outcomes have not been completely clarified. One plausible contributing mechanism is the tendency of those with depressive syndromes to experience suboptimal glycemic control [13], which might be due to less adherence to self-care behaviors [14]. Patients with T2DM who have depression are more likely to have distributed eating behaviors, less treatment-related adherence, and lower levels of physical activities [12, 13]. Up to now, there is limited and somehow controversial information regarding the impact of depression on glycemic control.

There are undoubtedly multiple pathways connecting depression and poor glycemic control. It is likely that physiologic and behavioral factors influence the effects of depression on poor glycemic control [15]. Possible factors that may partially explain the relationship between depression and poor glycemic control are patients’ self-efficacy and self-management behaviors [16]. Self-efficacy is defined as “the belief that one can successfully execute the behavior required to produce a given outcome” [17]. Low levels of self-efficacy have been associated with poor glycemic control as well as increased depressive symptoms [18]. There is an indication that self-efficacy mediates the effect of depression on glycemic control in patients with T2DM [18]. However, the effects were not completely overlaid. Some studies also suggest that self-efficacy mediates the association between depression and self-management behaviors [19]. In addition to the abovementioned connections, self-efficacy has been found to be the strongest predictor of self-management and HbA1c [20]. Although the mediating role of self-efficacy on the association between self-management and HbA1c has not been explored so far, Sousa et al. [21] have reported that greater self-efficacy leads to greater self-management which, in turn, leads to better glycemic control.

In recent years, several studies have addressed the possible relationships among depression, self-efficacy, self-management, and HbA1c. To the best of our knowledge, no studies have addressed the relationships between these factors in the same study. As a result, we were interested to examine the following hypothesis:

1. Self-efficacy mediates the association between depression and poor levels of HbA1c.
2. Self-management behaviors mediate the association between depression and poor levels of HbA1c.
3. Self-management behaviors mediate the association between self-efficacy and poor levels of HbA1c.
4. Self-efficacy mediates the association between depression and self-management behaviors.
5. Self-efficacy and self-management behaviors mediate the association between depression and poor levels of HbA1c.

**Methods**

**Study Design and Setting**

We conducted a cross-sectional design using baseline data from adult patients with T2DM enrolled in a randomized controlled trial (registration number: IRCT2016062528627N1) of a nurse-led diabetes self-management program. A detailed description of the study design and methods can be found elsewhere [22, 23]. This study was conducted at the endocrinology clinic in a single primary and secondary hospital between September and October 2016. This hospital is a teaching hospital affiliated to Ilam University of Medical Sciences. This hospital is one of the biggest and busiest hospitals in Ilam city that is dedicated to the treatment of patients with T2DM.

**Study Population and Selection Criteria**

Inclusion criteria were patients (1) who were Iranian adults aged ≥18 years, (2) with a confirmed diagnosis of T2DM at least 6 months, (3) who were independent in terms of their activities of daily living, and (4) with baseline HbA1c levels ≥8% were invited to participate. Exclusion criteria were patients (1) who were illiterate, (2) had an acute medical or surgical condition, (3) with uncontrolled hypertension (≥140 mm Hg), (4) cognitive impairment, and (5) diabetes-related complications. Patients with medical con-
conveys a better understanding of the diabetes control and denotes were categorized into 4 groups according to their HbA1c values. It blood sample was taken for assessing HbA1c values. The patients participants underwent fasting venous blood sampling. A 5 mL of from each patient after a detailed description of the study was pro-
ted. Prior to the enrolment, we obtained a written informed consent validated Instrumental Activity of Daily Living [25]. Eligible par-
ticipants were recruited using the purposive sampling technique. Prior to the enrolment, we obtained a written informed consent from each patient after a detailed description of the study was pro-
vided.

Study Outcomes
Hemoglobin A1c
The primary outcome of interest was HbA1c. HbA1c was mea-
sured using the NycoCard analyzer (made in the US). All enrolled participants underwent fasting venous blood sampling. A 5 mL of blood sample was taken for assessing HbA1c values. The patients were categorized into 4 groups according to their HbA1c values. It conveys a better understanding of the diabetes control and denotes very good (<7%), good (7–7.9%), suboptimal (8–8.9%), and very poor (≥9%) glycemic control. Patients with very good and good glycemic control were excluded from further analysis. The value of HbA1c ≥8% was chosen to make sure that only diabetic patients with poor glycemic control would be included in the present study. The previous study confirmed that patients with a history of diag-
osed depression had higher HbA1c values than patients without depression [26].

Depression
The Centre for Epidemiology Studies Short Depression Scale (CES-D) was used to measure the depression [27]. The CES-D is a brief self-administered questionnaire (10 items) designed to mea-
sure the depressive symptoms over the past weeks. The total score ranged from 0 to 30 points, with the higher score demonstrating severe depression. The CES-D has previously been validated for use in an Iranian adult population (α = 0.93) [28].

Self-Efficacy
The Diabetes Management Self-efficacy Scale (DMSES) was used to measure the self-efficacy [29]. The DMSES is a 20-item validated self-administered instrument design to assess the extent to which participants are confident that they can manage their blood glucose, physical activity, diet, medications, and feet care. The total score ranged from 0 to 200, with the higher score indicating greater self-efficacy. The DMSES is a commonly used instrument for self-efficacy measurement, which has been validated for use in the Iranian population [30].

Self-Management Behaviors
The Diabetes Self-Management Questionnaire (DSMQ) was used to measure the self-management behaviors [31]. The DSMQ is a 16-item self-administered tool designed to assess self-care ac-


ditions that may confound HbA1c measurement such as anemia and hemoglobinopathy were also excluded. A sample size of 142 poor glycemic control adults with T2DM was therefore obtained.

Recruitment
All patients with T2DM were invited to participate in the pres-
ent study through advertisements. Notices with information about the study were placed on the notice board of the involved hospital. Two weeks later, the medical records of all interested participants were screened for eligibility. The screening process involved (1) review of patients’ medical history via an existing database, (2) measurement of baseline HbA1c levels, (3) cognitive function assessment using the validated modified Mini-Mental State Examination [24], and (4) assessment of activity of daily living using the validated Instrumental Activity of Daily Living [25]. Eligible par-
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The study was reviewed and approved by the University Putra Malaysia Ethics Committee for research involving human sub-
jects, Malaysia, as well as the Ethics Committee of the Ilam Uni-
versity of Medical Sciences, Iran. Permission to reuse the instru-
ments, as well as the director of the selected hospital, was ob-
tained. After a complete description of the study was provided to the potential participants, all patients gave written informed con-
sent prior to their inclusion in this study. The data were collected without personal identifiers to guarantee appropriate confiden-
tiality.

Data Analysis
Statistical analysis was performed using IBM SPSS software (version 23). Continuous variables were presented as mean ± (SD) and categorical variables presented as absolute and relative fre-
quencies. Prior to conducting the main analysis, the data were ex-
amined for accuracy, missing values, and distributional properties. Normality of the data was assessed using the Shapiro-Wilk test, finding no reason to dismiss the hypothesis that the variables have a normal distribution. The correlation coefficients were calculated to examine the extent of the associations between different param-
eters.

Hierarchical regression analysis was used to explore the me-
diating effects of self-efficacy in the association between depres-
sion and poor glycemic control. Baron and Kenny’s steps were used to test the mediating role of self-efficacy. Regression analy-

sis does not verify the goodness-of-fit between the model and the sample data. In order to further confirm our hypothesized me-
diation, structural equation modeling (SEM) was performed using the AMOS 23 software package for Windows (SPSS, Chica-
go, IL, USA).

To assess the overall model goodness of fit to the data, the chi-square test, comparative fit index (CFI), the goodness-of-fit index (GFI), the adjusted GFI (AGFI), and the root mean square error of approximation (RMSEA) were considered. Generally, the hypothesized mediation pathway is deemed to fit the data appropriately if chi-square test is small and nonsignificant (p > 0.05); CFI, GFI, AGFI > 0.9; and RMSEA < 0.08 [32]. For all the tests used, a two-sided p value < 0.05 was considered statistically significant.
Results

Characteristics of the Study Participants

A total of 348 Iranian adult patients (aged ≥ 18 years) with T2DM were approached and invited to participate in this study. Out of 348 patients, 270 patients accepted and invited to participate. Of those invited, 128 (24%) were excluded from the study due to ineligibility (n = 83), losing contact following screening (n = 26), and declining to participate (n = 19). Therefore, 142 patients participated in this study. There was no significant difference in terms of sociodemographic characteristics between included and excluded patients. Finally, 142 patients, mean age 54.2 ± 11.8 years, 8.9 ± 7.4 years of diabetes, and 93 (65.5%) female, were included for further analysis.

Poor Glycemic Control and Associated Factors

Approximately three-quarters (73.2%) of participants had HbA1c ≥ 9%. The demographic data and clinical history outcomes were compared in the subgroup of suboptimal and poor glycemic control. Our analysis suggests that older age (p = 0.03), obesity (p = 0.03), depression (p = 0.001), self-efficacy (p < 0.001), and self-management behaviors (p < 0.001) were significantly associated with the poor glycemic control.

The mean levels of depression score were 12.15 ± (4.99) out of the possible score of 30, indicating that participants had moderate levels of depression. The mean level of self-efficacy score was 98.35 ± (13.95) out of a maximum possible score of 200 (ranged from 57 to 138), indicating that participants had low levels of self-efficacy. The mean level of diabetes self-management behaviors was 3.56 ± (1.22)

| Table 1. Association between glycemic control and patients characteristics |
|---------------------------------------------------------------|
| **Total sample, mean ± SD**                                  | Glycemic control suboptimal (8–8.9%) | Poor (≥9%) | **p value** |
| Age, years<sup>a</sup>                                      | 56±11.1                             | 50.76±12.13 | 55.58±9.68 | 0.03 |
| Gender<sup>c</sup>                                          |                                     |            |            | 0.08 |
| Male                                                        | 49 (34.5)                           | 17 (44.7)  | 32 (30.8)  |       |
| Female                                                      | 93 (65.5)                           | 21 (55.3)  | 72 (69.2)  |       |
| Education<sup>b</sup>                                       |                                     |            |            | 0.14 |
| Primary                                                     | 64 (45.1)                           | 12 (31.6)  | 52 (50)    |       |
| Secondary                                                   | 23 (16.2)                           | 8 (21.1)   | 15 (14.4)  |       |
| Tertiary                                                    | 55 (38.7)                           | 18 (47.4)  | 37 (35.6)  |       |
| Working status<sup>c</sup>                                  |                                     |            |            | 0.54 |
| Yes                                                        | 83 (58.5)                           | 16 (42.1)  | 43 (41.3)  |       |
| No                                                         | 59 (41.5)                           | 22 (57.9)  | 61 (58.7)  |       |
| Current smoker<sup>b</sup>                                  |                                     |            |            | 0.62 |
| Yes                                                        | 34 (23.9)                           | 8 (21.1)   | 26 (25)    |       |
| No                                                         | 108 (76.1)                          | 30 (78.9)  | 78 (75)    |       |
| Diabetes duration<sup>a</sup>                               | 8.9±7.4                             | 7.36±7.70  | 9.49±7.24  | 0.13 |
| BMI<sup>c</sup>                                             |                                     |            |            | 0.03 |
| Normal                                                      | 3 (2.1)                             | 2 (5.3)    | 1 (1)      |       |
| Overweight                                                  | 46 (32.4)                           | 17 (44.7)  | 29 (27.9)  |       |
| Obese                                                       | 93 (65.5)                           | 19 (50)    | 74 (71.2)  |       |
| Hypertension<sup>c</sup>                                    |                                     |            |            | 0.19 |
| Presence                                                    | 92 (64.8)                           | 22 (57.9)  | 70 (67.3)  |       |
| Absence                                                     | 50 (35.2)                           | 16 (42.1)  | 34 (32.7)  |       |
| Depression<sup>a</sup>                                      | 12.15±4.99                          | 10.18±4.85 | 13.28±4.58 | 0.001|
| Self-efficacy<sup>a</sup>                                   | 98.35±13.95                         | 111.29±13.27 | 93.42±13.79 | <0.001|
| Self-management behaviors<sup>a</sup>                       | 3.56±1.22                           | 4.68±1.19  | 3.26±1.13  | <0.001|

<sup>a</sup> Independent-sample t-test.  
<sup>b</sup> χ<sup>2</sup>-test.  
<sup>c</sup> Fisher exact test.  
Values represent n (%) unless otherwise indicated. BMI, body mass index.
out of the possible score of 10, indicating that respondents had poor self-management behaviors. Patient characteristics information is presented in Table 1. For further analysis, the mean value of the HbA1c values was used.

**Mediating Role of Self-Efficacy and Self-Management Behaviors**

Analysis started with the calculation of the correlation coefficients between the mediators (self-efficacy and diabetes self-management behaviors), the independent (demographic, clinical history, and depression), and the dependent (HbA1c) variable in a correlation matrix (Table 2). As we expected, direct correlation was found between HbA1c and age ($r = 0.21, p < 0.01$), BMI ($r = 0.19, p < 0.01$), and depression ($r = 0.23, p < 0.01$), whereas an inverse correlation was evident between HbA1c and self-efficacy ($r = -0.61, p < 0.001$) and self-management behaviors ($r = -0.56, p < 0.001$). Higher HbA1c levels were correlated with older age, higher BMI, and higher levels of depression. The opposite pattern was found for self-efficacy. Correlations between variables were weak to moderate, indicating that multicollinearity is not likely to be a problem in the model. Thus, we are capable of examining (a) whether self-efficacy mediated the association between depression and HbA1c, (b) whether self-management mediated the association between depression and HbA1c, (c) whether self-management mediated the association between self-efficacy and HbA1c, (d) whether self-efficacy mediated the association between depression and self-management, and (e) whether self-efficacy and self-management behaviors mediated the association between depression and HbA1c.

In order to test the first 4 proposed mediation modes (a, b, c, and d), 4 sets of hierarchical linear regression analysis were conducted. Prior to conducting the analysis, all assumption of the linear regression analysis was checked and verified. Hierarchical linear regression analysis was performed using a stepwise (enter method) procedure. In the first step (Model 1), sociodemographic and clinical outcomes (age, gender, education, working status, smoking status, diabetes duration, BMI, and hypertension diagnosis) were included in the regression model followed by antecedent (depression; Model 2) and mediators (self-efficacy and self-management behavior; Model 3).

In Model (a), we assessed the mediating role of self-efficacy in the association between depression and HbA1c. Depression had significant effects on both self-efficacy and HbA1c when analyzed separately. Model (a) showed that controlling for the demographic and clinical outcomes, the effects of depression on HbA1c become insignificant when self-efficacy is introduced as a mediating factor. This suggests that self-efficacy fully mediated the association between depression and HbA1c (Table 3).

The second set of regression analysis in Model (b) produced a similar result where the association between depression and HbA1c was completely mediated by the self-management behavior (when self-efficacy was not taken into account; Table 3).

The third set of regression analysis in Model (c) investigated the mediating role of self-management in the association between self-efficacy and HbA1c. Both self-efficacy and self-management behavior had significant effects on HbA1c when analyzed separately. Model (c) showed that the association between self-efficacy and HbA1c was partially mediated by self-management since both variables remained significant when entered into the model (Table 3).

The fourth set of regression analysis in Model (d) examined the mediating role of self-efficacy in the association between depression and self-management. Both self-efficacy and depression had significant effects on self-management when analyzed separately. Model (d) showed that the association between depression and self-management was fully mediated by self-efficacy (Table 3).

To test the proposed Model (e), we assessed the mediating role of self-efficacy and self-management on the association between depression and poor glycemic control.

### Table 2. Correlation matrix between independent variables and HbA1c

| Independent variables | $r$     | $p$ value |
|-----------------------|---------|-----------|
| Age, years $^a$       | 0.21*   | 0.01      |
| Gender $^b$           | 0.01    | 0.83      |
| Educational status $^c$ | -0.11  | 0.07      |
| Working status $^b$   | 0.02    | 0.78      |
| Current smoking $^b$  | 0.11    | 0.19      |
| Diabetes duration $^a$| 0.15    | 0.07      |
| BMI $^c$              | 0.19**  | <0.01     |
| Hypertension $^b$     | -0.15   | 0.07      |
| Depression $^a$       | 0.23**  | <0.01     |
| Self-efficacy $^a$    | -0.61** | <0.001    |
| Self-management behaviors $^a$ | -0.56** | <0.001 |

$^a$ Pearson product-moment correlation coefficient.  
$^b$ Point biserial correlation coefficient.  
$^c$ Kendall rank correlation coefficient.  
** Correlation is significant at the 0.01 level (2-tailed).  
* Correlation is significant at the 0.05 level (2-tailed).  
Dependent variable = HbA1c.
Hierarchical linear regression analysis was performed using a stepwise (enter method) procedure. In the first step (Model 1), sociodemographic and clinical outcomes (age, gender, education, working status, smoking status, diabetes duration, BMI, and hypertension diagnosis) were included in the regression model followed by antecedents (depression; Model 2) and mediators (self-efficacy [Model 3] and self-management behaviors [Model 4]). Model (e) showed that the association between depression and HbA1c was partially mediated by self-efficacy and self-management behaviors (Table 4).

Figure 1 illustrates the path diagram and the standardized coefficients of the SEM developed to examine the mediating roles of the self-efficacy and self-management behaviors in the association between depression and poor glycemic control. The SEM estimates suggest that the path coefficients for the path from depression to self-efficacy, from self-efficacy to self-management, and from self-management to HbA1c are all statistically significant. The chi-square test for goodness-of-fit indicated that the models were well calibrated (RMSEA = 0.09; CFI = 0.95; GFI = 0.96; AGFI = 0.81; \( \chi^2 \) = 35.88; \( p < 0.001 \)).

**Table 3. Hierarchical linear regression analysis**

| Variables       | Dep → SE → A1c | Dep → SMB → A1c | SMB → SE → A1c | Dep → SE → SMB |
|-----------------|----------------|-----------------|----------------|----------------|
| Step 1: controls |                |                 |                |                |
| Age, years      | 0.001          | 0.004           | 0.007          |                |
| Gender          | 0.03            | 0.11            | 0.06           |                |
| Educational status | -0.22          | -0.09           | -0.15          |                |
| Working status  | 0.46            | 0.26            | 0.42           |                |
| Smoking status  | 0.19            | 0.10            | 0.19           |                |
| Diabetes duration | 0.01           | 0.01            | 0.02           |                |
| BMI             | 0.46**          | 0.07            | 0.50**         |                |
| Hypertension    | -0.27           | -0.33           | -0.26          |                |
| Step 2: Antecedent | -0.4*           | -0.05           |                | -0.06**        |
| Step 3: Mediators |               |                 |                |                |
| SE              | -0.04**         | -0.02**         |                |                |
| SMB             | -0.42**         | -0.21**         |                |                |

R² = amount of variance explained by IVs; Dep, depression; SE, self-efficacy; SMB, self-management behaviors; A1c, HbA1c (glycemic control).

**Table 4. Hierarchical linear regression analysis**

| Variables       | Dep → SE → A1c | Dep → SMB → A1c | SMB → SE → A1c | Dep → SE → SMB |
|-----------------|----------------|-----------------|----------------|----------------|
| Step 1: controls |                |                 |                |                |
| Age, years      | 0.001          | 0.004           | 0.007          |                |
| Gender          | 0.03            | 0.11            | 0.06           |                |
| Educational status | -0.22          | -0.09           | -0.15          |                |
| Working status  | 0.46            | 0.26            | 0.42           |                |
| Smoking status  | 0.19            | 0.10            | 0.19           |                |
| Diabetes duration | 0.01           | 0.01            | 0.02           |                |
| BMI             | 0.46**          | 0.07            | 0.50**         |                |
| Hypertension    | -0.27           | -0.33           | -0.26          |                |
| Step 2: Antecedent | -0.4*           | -0.05           |                | -0.06**        |
| Step 3: Mediators |               |                 |                |                |
| SE              | -0.04**         | -0.02**         |                |                |
| SMB             | -0.42**         | -0.21**         |                |                |

R² = amount of variance explained by IVs; Dep, depression; SE, self-efficacy; SMB, self-management behaviors; A1c, HbA1c (glycemic control).
On one hand, the majority of the study respondents (73.2%) had HbA1c levels of < 7% [33]. On the other hand, a large proportion of the study participants (66.9%) were found to have clinical depression. In the present study, higher levels of depression were determined to be significantly associated with the poorer glycemic control ($p < 0.05$). Our findings were consistent with previous studies reporting that depression is associated with poor glycemic control in patients with T2DM [13, 34–37]. In line with previous studies, we found a negative association between HbA1c and self-efficacy as well as self-management behaviors ($p < 0.01$) [21, 38]. To delve deeper into the complex relationship between depression, self-efficacy, self-management behaviors, and HbA1c, series of hierarchical linear regression analyses were conducted, after controlling for the covariates.

Depression was negatively correlated with self-efficacy and self-management behaviors. However, depression had a direct negative correlation with self-efficacy, but the association between depression and self-management behavior was not direct. In line with the previous study, we also found that self-efficacy completely mediated the effect of depression on self-management behaviors [19].

We also found a positive indirect relationship between depression and HbA1c. Self-efficacy and self-management behaviors completely mediated the effect of depression on HbA1c when taken alone in the analysis. Our results are in accordance with previous studies [16, 17].

Self-efficacy in combination with self-management behaviors was found to partially mediate the association between depression and poor levels of HbA1c. The mediation effects of self-efficacy and self-management behaviors on the association between depression and HbA1c had not been investigated before. Results show that the pathway for the influence of depression on poor levels of HbA1c cannot be interpreted without considering the effects of mediators because there was no direct effect of depression on HbA1c. The comorbidity of depression and diabetes is associated with adverse diabetes-related outcomes. When co-occurring with diabetes, depression is associated with poorer self-efficacy [18, 21], self-care behaviors [39], and subsequently worse glycemic control [15]. Patients with depression have diminished beliefs in their capabilities to successfully execute a specific behavior, which, in turn, decreases the likelihood of performing self-management activities. They also have lower ability to care for themselves, which, in turn, decreases the likelihood of poor patients’ management. Poor levels of self-management have been associated significantly with poor glycemic control [21].

Based on the mediation effect analysis, we proposed that the combination of effects across multiple pathways could influence the association between depression and HbA1c. The influence of depression on HbA1c can take multiple pathways of influence: (a) through affecting self-efficacy, which in turn can affect HbA1c directly; (b) through affecting self-management, which in turn can affect HbA1c directly; and (c) through affecting self-efficacy, which, in turn, affects self-management and then HbA1c. Depression is the most common psychiatric disorder witnessed in the diabetes community. Depression can have a serious impact on a person’s well-being. Depression can also influence the patient’s ability and moti-
Depression and Poor Glycemic Control

In agreement with previous studies, our results indicated that self-efficacy and self-management behaviors influence the effects of depression on patients with uncontrolled glycemic control [15]. The treatment of comorbid depression is increasingly considered as an essential component of high-quality care for patients with T2DM. Understanding the nature and pathways influencing the effects of depression on the poor glycemic control will help to define appropriate policies and interventions to limit the negative impact of diminishing self-care activities. Our study may help clinicians better determine the existence of depression in patients with T2DM. The existence of poor glycemic control might be recognized as a later sign of depression, whereas decreasing self-efficacy and self-management behaviors can be considered as early signs of depression. The alert clinician who is aware of the pathway by which depression affects glycemic control can develop a specific protocol that can enhance patient compliance and optimize glycemic control. A clinical implication of this study is that all diabetes patients should be screened for depression. The future trial should consider not only early screening for depression but also carrying out such assessment continuously over time. With timely and appropriate screening and treatment for depression in diabetes population, the increase of quality of life can be achieved [40].

Typically, the objective of this study was to obtain a clearer understanding of the relationship between depression, self-efficacy, self-management behaviors, and HbA1c. The results of this study can provide better and more comprehensive information for healthcare professionals to improve their quality of care. These results can enable healthcare professionals to provide more effective and appropriate care rather than just focusing on patient education in order to achieve optimal glycemic control. It is important to stress upon the behavioral and psychological aspects of diabetes when developing a high-quality care management.

The potential limitation of our study is the cross-sectional design, which does not allow for analysis of the causal relationship between depression and glycemic control. Another weakness is the nonprobability sampling method applied that might reduce the external validity. Assessment of depression was based on a self-report of current symptoms using a validated instrument, not on the more accurate clinical diagnosis interview. An in-person interview with trained psychiatric would have probably yielded more accurate clinical information. We did not differentiate whether depression came from internal causes, such as genetic and/or biologic, or external causes, such as traumatic or stressful events. This could be seen as a limitation of the study. A body of the evidence indicated that internal depression is associated with the cognitive impairment [41]. The present study is a secondary analysis of baseline data from a randomized controlled trial evaluating the effectiveness of a nurse-led diabetes self-management education on HbA1c in Iranian adults with T2DM. The data of this study may not be generalized to other population, as only individuals with HbA1c levels ≥8% were recruited. We did not have information on whether patients were taking the prescribed antidepressive medications, which may confound our results. Thus, further studies are needed to delve deeper into the specific effects of antidepressive medications in the treatment of depressed patients with T2DM. This study only included patients with T2DM; effects on those with type 1 diabetes are unknown. This is highlighted as an interesting topic for further research.

Conclusion

Comorbid diabetes and depression are major clinical challenges impacting both personal experiences and public health care. Considering the high prevalence of depression in patients with T2DM, exploring the impact of depression on diabetes is a growing concern. Our study is consistent with some of the previous studies that had reported that cooccurrence of depression and T2DM may contribute to poor glycemic control. This study provides strong evidence that gave a clearer insight into the mediation effects of self-efficacy and self-management behaviors on the association between depression and poor glycemic control. Depression directly and negatively affects self-efficacy and indirectly affects self-management behaviors, which, in turn, have direct effects on HbA1c. Self-efficacy mediates the relationship between depression and self-management behaviors. Self-efficacy and self-management behaviors partially mediate the effect of depression on HbA1c. Screening for the early detection and treatment of depression is important in achieving good glycemic control and thus avoid further complications. Effective treatment programs should probably pay close attention to not only screening and treatment of depression but also skills training to enhance patient self-efficacy and self-management of diabetes to improve HbA1c. In this respect, it would be advantageous to have results of high quality, longer-term studies with larger sample sizes.
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Disclosure Statement
The authors have no conflicts of interest to declare.

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Depression and Poor Glycemic Control

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