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Association of Diabetes Management Self-efficacy with Adherence to Medication, Glycemic Control, and Disease Outcomes Among Type 2 Diabetes Patients

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Abstract

Background: Diabetes management self-efficacy (DMSE) positively affects diabetes self-care behaviors and can lead to better glycemic control and improved disease outcomes in diabetes patients.
Objectives: This study aimed to evaluate DMSE level and its relationship with medication adherence, glycemic control, and diabetes complications among type 2 diabetes (T2D) patients.
Methods: A cross-sectional study was carried out from November 2019 to January 2020 on T2D patients who attended the Diabetes Center of the Kerman University of Medical Sciences. Data were collected using two validated questionnaires including the diabetes management self-efficacy scale (DMSES) to evaluate DMSE level and the eight-item Morisky medication adherence scale (MMAS) to assess adherence to medication. The SPSS statistical software version 22 was employed for data analysis.
Results: Of 440 T2D patients entering the study, 72% were female with a mean (SD) age of 59.60 (10.48). The mean (SD) DMSE score of the respondents was 5.76 (1.87). A significant negative correlation was observed between DMSE with HbA1c ($r = -0.289$, $P < 0.0001$) and also with FBS ($r = -0.229$, $P < 0.0001$), but there was a significant positive correlation between DMSE and adherence to medication ($r = 0.208$, $P < 0.0001$). FBS level ($\beta = -0.252$, $P < 0.0001$), number of visits by specialty or subspecialty physicians ($\beta = -0.139$, $P = 0.002$), medication adherence score ($\beta = 0.165$, $P < 0.0001$), neuropathy ($\beta = 0.142$, $P = 0.002$), marital status $\beta = 0.125$, $P = 0.004$), household income ($\beta = -0.126$, $P = 0.004$), and blood glucose checks at home ($\beta = 0.109$, $P = 0.013$) were considered predictors of DMSE score.
Conclusions: Diabetes management self-efficacy is considered suboptimal among T2D patients. Patients with higher DMSE have better adherence to medication, better blood glucose control, lower risk of neuropathy, and fewer visits by specialty and subspecialty physicians.

Keywords: Diabetes Mellitus, Self Efficacy, Medication Adherence, Diabetes Complications, Iran

1. Background

Diabetes mellitus (DM) as a long-term condition is one of the most important public health challenges with a considerable increasing global prevalence in recent decades (1). According to the International Diabetes Federation estimation, the number of people living with diabetes was 463 million (prevalence 9.3%) in 2019, which will rise to 578 million (10.2%) by 2030 and 700 million (10.9%) by 2045 globally (2). Diabetes with various microvascular and macrovascular complications leads to a decreased quality of life and is a major cause of premature death and disability worldwide (1). Over recent decades in Iran, as in other developing countries, diabetes prevalence has been steadily increasing, and now it is a major cause of premature death, disability, and high healthcare costs (3).

Diabetic self-care practices include a set of actions to modify behaviors and lifestyles, such as healthy eating, proper physical exercise, blood glucose monitoring, and adherence to medications (4). They are an essential part of diabetes management for effective treatment and achieve good outcomes such as improving the quality of life and reducing diabetes-related complications and costs (4). Self-efficacy has been reported as a crucial factor affecting diabetes self-care (5). As a part of social cognitive theory, self-efficacy refers to individuals' belief regarding their capabilities to execute specific behaviors necessary

to achieve their goals (5, 6). Self-efficacy plays a crucial role in determining patients' performance in coping with a new or challenging situation, empowering them to make reasonable decisions and change their lifestyles and behaviors (6). Also, self-efficacy can predict the level of readiness to accept healthy behaviors, modify lifestyle, and execute interventions that are the most critical aspects of attaining diabetes management goals (7).

Diabetes management self-efficacy (DMSE) reflects the perception of individuals' commitment toward performing various diabetes self-management behaviors to control glycemic status and prevent or delay long- and short-term diabetes-related complications (6). Many studies have found that diabetes patients with better self-efficacy have higher adherence to medication, better compliance with healthy behaviors, higher healthy coping skills, lower glycosylated hemoglobin (HbA1c), and better quality of life (8-10). Moreover, the patient-centered approach as one of the essential strategies to attain diabetes control goals reflects self-efficacy as an important personal factor that should be considered in individualizing diabetes management (11).

2. Objectives

This study was conducted to assess DMSE and its relationship with medication adherence, glycemic control, and diabetes complications among type 2 diabetes (T2D) patients. The object was also to determine predictors of DMSE.

3. Methods

This descriptive-analytical, cross-sectional study was carried out from November 2019 to January 2020 in Kerman City, southeast Iran. The study population included T2DM patients attending the Diabetes Center of the Kerman University of Medical Sciences. The Diabetes Center was a multi-specialty clinic affiliated with a tertiary hospital. The inclusion criteria were adults aged 18 years or older diagnosed with T2D based on the World Health Organization criteria for diabetes and a history of diabetes for at least one year. The participants were recruited in the study using a convenience sampling method.

Data collection was conducted using a four-section questionnaire. The first section consisted of six questions about sociodemographic information such as sex, age, marital status, educational level, job, and household income. The second section contained nine questions about disease-related information, including disease duration, medication types, blood glucose checks at home by glucometer, number of blood glucose checks in a medical laboratory in the previous year, number of medical visits by a general physician or a specialist/subspecialist in the previous year, diabetes-related complication, fasting blood glucose (FBS) level, and hemoglobin A1c (HbA1c) level. The third section of the questionnaire was designed to assess DMSE using the diabetes management self-efficacy scale (DMSES). The original version of DMSES is a specific instrument with 20 items in five subscales, including medical control (3 items), blood glucose monitor (3 items), general nutrition (5 items), specific nutrition (5 items), and physical activity and weight control (4 items). Answers to the items were rated on a five-point scale ranging from 1 (cannot do at all) to (certainly can do) (12). The scale was developed to measure the patient's confidence level in performing required behaviors or actions for diabetes management in particular domains or situations (13). Studies have reported good psychometric properties of the questionnaire (12-14). A study in Iran revealed good reliability and validity of the Persian version of DMSES (14). In this study Cronbach's alpha values were reported 0.92 for the total scale and ranged from 0.68 to 0.87 for the subscales and also CVR were considered more than 0.8 for all items (14). The fourth section consisted of eight items to measure compliance with medication using the eight-item Morisky medication adherence scale (MMAS). Seven items of MMAS have yes/no answers, whereas one item is rated on a five-point Likert scale ("never," "rarely," "sometimes," "usually," and "all the time"). In Iran, a study has reported acceptable psychometric properties for the Persian version of MMAS (15).

For scoring MMAS, the items with yes/no answers were scored as 0 and 1, except item 5, which was scored in reverse. Moreover, for item 8, answers were rated as 0 (never), 0.25 (rarely), 0.5 (sometimes), 0.75 (usually), and 1 (all the time). Thus, the scores ranged from 0 to 8, and a higher score reflected better compliance with medication (15). For scoring DMSES, a summation of scores of the related items for each subscale and overall DMSE were calculated as raw scores. Then, we used the following formula to convert the raw scores to transformation scores:

$$Transformation\ Score = \frac{Observed\ Score - Potential\ Minimum\ Score}{Maximum\ Potential\ Score\ -\ Minimum\ Potential\ Score} \times 10$$

As a result, the scores ranged from 0 to 10, with a higher score representing higher self-efficacy.

Data were collected through the interview method by a trained interviewer. The interviewer firstly explained the study goals to the participants and ensured them of the confidentiality of the collected data. Then, after obtaining written consent from the participants, they were asked to complete the questionnaires. The study was approved by

the Ethics Committee of the Kerman University of Medical Sciences (ethics code: IR.KMU.AH.REC.1398.165).

The SPSS statistical software version 22 was employed for data analysis. The descriptive results were mean, standard deviation, percentage, and tables. Furthermore, we used the Pearson correlation test, independent samples *t*-test, and one-way analysis of variance for univariate analysis. We also used the multiple linear regression to determine predictors' factors of DMSE. A P-value equal to 0.05 or lower was considered significant.

4. Results

Of the 440 T2D patients entering the study, 72% were female, and over 83% were married. The mean ± SD age of the participants was 59.60 ± 10.48, and 65.5% were aged 64 years or younger (median = 60, interquartile range = 53-75). Also, of the participants, about 60% were homemakers, and about 60% (n = 263) reported inadequate household income conditions. Only 40% (n = 176) of the participants had high school or university education, and over 21% (n = 94) of them were illiterate. The mean ± SD disease duration of the participants was 12.05 ± 7.40 years (median = 10, interquartile range = 6 - 17), and near 60% (n = 263) of them had a disease duration of 10 years or higher. Near 56% (n = 246) of the patients had taken insulin alone or in combination with oral antidiabetic medications, and about 86% (n = 378) of them performed blood glucose checks at home by glucometer. The median number of blood glucose checks in a medical laboratory was three times (interquartile rang = 2 - 4), and only 30.5% (n = 134) of the patients had received at least one medical visit for diabetes care by a general physician in the previous year. The median number of medical visits for diabetes care by a specialist or subspecialist was four times (interquartile rang = 2 - 9) during the previous year.

The mean ± SD FBS and HbA1c were 179.22 ± 70.67 mg/dL (median = 161, interquartile range = 134 - 210) and 8.43 ± 1.68, (median = 8.20%, interquartile range = 7.20% - 9.20%), respectively. Half of the patients (n = 220) had at least a microvascular diabetes complication, including nephropathy (14.3%), retinopathy (23.2%), and neuropathy (31.4%). Also, over 14% (n = 62) of the patients had at least one macrovascular complication such as coronary artery disease (6.4%, n = 28), cerebrovascular accidents (0.9%, n = 4), and diabetic foot ulcer (7%, n = 31). About 54% (n = 236) of the participants had at least one macrovascular or microvascular diabetes complication (Table 1).

As presented in Table 2, the mean ± SD and median DMSE scores of the respondents were 5.76 ± 1.87 and 5.62, respectively. The medical care subscale had the highest mean score, followed by the blood glucose and general nutrition subscales. Also, the specific nutrition and physical activity subscales had the lowest mean scores (Table 2). Furthermore, the patients' mean ± SD and median adherence to medication scores were 6.36 ± 1.63 and 6.75, with an interquartile range of 5.50 to 8.00.

The mean DMSE score was significantly higher among men than women (P = 0.049), while it was higher among patients with spouses than those without spouses (P = 0.003). The homemakers had a lower mean DMSE score than the others (P = 0.011), but the patients with inadequate household income status had a higher mean DMES score than those with adequate status (P = 0.030). Also, the mean DMSE score had a significant difference regarding education level (P = 0.030), and the post hoc test showed that patients with university education had a significantly higher mean DMSE score than illiterate ones (6.18 vs. 5.32, P = 0.020). In addition, the mean DMSE score was higher among patients with blood glucose checks at home by glucometer (P = 0.008) and patients with less than four medical visits by a specialist or subspecialist to receive diabetes care in the previous year (P = 0.002). The mean DMSE score showed no difference in terms of antidiabetic medications type (P = 0.071), number of blood glucose checks in a medical laboratory (P = 0.068), and number of visits by general physicians in the previous year (P = 0.672) (Table 1).

The mean DMSE score was lower among patients with diabetes neuropathy ($P < 0001$) than the other patients, while it showed no differences among patients with retinopathy (P = 0.710) and nephropathy (P = 0.477) than the patients without these complications. Patients with at least one microvascular diabetes-related complication had significantly lower mean DMSE scores than those without complications (5.50 vs. 6.03, P = 0.003). The mean DMSE score showed no difference between the patients with and without macrovascular diabetes complications (P = 0.175). In contrast, patients with at least one diabetes-related complication (macrovascular or microvascular) had a significantly lower mean DMSE score than those without these complications (5.51 vs. 6.07, P = 0.002) (Table 3).

A significant negative correlation was observed between HbA1c with DMSE (r = -0.289, $P < 0.0001$) and its subscales and between FBS with DMSE (r = -0.229, $P < 0.0001$) and its subscales (Table 4). Moreover, there was a significant positive correlation between DMSE and adherence to medication (r = 0.208, $P < 0.0001$), while DMSE had no significant correlation with age (P = 0.079) and disease duration(P = 0.267) among the diabetes patients.

The results of the multiple linear regression model are presented in Table 5. FBS level, number of visits by specialists or subspecialists, medication adherence score, neuropathy, marital status, household income, and blood glucose checks at home were considered predictors of

Table 1. Frequency Distribution of Characteristics of the Studied Sample and Comparing Mean Scores of DMSE in Terms of Demographic and Diseases Related Variables

Variables and Categories	No. (%)	Mean ± SD	P-Value
Sex			0.049
Female	317 (72.0)	5.65 ± 1.85	
Male	123 (28.0)	6.05 ± 1.92	
Marital status			0.003
With spouse	368(83.6)	5.80 ± 1.89	
Without spouse	72(16.4)	5.17 ± 1.70	
Education level			0.030
Illiterate	94 (21.4)	5.32 ± 1.83	
Primary and secondary	170 (38.6)	5.81 ± 1.88	
High school	107 (24.3)	5.82 ± 1.83	
University	69 (15.7)	6.18 ± 1.90	
Job category			0.011
Homemaker	261 (59.3)	5.58 ± 1.82	
Others	179 (40.7)	6.04 ± 1.92	
Household income			0.030
Inadequate	247 (56.1)	5.93 ± 1.96	
adequate	193 (43.9)	5.54 ± 1.75	
Type of medication			0.071
Oral antidiabetic medications	194 (44.1)	5.95 ± 1.92	
Insulin	73 (16.6)	5.88 ± 2.05	
Combination	173 (39.3)	5.51 ± 1.72	
Checking of blood glucose at home			0.008
Yes	378 (85.9)	5.86 ± 1.85	
No	62 (14.1)	5.18 ± 1.91	
Number of blood glucose checks in lab (in the previous year)			0.068
< 3	160 (36.4)	5.55 ± 1.92	
≥ 3	280 (63.6)	5.89 ± 1.84	
Number of visits by general physicians (in the previous year)			0.672
0	306 (69.5)	5.74 ± 1.89	
≥ 1	134 (30.5)	5.82 ± 1.85	
Number of visits by specialists or subspecialists (in the previous year)			0.002
< 4	214 (48.6)	6.05 ± 2.05	
≥ 4	226 (51.4)	5.49 ± 1.65	

DMSE score in the model. These predictors explained 19.1% of the DMSE score variance (adjusted R^2 = 0.191) in the final model. FBS level was the most important predictor that alone explained 8.4% of the DMSE score variance (β = -0.252, R^2 change = 0.084). Number of visits by specialists or subspecialists (β = -0.139, R^2 change = 0.032) and adherence to medication (β = 0.165, R^2 change = 0.032) were the next two important predictors, each explaining 3.2% of the DMSE score variance. Neuropathy complication was another predictor that explained 1.7% of the DMSE

Table 2. Mean (± SD), Median, and Interquartile Range of Scores of DMSE and the Subscales Among the Studied Type 2 Diabetes Patients

Variables	Mean ± SD	Median	Interquartile Range
diabetes management self-efficacy	5.76 ± 1.87	5.62	4.50 - 7.00
Specific nutrition	4.74 ± 2.82	4.50	2.50 - 7.00
General nutrition	5.27 ± 2.62	5.00	3.50 - 7.50
Blood glucose control	6.18 ± 2.93	5.83	4.16 - 9.16
Physical activity and weight control	4.65 ± 2.81	4.16	2.50 - 6.66
Medical care	8.18 ± 1.63	8.12	7.50 - 10.0

Table 3. Comparison of Mean Scores of DMSE in Terms of Diabetes-Related Complications Among the Study Sample

Diabetes Complications and Categories	No. (%)	Mean ± SD	P-Value
Nephropathy			0.710
Yes	63 (14.3)	5.68 ± 1.77	
No	377 (85.7)	5.78 ± 1.89	
Retinopathy			0.477
Yes	102 (23.2)	5.65 ± 1.72	
No	338 (76.8)	5.80 ± 1.92	
Neuropathy			< 0001
Yes	138 (31.4)	5.15 ± 1.54	
No	302 (68.6)	6.04 ± 1.95	
Microvascular complications			0.003
Yes	220 (50.0)	5.50 ± 1.71	
No	220 (50.0)	6.03 ± 1.99	
Cardiovascular and cerebrovascular complications			0.945
Yes	32(7.3)	5.74 ± 1.74	
No	408 (92.7)	5.76 ± 1.89	
Foot ulcer			0.064
Yes	31 (7.0)	5.16 ± 1.92	
No	409 (93.0)	5.81 ± 1.87	
Macrovascular complications			0.175
Yes	62 (14.1)	5.46 ± 1.85	
No	378 (85.9)	5.81 ± 1.88	
Total complications			0.002
Yes	236 (53.6)	5.51 ± 1.71	
No	204 (46.4)	6.07 ± 2.01	

variance. Neuropathy was associated with a significantly lower DMSE score (β = 0.142, R^2 change = 0.017). Marital status was also a predictor of DMSE score, and patients with spouses had a higher DMSE score than those without spouses (β = 0. 125, R^2 change = 0.015). Moreover, adequate household income was associated with a lower DMSE score (β = -0.126, R^2 change = 0.014). Finally, patients with blood glucose checks at home had a higher DMSE score than the others (β = 0.109, R^2 change = 0.011).

5. Discussion

The results revealed that DMSE (mean = 5.62 out of 10) and its subscales were suboptimal among the

Table 4. Correlation Between DMSE and the Subscales with Age, Disease Duration, HbA1c, FBS and Adherence to Medication Among the Studied Type 2 Diabetes Patients.

Variables	r (P-Value)				
	Age	Disease Duration	HbA1c	FBS	Adherence to Medication
Diabetes management self-efficacy	0.084 (0.079)	0.053 (0.267)	-0.229 (< 0.0001)	-0.289 (< 0.0001)	0.208 (< 0.0001)
Specific nutrition	0.148 (0.002)	0.044 (0.361)	-0.138 (0.004)	-0.187 (< 0.0001)	-0.213 (< 0.0001)
General nutrition	0.109 (0.023)	0.106 (0.026)	-0.233 (< 0.0001)	-0.260 (< 0.0001)	0.144 (0.002)
Blood Glucose control	-0.045 (0.346)	0.039 (0.413)	-0.121 (0.011)	-0.193 (< 0.0001)	0.260 (0.009)
Physical activity and weight control	0.060 (0.210)	0.072 (0.129)	-0.193 (< 0.0001)	-0.185 (< 0.0001)	0.059 (0.239)
Medical Control	0.083 (0.083)	0.038 (0.442)	-0.143 (0.003)	-0.237 (< 0.0001)	0.205 (< 0.0001)

Table 5. Multiple Linear Regression Linear Regression Model to Determine Predictors of DMSE Among the Studied Type 2 Diabetes Patients [a]

Predictors		B	β	P	95%CI	R^2 Change
FBS (mg/dL)		-0.007	-0.252	< 0.0001	-0.009 - 0.004	0.084
Number of visits by specialists or subspecialists (in the previous year)	< 4 (Ref.)	-0.523	-0.139	0.002	-0.858 - 0.188	0.032
	≥ 4					
Adherence to medication score		0.190	0.165	< 0.0001	0.090 - 0.290	0.032
Neuropathy	Yes (Ref.)	0.575	0.142	0.002	0.215 - 0.935	0.017
	No					
Marital status	Without spouse (Ref.)	0.637	0.125	0.004	0.204 - 1.069	0.015
	With spouse					
Household income	Inadequate (Ref.)	-0.477	-0.126	0.004	-0.802 - 0.153	0.014
	Adequate					
Checking of blood glucose at home	No (Ref.)	0.586	0.109	0.013	01.049 - 0.123	0.011
	Yes					

[a] R square = 0.204; adjusted R square = 0.191; Durbin-Watson = 1.712.

studied patients. Four studies in Iran reported the mean self-efficacy score for diabetes management as 5.49 (out of 10), 106.8 (out of 190), 38.7 (out of 77), and 146.3 (out of 190 (16-19). Although some of the studies were conducted using different instruments, their results were consistent with our findings, revealing that DMSE was moderate or unfavorable. Patients in our study had lower self-efficacy for diabetes management compared to patients in studies in the United States, China, Myalgia, and Sudan (4, 20-22). Self-efficacy is an essential factor in a behavior change process. Compliance with medication and other diabetes management measures can lead to better outcomes such as blood glucose control, decreased acute and chronic diabetes-related complications, better quality of life, and increased life expectancy among diabetes patients (4-6).

The results of our study revealed a significant indirect correlation between FBS and HbA1c with DMSE and its subscales. Also, FBS level was an essential predictor of DMSE. Two studies in the United States and Malaysia reported similar findings that diabetes patients with higher self-efficacy had better glycemic control (20, 22). Also, D'Souza et al., in a review article, reported that higher self-efficacy was associated with self-care behaviors in determining glycemic control and lower HbA1c (23). However, inconsistent with these results, some studies reported no association between self-efficacy and glycemic control (17, 24). Therefore, considering the core role of self-care and patients' abilities to attain diabetes treatment goals such as glycemic control, assessing and improving DMSE should be considered an influencing factor in clinical practice to control disease.

The present study demonstrated a significant direct correlation between DMSE and adherence to medication. Consistent with our findings, previous studies revealed a positive association between self-efficacy and medication adherence (21, 23, 25). Patients with diabetes must implement extensive and profound lifestyle modifications and follow various therapeutic and preventive measures, such as taking medications regularly and several times daily, to control the disease (8). Self-efficacy as an

individual character positively affects adherence to prescribed recommendations strictly and lifelong in diabetes patients (5).

The study demonstrated that patients with at least one diabetes-related complication, especially those with microvascular complications, had lower DMSE than those without such complications. One explanation for this finding can be that patients with higher self-efficacy are more empowered to implement self-care behaviors for disease control (5). Moreover, similar to previous studies, this study demonstrated positive effects of self-efficacy on various diabetes treatments such as glycemic control, medication adherence, and blood glucose monitoring (18, 20, 22). Also, other researchers have found that self-efficacy can be an influencing factor for better diabetes self-care behaviors such as a healthy diet and physical activity (22, 23). A cohort study in Thailand revealed that the risk of developing adverse events such as hyper or hypoglycemia, unplanned visits for emergency conditions, and hospital admission was 4.4 times more in low self-efficacy diabetes patients than in those with high self-efficacy in a 12-month follow-up (26). Thus, better adherence to diabetes self-management in patients with a higher self-efficacy led to improved disease outcomes such as a lower risk of acute and chronic diabetes complications.

The present study revealed that patients with blood glucose checks at home by glucometer and those with less than four medical visits by a specialist or subspecialist to receive diabetes care in the previous year had higher self-efficacy than others. Studies have confirmed that diabetes self-efficacy education leads to multi-dimensional benefits such as clinical, physical, and behavioral positive outcomes (27, 28). Higher self-efficacy is associated with greater self-care practice and decreased acute and chronic diabetes-related comorbidity and mortality (5, 21). An explanation for these findings can be that patients with higher self-efficacy had better diabetes self-care behaviors and higher compliance with treatment and preventive recommendations. These features can lead to better disease control, decreased acute and chronic diabetes complications, and decreased need to take additional disease care services by health care providers.

The present study demonstrated that women, patients without spouses, homemakers, and those with adequate household income had lower self-efficacy. Previous studies have reported controversial findings regarding the association between self-efficacy and demographic characteristics (18, 21, 24, 29). Consistent with our findings, a study in Iran found that the mean diabetes self-efficacy score was higher in males, married patients, those with university education, and homemakers, although the latter was inconsistent with our study (18). Moreover, two studies in Sudan and China revealed that the mean self-efficacy score was not significantly different regarding gender, marital status, and occupation. In contrast, another study in Turkey showed that male patients with higher education had greater self-efficacy (21, 24, 29).

This study had some limitations. First, it was a cross-sectional study, and thus, we could not determine the temporal relationship between independent variables and DMSE as the outcome variable. Second, this study was conducted in a tertiary-level clinic, and thus, its results could not be generalized to all diabetic patients. Moreover, measuring human behavior via self-report cannot reflect the actual status well.

5.1. Conclusion

Diabetes management self-efficacy is considered suboptimal among T2D patients. The lowest components of DMSE are specific nutrition, physical activity, and weight control. Also, patients with higher DMSE have better adherence to medication, better blood glucose control, lower risk of neuropathy complications, and fewer visits by specialty and subspecialty physicians.

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Footnotes

Authors' Contribution: Study design, Ali Khalooei and Zohreh Hasheminejad; Analysis of data, Ali Khalooei; Drafting of the manuscript, Ali Khalooei; Critical revision of the manuscript for important intellectual content, Ali Khalooei and Zohreh Hasheminejad.

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