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The Effect of Nutrition Education Using MyPlate on Lipid Profiles, Glycemic Indices, and Inflammatory Markers in Diabetic Patients

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ABSTRACT

As a result of a nutrition transition, chronic diseases, including diabetes, have increased in Iran. Nutrition education is a cost-effective method for modifying diet and controlling diabetes. This study aimed to examine the effect of nutrition education using MyPlate recommendations on glycemic and lipid profiles and inflammatory markers in Iranian adults diagnosed with type 2 diabetes. A 12-week randomized clinical trial was conducted on 44 adults aged 30–50 years from Ahvaz, Iran. The participants were divided into education and control groups. The education participants were taught the MyPlate recommendations. Serum levels of fasting blood sugar (FBS), hemoglobin A1c (HbA1c), lipid profiles, and inflammatory markers, including high sensitivity C-reactive protein (hs-CRP), tumor necrosis factor-α, and adiponectin, were measured at the baseline and the end of the study. The results showed that serum levels of FBS ($p = 0.014$) and HbA1c ($p < 0.001$) decreased significantly in the education group at the end of the study. The serum level of low-density lipoprotein in the education group declined significantly at the end of the study ($p = 0.043$). Furthermore, the serum level of hs-CRP ($p = 0.005$) declined significantly while the level of adiponectin ($p = 0.035$) increased in the education group at the end of the study. The evidence of this study showed that nutrition education using MyPlate recommendations is an effective method for controlling diabetes complications. A longitudinal analysis with a larger sample size is recommended to confirm the evidence of this study.

Trial Registration: Iranian Registry of Clinical Trials Identifier: IRCT2015031921443N2

Keywords: Diabetic; Nutrition; Education; Inflammation

INTRODUCTION

Diabetes increased worldwide from 108 million in 1980 to 422 million in 2014. Diabetes was regarded as the main cause of 1.5 million deaths in 2019 [1]. Type 2 diabetes is the most common type of diabetes that imposes a substantial economic burden on the public health system with complications including cardiovascular diseases, hypertension, renal failure, blindness, and neuropathy [2]. Furthermore, diabetes is linked to chronic low-grade

Conflict of Interest
The authors declare that they have no competing interests.

Author Contributions
Conceptualization: Mohammadshahi M; Data curation: Shahmoradi S; Formal analysis: Latifi SM; Funding acquisition: Mohammadshahi M; Investigation: Haidari F, Shahmoradi S; Methodology: Mohammadshahi M; Project administration: Shahmoradi S, Haidari F; Resources: Mohammadshahi M; Software: Latifi SM; Supervision: Mohammashahi M; Validation: Mohammadshahi M; Visualization: Mohammadshahi M; Writing - original draft: Haidari F; Writing - review & editing: Haidari F, Mohammadshahi M.

inflammation with a high level of cytokine production, including high sensitivity C-reactive protein (hs-CRP) and tumor necrosis factor-α (TNF-α) [3].

While diabetes is increasing worldwide, the prevalence is more quickly rising in middle-income countries than in high-income countries [1]. Iran is a country in the Middle-East region that has experienced a nutrition transition over the past 5 decades [4,5]. As a result of the nutrition transition, obesity and chronic diseases such as diabetes have increased in Iran [4,6]. While 8.5% of adults over 18 years old had diabetes in 2014 worldwide, 11.5% of Iranian adults were diagnosed with diabetes in 2011 [1,7].

An unhealthy diet high in sugars and fats is one of the most important factors in developing diabetes [8]. As a result, one of the most important strategies to control diabetes is diet modification [9,10]. The evidence shows that increasing consumption of whole grains, fruits, non-starchy vegetables, fish, nuts, and legumes and a lower intake of red and processed meats and added sugars is helpful for the control of diabetes [11].

Previous evidence showed that nutrition education is a cost-effective method for controlling diabetes compared to treating patients in hospitals [11,12]. While MyPyramid has been used as a tool for nutrition education for years [13], the United States Department of Agriculture (USDA) and Centre for Nutrition Policy and Promotion replaced it with MyPlate, which was created based on Dietary Guidelines for Americans in 2011 [14]. While MyPyramid consists of recommendations on consuming food groups and their amounts, MyPlate aims to increase consumers' food choices and make a healthy plate. Furthermore, MyPlate incorporates recommendations for increasing the intake of whole fruits and whole grains and changes the diet towards consuming low-fat dairy products. It also indicates using a variety of vegetables and protein sources [14,15]. The effect of education of MyPlate on improving dietary behaviors was demonstrated in a previous study [16].

Limited studies have examined the effect of nutrition education on diabetic patients in Iran. Existing studies mostly applied the recommendations of MyPyramid and the Iranian Diabetes Association [14,17-19]. These studies showed that nutrition education was impactful in decreasing fasting blood sugar (FBS) [18,19], cholesterol, and triglyceride [18] in Iranian adults with diabetes. However, no previous study has examined the effect of nutrition education on inflammatory markers in diabetic patients. Furthermore, no study has applied the nutrition recommendations of MyPlate to educate Iranian diabetics. Therefore, this study aimed to evaluate the effect of nutrition education, using MyPlate recommendations, on glycemic and lipid profiles and inflammatory markers in Iranian adults diagnosed with type 2 diabetes.

MATERIALS AND METHODS

Participants and study design

This 12-week randomized clinical trial was conducted in Ahvaz, Iran. The ethics were approved by the Ethics Committee of Ahvaz Jundishapur University of Medical Sciences (approval No. IR.AJUMS.REC.1392.156), and the informed consent form was obtained from all patients. This trial was registered with the Iranian Registry of Clinical Trials (IRCT2015031921443N2). The sample size was calculated based on the previous study [20] using the mean and standard deviation of hemoglobin A1c (HbA1c) (16.7), FBS (21.03), total cholesterol (10.46), and low-density lipoprotein (LDL) (7.1). The suggested standard formula for clinical trials was used, considering a type 1 error (a) of 0.05 and type 2 error (b) of 0.20 (power, 90%). The largest sample size (n = 21) was calculated using the mean of FBS. Participants were included in the study if they were diagnosed with type 2 diabetes, aged between 30 to 50 years old, and signed the clinical trial consent form. Adults over 50 years old were not included as they might develop different chronic diseases which might influence the results of this study. Given this study aimed to examine the adults with type 2 diabetes mellitus, so under 30 years old were excluded. Chronic diseases (coronary artery diseases, stroke, congenital heart diseases, heart failure, heart attack, chronic renal failure, thyroiditis, or any other chronic inflammatory diseases), a weight reduction diet and/or a specific physical activity program, taking nonsteroidal anti-inflammatory medications, nutritional supplements, weight loss medication, and insulin, being in pregnancy and lactation period, alcohol consumption, smoking were considered as the exclusion criteria. A total of 44 adults with diabetes who were referred to the Diabetes Research Centre of Ahvaz Jundishapur University of Medical Sciences were included in this study and randomly were assigned to control (n = 22) and education groups (n = 22). Participants in the education group were instructed to attend a 2-hour nutrition class per week and were taught by a well-trained nutritionist for 3 months. The duration of the intervention was determined based on the previous study [20]. The education components were designed based on MyPlate that was created by the USDA [14]. The participants in the education group received information on how to make 30% of their plate vegetables and grains and 20% of their plate fruits and proteins and add dairy products to their meals [14]. They were educated on a higher intake of dark green, red, and orange fruits and vegetables. Furthermore, they were advised to increase the intake of whole grains up to half of the total grains in a day. They were instructed to consume skim or reduced-fat dairy products rather than full fat products. The nutritionist also emphasized a lower intake of saturated fat, trans-fat, and salt. In addition, participants received information on adding a variety of protein sources to their meals, consuming lean or low-fat meats, replacing sugar-sweetened beverages with water, and increasing daily physical activity [14]. Besides, specific nutrition education for diabetes was applied. Participants were instructed to make half their plate vegetables excluding starchy vegetables for lunch and dinner and divide the other half into an equal quantity of protein sources and grains. Additionally, they were educated to add one serving of fruit and one serving of skim or reduced-fat dairy products to lunch and dinner. For breakfast, participants were instructed to make half their plate grains, and the other half of the plate needs to be equal quantities of fruits and protein sources, with adding one serving of dairy products.

After the nutrition class, every participant in the education group received a designed booklet including MyPlate recommendations. The nutritionist contacted participants of the education group once a week through a phone call and reviewed the information with them. Participants were also provided with a telephone number to discuss any issues with the nutritionist. Participants in the control group also received information on macronutrients, food exchange lists, carbohydrate counting, and a lower intake of simple carbohydrates, fats, and salt according to the recommendations from the Iranian Diabetes Society [21]. They were asked to comply with these recommendations and were followed up over 3 months of intervention (**Table 1**).

Sociodemographic characteristics and anthropometric indices

Information on sociodemographic characteristics, including age, gender, and education, was collected from each participant at the onset of the study. At the baseline and end of the study, each participant's body weight was measured using the Seca scale (Seca, Hamburg,

Table 1. The nutrition education components

Groups	Components	Education duration
Education	MyPlate	A 2-hour nutrition class/week for 3 months
	- Make 30% of plate vegetables and grains and 20% of plate fruits and proteins	
	- Add dairy products	
	- Increase intake of dark green, red, and orange fruits and vegetables	
	- Increase the intake of whole grains up to half of total grains in a day	
	- Consume skim or reduced-fat dairy products rather than full fat products	
	- Decrease intake of saturated fat and trans-fat, and salt	
	- Add a variety of protein sources to meals	
	- Consume lean or low-fat meats	
	- Replace sugar-sweetened beverages with water, and increasing daily physical activity	
	3 days food record	Participants were trained how to record their dietary intakes
Control	The Iranian Diabetes Society	A 2-hour nutrition class at the baseline of the study
	- Information on macronutrients	
	- Food exchange lists	
	- Carbohydrate counting	
	- Lower intake of simple carbohydrates, fats, and salt	
	3 days food record	Participants were trained how to record their dietary intakes

Germany), without shoes and nearest 100 g and height was measured without shoes to the nearest 0.2 cm using a tape measure. Waist circumference and hip circumference were also measured for every participant. Body mass index (weight [kg]/height [m^2]) and waist-to-hip ratio were calculated. A body state set (Quadscan 4000; Bodystat, Douglas, British Isles) was used to measure body fat percentage.

Dietary intake and physical activity

Three consecutive food records (2 weekdays and one day of the weekend) were used to assess every participant's food and nutrient intake at the baseline and end of the study. Participants in both education and control groups were trained to record their dietary intakes. A modified Nutritionist IV was used to estimate the intake of nutrients [22]. The International Physical Activity Questionnaire was used to measure physical activity [23].

Biochemical analysis

Fasting blood samples were collected from every participant twice, at baseline and at the end of the study. A commercial kit (Pars Azmoon, Tehran, Iran) was used to measure the serum level of glucose. The chromatography method was applied to assess HbA1c. The levels of triglyceride, total cholesterol, high-density lipoprotein (HDL), and LDL were measured using the enzymatic colorimetric method. Serum levels of hs-CRP, TNF-α, and adiponectin were measured using a commercially available enzyme-linked immunosorbent assays method (Labor Diagnostika Nord, Nordhorn, Germany for hs-CRP and Orgenium laboratories-Finland, Helsinki, Finland for TNF-α and adiponectin).

Statistical analysis

SPSS (version 18; SPSS, Chicago, IL, USA) was used to perform the data analysis. A p value of < 0.05 was considered statistically significant. Kolmogorov-Smirnov test was used to check the normal distribution of all variables. Independent sample t-test and analysis of covariance were used for comparison of means between groups. The changes in the mean variables before and after the intervention were examined using Paired sample t-test. The confounders included age, gender, weight changes, physical activity and energy intake.

RESULTS

A total of 44 participants were included in the final analysis. **Table 2** shows the characteristics of participants in both education and control groups at the baseline of the study. There was no significant difference in the characteristics of participants in the education and control groups. The mean age was 46 and 47 years in the education and control groups, respectively. The majority of participants were females and had a low level of education in both groups. In both the education and control groups, the mean weight was 76 kg, and the mean energy intake was 1,945 and 1,996 kcal in the education and control groups, respectively. The mean physical activity was 1,572 and 1,260 (MET-minute/week) in the education and control groups.

The dietary intakes at the baseline and the end of the study were shown in **Table 3**. While there was no difference in energy intake between the education and control groups at the end of the study, the energy intake in the education group declined significantly. The intake of carbohydrates and protein was not significantly different between study groups at the end of the study, while the fat intake was significantly lower in the education group than in the control group ($p = 0.022$) at the end of the study after adjusting for confounders. Furthermore, there was no significant difference in the intake of saturated fatty acid (SFA), monounsaturated fatty acid (MUFA), polyunsaturated fatty acid (PUFA) at the end of the study between study groups, while SFA ($p = 0.001$) and MUFA ($p < 0.001$) intake declined significantly in the education group at the end of the study. The intake of vitamin A, vitamin E, vitamin C, and fiber was significantly higher in the education group at the end of the study than in the baseline ($p < 0.05$).

The glucose hemostasis parameters at the baseline and the end of the study were shown in **Table 4**. At the end of the study, the serum level of FBS was significantly lower in the education group than in the control group ($p = 0.003$). While FBS significantly decreased in the education group ($p = 0.014$), it increased in the control group ($p = 0.011$). Furthermore, the HbA1c level was significantly lower in the education group than in the control group at the end of the study ($p = 0.012$). Also, the HbA1c level declined significantly in the education group at the end of the study ($p < 0.001$), while no significant change was observed in the control group ($p = 0.151$).

Table 2. Sociodemographic characteristics in the education and control groups at the baseline (n = 44)

Characteristics	Education (n = 22)	Control (n = 22)	p value*
Age	46.4 ± 4.9	47.6 ± 2.9	0.304
Gender			0.542
Males	9 (40.9)	7 (31.8)	
Females	13 (59.1)	15 (68.2)	
Level of education†			0.057
Illiterate	5 (22.7)	8 (36.4)	
Low	9 (40.9)	11 (50.0)	
Moderate	5 (22.7)	3 (13.6)	
High	3 (13.6)	0 (0)	
Weight (kg)	76.59 ± 13.21	76.95 ± 9.52	0.917
Energy intake (kcal)	1,945.59 ± 587.45	1,996.54 ± 590.34	0.776
Physical activity (MET-minute/week)	1,572.20 ± 1,424.27	1,260.95 ± 816.60	0.668

Values are presented as number (%) or mean ± standard deviation.
*Independent t-test and χ^2 test were used for continuous and categorical variables, respectively; †Illiterate (unable to read and write), low (primary and secondary school completed), moderate (high school completed), high (college and university education).

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Table 3. Dietary intakes in the study groups at baseline and end of the study (n = 44)

Variables	Education (n = 22)	Control (n = 22)	p value*
Energy (kcal)			
Baseline	1,945.59 ± 587.45	1,996.54 ± 590.34	0.776
End	1,606.18 ± 309.83	1,872.09 ± 551.09	0.186
p value†	0.005	0.304	
Carbohydrate (% of energy)			
Baseline	52.27 ± 8.23	54.68 ± 7.58	0.319
End	54.09 ± 4.21	53.18 ± 10.58	0.223
p value†	0.285	0.484	
Protein (% of energy)			
Baseline	16.09 ± 3.01	14.86 ± 2.88	0.174
End	16.45 ± 1.82	15.68 ± 3.85	0.763
p value†	0.609	0.543	
Fat (% of energy)			
Baseline	31.50 ± 7.89	30.31 ± 7.40	0.611
End	29.45 ± 4.46	31.09 ± 10.35	0.310
p value†	0.226	0.728	
SFA (g)			
Baseline	18.94 ± 7.82	16.85 ± 6.46	0.338
End	14.12 ± 4.75	17.97 ± 8.48	0.009
p value†	0.001	0.533	
MUFA (g)			
Baseline	17.98 ± 6.85	16.15 ± 5.23	0.327
End	13.12 ± 3.67	17.18 ± 9.1	0.015
p value†	< 0.001	0.616	
PUFA (g)			
Baseline	23.22 ± 11.45	26.60 ± 10.27	0.309
End	20.40 ± 6.56	20.35 ± 10.59	0.312
p value†	0.176	0.030	
Cholesterol (mg)			
Baseline	241.94 ± 179.89	242.27 ± 221.74	0.996
End	187.60 ± 113.54	313.55 ± 417.85	0.151
p value†	0.253	0.336	
Fibre (g)			
Baseline	12.38 ± 4.52	14.84 ± 5.78	0.124
End	16.86 ± 4.71	12.03 ± 5.91	0.002
p value†	0.001	0.138	
Vitamin A (μg)			
Baseline	655.3 ± 649.48	601.34 ± 573.46	0.772
End	1,127.44 ± 1,110.95	592.49 ± 454.53	0.029
p value†	0.004	0.955	
Vitamin E (mg)			
Baseline	2.23 ± 1.72	3.02 ± 1.80	0.148
End	3.59 ± 1.91	2.55 ± 2.62	0.046
p value†	0.039	0.471	
Vitamin C (mg)			
Baseline	101.55 ± 80.05	97.88 ± 70.68	0.873
End	146.51 ± 53.25	70.76 ± 69.04	0.012
p value†	0.029	0.183	

SFA, saturated fatty acids; MUFA, monounsaturated fatty acid; PUFA, poly unsaturated fatty acid.
*Independent t-test was used for comparison between 2 groups; †Paired t-test was used for comparison in one group.

The serum level of lipids at the baseline and the end of the study were shown in **Table 5**. At the end of the study, after adjusting for confounders, no significant difference in the serum level of total cholesterol, triglyceride, HDL, and LDL was found between the education and control groups. While no significant change was observed in the education groups in the serum level of total cholesterol, triglyceride, and HDL, LDL levels decreased significantly in the education group at the end of the study (p = 0.043).

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Table 4. Serum levels of FBS, HbA1c in the study groups at the baseline and end of the study (n = 44)

Variables	Education (n = 22)	Control (n = 22)	p value*	p value†
FBS (mg/dL)				
Baseline	152.86 ± 70.67	152.18 ± 62.30	0.973	0.003
End	124.27 ± 38.58	192.04 ± 81.60	< 0.001	0.003
p value‡	0.014	0.011		
HbA1c (%)				
Baseline	7.49 ± 1.46	8.17 ± 1.51	0.138	0.007
End	6.78 ± 1.22	8.47 ± 1.62	< 0.001	0.012
p value‡	< 0.001	0.151		

FBS, fasting blood sugar; HbA1c, hemoglobin A1c.
*Independent t-test was used for comparison between 2 groups; †Analysis of covariance test was used for comparison between 2 groups after adjusting for age, gender, physical activity, weight and energy; ‡Paired t-test was used for comparison in one group.

Table 5. Serum levels of lipids in the study groups at baseline and end of study (n = 44)

Variables	Education (n = 22)	Control (n = 22)	p value*	p value†
Total cholesterol (mg/dL)				
Baseline	175.13 ± 33.95	175.45 ± 46.57	0.979	0.797
End	165.36 ± 32.20	186.77 ± 41.60	0.058	0.449
p value‡	0.076	0.244		
Triglyceride (mg/dL)				
Baseline	180.63 ± 145.26	154.36 ± 66.01	0.444	0.277
End	152.36 ± 80.36	190.45 ± 83.26	0.032	0.307
p value‡	0.299	0.006		
HDL (mg/dL)				
Baseline	34.40 ± 5.56	35.09 ± 7.60	0.736	0.808
End	35.45 ± 6.01	35.72 ± 6.48	0.734	0.517
p value‡	0.260	0.427		
LDL (mg/dL)				
Baseline	109.50 ± 32.75	109.77 ± 38.30	0.980	0.814
End	98.86 ± 28.35	113.00 ± 35.85	0.154	0.653
p value‡	0.043	0.696		

HDL, high-density lipoprotein; LDL, low-density lipoprotein.
*Independent t-test was used for comparison between 2 groups; †Analysis of covariance test was used for comparison between 2 groups after adjusting for age, gender, physical activity, weight and energy; ‡Paired t-test was used for comparison in one group.

Serum levels of inflammatory markers were shown in **Table 6**. After adjusting for confounders, no significant difference in the serum level of inflammatory markers, including TNF-α, hs-CRP, and adiponectin, was found between education and control groups at the end of the study. Furthermore, at the end of the study, no significant change was observed in the serum level of TNF-α in the education group. While the serum level of hs-CRP declined significantly (p = 0.005), the serum level of adiponectin increased in the education group at the end of the study (p = 0.035).

DISCUSSION

This study examined the effect of MyPlate education on the glycemic parameters, lipid profiles, and inflammatory markers in Iranian adults with type 2 diabetes. Findings showed that at the end of the study, in the education group, serum levels of FBS and HbA1c, hs-CRP, LDL decreased while serum levels of adiponectin increased.

The current findings reported that serum levels of FBS and HbA1c decreased at the end of the study in the education group. A possible explanation could be that MyPlate recommendations include a higher intake of whole grains. Previous evidence showed that diets high in whole

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Table 6. Serum levels of inflammatory markers in the study groups at the baseline and end of the study (n = 44)

Variables	Education (n = 22)	Control (n = 22)	p value*	p value†
hs-CRP (pg/mL)				
Baseline	2.52 ± 1.25	2.49 ± 1.09	0.917	0.647
End	1.77 ± 1.09	1.95 ± 1.31	0.539	0.575
p value‡	0.005	0.055		
TNF-α (pg/mL)				
Baseline	30.93 ± 18.80	30.59 ± 13.82	0.947	0.350
End	28.50 ± 14.32	31.17 ± 18.03	0.479	0.188
p value‡	0.316	0.870		
Adiponectin (μg/mL)				
Baseline	12.45 ± 3.12	12.55 ± 3.83	0.923	0.890
End	14.36 ± 2.64	13.26 ± 3.15	0.254	0.602
p value‡	0.035	0.252		

hs-CRP, high sensitivity C-reactive protein; TNF-α, tumor necrosis factor-α.
*Independent t-test was used for comparison between 2 groups; †Analysis of covariance test was used for comparison between 2 groups after adjusting for age, gender, physical activity, weight and energy; ‡Paired t-test was used for comparison in one group.

grains are associated with glycemic control [24,25]. Furthermore, the previous evidence showed that a higher intake of vegetables, one of the components of nutrition education in the current study, has been negatively associated with a higher risk of diabetes [26]. These effects might be attributed to the higher fiber content and its positive effect on blood glucose concentration as the fiber intake increased significantly in the education group [26]. Another possible explanation is that energy intake has significantly declined in the education group. Energy intake restriction is one of the approaches to controlling diabetes [27-29]. It is important to consider that nutrition education is related to higher knowledge in diabetic patients that might be associated with glycemic control. A previous study has reported an impact of nutrition education on improving the knowledge and attitude of British diabetic patients [30]. Due to the importance of nutrition education, the American Diabetes Association has included self-management education as the main part of diabetes therapy [31]. In line with our findings, a previous study reported a decline in FBS and HbA1c in patients with type 2 diabetes from Qom, Iran, during a 10-week trial [18]. Furthermore, another study found that a 12-week nutrition education positively lowered levels of FBS and HbA1c in type 2 diabetic patients from Rasht, Iran [19]. A randomized clinical trial on American adults over 65 years old reported that nutrition education was impactful in reducing levels of FBS and HbA1c [32].

This study found a decline in the serum level of LDL, while no significant change in total cholesterol, triglyceride, and HDL was observed in the education group. Consistent with our findings, Shabbidar et al. [19] found no changes in the level of lipids after nutrition education in 135 adults from Rasht, Iran. Contrary to our results, another study in Iranian diabetic patients reported a decline in the level of cholesterol and triglyceride after nutrition education [18]. The opposite results might be due to different sample sizes and confounders. While our study included 44 adults from Ahvaz, Askari et al. [18] examined nutrition education on 494 adults from Ghom, Iran. In addition, the current study controlled the analysis for age, gender, physical activity, weight, and energy, while the association was only adjusted for weight and smoking in the Askari et al.'s study [18]. In accordance with the present results, a study on American adults over 65 years old did not find any change in lipid profiles after nutrition education [32]. In another randomized clinical trial, the effect of 3 years of nutrition education was ineffective in reducing the serum level of lipids but on the cholesterol level in women only [33].

This study examined the effect of nutrition education on the serum level of inflammatory markers and showed a decline and an increase in the levels of hs-CRP and adiponectin,

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respectively. While there is no evidence of the effect of nutrition education on the inflammatory markers in diabetic patients, an unhealthy diet has been reported as one of the pro-inflammatory lifestyle factors [34]. The evidence shows that diets high in refined grains, saturated fats and low intake of fruits, vegetables, fiber, and whole grains may increase the production of inflammatory markers [35]. The decline in the level of inflammatory markers might be related to MyPlate recommendations that instructed diabetic patients towards a healthier diet with a higher intake of fruits, vegetables, whole grains, and a lower intake of high-fat dairy products and saturated fat. Our previous study that examined the effect of nutrition education on inflammatory markers in Iranian obese women showed a positive impact of nutrition education on reducing inflammatory markers, including hs-CRP and TNF-α and increasing adiponectin levels [36]. A systematic review reported a negative association between the higher diet quality measured by diet quality indices, including Mediterranean dietary score (MDS) and inflammatory markers. The higher MDS score indicates a higher intake of fruits, vegetables, legumes, whole grains, and a lower intake of saturated fats, which is consistent with the recommendations of this study [37]. Furthermore, a previous study on 486 healthy Iranian women aged 40–60 reported that a healthy dietary pattern (high in fruits, vegetables, tomato, poultry, legumes, tea, fruit juices, and whole grains) was negatively associated with hs-CRP levels [38]. The SFA intake has decreased significantly in the education group. Given the evidence showed a positive association between SFA intake and hs-CRP [39], a decline in hs-CRP level could be attributed to a lower intake of SFA.

This study has several strengths. To the best of our knowledge, this study was the first study that examined the effect of nutrition education on the levels of inflammatory markers. Furthermore, this study was the first study that applied nutrition education based on MyPlate for controlling the complications of Iranian diabetic adults.

This study has limitations and implications for future research. This study included 44 adults; thus, it is needed to include a larger sample size in future research. While this study analyzed the nutrient intake, the intake of food groups was not assessed. As this limitation, the change in the meal pattern could not be clearly identified.

In conclusion, the present study demonstrated that education of MyPlate recommendations effectively decreases serum levels of FBS, HbA1c, LDL, hs-CRP, TNF-α and increases the level of adiponectin. The findings showed that the recommendations of MyPlate could be used as a cost-effective approach to controlling complications of Iranian diabetic patients. Future research should extend these findings to examine whether a more extended education intervention improves the lipid profiles in diabetic patients.

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