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Original Article

Provision of nutritional/lifestyle counseling on diabetes self-management: A chance to improve metabolic control in new cases of type 2 diabetes

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A B S T R A C T

Background: Type 2 diabetes (T2D) is an increasing public health problem primarily because of increase in the prevalence of a sedentary lifestyle and obesity. The aim of this study was to evaluate the efficacy of self-management education on metabolic control in adults with T2D.

Methods: In a quasi-experimental study, 300 patients with T2D recruited from the Diabetes Society of Natanz, Isfahan, Iran, from October 2012 to January 2013. The patients participated in a 16-week educational program held by trained dietician. At baseline, the intervention group attended a 20 minutes lifestyle and nutritional oral education program. Participants were assessed at baseline, 2 and 4 months follow-up for changes in body mass index, glycemic status, and lipid profile. Non-parametric and parametric descriptive and group × time (pre-post) repeated measure analysis of variance was done.

Results: The mean (± standard deviation) amount of weight lost between baseline and the end of 16 weeks was 0.66 ± 1.62 kg in compared to baseline ($p < 0.0010$). Significant time × treatment interaction effects were found for triglycerides ($p < 0.0001$), high density lipoprotein-cholesterol ($p = 0.0010$), fasting blood sugar (FBS) ($p < 0.0001$), 2-hour postprandial glucose ($p < 0.0001$), systolic blood pressure (BP) ($p < 0.0001$), diastolic BP ($p < 0.0001$), and hemoglobin A1c (HbA1c) ($p = 0.0010$). Mean FBS concentrations decreased by 30 mg/dl at week 16. There was a non-significant increase in the HbA1c.

Conclusion: Nutritional/lifestyle counseling may improve metabolic control in T2D patients. Hence, it is possible to improve T2D control by means of non-pharmacologic interventions.

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Introduction

Type 2 diabetes (T2D) is an increasing public health problem and costly condition associated with considerable morbidity and mortality as a result of increasing obesity and sedentary lifestyle [1, 2]. Recent evidence shows dramatic increases in diabetes during the last decade in Iran [3]. Poorly controlled diabetes is associated with greater generally recognized complications

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of diabetes include accelerated atherosclerosis (macrovascular disease) and microvascular disease-related retinopathy, nephropathy, and neuropathy [4, 5].

Considering to aforementioned complications, primary prevention (including diet and exercise) for the prevention of T2D is important. The American Diabetes Association recommends to promote self-management skills and knowledge of diabetes patients at least annually and to provide or to encourage continuing diabetes education [6].

Some studies showed that a planned counseling program optimize metabolic control, prevent acute and chronic complications, and improve quality of life [7, 8]. Moreover, evidence showed this therapeutic approach leads to improved hemoglobin A1c (HbA1c) (long-term indices of blood glucose control in diabetes) and lipid profile and patient's awareness about diabetes and ability to solve their problems [9, 10]. Clinical trials in general populations demonstrated that behavioral treatment resulted in a significant weight reduction compared to baseline [11, 12]. However, a few studies showed that self-control of blood glucose do not have any beneficial effect on blood glucose in T2D and can only increase the costs [13]. It seems that differences in educational programs and adaptation of counseling with education level of patients have some effects on the outcomes. Therefore, it is important to understand the effectiveness of conventional counsels for T2D patients on their nutritional functions. Among these nutritional functions, metabolic control is very important due to diabetes complications. Therefore, the current study was conducted to determine the effectiveness of conventional nutritional counseling on metabolic control of T2D patients.

Methods

The study protocol was according to the ethics committee of Isfahan University of Medical Sciences, Iran, and all the study subjects signed written informed consent.

Subjects

A total of 300 patients with T2D (57% women and 43% men), 52.5 ± 7.4 years old (range 30 to 65 years) which were new cases of T2D were recruited from the Diabetes Society of Natanz, Isfahan. The inclusion criteria were: (a) fasting blood sugar (FBS) more than 126 mg/dl, (b) 30-65 years old, (c) new cases of T2D, (d) no use of any diabetic medicines, (e) without any disease or particular physiological conditions that can affect on lipid profile or blood pressure (BP). Exclusion criteria included: (a) patients with type 1 diabetes mellitus, (b) gestational diabetes, (c) referred to follow-up or in the treatment process, (d) users of any drugs that can effect on lipid profile and glycemic status and BP such as diabetes drugs, (e) diseases or conditions which affect on lipid and glucose profile.

Intervention protocol

The patients were referred to nutritional counseling after physician visit. At the first visit, the study protocol was described in detail. Following the informed consent receiving, patients received nutrition and lifestyle educational plan. Educational topics were according to the Health Center of Isfahan province which was instructed for signs and symptoms of hyperglycemia and hypoglycemia, sick day management, use of a home glucometer, and changing behaviors for physical activity. In nutrition education part specifically participants were encouraged to progressively change eating behaviors, including increasing the frequency of meals and increasing the intake of complex carbohydrate, dietary fiber, fruits, vegetables, and polyunsaturated and monounsaturated fatty acids (fish and olive oils, respectively). The subheadings of nutritional/lifestyle counseling program are presented in table 1. The same educations with an approach to solve patients' problems were performed in the second (after 2 months) and third (after 4 months) visits.

Demographic assessments

We fulfilled a questionnaire about general data including age, sex, physical activity, physiologic conditions or other particular diseases, and education levels (including illiterate, primary school, intermediate school, high school, bachelor, and master). The questionnaire was designed according to Isfahan University of Medical Sciences protocols.

Anthropometrics and BP

Weight was measured with light clothes and without shoes using a digital scale (Sega 707, Hamburg, Germany) to the nearest of 0.1 kg. Height was measured without shoes using a stadiometer (Seca, Hamburg, Germany) to the nearest of 0.1 cm. Body mass index (BMI) was calculated using the equation BMI = weight/height^2. To measure BP, subjects

Table 1. The contents of nutritional/lifestyle counseling for diabetes self-management

Subheadings	Contents
Concepts	A. Common complications of T2D B. Risk factors of T2D complications and the importance of changing behaviors for prevention C. The importance of self-management of T2D for preventing its secondary complications
Healthy nutritional behaviors	A. Recognition of healthy and unhealthy foods for T2D patients B. The benefits and detriments of healthy and unhealthy foods for T2D patients C. The best Diets for managing diabetes D. Healthy cooking methods for T2D patients E. Healthy eating behavior for T2D patients F. Active managing of eating behaviors for self-management of T2D G. Recognition of healthy and unhealthy commercial foods for T2D patients
Glycemic management	A. The importance of glycemic management for T2D patients B. The best times for blood glucose monitoring C. Methods for self-monitoring of blood glucose by glucometer D. The best methods for treatment of Hypo or Hyperglycemia
Lifestyle changing	A. The importance of a healthy lifestyle for T2D control B. Recognition of unhealthy behaviors C. The importance of avoiding smoking for T2D D. The importance of daily exercise for T2D patients E. The best types of exercise for T2D patients F. The best times for exercise in T2D patients G. The importance of self-monitoring of body health during and after exercise in T2D patients

T2D = Type 2 diabetes

remained in a sitting position for at least 10 minutes. BP was then measured twice by a standard barometer that was calibrated by Institute of Standards and Industrial Research of Iran. The average of the two measurements was considered as the BP of the patient.

Laboratory investigation

Blood sampling

A blood sample was drawn between 07.00 and 10.00 AM after 12 hours of fasting. All patients have referred to Natanz Central Laboratory for laboratory investigations.

Glycemic status, lipid profile

Fasting serum glucose (FSG), lipid profile including triacylglycerol (TG), total cholesterol (TC), and high-density lipoprotein cholesterol (HDL-C) were determined using enzymatic methods. For oral glucose tolerance test, all patients have received an oral 82.5 g glucose monohydrate solution (equivalent to 75 g dehydrated glucose), then the blood sample were taken after 2 hours and centrifuged at 7000 rpm for 5 minutes. Fasting blood glucose was measured by Selectra-2 auto analyzer set (Vital Scientific, Pankeren, Netherlands) and Pars Azmoun.co kit. Glycosylated HbA1c was determined using a colorimetric method (Biosystems, Barcelona, Spain).

Statistical analysis

Normal distribution of data was assured using Kolmogorov–Smirnov. Data were expressed as mean ± standard deviation. Time × treatment (pre-post) repeated measure analysis of variance was used to evaluate the overall effect of nutrition counseling on anthropometric measurements, glycemic status, BP, and lipid profile. In this study, $p < 0.0500$ was considered significant. All statistical analyses were done using the statistical package for social sciences (SPSS) for Windows version 18 (SPSS Inc., Chicago, IL).

Results

Of the 300 new cases of T2D, 56 subjects were lost to follow-up (Figure 1). Table 2 presents the subjects' demographic, anthropometric, dietetic, and metabolic parameters at study week 0, week 8, and week 16. Mean of BMI was 29.29 ± 4.28 and 27.41 ± 4.52 in women and men, respectively. 78% of T2D patients had low education levels (Table 2). 47.9% of participants met the criteria for Class I obesity (BMI 25-30), 24.9% for Class II (BMI 30-35), and 7.6% were in Class III (BMI 35-40).

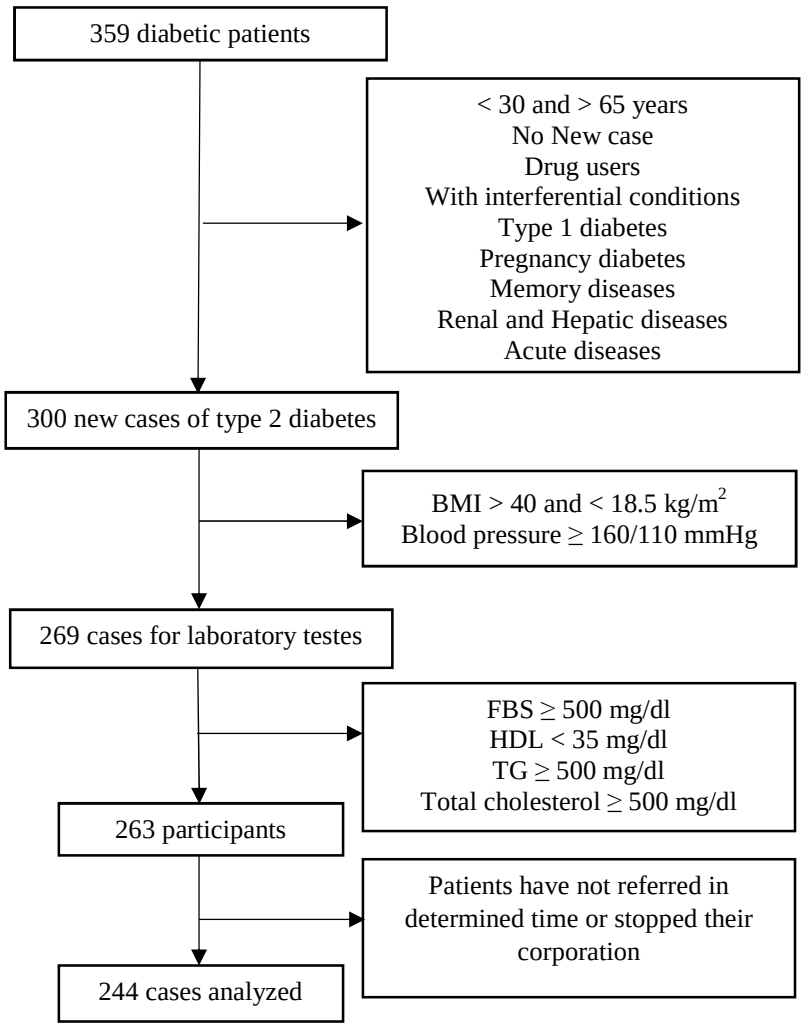

Figure 1. Study attrition diagram

Table 2. Demographic characteristics of the participants (n = 300) based on descriptive test

Variables	Categories	N (%)
Sex	Male	129 (43)
	Female	171 (57)
Education	Less than middle school	185 (61.7)
	Middle school graduate	34 (11.3)
	Less than high school	17 (5.6)
	High school graduate	46 (15.4)
	College graduate	18 (6)
Age	35 <	17 (5.6)
	35-50	60 (20)
	50-65	159 (53)
	> 65	64 (21.4)
BMI	18.5-25	59 (19.7)
	25-30	143 (47.6)
	30-35	75 (25)
	35-40	23 (7.7)
Body size	Small	23 (7.7)
	Medium	214 (71.3)
	Large	63 (21)
Activity level	Low	281 (93.7)
	Medium	17 (5.7)
	High	2 (0.6)

BMI = Body mass index

Table 3. Comparison of laboratory and blood pressure variables at baseline and during the study based on repeated measure test

Variables	Time 1 (week = 0)	Time 2 (week = 8)	Time 3 (week = 16)	Counseling p value	Time p value	Counseling and education p value
HbA1c	7.96 ± 1.83	7.67 ± 1.17	8.67 ± 7.69	0.0010	0.1590	0.0640
TG	155.6 ± 74.72	132.9 ± 40.34	130.6 ± 51.77	< 0.0001	0.1380	< 0.0001
TC	177.4 ± 42.51	158.2 ± 34.78	156.6 ± 38.55	< 0.0001	< 0.0001	< 0.0001
HDL	51.88 ± 38.19	49.34 ± 8.09	50.47 ± 10.95	0.0010	0.8480	
FBS	190.9 ± 69.40	176.6 ± 66.74	161.0 ± 55.72	< 0.0001	< 0.0001	< 0.0001
2hPPG	271.6 ± 100.6	242.9 ± 94.08	220.8 ± 84.32	< 0.0001	< 0.0001	< 0.0001
SBP	126.8 ± 18.01	124.2 ± 16.99	119.3 ± 17.78	< 0.0001	< 0.0001	0.0020
DBP	78.63 ± 11.37	77.33 ± 10.98	74.75 ± 10.85	< 0.0001	< 0.0001	< 0.0001
BMI	28.70 ± 4.43	28.23 ± 4.06	28.091 ± 3.95	< 0.0001	< 0.0001	< 0.0001

HbA1c = Hemoglobin A1c; TG = Triglyceride; TC = Total cholesterol; FBS = Fasting blood sugar; BMI = Body mass index; 2 hPPG = 2 hour post prandial glucose; SBP = Systolic blood pressure; DBP = Diastolic blood pressure

Frequency of patients with optimal diastolic BP (DBP) (lower than 80 mmHg) increased from 37.6% at week 0 to 45.8% at week 8 and 56% at week 16, respectively. Systolic BP (SBP) in 51.2% of the patients was <130 mmHg which increased to 63.3% and 75.6% at week 8 and week 12. Normal FSG (under 100 mg/dl) from 2.6% at week 0 reached to 7.1% at week 8 and 16. Normal HbA1c in diabetes patients (under 6%) from 12.5% at week 0 increased to 15.1% and 13.1% at week 8 and at week 16. Moreover, after 8 weeks frequency of 7.2% of diabetes patients with optimal 2-hours postprandial glucose (2hPPG) (under 140 mg/dl) reached to 12.5% at week 8 and 18.7% at week 16. Low HDL-C (under 40 mg/dl) showed significant reduces from 14.8% at week 0 to 5.2% at week 16. Optimal TC (under 200 mg/dl) increased from 70.1% at week 0 to 84.5% at week 16. Normal TG (under 200 mg/dl) increased from 83.9% at week 0 to 92.6% at week 8 and 88.5% at week 16.

Significant time effects between weeks 0 and 16 were observed for BMI, BP, glycemic status and lipid profile except for HbA1c ($p = 0.1590$), triglyceride ($p = 0.1380$), and HDL ($p = 0.8480$) (Table 3). Significant time × treatment interaction effects were found for triglycerides ($p < 0.0001$), HDL-C ($p = 0.0010$), FBS ($p < 0.0001$), 2hPPG ($p < 0.0001$), SBP ($p < 0.0001$), DBP ($p < 0.0001$), and HbA1c ($p = 0.0010$).

Discussion

The present study showed that nutritional and lifestyle education decreased BMI and improved both glycemic and dyslipidemic status in T2D patients which may have important implications for current clinical and public health practice. Our participants were new cases of T2D which had several and susceptible risk factors for long-term complications. The mean of BMI in T2D patients was in overweight ranges. This result is in favor with those of other studies which reported overweight and obesity are responsible for insulin resistance development [14, 15]. Moreover, low education levels of these patients may also have an important role in the disease development. The results also showed that the glycemic status of the patients was undesirable. Even without any elevated lipid profile and BP, several studies have shown that early prevention programs in early stages after the diagnosis of T2D can be more effective in control of the disease and to avoid secondary complications of T2D [16]. The low activity of patients is in favor of studies that have considered the low activity level as a risk factor for diabetes development [17, 18].

An intensive counseling (first 2 months) had a good effect on diabetes outcomes especially for lipid profile. These findings were in accord with results of a recent study by Beyazit et al., which found, with a 2-month-intensive lifestyle counseling, a significant reduction in HbA1c and BP in T2D patients compared with control group. The mean of BP also reached normal ranges [19]. Apart from the duration of education, a planned education had an important role in metabolic control through providing knowledge and skills and influencing on behavior to carry out self-care on routine basis [20]. Several published articles evaluating the effectiveness of education programs have demonstrated the efficacy of education on metabolic control, weight management, and lifestyle skills [21]. In 2000, an estimated 171 million people in the world had diabetes, and the numbers are projected to double by 2030 [22]. Interventions to prevent T2D will, therefore,

have an important role in future health policies [23]. Considering the low quality of life among patients with diabetes, nutritional counseling and lifestyle education can be tailored as a primary prevention for the development of T2D [24].

Among overweight persons with diabetes, weight loss improves insulin sensitivity and glycemic control [25, 26], whereas moderate intentional weight loss may be associated with reduced mortality. The reduced incidence of hypertension and diabetes in population, with impaired glucose tolerance or obesity that maintained weight loss over extended periods, provide indirect evidence of this benefit [14-16]. A meta-analysis by Yamaoka and Tango, provided an evidence for the efficacy of lifestyle education for individuals at high risk of T2D in reducing 2 hours plasma glucose and relative risk of diabetes [24]. Whereas, obesity is one of the components of the metabolic syndrome, as a predictor of T2D, many studies have examined BMI as one of the secondary outcomes. Some studies [27, 28] did not find a significant effect of lifestyle education on 2 hours plasma glucose, but they found a significant effect on BMI even after 1-week lifestyle [24]. Lifestyle-based weight loss interventions are also recommended to improve glycemic control and risk factors, but sustained weight loss is not determined yet. In a multi-center randomized clinical trial comparing the effects of intensive lifestyle intervention (ILI) and diabetes support and education (control group) on the incidence of major cardiovascular diseases (CVD) events, ILI could produce and maintain significant weight losses and improvements in fitness in individuals with T2D. Over the 4 years of follow-up period, those in ILI had better overall levels of glycemic control, BP, HDL-C and triglycerides, and thus spent considerable time with lower CVD risk [29].

Glycemic status was improved after 16 weeks except for HbA1c. FSG decreased significantly by 15.66%. However, we observed an increase in HbA1c by 8.91%. The time × treatment was not significant for HbA1c. Since HbA1c indicate glycemic control in the past weeks, so, it seems that our intervention period was short for affecting glycosylated HbA1c.

It was suggested that glycemic control may indeed play a role in the predication of many of the chronic complications of diabetes [30]. The U.K. prospective diabetes study showed that each 1% reduction in HbA1c over 10 years is associated with 21% reductions in risk for any end point related to diabetes, 21% for deaths related to diabetes, 14% for myocardial infarctions, and 37% for microvascular complications [31]. Norris et al., noted that self-management education improved HbA1c by 0.76% at immediate follow-up and by 0.26% after 4 months which is clinically significant [25]. The results from previous randomized clinical trials in Spain [32], Japan [33], and China [34] also provide evidences that dietary education program and lifestyle changes are effective in preventing diabetes, reducing plasma glucose levels and HbA1c percent and the magnitude of the benefit in these studies was similar to that in our study. Pementel found that with a Nutrition Education Program, HbA1c decreased significantly in the intervention group (−24.0%) and was not significant in the control group (+7.7%) [35]. In contrast, some of the studies did not find a significant effect of lifestyle education on 2 hours plasma glucose and HbA1c [27, 28, 36]. A recent meta-analyses and meta-regression by Ricci-Cabello et al. [37] support the efficacy of diabetes self-management education, with an effect size of 0.31 for HbA1c (95% confidence interval 0.14-0.48).

HbA1c is the best criterion for evaluation of metabolic control since it is not affected by recent changes in diets and lifestyle or medications [38]. However, Sone et al. reported that the decrease in HbA1c level occurred only in patients with HbA1c level 7.5% or higher regardless of intervention or control group [39]. It is suggested that the repetition of the education topics is in accordance with the needs of patients. Some have discussed that the type of education delivery and teaching method may influence metabolic control in T2D [40]. It was noted that face to face delivery, exercise in the content, and cognitive reframing explained 44% of variance in glucose control. That conflicts with results from Norris et al. [25] and Sigurdardottir et al. [41] where delivery, teaching methods or content did not influence reduction in HbA1c level.

In the current study, in addition to the improvements in the glycemic status and successful weight loss, we achieved significant improvements in TG and cholesterol levels. Lack of glycemic control in diabetes patient results in increase in cholesterol and TG levels [42]. Therefore, one of the most important predictors of good glycemic control is improvements of lipid profile in patients who receive lifestyle education [43]. Our patients did not have dyslipidemia, but they were at risk of

CVD. The educational program recommendations for lipid lowering were according to the National Cholesterol Education Program Policy [44] which decreased TG, low-density lipoprotein-cholesterol and TC and in contrast increased HDL-C. In addition to nutrition recommendations, changes in physical activity and other lifestyles definitely made improvements in lipid profiles. Changes in weight and reduces in BMI also are important determinants of decreases in TG and cholesterol levels.

In addition to long- and/or short-term educational programs, differences in counseling concepts, counseling environment, education levels of patients, and counsels' adaptation with their education levels can affect the outcomes of diabetes [45]. However, Dorland and Liddy, have investigated effects of two different counseling models on T2D patients' outcomes. Although, both of them had a well effect on blood glucose and BP profiles, there were no significant differences between the two types in the end of the study [46]. Then, it seems that there are some other variables that interact with counsels' effectiveness. Ong et al., suggested causes can be finance, frustration, and inconvenience, lack of motivation and education, and lack of self-reliance [45].

Conclusion

Our nutrition and lifestyle educational program could help patients to improve their metabolic profile. Whereas diabetes is a lifetime disease, patients need continues education as a part of their treatment plan. Further studies suggest to be conducted to determine the effect of education on metabolic control with a larger sample and over a longer period of time.

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Conflict of interest

None of the authors had any personal or financial conflicts of interest.

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