The impact of the Nutritional Educational Program on knowledge, practices, and glycemic control among adult diabetics in KSA

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Abstract

Introduction: adherence to the recommended diet for diabetics is a necessary part of diabetes control particularly, for the elderly. This study is carried out to investigate the impact of nutrition education on glycemic control of Saudi diabetic adults in Riyadh City in KSA. **Methods:** the pretest-posttest two group's experimental research design was used for conducting the study. Participants were 202 Saudi adults with type 2 diabetes at the Diabetic Center in Riyadh city. They were divided into experimental and control groups. The experimental group (141) was divided into two groups according to the educational method used in the nutrition education program. The first experimental group (72) was subjected to five days of group education, and The second experimental group (69) received individual nutrition education. The control group included 61 diabetics followed regularly in two PHC centers and they were given basic diabetes care. A questionnaire was used for pre and post-tests. The questionnaire was developed and tested by a pilot study. Both experimental and control groups were given the questionnaire before attending the educational programs. The questionnaire was followed by anthropometrics and blood biomedical measurements. Participants in the control groups were not involved in the education program. The impact of the program was assessed by the distribution of the previously used questionnaire both experiment and control groups as a post-test. The questionnaire was followed by a second biochemical assay to assess the outcomes of the implemented program. Data

collection was followed by pre-coded data analysis; tabulated and presented by numbers and percentage, mean, and standard deviation. Statistical analyses were performed using SPSS packages.

Results: the implemented nutrition education program in the present study revealed a significant increase in dietary knowledge score and total knowledge score among the experimental groups compared to the control group. Also, there is a significant improvement in the score of patients' perceived benefits of dieting and exercise among both experimental groups. **Conclusion**: **t**he implemented nutrition education program in this study revealed the importance of using a locally well-designed nutritional program in the management of diabetes mellitus among the elderly. Diabetes education, the process of teaching individuals and groups to manage their diabetes, has been considered an important part of clinical management for diabetics.

Introduction

Diet is a major treatment modality for persons with diabetes mellitus (ADA, 2010), it is often called the cornerstone of diabetes management. Yet, diet is reported to be the biggest problem experienced by diabetic patients (Lockington et al, 1988). Adherence to the recommended diet is low and less than half of the people with diabetes mellitus were reported to use written plans as part of their treatment plans (Evert & Boucher, 2013). Lifestyle changes required to adjust eating habits are difficult, particularly when patients do not receive adequate information and support. Moreover, lifestyle education (combined diet and exercise) can be considered a powerful tool. In a previous study, a randomized controlled trial of a new dietary education program to reduce plasma glucose levels among Japanese male workers showed that the new dietary education could reduce glucose levels by real changes in the total energy intake of individuals at high risk for type 2 diabetes (Watanabe et al, 2004). Most current lifestyle education interventions are based on a combination of dietary education with exercise. Thus, the world is compelled to deliver diabetes care that improves glycemic control, and effective diabetes nutritional education is an integral part of comprehensive diabetes care.

Diabetes self-management education and support is an essential part of treatment and useful in facilitating positive healthcare outcomes (ADA, 2015 & Mensing et al, 2007). Earlier research has suggested that a single nutrition counseling session can have a positive effect on blood values and body-mass index for diabetes and cardiovascular patients (Gaetke et al, 2006).

Studies that provided nutrition education to motivated persons or addressed older adults' health concerns were generally more successful. Literature showed that motivated persons such as those who initiated calls to obtain nutritional information were more successful in reaching their goals (Marcus et all, 2001). The process of teaching individuals to manage their diabetes has been considered an important part of the clinical management for diabetics since the 1930s that had led to enhanced management and dramatic control of diabetes mellitus (Elhadd, Al-Amoudi, Alzahrani, 2007; International Diabetes Federation, 2003). Studies showed that diabetes education can reduce diabetes-related morbidity, and mortality, and reduce the costs of diabetes care [Miller et al, 2002 & Taylor et al, 2000]

Patient education is an essential component of initial diabetes care. The efficacy of diabetes education on diabetes control has been recognized (Portero-Mclellan et al, 2007). Studies showed that early diabetes education has an overall valuable impact on patient well-being and glycemic control in different settings (Pimentel, et al, 2010).

Diabetes education play important role in reducing the risk factors that lead to diabetes complications. For example, increasing dietary fiber intake lead to reduce total cholesterol and hyperglycemia in patients with both impaired glucose tolerance and type two diabetes (Behall et al, 2006).

The importance of diet combined with medical interventions for diabetes has been well recognized. Patients often look for guidance about general diabetes care, including diet (Gans et al, 2003). The American Diabetes Association (ADA, 2009) stated that diabetics should be educated about diet to achieve treatment goals, and preferably provided by a registered dietitian.

Furthermore, the ADA's position statement titled "Nutrition Recommendations and Interventions for Diabetes" highlights the importance of nutrition education in preventing, managing existing diabetes, and preventing and slowing the onset of diabetes-related complications (Bantle JP, et al, 2008).

One of the most effective educational programs is Diabetes self-management training (DSMT) which is an education and training program that helps patients manage their diabetes. This program consists of 1 hour of individual assessment and 9 hours of group classes. One of the content areas outlined in the DSMT curriculum is incorporating nutritional management into the lifestyle. The nutrition education program provides intensive nutrition counseling and a therapy regimen that relies heavily on follow-up and feedback to assist patients with changing their behavior(s) over time. The program can be administered by a registered nurse, dietitian, or general physician.

Some studies' findings showed improvements in the Glycosylated hemoglobin ranging from 0.9 to 1.9% for diabetics getting nutrition education and better improvement in Glycosylated hemoglobin compared to study groups that getting less nutrition education (Pastors et al, 2002).

The American Dietetic Association reviewed seven studies implementing nutrition education and 16 studies implementing intensive lifestyle intervention with nutrition education. Their findings concluded that nutrition therapy is effective in lowering the occurrence of type 2 diabetes. Also, they concluded the reviewed seven studies showed that lifestyle interventions were more effective than pharmacotherapy at reducing diabetes occurrence (ADA, 2009). Therefore, ADA recommends the use of medications and the use of nutrition therapy and lifestyle changes as substitutes and complements to medications (ADA, 2009).

The Look AHEAD (Action for Health in Diabetes) study is currently underway to test the effects of similar lifestyle interventions in the treatment of 5,145 men and women who have already been diagnosed with type 2 diabetes. Although this trial is planned to extend for 11.5 years, the researchers recently published 1-year results that reported that the intensive lifestyle intervention group lost 8.6% of initial weight compared to 0.7% in the control group (Wadden et al, 2009). The intensive lifestyle intervention included comprehensive diet counseling from registered dieticians, whereas the control group received basic, or "usual," care for diabetes. The experimental group also had significantly greater

decreases in A1C, systolic and diastolic blood pressure, and triglyceride levels in the first year, compared to the control group (Wadden et al, 2009).

Research has shown that the nutrition education program is effective for the treatment of both type 1 and type 2 diabetes. The American Dietetic Association reviewed 8 randomized controlled studies that verified a positive effect of nutrition education programs in diabetes management, measured by improvement in A1C levels.

The need to educate diabetics, particularly elderly diabetics to enable them to modify their dietary practices becomes a necessity. A question that arises frequently is whether nutrition interventions made at a later age can improve health status and quality of life and reduce health care expenditure.

This study aims to evaluate the impact of nutrition education on glycemic control of Saudi diabetic adults in Riyadh City in KSA, compare between experimental groups and the control group before and after the nutrition education program, and identify the factors predicting changes in knowledge, practices, beliefs, and attitudes before and after implementing the nutrition education program.

Materials and Methods

The pretest-posttest two group's experimental research design was used for conducting the study. Participants were 202 Saudi adults with type 2 diabetes regularly coming or referred to the Diabetic Center in Riyadh city. They were divided into experimental and control groups. Only patients (141) referred within 6 months from two assigned PHC centers to the nutrition clinic in the Diabetic center in Riyadh were included in the experimental sample. The experimental group (141) was divided into two groups according to the educational method used in the nutrition education program. The first experimental group (72) was subjected to five days of group education, a constantly running diabetic education program in the diabetic center. The second experimental group (69) received individual nutrition education. However, a well-designed new diabetic nutrition education program was used for both experimental groups. The sessions for the experimental group were held by an expert dietitian and simple teaching aids were used. The control group included 61 diabetics followed regularly in two PHC centers and they were given basic diabetes care.

A well-designed questionnaire was used for pre and post-tests. The questionnaire was developed through a review of the literature and reviewed by two experts in nutrition and behavioral sciences with the principal investigator. The questionnaire was tested by a pilot study. Both experimental and control groups were given the questionnaire before attending the educational programs. The questionnaire was followed by anthropometrics and blood biomedical measurements. Anthropometric measurements were used to assess the nutrition status of the studied sample. It includes weight, height, and body mass index. Blood biochemical tests included fasting and post-prandial blood glucose, and glycated hemoglobin. The lipid profile was assessed by total serum cholesterol and serum triglycerides.

The first experimental group was assigned five days of educational activities. Patients' total energy expenditure was calculated on the first day by the nutritionist to prescribe suitable individualized meals for each participant attending the program. The face-to-face education method was used for the second

experimental group in one session for 45 minutes. The content of the session was similar for both experimental groups. All sessions were held by an expert dietitian.

Participants in the control groups were not involved in this education they received their regular diabetic care in the two selected primary healthcare centers.

The impact of the program was assessed by the distribution of the previously used questionnaire for all participants (experiment and control groups) as a post-test. The questionnaire was followed by a second biochemical assay to assess the outcomes of the implemented program. For ethical consideration, the control group was given sessions on nutrition at the end of the study.

Data collection was followed by pre-coded data analysis; tabulated and presented by numbers and percentage, mean, and standard deviation. Statistical analyses were performed using SPSS packages.

One-way analysis of variance was used to compare the three study groups before and after implementing the nutrition education program

The paired t-test for comparison between data before and after implementation of the nutrition education program to detect the impact of the program on the anthropometric measures and metabolic control of the diabetic sample.

The stepwise multiple regression analysis was used to determine the factors predicting the change in knowledge, practice, beliefs, and attitudes among the studied group before and after the implementation of the nutrition education program.

Results

202 Saudis adult diabetics were the participants in this study (51% males and 49% females) their ages ranged from 41to 50 years (45.1%) with a mean age of 46.08. 28% reported that they did not have formal education, 15.4% were primary school graduates, 15% were intermediate school graduates, and 17% were secondary school graduates. 18.8% completed their university education and 6% were postgraduates. The duration of diabetes since it was first diagnosed was 0-10 years, with a mean duration of 4.15 ± 3.11 years. Newly diagnosed diabetics (less than one year) were only 17.8%. Most of the participants (74.8%) were managed with oral hypoglycemic agents, 5.4% were on insulin injections, and 18.8% were managed by diet only.

However, about 44% of the total sample suffered from diabetic complications. One-quarter of the sample (25%) had hyperlipidemia, 9.41% had retinopathy, 2% had neuropathy, 1.48% had nephropathy, and 0.5% of the sample had cardiovascular problems. The majority of patients (67.8%) had a positive family history of diabetes, related to 1st and 2nd-degree relatives.

The impact of nutrition education program on knowledge, practices, and attitudes of participants

A comparison of the mean dietary knowledge among the three groups (individual teaching group, group teaching, and control group) within the pretest period, revealed that the experimental group had a

slightly higher mean score of dietary knowledge than the control group in most of the studied items. However, only 4 items {number of main daily meals recommended for diabetics (p=0.0006), foods that raise the blood sugar (p=0.012), type of snacks recommended (p=0.015), foods that help in controlling the blood sugar (p=0.035)} from 17 studied knowledge items revealed a significant difference in the three study groups within the pretest period.

After implementing the program, there was a marked significant increase in the mean dietary knowledge and total knowledge scores among the experimental groups compared to the control group (P=0.000) in all items. Similarly, the medical awareness score showed slight improvement but with no significant difference (p=0.076). The highest improvement in total knowledge score was among those receiving group teaching programs. (Table 1)

Table 1 Impact of the Nutrition Education Program on dietary knowledge and medical awareness of the participants.

	Pretest				Post-test			
Question related to dietary practices	Individual n=69	Group n=72	Control n=61	P value	Individual n=3s	Group n=48	Control n=37	P value
Which food raises blood sugar?	1.49±0.68	1.21±0.69	1.52±0.67	0.012	1.77±0.43	1.46 ± 0.5	1.49 ± 0.65	0.022
Which food is rich in fat?	1.49 ±0.69	1.32 ±0.88	1.19 ±0.81	0.109	1.63 ±0.59	1.52 ±0.77	1.41 ±0.64	0.389
Which food is protein?	0.93 ±0.93	1.22 ± 0.95	0.85 ±0.89	0.050	1.26 ±0.85	1.52 ±0.77	1.05 ±0.88	0.038
Which foods are high in cholesterol/	1.33 ±0.61	1.31 ±0.62	1.24 ±0.77	0.749	1.74 ±0.51	1.60 ±0.54	1.38 ± 0.64	0.023
Which diseases are caused due to high blood cholesterol levels?	1.51 ±0.72	1.28 ±0.83	1.39 ±0.84	0.234	1.69 ±0.58	1.69 ±0.69	1.54 ±0.73	0.549
Which food help in controlling the blood sugar?	1.12 ±0.96	1.44 ±0.87	1.06 ±0.95	0.035	1.69 ±0.72	1.79 ±0.54	1.11 ±0.94	0.000
Which foods are high in fiber?	1.01 ±0.63	1.14 ±0.66	0.93 ±0.77	0.222	1.23 ±0.55	1.31 ±0.51	1.24 ±0.76	0.793
How many main mails are recommended for diabetics per day?	0.93 ±1.00	0.69 ±0.96	1.25 ±0.97	0.006	1.14 ±1.00	1.08 ±1.01	1.08 ±1.01	0.956
How many times diabetic are recommended to take snacks?	1.22 ±0.94	1.15 ±0.94	1.08 ±1.00	0.725	1.37 ±0.94	1.66 ±0.72	1.14 ±0.98	0.022
What is the role of snacks in a diabetic diet?	1.12 ±0.99	1.21 ±0.98	0.97 ±0.98	0.370	1.17 ±0.98	1.56 ±0.82	1.14 ±0.98	0.061

What types of snacks are recommended?	1.81 ±0.46	1.88 ± 0.33	1.66 ±0.51	0.015	1.86 ±0.36	1.81 ±0.39	1.49 ±0.56	0.001
Drinks related to dietary knowledge	0.55±0.79	0.50±0.82	0.36±0.66	0.351	1.11±0.96	1.04±0.99	0.54±0.87	0.019
Best (suitable) timing to drink juices	0.62±0.93	0.61±0.93	0.33±0.72	0.098	0.43±0.81	0.17±0.56	0.35±0.75	0.216
Which foods are suitable for hypoglycemia?	1.01±0.88	1.29±0.88	1.07±0.83	0.134	1.57±0.74	1.38±0.79	1.00±0.82	0.008
Dietary knowledge Score 0-28	16.14±4.01	16.25±5.35	14.92±5.28	0.236	19.66±3.26	19.60±3.98	15.95±4.99	.000
What is the most convenient time to inject insulin	.000289 ±.24	0.13±0.47	0.13±0.49	0.282	0.00±0.00	0.000833 ±0.40	0.00±0.00	0.222
What is the purpose of giving OHA?	0.94±0.98	1.07±0.99	1.16±0.99	0.439	1.00±1.00	0.96±1.01	0.70±0.97	0.377
What are the symptoms of hypoglycemia?	1.12±0.92	1.15±0.89	1.00±0.91	0.609	1.37±0.88	1.39±0.82	1.05±0.91	0.156
Medical Awareness Score 0-6	2.09±1.40	2.35±1.65	2.29±1.33	0.547	2.37±1.42	2.44±1.51	1.76±1.38	0.076
Total Knowledge 0-34	18.23±4.78	18.59±6.21	17.21±5.75	0.350	22.03±3.79	22.04±4.54	17.70±5.67	0.000

Diabetic patients' practice:

When comparing the total dietary practices of groups before implementing the program, there was no significant difference between the total dietary practice score of the three groups (individual, group teaching, and control) 29.38 ± 3.73, 30.14 ± 3.70, and 30.15 ± 3.61, respectively and P = 0.376). However, after program implementation, there was a significant difference (P=0.000) effect on the mean score of patients' dietary practices in both experimental groups – participants receiving individual teaching program (31.99 ± 3.14) and group teaching program (32.27 ± 3.86) compared to the control group (28.93 ± 3.96). The improvement was observed in the items related to the use of low fat or skimmed dairy products, number of regular visits to a dietician, number of regular meals per day, and changes in food preparation (P=0.001, 0.001, 0.016, and 0.037 respectively).

The impact of the nutrition education programs on physical activity practices of diabetic patients.

There were no significant differences between the mean score of physical activity practice among patients receiving individual teaching programs, group teaching programs, and control groups before implementation of the nutrition education programs (2.93 ± 2.90, 2.85 ± 2.45, and 2.47±2.44 respectively, p=0.425). Program implementation brought about a significant increase in the total score of physical activities in the experimental group, with individual teaching at 4.97 ± 3.21 and group teaching at 4.71 ± 3.35 compared to the mean score of the control group (2.03 ± 1.96) with p=0.000. The improvement was of greater magnitude in patients receiving individual teaching than group teaching.

Diabetic patients' beliefs, attitudes, and perceptions:

The impact of the nutrition education program on perceived benefits of dieting and exercise among participants.

There was a significant difference (p = 0.491) in the perceived benefits of dieting and exercise among the three groups before the program. A significant difference was observed among the experimental group in their beliefs after the program such as the use of bitter and sour taste foods, herbals, and traditional prescriptions in managing diabetes (P-value = 0.000, 0.004 respectively), the importance of regular meals, quantified food intake, and using brown bread and honey will not benefit blood sugar (P-value = 0.006, 0.009 and 0.019 respectively). Table 2

There was a significant difference in the total perceived barriers score about dietary management after implementing the program among the three study groups (p =.007). Whereas, there were no significant differences in the barriers to exercise management (p = 0.131).

Table 2: Impact of the Nutrition Education program on perceived benefits of dieting and exercising of diabetic patients.

Items of Perceived benefits	Pretest				Post-test			
	Individual n=69	Group n=72	Control n=61	P value	Individual n=35	Group n=48	Control n=37	P value
Adherence to diet regimen	2.96 ±0.21	2.89 ±0.36	2.85 ±0.44	0.216	2.89 ±0.47	2.98 ±0.14	2.86 ±0.42	0.287
Regulate times and quantities of meals	236±0.73	2.35±0.72	2.33 t0.75	0.964	2.60 ±0.65	2.56±0.58	2.14 ±0.82	0.006
Using brown bread will not raise the blood sugar	1.49±0.76	1.51±0.79	1.59±0.82	0.764	2.09 ±0.92	1.63±0.87	1.49 ±0.77	0.009
Dates will not affect blood sugar	2.62±0.73	2.58±0.62	2.75 ±0.62	0.357	2.77 ±0.59	2.69±0.69	2.81 ±0.52	0.638
Honey will not affect blood sugar	2.30 ±0.71	2.28 ±0.75	2.18±0.72	0.601	2.40 ±0.77	2.56±0.54	2.14 ±0.75	0.019
Drinking tea after meals will decrease the blood sugar	2.26 ±0.59	2.38±0.70	2.29±0.74	0.590	2.43±0.61	2.44±0.62	2.26 ±0.59	0.084
Diabetics should avoid all starch	1.78 ±0.87	1.97 ±0.89	1 .95 ±0.92	0.396	2.00±0.91	2.35±0.86	1.92±0.98	0.067
Diabetics should avoid all fruits	2.54 ±0.72	2.65 ±0.63	2.74 ±0.57	0.205	2.74 ±0.51	2.73±0.51	2.73±0.51	0.993
Foods that have bitter and sour tastes may benefit diabetics	1.86 ±0.73	1.96 ±0.78	1.77 ±0.78	0.366	2.17 ±0.79	2.46±0.71	1.65 ±0.82	0.000

Regular exercise benefit diabetic	2.94 ±0.29	2.94±0.23	2.97±0.18	0.808	3.00±0.00	3.00±0.00	3.00±0.00	-
Maintain or reduce your weight	2.48 ±0.83	2.54 ±0.73	2.33±0.89	0.311	2.68±0.72	2.77±0.52	2.57±0.77	0.375
Herbals and traditional prescriptions may help manage diabetes	1.93±0.77	2.15±0.76	2.18 ±0.72	0.104	1.83 ±0.82	2.39±0.68	2.22±0.79	0.004
Total Perceived Benefit score 12-36	27.51±3.56	28.21± 3.36	27.93± 3.35	0.491	29.60±3.77	30.56±2.97	27.64±3.57	0.001

Biochemical assessment:

The impact of the different nutrition education programs on different biochemical parameters of male diabetic patients showed that the individual group teaching programs brought about a significant decrease ($P<0.05$) in fasting blood glucose levels. In the control group, the effect was negative. Similarly, the group teaching program caused a significant decrease in 2 hours post-prandial level. However, the education program had no impact on serum glycated hemoglobin triglyceride and cholesterol levels may be for the short period of the program.

However, there was no significant effect of the education program on FBG, 2hrpp, glycated hemoglobin, and lipid profile among female participants in the experimental and the control group.

But there was a significant improvement in serum cholesterol among females individual teaching group ($p=0.034$) when compared to the results before the program. Table 3

Table 3: Biochemical assessment

Male Parameters	Diabetic sample	Pretest		Post-test		Pre vs. Post
		Mean ± SD	P=value	Mean ± SD	P=value	Paired t-test
Fasting blood glucose level (mmol/l)	Individual group control	11.27±3.71 10.45±3.89 9.77±3.44	0.281	10.39±3.48 9.17±3.19 9.48±3.87	0.635	2.157 1.775 0.394
2hr post-prandial level (mmol/l)	Individual group control	16.16±5.04 14.49±3.88 14.29±4.41	0.283	14.46±4.89 12.63±4.89 13.74±5.58	0.651	1.239 1.465 1.996
Glycated hemoglobin level (%)	Individual group control	7.89±2.10 8.54±2.02 8.65±2.64	0.708	8.82±1.80 8.10±1.88 7.39±1.59	0.114	-2.882 0.935 1.678

Serum triglycerides (mmol)	Individual group control	2.22±1.90 1.70±1.19 1.81±1.51	0.413	1.78±0.80 1.57±0.76 1.76±0.88	0.741	0.829 -0.150 -1.159
Serum cholesterol (mmol/l)	Individual group control	5.33±1.31 4.79±1.23 4.93±1.05	0.220	4.96±0.71 4.99±0.93 5.10±1.31	0.937	2.621* -1.002 -0.813

Female Parameters	**Diabetic sample**	**Pretest**		**Post-test**		**Pre vs. Post**
		Mean ± SD	P=value	Mean ± SD	P=value	Paired t-test
Weight (kg)	Individual group control	12.27±4.34 11.20±4.99 9.43±3.24	0.081	8.08 ± 3.08 8.26 ± 2.96 10.17±3.46	0.118	2.766* 2.940* -2.262
Body mass index (kg/m2)	Individual group control	17.39±7.78 16.46±7.46 13.39±4.17	0.153	11.60±4.66 10.59±3.56 11.71±4.48	0.639	1.597 3.066* 1.677
Glycated hemoglobin level (%)	Individual group control	8.90±2.05 8.85±2.34 9.04±2.07	0.974	8.33±1.94 8.06±1.92 7.38±2.17	0.436	2.357 1.158 2.541*
Serum triglycerides (mmol)	Individual group control	2.05±1.36 2.05±1.27 5.25±11.06	0.133	1.75±0.59 1.77±0.80 4.77±9.06	0.142	-0.951 -1.013 0.773
Serum cholesterol (mmol/l)	Individual group control	5.42±0.99 5.39±1.13 5.02±2.03	0.608	5.47±1.09 5.01±0.76 5.37±1.79	0.501	0.181 0.589 -0.0803

Analysis of factors predicting change in knowledge, practices, beliefs, and attitudes after implementing the Nutrition Education program.

Stepwise multiple regressions:

Eight factors affecting knowledge among participants were entered into multiple regression analysis (type of education intervention, age, sex, education level, family monthly income, duration of diabetes, family diabetic history, and medical problems associated with diabetes.). The data showed that out of the eight examined variables; only four variables had significantly accounted for 20.4% of the variation in knowledge of participants before the program {education (Beta = 0.536), sex (Beta =0.330) with males reporting higher knowledge than females, duration of diabetes (Beta =0.156), and the family diabetic history (Beta=0.146)}.

After implementing the program, it was found out in the eight examined variables, four variables were significantly predicting 38.1% of the variation of knowledge. Those variables were education level (Beta=0.244), type of educational intervention (Beta=-0.293), family diabetic history (Beta=0.241), and

family income (Beta=0.237). It was found that only one type of educational intervention had a negative effect on knowledge change (r=0.536, p=0.000).

Dietary practice

Thirteen factors affecting dietary practices entered the regression analysis (type of education intervention, age, sex, education level, family monthly income, duration of diabetes, family diabetic history, medical problems associated with diabetes, total knowledge score, total perceived benefits score, total dietary barriers score, total exercise barriers score and total perceived severity score). Results showed that only three variables explained 14.5% of the variation in diabetic patients' dietary practices before the program. The total perceived benefits of dieting and exercising alone explained 8.1% of that variance (Beta =0.197), followed by total knowledge (Beta =0.188) and dietary barriers (Beta = -0.173). Dietary barriers had a negative effect on dietary practices change (r= 0.380, p= 0.010), denoting that increased perceived barriers to dieting will hinder dietary practices.

After implementation of the program, it was observed that the perceived dietary barriers and type of education intervention had a negative effect on change in dietary practices (Beta=- 0.385 and Beta =-0.154 respectively); while total perceived benefits and age had a positive effect change in dietary practice (Beta =0.284 and Beta =0. 178, respectively). These four predictors explained 38.6% of the total variation in dietary practice. Perceived dietary barriers alone had the highest share 25.4% of the variance.

Physical activity practices

Also, results showed that only three variables from the thirteen factors (in table 35) were significantly accounting for 21 .5% of the variation in patient's physical activity practices before the program: sex (Beta= -0.300), perceived exercise barriers (Beta= -0.312) and total knowledge (Beta= 0.151). It was found that sex and exercise barriers were negatively affecting exercise practice, which means that males and those who had no barriers to exercising were better at practicing exercise.

After implementation of the program, five factors account for 35% of the variation in physical activity Education level and total perceived benefits were positively affecting physical activity practices. practices (Beta =0.241 and Beta =0.164 respectively). Negative effect was found between physical activity practices and type of education intervention (Beta = - 0.217), dietary perceived barriers (Beta = -0.199), and exercise perceived barriers (Beta= -0.171). This indicates that those who received individual teaching perceived no barriers to dieting or exercising, and had better physical exercise practices.

Discussion

The main aim of the present study was to evaluate the impact of nutrition education programs on Saudi adult diabetics' knowledge, attitudes, practices, as well as their glycemic control.

The implemented nutrition education program in the present study revealed a significant increase in dietary knowledge score and total knowledge score among the experimental groups compared to the

control group. The program showed some improvement in medical awareness but it doesn't reach statistical significance. A slight improvement was also observed in the total dietary knowledge in the control group after the implementation of the program but the improvement is much less than that of the experimental groups. This finding is not unusual if we consider the pretest-posttest maturation. Maturation can occur because the posttest was carried out after three months of the program, which is considered enough time to acquire knowledge from other sources such as doctors, media, written materials, or even from personal experience.

In comparison between the two experimental groups (individual & group education settings), both reached nearly equal total mean knowledge scores. Patti, 2002 demonstrated that group and individual diabetes education are equally effective when using a consistent curriculum systemically delivered over a definite time frame. Many studies confirmed the effectiveness of using the 5-day educational program in diabetes knowledge, which can be easily explained by the fact that during the whole week patients participated in many lessons and were trained to repeat things that they should remember (Tankova et al, 200I).

After the implementation of the program, there was a significant improvement in the score of patients' Moreover, the mean scores of perceived benefits of dieting and exercise among both groups. perceived benefits of the different items of dieting were increased after the program. Meanwhile, no change was evident in the control group. The increased perceived benefits may be attributed to the apparent increased dietary knowledge after the program. This is supported by the finding of multiple regression analysis where patients' total knowledge was a predictor of diabetics' perceived benefits of dieting (R 2=0.271).

The implemented education program covered an important section on the dietary beliefs and misconceptions of diabetic patients. Research has shown that management-related misconceptions may be reflected negatively on patients' compliance and satisfaction with treatment, diet, knowledge regarding the disease, and regularity of follow-up (Philis et al, 2001; Al-Saeedi et al, 2002). To deliver effective nutrition education for patients, correction of dietary misconceptions should be done and supported by scientific and practical evidence. Therefore, our program succeeded to correct patients' dietary beliefs so, they were less believing in the benefit of bitter and sour taste foods and the use of brown bread, honey, herbals, and traditional prescriptions in managing diabetes. Also, they believed more in the importance of regular meals and quantified food intake.

Impact of Nutrition Education program on diabetic patients' practices:

program showed a significant improvement in almost all aspects The implemented nutrition education of dietary practices related to diabetes management well as the total practice score among the experimental groups compared to the control group. This could probably be attributed to the improvement of diabetic patients' knowledge, perceived benefits of dieting, and the decrease in perceived dietary barriers as those indicated by regression analysis. Van den Arend et al, 2000 reported that dispensing knowledge is an essential part of behavior change but alone is not sufficient for that change. Knowledge can lead to a favorable change in attitudes, perceptions, and beliefs, which may probably be related to the active involvement of the patient in his/her, own decision, constant

reinforcement, and his/her motivation (Sarkar et al (2010) and Whittemore R. (2000). A triggering event or cue to action is needed to put a decision into action. Patients are more likely to perform the desired behavior when they are reminded or have cues to perform the behavior. Educational messages given in the implemented program included some forms of cues to actions. In addition, the distribution of pamphlets about what was discussed during the teaching session and application of the information in the form of examples had been probably a type of support for the favorable behavioral change. It was previously shown that patients had a significantly better response in understanding and recall when they were given written instructions. (Wong et al 2014).

In the present study, both groups either individual or group education settings were nearly equal in influencing diabetic patients' dietary practices. This influence was lasting to 3 months after the program.

There was a significant improvement in compliance with dietician visits after the program ($p = 0.001$) and the improvement was obvious in the experimental groups compared to the control group. This may be due to a change in their perception of the importance of diet and increased perceived benefits of dieting. It is suggested that diabetes education programs should be developed with active listening, empathy, and mutuality. Human interaction is the best way to enhance compliance because satisfaction with care is a contributing factor to compliance (Robinson et al, 2008). Most studies that examined dietary changes were positive for self-reported changes, including improvements in dietary carbohydrate or fat intake, a decrease in caloric intake, and an increase in consumption of lower glycemic index foods (Susan et al, 2001). On the other hand, a study of a multimethod group program demonstrated the program's effects in improving compliance with the carbohydrate and fat composition of the diet, as well as glycemic control (Gregg et al, 2012).

There was a significant improvement in the total physical activity practices among the experimental groups compared to the control group. The importance of physical activities was stressed in both educational settings, moreover, the group teaching setting give a practical demonstration of exercise in the five days' education program. However, in the individual teaching group, the improvement seems to be apparent but not true. This is because the scores of times per week exercising and duration of exercise per time were decreased which reflects their real physical activities. Many studies with shorter follow-up duration noted an increase in physical activity at 4 months (Wood, 1989) and an increase in the number of minutes of activity 3 months after an intensive intervention (Glasgow et al, 1992).

Predictors of knowledge, beliefs, and practices after implementation of the program:

The stepwise multiple regression analysis identified four predictors (education level, type of education level, family history of diabetes, and monthly income) to account for 38.1% of the variation in diabetes knowledge after the implementation of the program. This indicates that apart from the variables investigated in this study, many unknown factors influence knowledge acquisition. Patients' educational level alone was responsible for 20% of that variation. Educational level may influence patients' readiness to learn and may enhance intrinsic motivation for knowing about diabetes. It seems that the prognosis of diabetes among their relatives has probably helped the change in their knowledge and beliefs. Family monthly income was another factor that predicted changes in diabetics' knowledge. This might be attributed to higher education of families of higher income.

Also, four predictors were found to predict 38.6% of the variation of dietary practices of diabetic barriers. The variance of dietary barriers constituted 25.4% of that variation. Perceived barriers were proved to be the strongest predictor of sick role behavior (Brown A. S. 2005; Janz et al, 1984). Also, total perceived benefits were one of the predictors of dietary practices. Improved personal attitudes were one of the predictors of dietary practices. Improved personal attitudes toward diet and motivations are more effective than knowledge in improving behavior and metabolic control (Lockington et al, 1988). A positive relation between total dietary practices and age showed that older patients had better dietary practices and were more suitable for health changes. So, dietitians need to consider younger persons with diabetes in their education process. In 1997 Terri reported that dieticians should take into consideration patient socio-demographic characteristics and that older patients are more recipients of changes for healthy living and we need to improve communication with patients to increase their understanding of diabetes (Terri, 1997).

Susan, 2001, stated that individual and group lifestyle intervention had positive effects on diet and self-care behavior. Notably, skills teaching was effective in both group and individual settings.

Other predictors that affect physical activity should be investigated such as cultural norms, availability of exercise facilities, cost of exercise, as well as self-efficacy, and locus of control beliefs. The sedentary lifestyle of the majority of Saudi people may explain the difficulty that patients meet in practicing physical activity after implementing the program.

Impact of Nutrition Education Program on diabetic patients' nutritional and health status

Despite the improvement in knowledge attitudes beliefs and practices of the patients, there was no significant difference in weight as well as BMI before and after the nutrition education program for both sexes. However, the mean weight and BMI of male's individual teaching setting were reduced from 79.04 kg to 77.74 kg and from 28.21 to 27.22 respectively during the study period (3 months) compared to group teaching setting and control groups. On the other hand, the mean weight for females in the group teaching setting was reduced from 79.1 kg to 78.57 kg during the same period compared to the other groups. This reflects the importance of short period follow-up visits to dieticians to give feedback, hence, it improves patient weight outcomes. Previous studies concluded that with more intensive nutrition intervention, which includes at least 3 visits with the dietician, lifestyle changes can lead to significant improvement in metabolic control and weight loss (Pi-Sunyer et al, 2007; Rao and Kirley, 2013).

Despite the small magnitude of the weight loss, the implementing program's short-term data showed improvement in fasting blood sugar, 2 hours past-prandial, and glycated hemoglobin. Knowler, 1980 mentioned that correcting the hyperglycemia may have improved insulin secretions without significant weight loss. The improvement in glycaemic control is likely to result from a change in attitudes and beliefs regarding diabetes, leading to a subsequent change in diabetes self-care behaviors (Snoek et al, 2001). Meta-analysis studies have shown that nutrition education is effective in improving knowledge, skills, psychosocial adjustment, metabolic control, and weight loss (Steinsbekk et al, 2012; Delahanty

and Nathan, 2008; Norris et al, 2001). However, Susan, 2001 reviewed other studies that showed positive effects on knowledge but mixed results on glycemic control and no effect on weight.

The glycemic control was more obvious among males compared to females; which may be related to the higher education level of the male patients. The decrease in glycated hemoglobin was found to be insignificant among both males and females in the experimental groups. Consistent with the results of Patti et al study the present study also revealed that the difference in HbAlc improvement was slightly greater in patients assigned to group versus individual education settings. This improvement in HbA1c was achieved within 3 months and maintained at 6 months for those who completed the program. (Patti et al, 2002). Opposite to the expectation, the control group showed more decrease in HbA1c compared to the experimental group due to unclear causes. This might be attributed to a problem in sampling and missed data for those subjected to biochemical assay. The results of other studies revealed that patients who received intervention incorporating the nutrition practice guidelines achieved a greater reduction in HbA1c than those patients who received standard nutrition intervention (Gregg et al, 2012).

Conclusion

The implemented nutrition education program in this study revealed the importance of using a locally well-designed nutritional program in the management of diabetes mellitus among the elderly. Diabetes education, the process of teaching individuals and groups to manage their diabetes, has been considered an important part of the clinical management for diabetics since the 1930s that enhanced the management and dramatic control of diabetes mellitus (Elhadd, Al-Amoudi, Alzahrani, 2007; International Diabetes Federation, 2003). Many studies showed that diabetes education can reduce diabetes-related morbidity and mortality while also reducing the costs of diabetes care [Miller et al, 2002 & Taylor et al, 2000]. To improve educational outcomes there seems no doubt that educational and psychosocial diagnoses are needed, also demographic characteristics can help in determining populations targeted for the education program.

Diabetes mellitus is a chronic lifelong disorder and a professional management plan is becoming necessary with careful follow-up to adopt and expand a plan according to patient circumstances.

study limitations

The first limitation is the small number of enrolled diabetic patients. The second limitation is that there were no available historical data regarding the diabetics' awareness of their nutritional needs.

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