Effects of Nutrition Education on Metabolic Profiles of Patients with Type 2 Diabetes Mellitus to Improve Glycated Hemoglobin and Body Mass Index

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Abstract

Objectives : Diabetes mellitus is a lifelong condition, in which patient self-management is one of the key aspects of treatment .Therapeutic education is an integral part of the therapeutic strategy for diabetic patients. Changing patients' lifestyles by modifying their diets through nutrition therapeutic education programs can reduce their body mass index (BMI), glycated hemoglobin (HbA1c) levels and control type 2 diabetes (T2DM). The aim of this study was to evaluate the effect of a proposed nutrition therapeutic education program on BMI and HbA1c in patients with T2DM.

Methods: The target population was T2DM patients from the Fez-Meknes region of Morocco, consulting at Al Amal diabetic association in Fez, Morocco, from February 2021 to July 2021. Before and after 3 months of the educational session, patients' glycemic profile, BMI and HbA1c were measured.

Results: A total of 160 diabetic patients with an average age of 56.8 ± 10.2 years were included in the study. Most participants lived in urban areas (86.3 %), were illiterate (39.4 %), and overweight (49.0 %). The results demonstrated that nutrition therapeutic education sessions reduced BMI and HbA1c of patients. A mean decrease of 0.8 kg/m^2 from 28.9 ± 5.2 to 28.1 ± 4.9 was observed for BMI. On average, HbA1c decreased 1.1 % from 8.6 ± 1.7 to 7.5 ± 1.0 ($p<0.001$).

Conclusion: The results suggest that the therapeutic education nutrition program was effective in decreasing the BMI and HbA1c of diabetic patients. Implementing such programs in all regions of Morocco is an urgent need.

Key words: Types 2 diabetes mellitus, Therapeutic education, Metabolic profile, Glycated hemoglobin, Body mass index.

Introduction

Due to its increased prevalence and comorbidities, over the past 30 years, diabetes has been a major public health problem (Escobedo et al., 2009). T2DM is considered one of the chronic illnesses with the greatest burden on public health (American Diabetes Association, 2013). The International Diabetes Federation defines diabetes illness as a true pandemic. In 2019, the global prevalence of diabetes has increased from 4.7% in 1980 to 9.3% among adults aged 18 years and older (Internationale Diabete Federation, 2019). Complications from diabetes are the direct cause of 4.2 million deaths among diabetic patients (Internationale Diabete Federation, 2019), nearly 80% of diabetics live in developing countries (WHO, 2014). The World Health Organization (WHO) predicts that by 2030, diabetes will be the 7th leading cause of death worldwide (Mathers & Loncar, 2006).

In the Middle East and North Africa, the total number of diabetic patients will double during the next 20 years (Internationale Diabete Federation, 2019). In Morocco, the national prevalence of diabetes among adults aged 20 years and older ranged from 6.6% in 2000 to 12.4% in 2016 (Chetoui et al., 2018). Between 2011 and 2015, the number of diabetics increased from 1.5 million to more than 2 million (Louardi, 2015). In addition, diabetes is the greatest cause of blindness, amputation, renal failure, and the 6th greatest cause of death. Moreover, the risk of cardiovascular mortality has tripled for diabetics relative to the rest of the population. 40% to 50% to of neuropathies and / or retinopathies were observed in diabetic cases, and diabetic life expectancy was decreased by 5 to 10 years (Belkhadir, 2017). Hence, therapeutic education, which is the process of teaching patients to manage their diabetes (Mensing et al., 2005), has become an integral part of the diabetic therapeutic strategy. Accordingly, the High Authority of Health (HAS) designated therapeutic education as a pivotal component for management of diabetes (HAS, 2014), through improving psychosocial, lifestyle, and clinical outcomes, increasing the patients' knowledge and skills, and changing behaviors of patients (Coppola et al., 2016).

T2DM is strongly linked to nutrition and lifestyle (Sami et al., 2017). Thus, insulin sensitivity in T2DM patients with can be significantly improved by modifying nutritional style (Guo et al., 2020). This is known as diabetes reversal, since most diabetic patients notice a gradual increase in blood glucose, weight, and medication doses, which can be controlled by nutritional education programs. This can lead to improvement in neuropathy and heart disease (Barnard & Grogan, 2007). Therapeutic education improves the quality of life and affects

significantly the treatment efficacy, which results in decreases in weight and associated complications (Golay, 2006).

Both direct and indirect, lifetime economic burdens on diabetic patients can be huge. DM care has been estimated to account for 12% of health expenditures (Dagogo-Jack, 2016). Prevention of complications by therapeutic education programs will not only improve the quality of life of patients but will also reduce the costs of medical care (International Diabetes Federation, 2006). Hence, a healthy diet, physical activity, medication, regular screening, and treatment of complications can avoid or delay the relevant complications (Roglic, 2016).

Considering the cited above elements; a high prevalence rate of T2DM and the effectiveness of nutritional therapeutic education in the management of T2DM complications, it was decided to conduct this study in order to evaluate the effects of a nutritional therapeutic education program on body mass index (BMI) and glycated hemoglobin (HbA1c) in T2DM patients in the region of Fez-Meknes, Morocco.

Material and methods

This study was performed from February 2021 to July 2021, in the region of Fez-Meknes of Morocco. A total of 160 diabetic patients , 94 women and 66 men , were included in this study. They were all consulting a medical association of diabetes (Al Amal: Hope) in the Fez-Meknes region. Inclusion criteria were as follows: a) to be a Moroccan citizen, b) aged 18 years old and over, c) to be a type 2 diabetic for at least 3 months, d) showing an HbA1c level ≥ 7% for at least 3 months before starting the study, e) depicting or not degenerative complications, and f) speaking Moroccan dialect Arabic. The cut-off of HbA1c=7% was based on the High Authority of Health (HAS) recommendations that endorses HbA1c <7% for the T2DM treatment when the level of HbA1c crosses the threshold 7% (Haute Autorité de Santé, 2013). All participants gave fully informed consent before starting the study., and after informing them of the study's process and purpose while ensuring their confidentiality and anonymity. Researchers had ensured that the internationally accepted ethical principles for research involving human subjects were followed throughout this research, and all methods were applied in accordance with relevant guidelines and regulations.

Effects of an individual session of nutrition therapeutic education were made for the glycemic profile and body mass index of T2DM patients before and after the therapeutic program. Mixed methods were used; The first consisted of a questionnaire of T2DM, which was validated and used to collect socio-demographic, clinical, and biological data. Other

parameters, including weight, height, blood pressure, blood glucose, and glycated hemoglobin were measured. After 3 months of educational sessions, patients were reassessed, and glycemic profile and body mass index were measured.

Statistical analysis

We used SPSS (Statistical Package for the Social Sciences) version 24.0 to analyze the data. Normality was checked by using the Shapiro–Wilks test and the assumption of homogeneity of variance were evaluated using Levene's test. Non-parametric statistics, such as the Man-Whitney U test. Descriptive and univariate analyses were performed upon quantitative and qualitative variables. The Body mass index (BMI) was calculated (Equation 1).

(1) BMI= body mass (kg)/[height (m)]^2

Results

According to the results socio-demographic and clinical characteristics of patients with T2DM, 160 patients included in the study, 41.3% were male and 58.8 % were female (with sex ratio M/W = 0.7). The average age of patients was 56.8 ± 10.2 years, most participants belonged to the age groups 46-60 and older than 60 years, and 39.4% were illiterate. Most recruited patients lived in urban areas (86.3%), were married (76.3%), unemployed (51.3%), and had medical coverage (81.9%). Among participants, 60.6% were diagnosed with T2DM between 1 and 10 years, and only 21.2% of the patients had a normal BMI (18.5 to 24.9) (Table 1).

Table 1: Sociodemographic and clinical characteristics of the T2DM patients (N=160).

Variables	No. of patients	%
Gender		
Male	66	41.3
Female	94	58.8
Age groups (years)		
30 to 45	27	16.9
46 to 60	70	43.8
> 60	63	39.4
Place of residency		
Urban	138	86.3
Rural	22	13.8
Marital status		
Single	10	6.3
Married	122	76.3
Divorced	12	7.5
Widowed	16	10.0
Employment status		
Unemployed	13	8.1
Employed	35	21.9
Retired	30	18.8
Not working	82	51.3
Medical coverage		
Yes	131	81.9
No	29	18.1
Education		
College	29	18.1
University	12	7.5
Illiterate	63	39.4
High School	19	11.9
Primary	37	23.1
Diagnosed duration (year)		
< 1	14	8.8
1 to 10	97	60.6
11 to 20	41	25.6
21 to 30	8	5.0
Body mass index (kg/m^2)		
18.5 to 24.9	32	21.2
25 to 29.9	74	49.0
> 30	45	29.8

Regarding the results obtained on the effects of the therapeutic nutrition education program on the BMI of the participants, we observed that there was a decrease of 0.7 kg/m^2 in mean BMI of patients, which was observed in various age groups, gender, residency, education, marital status, employment, and medical coverage. A small increase of 0.1 kg/m^2in BMI was observed among patients whose duration of diabetes diagnosis was less than one year. After 3 months of the therapeutic program, the total and the significant decrease in mean BMI was 0.8 kg/m^2, from 28.9 ± 5.2 to 28.1 ± 4.9 ($p < 0.001$) (Table 2).

Table 2: Effects of the nutrition therapeutic education program on BMI of participants.

Variables	No. of patients	Mean BMI[1] (kg/m^2) (Pre)-SD[2]	Mean BMI[1] (kg/m^2) (Post)-SD[2]	Mean differences
Sex				
Male	61	27.8 (5.3)	26.8 (4.7)	1.0
Female	90	29.7 (5.0)	28.9 (4.9)	0.8
Age groups (years)				
30 to 45	26	29.1 (6.1)	28.2 (5.8)	0.9
46 to 60	69	29.5 (5.7)	28.7 (5.4)	0.8
Over 60	56	28.1 (4.0)	27.3 (3.7)	0.8
Place of residency				
Urban	130	29.1 (5.3)	28.4 (5.1)	0.7
Rural	21	27.6 (3.9)	26.4 (3.3)	1.2
Marital status				
Single	10	30.3 (8.1)	29.8 (7.8)	0.5
Married	114	28.8 (5.0)	27.9 (4.7)	0.9
Divorced	12	27.8 (3.9)	27.3 (3.7)	0.5
Widowed	15	29.6 (5.1)	28.6 (4.8)	1.0
Employment status				
Unemployed	13	29.6 (7.6)	28.5 (7.0)	1.1
Employed	35	28.3 (5.7)	27.3 (5.3)	1.0
Retired	26	27.1 (3.7)	26.2 (3.0)	0.9
Not working	77	29.7 (4.8)	29.0 (4.8)	0.7
Medical coverage				
Yes	123	29.4 (5.5)	28.5 (5.2)	0.9
No	28	26.8 (2.5)	26.3 (2.5)	0.5
Education				
College	26	28.5 (4.4)	27.4 (4.1)	1.1
University	11	26.6 (2.5)	25.7 (2.3)	0.9
Illiterate	61	29.6 (5.2)	28.7 (4.9)	0.9
High School	18	28.6 (5.6)	27.8 (5.3)	0.8
Primary	35	29.0 (6.0)	28.4 (5.7)	0.6
Diagnosed duration (year)				
< 1	14	27.6 (3.5)	27.7 (3.1)	0.1
1 to 10	93	29.3 (5.5)	28.5 (5.1)	0.8
11 to 20	36	29.0 (4.9)	28.2 (5.0)	0.8
21 to 30	8	26.5 (3.9)	25.8 (3.5)	0.7
Overall				
Total no.	137	28.9 (5.2)	28.1 (4.9)	0.8 p<0.001

1 BMI: Body Mass Index 2 SD: Standard Deviation

A reduction of 1.1% was also observed on the patients' HbA1c levels (from 8.6 ± 1.7 to 7.5 ± 1.0; $p < 0.001$). This significant decrease in HbA1c in patients with T2DM, demonstrated the efficiency of the proposed nutrition education program (Table 3).

Table 3: Effects of the nutrition therapeutic education program on HbA1c of participants.

Variables	No. of patients	Mean HbA1c[1] (%) (Pre)-SD[2]	Mean HbA1c[1] (%) % (Post)-SD[2]	Mean differences
Sex				
Male	66	8.8 (1.9)	7.5 (1.2)	1.3
Female	94	8.6 (1.6)	7.5 (0.9)	1.1
Age groups (years)				
30 to 45	27	9.5 (2.1)	8.0 (1.3)	1.5
46 to 60	70	8.6 (1.5)	7.4 (0.9)	1.2
Over 60	63	8.3 (1.8)	7.3 (1.1)	1.0
Place of residency				
Urban	138	8.6 (1.4)	7.5 (0.6)	1.1
Rural	22	8.7 (1.8)	7.3 (1.1)	1.4
Marital status				
Single	10	9.1 (2.0)	7.5 (1.0)	1.6
Married	122	8.7 (1.8)	7.5 (1.1)	1.2
Divorced	12	8.3 (1.1)	7.3 (0.8)	1.0
Widowed	16	8.3 (1.4)	7.6 (0.9)	0.7
Employment status				
Unemployed	13	8.4 (1.5)	7.3 (0.6)	1.1
Employed	35	9.1 (2.0)	7.8 (1.2)	1.3
Retired	30	8.5 (1.9)	7.2 (1.3)	1.3
Not working	82	8.5 (1.6)	7.5 (0.9)	1.0
Medical coverage				
Yes	131	8.6 (1.8)	7.5 (1.1)	1.1
No	29	8.7 (1.7)	7.5 (0.9)	1.2
Education				
College	29	8.8 (1.8)	7.5 (1.1)	1.3
University	12	7.7 (0.8)	7.0 (0.5)	0.7
Illiterate	63	8.6 (1.8)	7.5 (1.0)	1.1
High School	19	8.7 (1.5)	7.5 (0.9)	1.2
Primary	37	8.8 (2.0)	7.6 (1.3)	1.2
Diagnosed duration (year)				
< 1	14	8.9 (2.4)	7.4 (1.2)	1.5
1 to 10	97	8.5 (1.5)	7.4 (0.9)	1.1
11 to 20	41	8.8 (1.9)	7.7 (1.2)	1.1
21 to 30	8	9.7 (1.6)	7.6 (0.6)	2.1
Overall				
Total no.	144	8.6 (1.7)	7.5 (1.0)	1.1 p<0.001

1 HbA1c: Glycated Hemoglobin 2 SD: Standard Deviation

Discussion

The current study determined effects of a nutritional therapy education program on the control of T2DM of 160 patients. Results showed that T2DM was more frequent in women (58.8%). This is consistent with previous results that suggested more diabetics were women (66.4%) (Meisinger et al., 2002), and similar to results of other studies that found that T2D affected women disproportionately (Misra & Lager, 2009). Besides, findings of the study, results of which are reported here, that most (43.8%) of the patients were between 46 and 60 years. In fact, according to the World Health Organization (WHO), 75% of diabetic patients are 45 years old and above in developing countries (WHO, 2014). Even in developed countries, such as the United States, the Centers for Disease Control and Prevention (CDC) stated that in 2015, the group age 45- 64 was the most diagnosed with diabetes in this country (CDC, 2020).

Most (86.3%) of the diabetic patients resided in urban areas, which is consistent with other findings stating that prevalence of diabetes in urban areas is twice that of rural areas (Seck et al., 2015). Diabetes was also more prevalent among illiterate patients and those with lesser education. Similarly, previous studies have found that people with less education had a greater prevalence of diabetes (Bharati et al., 2011). Any program to educate people must be easy to understand since the level of education is an important factor in knowledge acquisition (Russell-Minda et al., 2009). Concerning the BMI, half of the diabetic patients (49.0 %) were overweight (BMI 25-29.9 kg/m^2) and one third of the patients (29.8 %) were obese (BMI ≥30 kg/m^2). These results are consonant with previous findings of an investigated the mechanism linking obesity and T2DM (Kahn et al., 2006).

Based on results of this study, the proposed nutrition therapy education program was effective in reducing the BMI of diabetic patients in all the studied age groups such that the overall mean decreases in patient BMI by a rate of 0.8 kg/m^2 at the end of the study. Similarly, the BMI of patients decreased by 0.5 kg/m^2 at the end of the six- months educational program (Coppell et al., 2010). Likewise, other studies have also reported the effect of nutrition education program on decreasing BMI in diabetic patients (Di Onofrio et al., 2018; Pérez-Cornejo et al., 2021).

Results of the present study demonstrated that the proposed nutrition therapy education program resulted in a total mean decrease of (1.1%) in HbA1c. Glycated hemoglobin decreased in all groups, including age, sex, place of residency, education levels, BMI levels, and lengths of diagnosis. The highest level of decrease in HbA1c was observed in patients with duration of

diagnosis between 21 and 30 years. Likewise, other studies have found that the proposed nutrition intervention led to an improvement decrease in (0.4%) HbA1c (Coppell et al., 2010). When effectiveness of simplified diabetes nutrition education on control blood glucose and other diabetes-related outcomes in patients with T2DM (Hashim et al., 2021), it was found that the proposed nutritional program resulted in a significant decrease of 1.7% in HbA1c. Furthermore, results of the study reported here were consistent with several trials that have shown a decrease in HbA1c of 1-2% in type 2 diabetes through medical and nutritional therapy (Pastors et al., 2002, 2003). Finally, a similar study carried out previously show that education program had significant effects on knowledge of subjects about their disease, particularly regarding nutrition (Otero et al., 2008).

One of the limits that we faced in our study is the cultural diversity of our population, which could be a source of difference in the results. We also note that our intervention has only one educational intervention evaluated after 3 months, which didn't allow a long-term periodic follow-up.

Conclusion

According to the results of our study, T2DM can be reversed and controlled by therapeutic nutrition education programs by reducing HbA1c and BMI. Such structured educational programs should be implemented and monitored as part of the treatment of diabetes in Morocco. This will allow us to reduce the costs of managing the disease and also improve the quality of life of patients.

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