FACTORS ASSOCIATED WITH ADHERENCE TO RECOMMENDED DIETARY REGIMEN AMONG ADULTS WITH DIABETES IN LEBANON

A Thesis

presented to

the Faculty of Nursing and Health Sciences

at Notre Dame University-Louaize

In Partial Fulfillment

of the Requirements for the Degree

Master of Science in Human Nutrition

---

by

SARAH GHEMRAWI

MAY 2022

Notre Dame University-Louaize (NDU)

Faculty of Nursing and Health Sciences

Department of Nursing & Health Sciences

We hereby approve the thesis of

Sarah Ghemrawi

Candidate for the Master of Science in Human Nutrition

Doris Jaalouk, PhD, MPH	Co-Supervisor
Cecile Obeid, MS	Co-Supervisor
Maya Abou Jaoudeh, MS	Committee Member
Samar Merhi, MS	Committee Member

ACKNOWLEDGEMENTS

First and foremost, I would like to thank God, for letting me through all the difficulties.

I would like to express my deepest gratitude to my advisor, Dr. Doris Jaalouk, for providing guidance and dedicated support from the initial step. Her patience, vision, and motivation have deeply inspired me. This work would not have been completed without her.

Special thanks to Mrs. Cecile Obeid for being my co-advisor and to the committee members Mrs. Maya Abou Jaoude and also Mrs. Samar Merhi who provided guidance in data statistical analysis.

I am grateful for my parents for their constant love, prayers, caring and sacrifices for educating and preparing me for my future.

Finally, I owe my deepest thanks to my husband for unconditional love and support.

Table of Contents

ABSTRACT:

Background: Diabetes is a major health disease reaching epidemic levels in the Middle East Regions. It is associated with many complications that have an adverse effect on patient's quality of life. Nutrition therapy is essential, where dietary modification and improved dietary habits are important for its management and control. **Objective:** This study aimed to assess the adherence to dietary recommendations of adult patients with Type 2 Diabetes Mellitus (T2DM) diagnosed since at least one year residing in north Lebanon and to explore factors associated with this adherence.

Methods: A cross-sectional study was conducted among a convenient sample of 97 diabetic subjects recruited from diabetes outpatient clinics and primary health care center, in North Lebanon. Dietary adherence was assessed using Perceived Dietary Adherence Questionnaire (PDAQ), and data about sociodemographic, lifestyle, and disease related variables were collected using a well-structured background questionnaire. Data were analyzed using SPSS software and the significance level was set at $p<0.05$.

Results: Sample mean age (SD) was 53.6 ± 8.5 years and 53.6% were males. While majority (53.6%) had moderate adherence, 41.2% had poor adherence to dietary recommendations. Adherence was highest for fruit and vegetable intake and avoiding foods high in sugar, and was lowest for eating fish and spacing carbohydrates during the day.

Adherence to dietary recommendations was significantly associated with seeking care from outpatient clinics, being obese, low physical activity level, high stress level, somewhat recent diabetes diagnosis and having hypertension or renal disease as other comorbidities.

Future Implications: Improvement in adherence to recommended diet is one way to achieve glycemic control in diabetes. Furthermore, promoting a more positive attitude towards proper dietary choices and habits can yield a good management for the disease.

Key words: Type 2 Diabetes, Dietary recommendations, Dietary Adherence, Determinant

I. Background:

A. Diabetes

1. Definition, prevalence, risk factors and complications:

Diabetes is a major non-communicable disease that is increasing worldwide (Guariguata et al.,2014) and it is prevalent in both developed and developing countries (Li et al.,2012). According to International Diabetes Federation (IDF), in 2019, approximately 463 million adults (20-79 years) were living with diabetes where 1 in 5 of the people above 65 years old have diabetes. Moreover, IDF estimated that the global prevalence of diabetes will rise to 700 million by 2045. Type 2 diabetes is characterized by increased glucose levels in blood (hyperglycemia) due to insulin resistance where the body's cells become resistant to insulin (CDC,2017). It is the most common type of diabetes that accounts for 90-95% of cases (Zheng et al.,2018). It is more frequent in people aged 45 and above (CDC.,2017). According to the IDF, changes in life trends such as urbanization, nutrition transition, and sedentary lifestyles are the main risk factors contributing to this prevalence (IDF.,2015). Diabetes development is related to unhealthy lifestyle habits (ADA.,2018), and it is considered as a diet-dependent disease (ADA.,2016). A strong positive association was found between body mass index (BMI) and T2DM development (Sabbagh et al.,2014).). Diabetes can lead to series of complications: macrovascular, microvascular, and neuropathies. Diabetic patients are at increased risk of developing infections (IDF.,2015) and have double the risk for cardiovascular disease compared to diabetes-free individuals (Lancet.,2010). Other complications for diabetes include chronic kidney disease (nephropathy), retinopathy and

limb amputation (Pedicino et al.,2013). These numerous complications will pose a great burden on the health care systems due to management measures' costs needed (Brandle et al.,2003).

2. Treatment/ management of diabetes:

The main goal for a diabetic individual is to be able to manage the disease and its complications (ADA.,2018). Successful management is highly dependent on the patient's involvement in self-care behaviors (Lanting et al.,2008). These behaviors are categorized into three modifying approaches which aid in achieving optimal glucose levels: Prescriptions for medications, diet modification, and physical activity (Jordan and Jordan.,2010). Mechanisms of action for medications includes stimulating insulin secretions, increasing glucose uptake by cells, delaying carbohydrate's absorption and many more (Cavaiola et al.,2017). Metformin is the most commonly used medication under the class of biguanide which works on increasing glucose uptake by the muscles (Olokoba et al.,2012). Physical activity is shown to reduce glycemia and improve insulin resistance (Sigal et al.,2008). Finally, high importance is given to weight management (Bluher et al.,2022).

B. Dietary Management in diabetics

1. Importance and recommended diet:

A study conducted in Mexico among participants with type 2 diabetes from indigenous communities revealed an alarming finding: patients consider that diabetes is rooted in emotional aspects and that food has no relation with the disease (Juárez-Ramírez et al.,2019). However, of the preferred lifestyle changes, dietary modifications are the first recommended strategies to

consider while managing diabetes although it is considered a challenging step (Forouhi et al.,2018). Adherence to dietary regimens tend to decrease glycosylated hemoglobin levels (HbA1c) by 0.61-0.66% (Mottalib et al.,2018). In a study by Ekore et al (2008), appropriate dietary practices emphasize on the intake of fiber, fish, soy products, fruits and vegetable and the restriction of fat and sodium containing foods. Whereas other studies emphasize on energy restriction (Snel et al.,2012), low carbohydrate diet, increasing fiber intake, decreasing sodium intake, eating regular meals, and avoiding excessive alcohol consumption (Nielsen and Joensson.,2008). The Mediterranean diet (MD) was also found to be effective for diabetes management by improving insulin sensitivity and reducing blood glucose levels (Schwingshackl et al.,2015). Furthermore, a study conducted among 500 diabetic Iranian patients (mean age 56.9 ± 0.5; 41% males) found that MD adherence was negatively associated with HbA1c levels, and this correlation was statistically significant. This was shown to reduce the risk of developing retinopathy and nephropathy by 94% and 86%, respectively (Mirahmadizadeh et al.,2020).

2. Adherence assessment to recommended diet among diabetics:

Adherence to dietary recommendations among diabetics has been assessed using different tools. Multiple studies used the Perceived Dietary Adherence Questionnaire (PDAQ) (Ayele et al., 2018; Doglikuu et al., 2021; Doglikuu et al., 2021; Mohammed et al., 2020; Raj et al., 2018), which assesses adherence based on recommendations of the Canadian Diabetes Association (CDA) with reference to following Canada's Food Guide (CFG) (Asaad et al.,2015). Other studies used the Patient Diet Adherence in Diabetes (PDAD) (Jaworski et al.,2018) alongside assessment of dietary intake by way of Food Frequency Questionnaire (FFQ), or diet records. Non-adherence was common among Ethiopian diabetics (n=303; mean age 51 ± 7.6; 47.6% males) where percentage

reached 55.7%, based on a 10-item dietary adherence scale developed by the authors (Mohammed and Sharew et al.,2019). Moreover, from another Ethiopian study (n=320; mean age 52.7 ± 12.3; 53% males), poor adherence to dietary recommendations was reported by 74.3% of diabetics (Ayele et al.,2018). Among the studies that used the PDAQ in addition to the diet records, is the one conducted in 2016 among a sample of 80 diabetic Canadians (mean age 61.2 ± 10.4; 40% males). This study aimed to evaluate the associations between dietary adherence to Canadian Diabetes Association (CDA) and Healthy Canada guidelines and glycemic control. PDAQ scores were analyzed and low adherence was observed especially for the avoidance of foods high in fats and the inclusion of food rich in omega 3 fatty acids. This study confirmed that high sodium intake, high saturated fat intake, and lower PDAQ scores were associated with higher HbA1c levels (Raj et al.,2018). KDA-KMHW (Korean Diabetes Association; Korean Ministry of Health and Welfare) index was also used to evaluate dietary adherence among Korean people (n=4955; aged above 30). The least followed recommendations were moderate consumption of calories and carbohydrates and the limitation of sodium. On the other hand, maintaining regular meal patterns was the most followed recommendation. Improvements in vegetables and alcohol intakes were achieved by time (alcohol intake decreased; vegetable intake increased) (Park.,2015). Furthermore, low adherence for fruits and vegetables, whole grains and beans, food prepared with walnut and canola oil was observed in a recent study in Ghana (Doglikuu et al.,2021).

3. <u>Determinants associated with dietary adherence:</u>

Several determinants (sociodemographic, lifestyle-related, and disease related factors) showed association with dietary adherence among diabetics. While males were found to have significantly higher adherence scores than females in Canada (mean age 61.2 ± 10.4; 40% males) (Raj et

al.,2018), there was no association between sex and dietary adherence level among a sample of 320 Ethiopian diabetics (mean age 52.7 ± 12.3; 53% males) (Ayele et al.,2018). Other determinants associated with poor diet adherence were rural residence, low educational level, unemployment, low-income, long-time duration since diabetes diagnosis (>10 years), presence of comorbidities, and lack of previous exposure/ explanation to any education related to diet from a healthcare provider (Ayele et al.,2018). Attending diabetes education and having the disease for more than 10 years showed significant positive correlation with adherence in another study conducted in 2019 in Ethiopia (n=303 with mean age 51 ± 7.6; 47.9% males) (Mohammed and Sharew.,2019). Poverty and ethnicity were linked to dietary adherence as per findings from a study conducted among diabetics from Mexico (mean age 56.5 ± 11; 14% males) (Juárez-Ramírez et al.,2019). Moreover, diabetic patients who were treated with a combination of diet and oral antidiabetic medications (or insulin) were found to have significantly better adherence to dietary recommendations compared to those who were only treated with diet regimen according to a study in Poland (n=91, mean age 55.2 ± 11.57; 41.8% males) (Jaworski et al.,2018). Patients who regularly performed self-blood glucose monitoring exhibited better adherence too (Jaworski et al.,2018). Men whose wives prepared their meals, and young adults whose mothers prepared their meals reported greater adherence to dietary recommendations (Juárez-Ramírez et al.,2019). Being married and having a high socioeconomic status were associated with higher PDAQ scores according to a recent study in Ghana (Doglikuu et al.,2021). According to a Korean study, the total KDA-KMHW index was significantly lower in those aged 30-64 years old compared to elderly (≥ 65 years). On the contrary, being overweight and obese, having advanced age, and smoking were factors significantly associated with poor adherence to MD in Iran (Mirahmadizadeh et al.,2020).

Adherence to dietary treatment was positively associated with the doctor's explanations about the disease (Juárez-Ramírez et al.,2019).

4. Barriers for dietary adherence among diabetics:

Many factors were found to negatively influence dietary adherence in diabetics. A cross-sectional study in Iran (n=146, mean age 52.3 ± 6.6; 16% males) sorted these barriers into subcategories. Among these barriers were the situational ones, like difficulty with meals and snacks plan, confusion about dietary recommendations, stress related barriers, small portion sizes, work related barriers, lack of palatability, and family support. Difficulty with meal and snack plans constituted the most significant barrier (Halali et al.,2016). Gathering with friends and family and eating outside home was identified as a barrier to diet adherence among an Ethiopian sample (Mohammed and Sharew.,2019) whereas dislike of recommended diet and high cost of food were reported by 52.5% and 26.2% respectively, in a cross -sectional study conducted among diabetic patients in Mexico (n=195; mean age 56.5 ± 11; 14% males) (Juárez-Ramírez et al.,2019). Lack of knowledge about the appropriate diet emerged as a barrier for many diabetics (87%), where many (67%) did not believe that a recommended diet can control and achieve normalized blood glucose levels (Ayele et al.,2018). The consumption of traditional foods related to some cultural practices had inhibited many from adhering to diet recommendations among a sample of diabetics from Mexico (Juárez-Ramírez et al.,2019).

C. Diabetes in Lebanon

As part of the Eastern Mediterranean region, Lebanon is experiencing an increase in diabetic cases (IDF.,2015) where its prevalence was found to be 7.95% according to a national study (n=17832; mean age 35.9 ± 20.4 years; 55.4% males) (Bou-Orm and Adib.,2020). Published studies from Lebanon mainly focused on prevalence and risk factors for diabetes (Costanian et al.,2014), factors associated with glycemic control (Haraty et al.,2019) and medication adherence (Mroueh et al.,2018 and Ayoub et al.,2019), as well as patient's knowledge and diabetes self-management practices (Karaoui et al.,2018). Other studies addressed the association between emotional states (depression, alexithymia) and diabetes (Ahmadieh et al.,2018), and explored factors associated with consulting a dietitian (Alameddine et al.,2013). The prevalence of T2DM was reported at 8.5% according to a study published in 2014 (n=2195; mean age 44.7±14.9; 46.4% males). Factors that were found to be associated with an increased risk of diabetes included being obese, being widowed or divorced, and having a family history for diabetes (Costanian et al.,2014). In another study by Ahmadieh et al. (2019), BMI was confirmed to be positively correlated with type 2 diabetes (n=595 diabetics; mean age 59.37 ± 10.85).

The most commonly reported complications for diabetes were retinopathy (Bou-Orm and Adib.,2020) and heart diseases (Costanian et al.,2014). Hypoglycemia was another severe consequence that occurred in 30% of patients, among which at least one third required medical attention including hospitalization (Bou-Orm and Adib.,2020).

Factors that have significant correlations with levels of HbA1c were addressed also. A recent cross-sectional study by Haraty et al in 2019 (n=280, mean age 58.24 ±13.48; 46.24% males) showed that advanced age, female gender, and diabetes education were significantly correlated

with lower levels of HbA1c. Contrarily, having diabetes for more than 11 years, having higher number of diabetes complications, having higher scores on diabetes fatalism (cultural belief where the individual loses self-control for chronic disease and believes that a higher power predetermines its health outcomes) and having higher emotional distress were associated with higher levels of HbA1c (Haraty et al.,2019).

Two studies assessed adherence to diabetic medications. A study done by Mroueh et al. (2018) among 245 diabetics (average age 59.32, 45.7% males) showed that 68.2% of diabetic people had low medication adherence. Several factors showed significant correlation with low medication adherence including forgetfulness, experiencing side effects, having high drug cost, and being treated with complex regimens (Mroueh et al.,2018). Additional factors such as long working hours, increased number of drugs taken per day, drug discontinuation or skipping, and duration of the disease were also associated with low adherence to oral antidiabetic treatment in the Lebanese population in a study conducted among 500 diabetics (mean age= 59.2±10.7, 40% males). On the other hand, once daily dosing of drug, understanding of treatment, and following the doctor's recommendations were associated with increasing adherence to anti-diabetic medications (Ayoub et al.,2019).

In order to assess knowledge and practice in regards to diabetes self-management, Karaoui et al. (2018) conducted a study (n=207 where 94% have T2DM with a mean age 60.3 ±14; 57.9% males) and results showed that having higher educational level, and following a special diet were significantly associated with higher diabetes knowledge scores (Karaoui et al.,2018). The importance of education was also revealed in another intervention study which aimed to educate 71 newly diagnosed with T2DM patients, with no prior dietary consultation, about the Academy

of Nutrition and Dietetics Evidence Based Nutrition Practice Guidelines (EBNPGs) for diabetics (mean age 55 ± 10.7; 48% males). After several educational visit sessions conducted by dietitians, results revealed a significant reduction in HbA1c, BMI, and blood lipids levels at the 12-months follow up (Yahia et al.,2017).

Depression was assessed in a study conducted among a sample of 436 diabetic Lebanese (mean age 64.08 ± 17.06, 35.8% males). More than one quarter revealed depression. The presence of hypoglycemic episodes, internet source of disease education, and the presence of complications such as retinopathy and nephropathy were the main determinants associated with depression (Ahmadieh et al.,2018). In another study (104 T2DM cases and 100 controls; mean age 59.4 ±14.2; 60.6% males), investigators examined the link between alexithymia, defined by the person's difficulty to express feelings and emotions or to describe them, and glycemic control in diabetes. Alexithymia was found to be prevalent among people with T2DM (35.5%) and showed significant positive correlation with blood glucose and HbA1c levels. In addition, diabetic patients who experienced alexithymia had 5 times more hospitalization cases compared to those who were alexithymia free (Fares et al.,2019).

With regard to dietary counseling, findings from a cross-sectional study revealed that 75% of diabetics (n=333 with a mean age 60.18± 11.9; 55.3% males) believed that a dietitian can help in changing behavior and habits; however only 38% consulted a dietitian. Referral by the physician was the strongest factor to be positively associated with consulting a nutritionist. Other factors included presence of health insurance, duration of the disease, and the belief that a dietitian really aids in changing behaviors (Alameddine et al.,2013). Only around half of Lebanese people were following a healthy diet and exercise plan (Ahmadieh et al.,2019).

D. Knowledge Gap in Lebanon

In Lebanon, there is shortage of studies and lack of information assessing adherence to dietary regimens among diabetic people and its associated determinants (barriers as well as facilitators), which clearly indicates the need for conducting a study addressing this. In order to promote diabetic self-care management in Lebanon, the associated factors for diet adherence need to be clearly identified among diabetic patients. Therefore, the present study was conducted to assess the adherence of diabetic people to dietary recommendations and its determinants.

Research Objectives:

1- Assess the level of adherence of diabetic type 2 patients aged 20 years and older residing in North Lebanon to dietary recommendations
2- Assess the main individual determinants associated with adherence level to dietary regimen

II. Methods:

A. Study population:

A convenient sample of 97 subjects of both genders was recruited from five private diabetes outpatient' clinics and one public primary health care centers, in North Lebanon. Subjects were eligible to participate in this study if they met the following inclusion criteria: Being a Lebanese adult aged 20-65 years' old who had received a medical diagnosis of diabetes type 2 (T2DM) for at least 1 year. Exclusion criteria were: pregnant and lactating women, critically ill patients, those

suffering from cognitive decline or impairment, and those who have had severe diabetes complications (kidney failure- foot amputations). Patients were asked to provide verbal/oral consent for participation, subsequent to communicating with them the study aim and expectations. Subjects were assured that their data will be strictly used for scientific purposes and that the information they provide will be kept anonymous. IRB approval was secured from Notre Dame University-Louaize (NDU) Lebanon on May 2021.

B. Exposure / Independent variables Assessment:

Multiple independent variables were sorted into the following categories: Sociodemographic, lifestyle, anthropometric, disease-related, and patient- healthcare provider relationship determinants were assessed through a questionnaire.

Sociodemographic Determinants: Data on sociodemographic status included age (in years), gender (male, female), marital status (single, married, divorced, widowed), place of residence (urban, rural), educational status (no formal education, primary education, secondary education, university) and employment status.

Lifestyle and Anthropometric Determinants: Data on lifestyle factors included smoking status (non-smoker, ex- smoker, smoker), physical activity, eating habits and perceived stress. Anthropometrics include weight (kg) and height (cm) for determination of BMI (According to WHO, BMI=weight (in kg)/ height^2 (in m^2); underweight (<18.5 kg/m^2), normal weight (18.5-24.9 kg/m^2, Overweight (25-29.9 kg/m^2), Obesity (≥30 kg/m^2))

Disease-related Determinants: Duration/ time since diabetes medical diagnosis (in years), prescribed treatment (pharmacological and lifestyle), presence of diabetes-related complications, presence of comorbidities (other diseases), family history of diabetes, and knowledge/ education about dietary recommendations in diabetes.

C. Outcome Assessment:

The outcome addressed in this study was the adherence level to dietary recommendations for diabetics. Dietary adherence was assessed using the PDAQ. The score includes nine questions structured to cover recommendations as per the Canadian Diabetes Association (CDA) guidelines. The response is based on a 7-points Likert scale to answer the questions phrased as "On how many of the last SEVEN DAYS did you …? ".

Higher scores on seven out of nine questions indicate higher perceived adherence. For questions that relate to the consumption of high-fat and high-sugar foods (questions 4 and 9), higher scores indicate lower adherence. Answers to these two questions were inversely recorded hence a score of 7 was recorded as 0. Scores on the 9 questions in the PDAQ were summed up to form a total PDAQ score. The maximum PDAQ score to be obtained is 63; the minimum score is 7.

Patients who scored 0 to 21 points on the scale were considered to have low adherence, those who scored from 22 to 42 were said to have moderate adherence and those who scored 43–63 points were said to have high adherence to dietary recommendation (Doglikuu et al., 2021).

D. Data collection procedure:

To assess questionnaire formulation and time needed for completion, the search assessment tools (questionnaire plus the PDAQ) were tested on a pilot sample of 10 patients (from nearby community). The manager of the PHC was contacted for permission to conduct this study on site and to reach out to the participants. As for the outpatient clinics, physicians were contacted about study objectives and eligibility requirements were discussed. Therefore, patients were referred by the physicians to the investigator. Data was collected via face-to-face interview with participants using a well-structured questionnaire developed based on literature. Data was collected in two phases with a 6 months gap. The response rate was around 70% and 83% for phase 1 and phase 2 participants, respectively. The questionnaire was written in English and translated to Arabic to facilitate its comprehension and was filled by the researcher (a certified dietitian). Subsequently, the final version of the assessment tools was deployed. Data collected from the pilot sample were not included in the study analysis.

E. Data Analysis:

Analysis of data was carried out using Statistical Package for the Social Science (SPSS) software version 26.0 for Windows. Descriptive statistical analysis was performed to determine means and standard deviations (SD) for continuous variables, and frequencies and percentages for categorical ones. To explore relationships between two continuous and 2 categorical variables, correlation analysis (Pearson - Spearman) and chi square tests were used, respectively. Mean groups differences were tested using independent samples T-Test (or its non-parametric equivalence, Mann-Whitney test) for comparing two groups and one-way ANOVA (or its non-

parametric equivalence, Kruskal Wallis test) when there were more than 2 groups to be compared. Normality was assessed by histograms and assumptions were tested. In case the assumptions were not met (no linear correlation with the dependent variable), some continuous variables were recoded as categorical to perform the tests (age, years since diagnosis). A p-value < 0.05 was considered to be statistically significant.

III. Results

1. Sociodemographic, Anthropometric, and Lifestyle Characteristics

A total number of 97 participants out of 130 (response rate of 74.6%) agreed to complete the questionnaire. The mean age of the total sample was 53.6 ± 8.5 years. The enrolled sample included more males (53.6%) than females (46.4%). Close to 80% lived in urban places, and 78% were married. Concerning educational status, 35.1%, 28.9%, and 19.6% of participants had primary, secondary, and university education, respectively, while 16.5% had no formal education. Approximately, half of participants (51.5%) were unemployed. Participants were almost equally recruited from outpatient clinic (52.6%) and primary healthcare center (47.4%). Close to 90% of study participants were overweight (32%) and obese (57.7%). Furthermore, 43.3% were smokers, and 81.4% were not physically active. When participants were asked to rate their stress level on a scale from 1 to 7, the mean stress level reported was 5.2 ± 1.5. As regards to eating habits, 62% do not eat their meals at the same time, while one third (33%) eat main meals, sometimes or usually, outside home. (Table 1)

Table 1:Sociodemographic, Anthropometric, and Lifestyle Characteristics of the Study Sample (Total n= 97)	
	Mean ± SD, Or n (%)
Age (years)	53.6 ± 8.5
Gender	
Male	52 (53.6%)
Female	45 (46.4%)
Place of Residence	
Urban	77 (79.4%)
Rural	20 (20.6%)
Marital Status	
Single	8 (8.2%)
Married	76 (78.4%)
Divorced	6 (6.2%)
Widowed	7 (7.2%)
Educational Level	
No formal Education	16 (16.5%)
Primary	34 (35.1%)
Secondary	28 (28.9%)
University	19 (19.6%)
Employment Status	
Unemployed	50 (51.5%)
Employed	41 (42.3%)
Retired	6 (6.2%)
Source	
Outpatient clinic	51 (52.6%)
Primary healthcare center	46 (47.4%)
BMI	
Normal (18.5-24.9 kg/m^2)	10 (10.3%)
Overweight (25-29.9 kg/m^2)	31 (32%)
Obesity (≥ 30 kg/m^2)	56 (57.7%)
Smoking Status	
Non-Smoker	49 (50.5%)
Smoker	42 (43.3%)
Ex-smoker	6 (6.2%)
Physical Activity	
No	79 (81.4%)

Yes	18 (18.6%)
Stress Level	5.2 ± 1.5
Same Time Meals	
No	60 (61.9%)
Yes	37 (38.1%)
Meals Outside Home	
Rarely	65 (67.0%)
Sometimes	25 (25.8%)
Usually	7 (7.2%)

SD: Standard Deviation; BMI: Body Mass Index

2. Disease Related Characteristics

The mean duration since diagnosis of DM was 9.6 ± 7.2 years. About 79.4% of participants had a family history of DM. The prevalence of comorbidities was 69.1%, where 41.2% had one comorbidity and 27.8% had more than one. The most reported comorbidity was hypertension (52.6%). While more than half of the participants were obese, only 14.4% reported presence of high cholesterol and 7.2% high triglycerides levels. Renal disease was prevalent in 9.3% of the sample. Close to three fourths (75.3%) had received education regarding recommended diet in diabetes from their healthcare provider, and 79.4% considered that diet is important in controlling their blood sugar levels. Finally, 86.6% of participants were on antidiabetic medications, and only 16.5% were following lifestyle modifications (diet and physical activity) as a treatment for diabetes (Table 2).

Table 2:Disease Related Characteristics of the Study Sample

	Mean ± SD, Or n (%)
Years Since Diagnosis	9.6 ± 7.2
Family History of Diabetes	
No	20 (20.6%)

Yes	77 (79.4%)
Presence of Comorbidities	
No	30 (30.9%)
Yes (one comorbidity)	40 (41.2%)
Yes (more than one)	27 (27.8%)
Presence of Hypertension	
No	46 (47.4%)
Yes	51 (52.6%)
Presence of High Cholesterol Levels	
No	83 (85.6%)
Yes	14 (14.4%)
Presence of High Triglycerides	
No	90 (92.8%)
Yes	7 (7.2%)
Presence of Cardiovascular Disease *(abnormal heart rhythms, surgery, cardiomyopathy)*	
No	81 (83.5%)
Yes	16 (16.5%)
Presence of Renal Disease *(chronic kidney disease, on dialysis, polycystic kidney disease)*	
No	88 (90.7%)
Yes	9 (9.3%)
Presence of Hyperthyroidism	
No	92 (94.8%)
Yes	5 (5.2%)
Exposure to Nutrition Education from Healthcare Provider	
No	24 (24.7%)
Yes	73 (75.3%)
Perception that Diet is Important in Controlling Diabetes	
No	20 (20.3%)
Yes	77 (79.4%)
Treatment *(more than 1 answer may apply)*	
Antidiabetic medications	
No	13 (13.4%)

Yes	84 (86.6%)
Insulin	
No	79 (81.4%)
Yes	18 (18.6%)
Lifestyle modifications	
No	81 (83.5%)
Yes	16 (16.5%)

3. Perceived Adherence to Dietary Recommendations

The mean PDAQ score among all participants was 25.2 ± 8.7. The highest mean adherence score (4.4 ± 2.3) was reported for the recommended intake of fruits and vegetables. The second highest mean adherence score (3.8 ± 2.1) emerged for intake of foods low in sugar. Participants had the lowest mean adherence score (0.9 ± 1.3) for intake of fish or other foods high in omega-3 fats followed by spacing carbohydrates evenly throughout the day (1.1 ± 1.9). Regarding overall adherence, and as per classification adopted by Doglikuu et al. (2021), 53.6% had moderate adherence to recommended dietary guidelines for diabetics and 41.2% had poor adherence. Only 5.2% were considered as high adherent. (Table 3)

Table 3:Perceived Adherence to Dietary Recommendations

		Mean ± SD, or n (%)
1	On how many of the last SEVEN DAYS have you followed a healthful eating plan?	2.4 ± 2.3
2	On how many of the last SEVEN DAYS did you eat the number of fruit and vegetables?	4.4 ± 2.3
3	On how many of the last SEVEN DAYS did you eat carbohydrate-containing foods with a low Glycemic Index? (Example: dried beans, lentils, barley, pasta, low fat dairy products)	3.4 ± 2.0
4	On how many of the last SEVEN DAYS did you avoid eating foods high in sugar, such as rice, potatoes, etc.?	3.8 ± 2.1

5	On how many of the last SEVEN DAYS did you eat foods high in fiber such as oatmeal, high fiber cereals, and whole-grain breads	2.6 ± 2.2
6	On how many of the last SEVEN DAYS did you space carbohydrates evenly throughout the day?	1.1 ± 1.9
7	On how many of the last SEVEN DAYS did you eat fish or other foods high in omega-3 fats?	0.9 ± 1.3
8	On how many of the last SEVEN DAYS did you eat foods that contained or was prepared with canola, walnut, olive, or flax oils?	3.6 ± 2.2
9	On how many of the last SEVEN DAYS did you avoid eating foods high in fat (such as high fat dairy products, fatty meat, fried foods or deep-fried foods)?	3.4 ± 2.3
	Total PDAQ score	25.2 ± 8.7
	Adherence to PDAQ	
	Low Adherence	40 (41.2%)
	Moderate Adherence	52 (53.6%)
	High Adherence	5 (5.2%)

PDAQ: Perceived Dietary Adherence Questionnaire

4. Association between sociodemographic, anthropometric, and lifestyle variables with PDAQ score

None of the sociodemographic variables, such as age, gender, residence, marital status, level of education and employment status showed significant associations with PDAQ scores. Participants enrolled from primary healthcare centers had statistically significant higher mean adherence score (29.3 ± 8.5) than those enlisted from outpatient clinics (21.6 ± 7.1). Overweight subjects had higher mean adherence score (27.7 ± 9.7) than obese ones (23.1 ± 7.5). Participants who had at least 150 minutes of moderate intensity physical activity per week had higher mean adherence score (30.9

± 7.9) than those who did not (23.9 ± 8.3). Stress level showed statistically significant negative correlation with adherence score (r=-0.307; p=0.002). (Table 4)

Table 4:Associations between sociodemographic, anthropometric, and lifestyle variables with PDAQ total score

	Mean	SD	P Value*	Statistical Test
Age Group				
30-39	29.3	7.4	0.101	One Way ANOVA
40-49	22.3	6.7		
50-59	24.6	9.0		
>=60	27.8	9.2		
Gender				
male	25.4	1.3	0.886	Independent Sample T Test
female	25.1	1.2		
Residence				
Urban	25.4	8.8	0.797	Independent Sample T Test
Rural	24.8	8.3		
Marital status				
Single	25.6	9.1	0.866	One Way ANOVA
Married	25.5	8.9		
Divorced	22.3	5.0		
Widowed	25.0	8.7		
Educational Level				
No formal education	22.8	9.3	0.553	One Way ANOVA
Primary	25.1	9.3		
Secondary	25.5	8.8		
University	27.1	6.7		
Employment Status				
Unemployed	25.9	8.4	0.682	One Way ANOVA
Employed	24.3	9.3		
Retired	26.0	6.7		
Source				
Outpatient clinic	21.6	7.1	**0.000**	Independent Sample T Test
Primary healthcare center	29.3	8.5		
BMI				

Normal	29.5	8.6	**0.014** *(overweight vs obese)*	One Way ANOVA
Overweight	27.7	9.7		
Obese	23.1	7.5		
Smoking Status				
Non-smoker	26.9	8.7	0.152	One Way ANOVA
Smoker	23.4	8.3		
Ex-smoker	24.5	9.5		
Physical Activity				
No	23.9	8.3	**0.002**	Independent Sample T Test
Yes	30.9	7.9		
Stress Level			**0.002**	Correlation (Spearman) (r= -0.307)
Same Time Meals				
No	25.0	7.7	0.758	Independent Sample T Test
Yes	25.6	10.1		
Meals Outside Home				
Rarely	25.9	8.7	0.209	One Way ANOVA
Sometimes	22.8	8.3		
Usually	28.0	9.1		

*** Significant at p < 0.05**
(p: Probability value)

5. Associations between disease related variables and PDAQ score

Patients who had been diagnosed with diabetes since 6 to 10 years had lower mean adherence score than those who had diabetes for more than 16 years (22.6 ± 7.7 vs. 31.1 ± 9.4). In addition, patients with hypertension showed significantly lower mean adherence score (23.3 ± 7.8) than patients who did not report presence of hypertension (27.5 ± 9.1). Likewise, patients with renal disease had lower mean adherence score (20.7 ± 4.8) than those who did not (25.7 ± 8.8). Neither education

about the recommended diet from healthcare provider nor patient's perception that diet is important in managing diabetes were associated with mean adherence score. (Table 5)

Table 5:Associations between disease related characteristics and PDAQ total score

	Mean	SD	P Value*	Statistical Test
Years Since Diagnosis				
1-5	25.2	8.1	**0.020** (group 6-10 vs. group=>16)	One Way ANOVA
6-10	22.6	7.7		
11-15	25.6	9.2		
>=16	31.1	9.4		
Family History of Diabetes				
No	27.2	5.4	0.131	Independent Sample T Test
Yes	24.7	9.3		
Presence of Comorbidities				
No	27.2	9.1	0.138	Independent Sample T Test
Yes	24.4	8.4		
Presence of Hypertension				
No	27.5	9.1	**0.016**	Independent Sample T Test
Yes	23.3	7.8		
Presence of High Cholesterol				
No	25.7	9.0	0.126	Independent Sample T Test
Yes	22.7	5.9		
Presence of High Triglycerides				
No	25.0	8.5	0.411	Independent Sample T Test
Yes	27.9	10.5		
Presence of Cardiovascular Disease				
No	25.0	8.6	0.550	Independent Sample T Test

Yes	26.4	9.1		
Presence of Renal Disease				
No	25.7	8.8	**0.016**	Independent Sample T Test
Yes	20.7	4.8		
Presence of Hyperthyroidism				
No	25.2	8.8	0.926	Independent Sample T Test
Yes	25.6	6.1		
Exposure to Nutrition Education from Healthcare Provider				
No	25.5	8.8	0.849	independent Sample T Test
Yes	25.2	8.7		
Perception that Diet is Important in Controlling Diabetes				
No/maybe	25.1	7.5	0.932	Independent Sample T Test
Yes	25.3	9.0		

*** Significant at p < 0.05**

IV. Discussion

The present study assessed the adherence of a convenient sample of Lebanese diabetic patients to dietary recommendations, as well as associations of multiple sociodemographic, lifestyle and disease related variables with adherence level. Majority of participants (53.6%) had moderate perceived adherence level, but 41% had low adherence level. Adherence level was highest for intake of fruits and vegetables and low sugar foods, and lowest for eating fish and spacing carbohydrates. While none of the sociodemographic factors associated with adherence level,

obesity, lack of physical activity, and high stress level had statistically significant associations with low dietary adherence levels. As regards disease related variables, three factors showed statistically significant associations with low dietary adherence levels: somewhat recent diabetes diagnosis, presence of hypertension and renal disease.

The mean PDAQ score in our sample was 25.2 ± 8.7 (lower limit of the moderate adherence level range), which is in the same range as that reported among a sample of 80 Canadian diabetics (mean age= 61.2 ±10.4; 40% males) yet lower (mean PDAQ= 31.5± 9.5 among the Canadian sample) (Durai Raj et al.,2018). While most of our study participants had moderate adherence to dietary recommendations for diabetics (53.6%); 41.2% had poor adherence to the recommended guidelines. However, this was lower than that reported among a sample of 120 diabetics from South India (mean age= 60.1 ± 14.0; 60.8% males) where 72% had poor adherence based on PDAQ (Regi Bai and Kumari, ,2020), and in a sample of 307 diabetics from Eastern Ethiopia (45% males) where 62.5% had poor adherence based on PDAQ (Mohammed et al.,2020) (Both studies used different categories definition). This could be explained by the difference in setting and sociodemographic characteristics of the study participants and the availability, accessibility and affordability of a healthy diet in the area.

The diabetic patients included in this study had a low consumption of fish or other foods that are high in omega 3 fats. Similar finding was seen in a study done in Ethiopia among 320 diabetics (mean age= 52.7 ± 12.3; 53% males) with low consumption of omega 3 fats (Ayele et al.,2018) where inability to afford food cost was cited by diabetic patients among the barriers for the low adherence (Regi Bai and Kumari, 2020). This explanation is reasonable especially due to the economic crisis in Lebanon, which is affecting food prices.

Study participants consumed recommended intake of fruits and vegetables on more than 4 days a week. This was higher than that documented among an Indian sample of 120 diabetics by Regi Bai and Kumari (2020) (mean = 2.20 days a week) and in an Ethiopian sample of 320 diabetics by Ayele et al. (2018) (mean= 1.84 days a week). This disparity might be due to the accessibility of relative cheapness of fruits and vegetables in the study setting compared to other food like meat and poultry. Another reason is the culture, since many of the Lebanese recipes and daily meals include fruits and vegetables.

None of age, gender, and educational level was associated with adherence PDAQ score in our study. This can be explained by the inconsistent pertinent findings on relation of adherence with age (Asaad et al., 2015; Ayele et al., 2018; Doglikuu et al., 2021; Durai Raj et al., 2018; Mirahmadizadeh et al., 2020; Mutyambizi, 2020); association of adherence with gender (Asaad et al., 2015, Ayele et al., 2018; Durai Raj et al. 2018; Mohammed et al. 2020; Mutyambizi et al., 2020); and relationship of adherence with educational level (Ayele et al., 2018; Doglikuu et al., 2021; Mohammed and Sharew, 2019; Mutyambizi et al., 2020). While we did not find any relationship between place of residence and recommended diet adherence, two studies showed that adherence is higher among patients living in urban places (Ayele et al., 2018; Mohammed et al., 2020). This can possibly be credited to the study sample characteristics (almost 80% were urban dwellers), or to the different connotation of urban living deployed in these studies.

Participants who adhered to physical activity recommendations in our study had higher mean PDAQ score compared to those who did not. This is line with the finding of a statistically significant positive correlation between physical activity level and adherence based on PDAQ among a sample of 530 diabetics from Ghana (Doglikuu et al., 2021). One possible explanation

is that physical activity may act as a catalyst for other healthy behavior changes; individuals who are more active often consume healthier diets (Wankel and Sefton.,1994).

BMI was also found to associate with mean dietary adherence score. While subjects with normal BMI had the highest mean adherence score, obese subjects had statistically significant lower mean adherence score compared to overweight subjects. Similarly, our finding agrees with that reported by Asaad et al. (2015) as regards negative correlation between dietary adherence based on PDAQ and body weight, and that reported by Mirahmadizadeh et al. (2020) where obese and overweight diabetics had statistically significant poor adherence to the Mediterranean diet compared to normal weight subjects.

We found statistically significant weak negative correlation between stress level and dietary adherence. We could not find studies that looked at perceived stress and adherence to dietary recommendations in adults with type 2 diabetes. Nonetheless, high perceived stress was significantly associated with lower adherence to the dietary recommendations in type 1 diabetic sample (Ahola et al.,2020), and there was a positive association between perceived stress and consumption of sweets, particularly in those with type 2 diabetes (Laugero et al.,2011).

Furthermore, a number of studies have linked perceived stress with higher intake of fast foods or snacks in overweight and obese African Americans (Errisuriz et al.,2016). Preference for quickly available meals when stressed is in concordance with the reports that perceived stress is also associated with haphazard meal planning as shown in a study among college students (predominantly females) (Sims et al.,2008). During stressful periods, an individual may, therefore, be less likely to plan one's meals carefully.

Regarding the site from where participants were enrolled, patients selected from primary healthcare centers (PHC) were found to have better adherence than those selected from outpatient clinic. This can possibly be attributed to a good doctor-patient communication at PHC hence patients are more likely to comply with their physicians' recommendations. Moreover, when visiting the PHC, the patient is more likely to contact more healthcare professionals such as the nurse before meeting with the doctor. However, in case of private clinic, the patient will only get in contact with the doctor and the duration of visit is affected by time constraints.

Regarding years since diagnosis of DM, there was significant difference with PDAQ mean scores among the two groups (those with 6-10 years of having the disease and those having it for more than 16 years). Patients who were diagnosed with diabetes for 16 or more years had better adherence to the dietary recommendations than those with somewhat recent diagnosis- 6 to 10 years. This is in agreement with the findings of positive association between duration since diabetes diagnosis (> 10 years vs. 0-5 years) and good adherence based on PDAQ score (Ayele at al. (2018), positive correlation between disease duration (in years) and PDAQ score (Doglikuu et al.; 2021), and positive association between duration since starting diabetes treatment (> 10 years vs. ≤ 10 years) and good adherence based on PDAQ score (Mohammed et al., 2020). Moreover, similar finding was reported in another study by Grahovac et al. (2021) among 273 patients with type 2 diabetes (mean age 68.5 ± 12.1; 50% males) which revealed a significant positive correlation between disease duration and Mediterranean diet adherence level among diabetics (Grahovac et al.,2021).

The possible explanation is that patients with longer duration of the disease would have had more frequent contacts with healthcare professionals and are more likely to be given repeated advice

and education regarding proper dietary intake for better management of their diabetic condition. As a result, these patients become more aware about consequences and complications, and thus will try to adopt healthy behaviors (Mohammed and Sharew.,2019).

Presence of comorbidities was also shown to be associated with PDAQ scores. In our study, respondents who reported having hypertension or renal disease, were more likely to have poor adherence to diet recommendations than those who were non-hypertensive, or did not have renal disease. This agrees with the finding of Ayele et al. (2018) as to the positive association between presence of comorbidities and poor adherence to dietary recommendations. This result could be attributed to the fact that patients with comorbidities are often on complex medication and dietary regimens especially those with renal failure who require special attention to what to eat and have many diet restrictions. In addition, they may experience high stress levels. Therefore, diabetic patients with comorbidities should have special focus and should be provided with adequate information about the benefit of dietary adherence (Ayele et al.,2018).

We did not find significant relationship between having received education about the recommended diet in diabetes from healthcare providers and good adherence level; a finding in disagreement with those reported by Ayele et al. (2018) and Mohammed et al. (2020). Would have asked questions regarding the source of dietary education (whether from a nurse, doctor, or a dietitian), maybe different results and explanation could have been obtained.

Study strengths and limitations

This study has limitations that must be considered while interpreting the results. First, the cross-sectional nature of this study makes it unreliable to form a causal relationship between the

exposure and the outcome variable. Second, this study was conducted on a small sample size with unique characteristics, therefore readers should be aware that the results of the present study are not and cannot be generalized to the adult diabetic patients in Lebanon. Third, due to distance constraints, we were forced to complete data collection via phone calls rather than conducting face to face interviews. This change might have impacted subjects' responses to the questionnaire. Fourth, all data were self- reported including diabetes diagnosis: For example, weight and height were self-reported, this might have caused underestimation for BMI. In addition, comorbidities were not assessed or checked if they were accurate or not.

Further studies are needed to assess dietary adherence with larger sample sizes and relying on data sources other than the subjects.

However, to our knowledge, this study is the first to explore associations of several sociodemographic, anthropometric, lifestyle and disease related characteristics to dietary adherence among diabetics in Lebanon. There are studies which looked at the relationship between medication adherence and disease outcome among adult Lebanese diabetics (Mroueh et al.,2018 and Ayoub et al.,2019).

V. Conclusion

In conclusion, the prevalence of poor adherence to recommended diet was observed among 41.2% of diabetic patients, which indicates a major public health problem. Diabetics who seek disease treatment from outpatient clinics, are obese, with low physical activity level and high stress level,

had somewhat recent diabetes diagnosis, and have hypertension and/ or renal disease are particularly at risk of not following the diet recommendation, a proven effective approach in diabetes management, require special attention. Healthcare providers including dietitians should be made aware about the alarmingly low proportion of adherence to dietary recommendations among the diabetic population in the study area. Studies on larger samples particularly with prospective designs should be done to contribute more information regarding the level of adherence and determinants of non-adherence to diet**.**

APPENDIX 1

Questionnaire

Background Questionnaire (19 Q)

ID: ----------

Interview Date: ----------

Center (PHC, outpatient clinics, other): ----------

Confirms absence of diabetes-related complications (No; Yes excluded): ----------

Please check one box for each question where there are check boxes, and fill in the blank where applicable

Sociodemographic Section

1. What is your age? (in years): _____
2. Gender: ☐ Male ☐ Female
3. What is your current place of residence? ☐ Urban ☐ Rural
4. What is your marital status? ☐ Single ☐ Divorced

☐ Married ☐ Widowed

5. What is your educational status? ☐ No formal education ☐ Secondary ☐ Primary ☐ University

6. What is your employment status? ☐ Employed ☐ Retired ☐ Unemployed

Lifestyle Section

7. What is your current height? (in cm): _____

8. What is your current weight? (in kg): _____

9. Smoking status at present? ☐ Smoker ☐ Ex- smoker ☐ Non-smoker

10. Do you perform regular moderate intensity physical activity at least 150 minutes per week with no more than 2 consecutive days without exercising?

☐ No ☐ Yes

11. How do you rate your stress level on a scale from 1 (low) to 7 (high) during the past year?

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

12. Do you usually eat meals at the same time?

☐ No ☐ Yes

13. How often do you eat your main meals outside home?

☐ Rarely ☐ Sometimes ☐ Usually

Disease-Related Section

14. For how many years have you been diagnosed with diabetes? _____

15. Do you have a family history for diabetes? ☐ No ☐ Yes

16. Do you have other comorbidities than diabetes? ☐ No ☐ Yes

If yes, please specify _____

17. Have you had any exposure to any education regarding recommended diet in diabetes from your healthcare provider?

☐ No ☐ Yes

18. Do you think that diet is important in controlling blood glucose levels?

☐ No/maybe it helps

☐ Yes, it helps a lot

19. What is your current diabetic treatment?

☐ Antidiabetic Medications

☐ Insulin

☐ Lifestyle Modifications (Diet and Ex)

Perceived Dietary Adherence Questionnaire (PDAQ) (9 Q)

Please circle one correct answer corresponding to each question.

Items	Response
On how many of the last SEVEN DAYS have you followed a healthful eating plan?	0 1 2 3 4 5 6 7
On how many of the last SEVEN DAYS did you eat the number of fruit and vegetables?	0 1 2 3 4 5 6 7
On how many of the last SEVEN DAYS did you eat carbohydrate-containing foods with a low Glycemic Index? (Example: dried beans, lentils, barley, pasta, low fat dairy products)	0 1 2 3 4 5 6 7
On how many of the last SEVEN DAYS did you eat foods high in sugar, such as rice, potatoes, etc.?	0 1 2 3 4 5 6 7
On how many of the last SEVEN DAYS did you eat foods high in fiber such as oatmeal, high fiber cereals, and whole-grain breads	0 1 2 3 4 5 6 7
On how many of the last SEVEN DAYS did you space carbohydrates evenly throughout the day?	0 1 2 3 4 5 6 7
On how many of the last SEVEN DAYS did you eat fish or other foods high in omega-3 fats?	0 1 2 3 4 5 6 7
On how many of the last SEVEN DAYS did you eat foods that contained or was prepared with canola, walnut, olive, or flax oils?	0 1 2 3 4 5 6 7
On how many of the last SEVEN DAYS did you eat foods high in fat (such as high fat dairy products, fatty meat, fried foods or deep-fried foods)?	0 1 2 3 4 5 6 7

References

1. Ahmadieh, H., Itani, H., Itani, S., Sidani, K., Kassem, M., Farhat, K., ... & Itani, A. (2018). Diabetes and depression in Lebanon and association with glycemic control: a cross-sectional study. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, *11*, 717.
2. Ahmadieh, H., Sawaya, M. T., & Azar, S. T. (2019). Management and control of type 2 diabetes mellitus in Lebanon: Results from the International Diabetes Management Practices Study Wave 6. *World Journal of Diabetes*, *10*(4), 249.
3. Ahola, A. J., Forsblom, C., Harjutsalo, V., & Groop, P. H. (2020). Perceived stress and adherence to the dietary recommendations and blood glucose levels in type 1 diabetes. *Journal of diabetes research*, *2020*.
4. Alameddine, M., Nasreddine, L., Hwalla, N., Mourad, Y., Shoaib, H., Mousa, D., & Naja, F. (2013). Factors associated with consulting a dietitian for diabetes management: a cross-sectional study. *BMC health services research*, *13*(1), 504.
5. American Diabetes Association (2018) Introduction: standards of medical care in diabetes 2018. Diabetes Care 41, Suppl. 1, S1–S2.
6. American Diabetes Association. Standards of medical care in diabetes 2016. *Diabetes Care*. 2016;39(Suppl 1): S1–S109.
7. Asaad, G., Sadegian, M., Lau, R., Xu, Y., Soria-Contreras, D. C., Bell, R. C., & Chan, C. B. (2015). The reliability and validity of the perceived dietary adherence questionnaire for people with type 2 diabetes. *Nutrients*, *7*(7), 5484-5496.
8. Ayele, A. A., Emiru, Y. K., Tiruneh, S. A., Ayele, B. A., Gebremariam, A. D., & Tegegn, H. G. (2018). Level of adherence to dietary recommendations and barriers among type 2 diabetic patients: a cross-sectional study in an Ethiopian hospital. *Clinical Diabetes and Endocrinology*, *4*(1), 21.
9. Ayoub, D., Mroueh, L., El-Hajj, M., Awada, S., Rachidi, S., Zein, S., & Al-Hajje, A. (2019). Evaluation of antidiabetic medication adherence in the Lebanese population: development of the Lebanese Diabetes Medication Adherence Scale. *International Journal of Pharmacy Practice*, *27*(5), 468-476.
10. Bai RR, Kumari R. Perceived Dietary Adherence and its Barriers to Dietary Recommendations among Type 2 Diabetes Mellitus Patients. Innov J Nurs Healthc. 2020;6(3):1-5
11. Blüher, M., Ceriello, A., Davies, M., Rodbard, H., Sattar, N., Schnell, O., ... & Giorgino, F. (2022). Managing weight and glycaemic targets in people with type 2 diabetes—How far have we come? *Endocrinology, Diabetes & Metabolism*, e00330.
12. Bou-Orm, I., & Adib, S. (2020). Prevalence and clinical characteristics of diabetes mellitus in Lebanon: a national survey. *East Mediterr Health J*, *26*(2), 182-188.
13. Brandle, M., Zhou, H., Smith, B. R., Marriott, D., Burke, R., Tabaei, B. P., ... & Herman, W. H. (2003). The direct medical cost of type 2 diabetes. *Diabetes care*, *26*(8), 2300-2304.
14. Cavaiola, T. S., & Pettus, J. H. (2017). Management of type 2 diabetes: selecting amongst available pharmacological agents. In *Endotext [Internet]*. MDText. com, Inc.
15. Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2017. Atlanta, GA: Centers for Disease Control and Prevention, U.S. Dept of Health and Human

Services; 2017 p.20. Available from: https://www.cdc.gov/diabetes/data/statistics/statistics-report.html. Accessed 15 Sept 2018.

16. Costanian, C., Bennett, K., Hwalla, N., Assaad, S., & Sibai, A. M. (2014). Prevalence, correlates and management of type 2 diabetes mellitus in Lebanon: findings from a national population-based study. *Diabetes research and clinical practice*, *105*(3), 408-415.
17. Doglikuu, B. I. D., Abdulai, A., Yaseri, M., Shakibazadeh, E., Djazayery, A., & Mirzaei, K. (2021). Association of Adherence to Diabetics Feeding Recommendation with Glycaemic Control and with Malnutrition Risk Among Normal Weight Persons with Type 2 Diabetes in Ghana. *The Malaysian Journal of Medical Sciences: MJMS*, *28*(2), 84.
18. Doglikuu, B. I. D., Abubakari, A., Yaseri, M., Shakibazadeh, E., Djazayery, A., & Mirzaei, K. (2021). Association of household socioeconomic status, neighborhood support system and adherence to dietary recommendation among persons with T2DM, a facility-based cross-sectional study in Ghana. *BMC Public Health*, *21*(1), 1-8.
19. Ekore, R. I., & Ekore, J. O. (2008). Dietary management of diabetes: a practical approach for primary care physicians in Nigeria
20. Emerging Risk Factors Collaboration. (2010). Diabetes mellitus, fasting blood glucose concentration, and risk of vascular disease: a collaborative meta-analysis of 102 prospective studies. *The Lancet*, *375*(9733), 2215-2222.
21. Fares, C., Bader, R., & Ibrahim, J. N. (2019). Impact of alexithymia on glycemic control among Lebanese adults with type 2 diabetes. *Journal of Diabetes & Metabolic Disorders*, *18*(1), 191-198.
22. Federation, International Diabetes (2015). IDF diabetes atlas (https://www.worldcat.org/oclc/961366911) (Seventh ed). Brussels: International Diabetes Federation. ISBN 9782930229812. OCLC 961366911 (https://www.worldcat.org/oclc/961366911).
23. Forouhi, N. G., Misra, A., Mohan, V., Taylor, R., & Yancy, W. (2018). Dietary and nutritional approaches for prevention and management of type 2 diabetes. *Bmj*, *361*, k2234.
24. Ghassibe-Sabbagh, M., Deeb, M., Salloum, A. K., Mouzaya, F., Haber, M., Al-Sarraj, Y., ... & Ahdab, R. (2014). Multivariate epidemiologic analysis of type 2 diabetes mellitus risks in the Lebanese population. *Diabetology & metabolic syndrome*, *6*(1), 89.
25. Grahovac, M., Kumric, M., Vilovic, M., Martinovic, D., Kreso, A., Kurir, T. T., ... & Božić, J. (2021). Adherence to Mediterranean diet and advanced glycation end products in patients with diabetes. *World Journal of Diabetes*, *12*(11), 1942.
26. Guariguata, L., Whiting, D. R., Hambleton, I., Beagley, J., Linnenkamp, U., & Shaw, J. E. (2014). Global estimates of diabetes prevalence for 2013 and projections for 2035. *Diabetes research and clinical practice*, *103*(2), 137-149.
27. Halali, F., Mahdavi, R., Mobasseri, M., Jafarabadi, M. A., & Avval, S. K. (2016). Perceived barriers to recommended dietary adherence in patients with type 2 diabetes in Iran. *Eating behaviors*, *21*, 205-210.
28. International Diabetes Federation. IDF diabetes atlas. 7th ed. Brussels: International Diabetes Federation; 2015
29. International Diabetes Federation. Lebanon. Diabetes by Region: Middle East and North Africa Lebanon. http://www.idf.org/membership/ mena/lebanon. Published 2015. Accessed August 18, 2016.

30. Jaworski, M., Panczyk, M., Cedro, M., & Kucharska, A. (2018). Adherence to dietary recommendations in diabetes mellitus: disease acceptance as a potential mediator. *Patient preference and adherence*, *12*, 163.
31. Jordan, D. N., & Jordan, J. L. (2010). Self-care behaviors of Filipino-American adults with type 2 diabetes mellitus. *Journal of Diabetes and its Complications*, *24*(4), 250-258.
32. Juárez-Ramírez, C., Théodore, F. L., Villalobos, A., Allen-Leigh, B., Jiménez-Corona, A., Nigenda, G., & Lewis, S. (2019). The importance of the cultural dimension of food in understanding the lack of adherence to diet regimens among Mayan people with diabetes. *Public health nutrition*, *22*(17), 3238-3249.
33. K. D. Laugero, L. M. Falcon, and K. L. Tucker, "Relationship between perceived stress and dietary and activity patterns in older adults participating in the Boston Puerto Rican Health Study," Appetite, vol. 56, no. 1, pp. 194–204, 2011
34. Karaoui, L. R., Deeb, M. E., Nasser, L., & Hallit, S. (2018). Knowledge and practice of patients with diabetes mellitus in Lebanon: a cross-sectional study. *BMC public health*, *18*(1), 525.
35. Lanting, L. C., Joung, I. M., Vogel, I., Bootsma, A. H., Lamberts, S. W. J., & Mackenbach, J. P. (2008). Ethnic differences in outcomes of diabetes care and the role of self-management behavior. *Patient education and counseling*, *72*(1), 146-154.
36. Li, R., Lu, W., Jiang, Q. W., Li, Y. Y., Zhao, G. M., Shi, L., ... & Xu, W. H. (2012). Increasing prevalence of type 2 diabetes in Chinese adults in Shanghai. *Diabetes care*, *35*(5), 1028-1030.
37. Mirahmadizadeh, A., Khorshidsavar, H., Seif, M., & Sharifi, M. H. (2020). Adherence to Medication, Diet and Physical Activity and the Associated Factors Amongst Patients with Type 2 Diabetes. *Diabetes Therapy*, *11*(2), 479-494
38. Mohammed, A. S., Adem, F., Tadiwos, Y., Woldekidan, N. A., & Degu, A. (2020). Level of adherence to the dietary recommendation and glycemic control among patients with type 2 diabetes mellitus in eastern ethiopia: a cross-sectional study. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, *13*, 2605.
39. Mohammed, M. A., & Sharew, N. T. (2019). Adherence to dietary recommendation and associated factors among diabetic patients in Ethiopian teaching hospitals. *The Pan African Medical Journal*, *33*.
40. Mottalib, A., Salsberg, V., Mohd-Yusof, B. N., Mohamed, W., Carolan, P., Pober, D. M., ... & Hamdy, O. (2018). Effects of nutrition therapy on HbA1c and cardiovascular disease risk factors in overweight and obese patients with type 2 diabetes. *Nutrition journal*, *17*(1), 42.
41. Mroueh, L., Ayoub, D., El-Hajj, M., Awada, S., Rachidi, S., Zein, S., & Al-Hajje, A. (2018). Evaluation of medication adherence among Lebanese diabetic patients. *Pharmacy Practice (Granada)*, *16*(4).
42. Mutyambizi, C., Pavlova, M., Hongoro, C., & Groot, W. (2020). Inequalities and factors associated with adherence to diabetes self-care practices amongst patients at two public hospitals in Gauteng, South Africa. *BMC Endocrine Disorders*, *20*(1), 1-10.
43. Nielsen, J. V., & Joensson, E. A. (2008). Low-carbohydrate diet in type 2 diabetes: stable improvement of bodyweight and glycemic control during 44 months follow-up. *Nutrition & metabolism*, *5*(1), 1-6

44. Olokoba, A. B., Obateru, O. A., & Olokoba, L. B. (2012). Type 2 diabetes mellitus: a review of current trends. *Oman medical journal*, *27*(4), 269.
45. Pedicino, D., Liuzzo, G., Trotta, F., Giglio, A. F., Giubilato, S., Martini, F., ... & Cialdella, P. (2013). Adaptive immunity, inflammation, and cardiovascular complications in type 1 and type 2 diabetes mellitus. *Journal of diabetes research*, *2013*.
46. Raj, G. D., Hashemi, Z., Contreras, D. C. S., Babwik, S., Maxwell, D., Bell, R. C., & Chan, C. B. (2018). Adherence to diabetes dietary guidelines assessed using a validated questionnaire predicts glucose control in adults with type 2 diabetes. *Canadian Journal of Diabetes*, *42*(1), 78-87.
47. Schwingshackl, L., Missbach, B., König, J., & Hoffmann, G. (2015). Adherence to a Mediterranean diet and risk of diabetes: a systematic review and meta-analysis. *Public health nutrition*, *18*(7), 1292-1299.
48. Sigal, R. J., Armstrong, M. J., Bacon, S. L., Boulé, N. G., Dasgupta, K., Kenny, G. P., & Riddell, M. C. (2018). Physical activity and diabetes. *Canadian journal of diabetes*, *42*, S54-S63.
49. Sims, S. Gordon, W. Garcia et al., "Perceived stress and eating behaviors in a community-based sample of African Americans," Eating Behaviors, vol. 9, no. 2, pp. 137–142, 2008
50. Snel, M., Jonker, J. T., Hammer, S., Kerpershoek, G., Lamb, H. J., Meinders, A. E., ... & Jazet, I. M. (2012). Long-term beneficial effect of a 16-week very low-calorie diet on pericardial fat in obese type 2 diabetes mellitus patients. *Obesity*, *20*(8), 1572-1576.
51. Sukkarieh-Haraty, O., Egede, L. E., Abi Kharma, J., & Bassil, M. (2019). Diabetes fatalism and its emotional distress subscale are independent predictors of glycemic control among Lebanese patients with type 2 diabetes. *Ethnicity & Health*, *24*(7), 767-778
52. V. L. Errisuriz, K. E. Pasch, and C. L. Perry, "Perceived stress and dietary choices: the moderating role of stress management," Eating Behaviors, vol. 22, pp. 211–216, 2016.
53. Wankel L, Sefton J: Physical activity and other lifestyle behaviors. In Physical Activity, Fitness, and Health Campaign. Bouchard C, Shepard R, Stephens T, Eds. Champaign, IL, Human Kinetics, 1994, p. 530–550
54. Yahia, N., Khoury, M., Salloum, T., Younes, R., Saleh, M., & Myers, E. (2017). Implementing Evidence-Based Nutrition Practice Guidelines for Type 2 Diabetes Mellitus in Lebanon. *Topics in Clinical Nutrition*, *32*(4), 316.
55. Zheng, Y., Ley, S. H., & Hu, F. B. (2018). Global aetiology and epidemiology of type 2 diabetes mellitus and its complications. *Nature Reviews Endocrinology*, *14*(2), 88.