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The Association between Therapeutic and Nutritional Care with the Control of Type 2 Diabetes Based on an Observational Study in Kermanshah, Iran

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ABSTRACT

Background: The measures and interventions which contribute to the control of diabetes may play an important role in the disease prognosis. This study was conducted with the aim of evaluating the effect of medical and nutritional care in the control of type 2 diabetes. **Methods:** This work as retrospective cohort, was conducted on 200 patients diagnosed with type 2 diabetes, utilizing medical records of those receiving medical care. The participants completed the Diabetes Self-Management Questionnaire (DSMQ), which assesses self-care activities pertaining to glycemic control. Additionally, demographic information, disease history, treatment monitoring, self-monitoring of blood sugar, diet data, physical activity, and biochemical tests were obtained for analysis. **Results:** Out of the 200 patients with type 2 diabetes studied, 45% were male and 55% were female. The majority of patients (90%) lived in urban areas. The study found that patients who received nutritional education, including information on portion sizes, glycemic index, and adherence to weight loss diets, and who were followed up by a nutritionist, had better control of their diabetes. Patients who were aware of normal blood glucose levels and the consequences of uncontrolled diabetes also showed a significant relationship with better control of the disease. **Conclusion:** Overall, these findings highlight the importance of incorporating nutritional education into the management plan for patients with type 2 diabetes, as it can have a significant impact on both short-term and long-term health outcomes.

Introduction

Diabetes mellitus is a chronic and progressive disease that affects the function of various organs, causing long-term complications and reducing the quality of life. Over 90% of diabetes cases are type 2 diabetes, characterized by defective insulin secretion from pancreatic islet β-cells, insulin resistance and lack of adequate compensatory insulin response (Singh *et al.*, 2018). The global prevalence of diabetes is over 10% and future prediction estimate that by 2045

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the number of persons with diabetes will have reached by 46% worldwide. The prevalence of diabetes in Iran varies from 2.4-19.1% for men and 3.2-19.8% for women (Adab *et al.*, 2019). Diabetes has various complications. Macrovascular complications such as peripheral vascular disease, stroke and coronary heart disease as well as microvascular complications including neuropathy, nephropathy, retinopathy and lower-extremity amputations are accountable for the most burden related to diabetes.

Diabetes also imposes a remarkable burden on society in terms of higher healthcare and medical costs. Various anti-diabetes agents including thiazoledinediones, alpha glucosidase inhibitors, sulphonylureas, DPP-4 (Dipeptidyl peptidase-4) inhibitors and GLP-1 (Glucagon-like peptide-1 receptor) agonists as well as bariatric surgery were used for the control of this disease. However, these treatment options have several adverse effects and clinical limitations (Cruz-Jentoft *et al.*, 2019).

Nowadays, adherence to medical nutrition therapy (MNT) has dramatically increased in popularity. According to existing evidence, MNT is an effective approach for improving the clinical outcomes of diabetes and reducing the medical costs. Many studies indicate the fifty-fifty role of MNT in medical treatment of diabetes and the American Diabetes Association considers MNT as the basis of all diabetes management programs. In a study to assessment the effect of registered dietitian interventions on diabetic dyslipidemia and glycemic control, Glycated Hemoglobin A1c (HbA1c) was significantly decreased to target values (≤7%) in 62% of patients by following MNT; Also, a significant improvement was observed in High-Density Lipoprotein Cholesterol (HDL-c), Triglyceride (TG) and TG-to- HDLc ratio (P<0.05). In another study, the efficacy of follow up and supervision of dietitians in improvement of biochemical indices of patients with type 2 diabetes was significant. Several studies have highlighted the prominent effects of MNT in control of diabetes (Guariguata *et al.*, 2011). The measures and interventions which contribute to the control of diabetes may play an important role in the disease prognosis, reducing the pain as well as the burden of disease in the society. In patients with diabetes without being affected by any intervention studies, the disease control status has a wide range. Some patients are successful in disease management and others are unsuccessful (Zheng *et al.*, 2018). One of the types of studies investigating how some patients have been able to control their disease are observational studies. This observational study was conducted with the aim of evaluating the effect of medical and nutritional care in the control of type 2 diabetes.

Materials and Methods

Study design and participants

The present study is a retrospective cohort study conducted on 200 patients with type 2 diabetes who referred to the Taleghani Diabetes Clinic in Kermanshah between April 2017 and March 2019. The data was collected using medical record information of patients. The patient files were selected based on inclusion and exclusion criteria. *Inclusion criteria*: Confirmed diagnosis of type 2 diabetes according to the American Diabetes Association (ADA) criteria; Age between 30 and 75; Both sexes (male and female); Ability to communicate and provide information for completing questionnaires; At least two HbA1c test results recorded during the past 12 months; No change in diabetes treatment type (oral medication or insulin) during the previous 6 months and Ability to read or have basic literacy to complete the self-management questionnaire (DSMQ).

*Exclusion criteria***:** Type 1 diabetes, gestational diabetes, or other secondary forms of diabetes; Severe comorbid diseases that could affect glycemic control (e.g., chronic kidney disease stage ≥3, cardiovascular disease, malignancy, or advanced liver disease); Use of corticosteroids or other drugs influencing glucose metabolism; Incomplete medical records or missing laboratory data; Cognitive or psychiatric disorders preventing valid participation; Pregnancy or lactation during the study period; Refusal to participate in

interviews or follow-up and Patients who did not meet the above criteria were excluded from the study.

Initially, 275 files which met the inclusion criteria were reviewed. After completing the information that was not in the files through interviews, 200 files were included.

General information

Demographic information and socio-economic status including level of education, position in the family, marital status, household population, type of residence, occupation, access to basic infrastructure, insurance coverage, access to food market, monthly income and history of smoking were recorded.

Medical information

The data was collected using medical record information of patients. The diabetes self-management questionnaire (DSMQ) is a sixteen-item questionnaire evaluating self-care activities related to glycemic control which was completed for all the participants. The validity and reliability of this questionnaire has been confirmed in many studies (Schmitt *et al.*, 2013). Disease history including the time and method of diagnosis, family history of diabetes, history of death due to diabetes and its complications in relatives, history of gestational diabetes, miscarriage, polycystic ovary and birth of a macrosomic baby were also recorded. Disease status was monitored by the physician every 3 months through evaluation of laboratory tests and physical examinations (such as cardiovascular, eye, foot, oral and dental examinations). Also, patients were educated about normal blood glucose levels and how to deal with its fluctuations. Biochemical indices including HbA1c, lipid profiles, serum creatinine and urine test were recorded.

Physical activity, anthropometry and nutritional information

Anthropometric indices, including weight, height and body mass index (BMI), physical activity level, dietary intake and nutritional behaviors were recorded by a nutritionist. Dietary status was monitored by the nutritionist every month and the nutritional recommendations were provided.

Definition of study groups

To assess the relationship between nutritional and medical care with glycemic control, patients were categorized into two main groups based on HbA1c levels:

- Controlled group: HbA1c ≤ 7%
- Uncontrolled group: HbA1c > 7%

Ethical considerations

This study was approved by the Ethics Committee of Kermanshah University of Medical Sciences and registered at the deputy of Research and Technology (IR.KUMS.REC.1400.316).

Data analysis

Data were analyzed by SPSS Software (version 22), and two independent t-tests were used to compare the quantitative variables between groups. Nominal variables were then compared using the Chi-square test between groups and Spearman correlation coefficient was used for correlation analysis. The value of P-value less than 0.05 was significant.

Results

In this study, 275 files meeting the inclusion criteria were examined. Finally, 200 files were studied due to the lack of cooperation of some patients (**Figure1**). Of these, 90 (45%) were men and 110 (55%) were female, 180 (90%) were urban and 20 (10%) were rural. The variables including age, weight, height, BMI, marital status, education level, residence, insurance coverage, the course of diabetes and glycosylated hemoglobin percentage were compered between the two sexes at baseline. There was no significant difference between the two sexes regarding the course of diabetes, age, BMI, glycosylated hemoglobin percentage, residence and insurance coverage ($P \geq 0.05$). However, a significant difference was observed between the two sexes in terms of weight, height, education level and marital status ($P < 0.05$, **Table 1**).

Referral of the patient to the nutritionist by the physician was evaluated based on sex, BMI,

education level, use or non-use of insulin and HbA1c. No significant difference was observed in the referral based on the mentioned variables ($P \geq 0.05$. **Table 2**). Moreover, the association between diabetes control and demographic variables based on HbA1c (≤7%: controlled diabetes and 7%<: uncontrolled diabetes) was assessed. There was no significant association between sex and marital status with diabetes control. Otherwise, higher education level was significantly associated with better diabetes control ($P<0.001$, **Table 3**).

In evaluating the association between socio-economic variables including residence, employment status and insurance coverage and diabetes control based on HbA1c, only insurance coverage was significantly associated with diabetes control (**Table 4**).

Table 1. Demographic characteristics of the participants.

Variable	Male	Female	P-value
Age (y)	58.11±9.98[a]	55.90±8.85	0.111
Weight (kg)	85.41±18.86	84.87±12.07	<0.001
Height (cm)	1.71±0.68	1.60±0.62	<0.001
BMI (kg/m^2)	29.16±6.26	29.09±4.64	0.178
HbA1c (%)	8.21±1.92	8.14±1.70	0.275
Course of diabetes (y)	7.27±5.95	8.35±5.70	0.834
Marital status			
Married	88 (97.7)[b]	85 (77.27)	<0.001
Single	2 (2.3)	25 (22.73)	
Education level			
Illiterate	19 (21.11)	62 (56.36)	<0.001
Elementary	26 (28.89)	18 (16.38)	
Junior high school	16 (17.77)	12 (10.9)	
Senior high school	18 (20.00)	16 (14.55)	
University	11 (12.23)	2 (1.81)	
Residence			
Urban	79 (87.77)	101 (91.82)	0.343
Rural	11 (12.23)	9 (8.18)	
Insurance			
Public	75 (83.33)	96 (87.27)	0.923
Supplementary	24 (26.66)	30 (27.27)	

*[a]: Mean±SD; [b]: n (%);**BMI**: Body mass index; **HbA1c:** Hemoglobin A1c..*

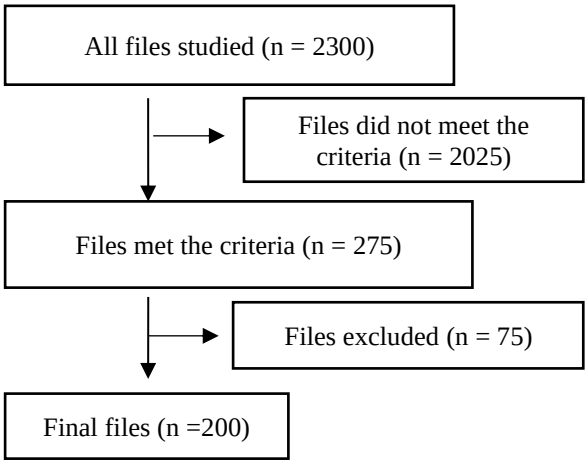

Figure 1. Flowchart of study.

In assessment of the relationship between diabetes control and disease history variables including the course of disease, family history and its degree, no significant association was observed between these variables and diabetes control (**Table 4**).

The association between self-monitoring blood glucose (by means of a glucometer), being aware of the normal range of blood glucose, and the consequences of uncontrolled levels with diabetes control is shown in **Table 4**. According to the results of this table, the patient's awareness of normal blood glucose levels and the consequences of uncontrolled diabetes showed a significant relationship with the control of this disease.

In assessing the effect of anthropometric indices and weight loss dieting on diabetes control, this control was significantly better in patients with weight assessment compared to patients without this assessment (approximately 33 vs. 15%) ($P=0.004$). Diabetes management was significantly better in the group receiving weight control recommendations than the others (29.3 vs. 16.8%) ($P=0.037$). Also, more than half of patients on a weight-loss diet showed a significant improvement in diabetes control, whereas this improvement was observed in fewer than 20% of those on a no-weight-control diet ($P=0.001$). Moreover, the period of adherence to the weight loss diet showed a significant difference in diabetes control in favor

of patients with a longer period of adherence compared to a shorter period.

Evaluating the effect of variables related to diet on diabetes management showed a significant improvement in diabetes control in patients with complete adherence to the diet compared to those without full compliance (70 vs. 18.9%, $P<0.001$). Furthermore, a longer period of adherence caused a significant difference in diabetes control (80% in patients following the diet for more than one year versus 29.6% in those following the diet for one year or less) ($P=0.002$). Diabetes control was also significantly better in patients who received nutrition education compared to others (46.7 vs. 14.2%, $P<0.001$). Periodic follow-up by a nutritionist as well as increasing the frequency of anthropometric measurements led to a significant improvement in diabetes control ($P=0.004$). Controlled diabetes was reported in 80% of patients familiar with the exchange list of food groups and less than 20% of patients who did not know this list ($P<0.001$). Controlled diabetes was reported in 45% of patients familiar with portion sizes compared to less than 20% in others ($P=0.004$). Familiarity with glycemic terms showed a significant improvement in diabetes control (83.3 vs.15.1%, $P<0.001$, **Table 4**).

Discussion

As a chronic disease, diabetes is a major health problem which affects the quality of life and imposes a significant cost burden on society. So, any intervention or treatment with minimal side effects may significantly reduce the treatment costs (Franz *et al.*, 1995). Various treatment methods are used for diabetes; however, their adverse effects have caused a shift towards educational approaches. Many studies have shown that education may play a significant role in diabetes management (Franz *et al.*, 1995).

Moreover, educational approaches are less expensive than other methods, an issue that policy interventions are usually guarded against. Assessing the role of education and nutritional care in diabetes management, this study aimed to provide affordable treatment to improve blood glucose and diabetes control (Gaetke *et al.*, 2006). Dysregulation of insulin signaling pathway or insulin resistance is the main cause of diabetes. Active insulin signaling reduces glucose production, increases glycogen synthesis and facilitates glucose uptake in peripheral tissues such as skeletal muscles and adipose tissue (Adu *et al.*, 2019). Disruption of this signaling causes the complex metabolic disorder of insulin resistance, which is closely related to many pathways including lipid metabolism, energy expenditure and inflammation (Early and Stanley, 2018). Therapeutic approaches based on diet or pharmacological agents affect molecular signaling pathways and impaired glucose homeostasis (Marincic *et al.*, 2017). Many studies showed that dietary components may affect glucose levels. For example, a mixed diet containing fiber, specific proteins or lipids may benefit type 2 diabetes patients by influencing the rate of carbohydrate digestion and absorption (Nam *et al.*, 2011). Replacing saturated fat with monounsaturated fatty acids (MUFA) or polyunsaturated fatty acids (PUFA) may improve glucose or insulin tolerance. Different diets with various nutrient contents may lead to changes in metabolites and gut microbiome which are responsible for glucose metabolism in the body (Russell *et al.*, 2016). Considering the role of nutrition in diabetes control, education of patients focusing on changing nutritional behaviors and lifestyle is one of the interventions that may be useful in achieving the goals of diabetes management. According to the results of this study, higher education level was positively associated with diabetes control; awareness of normal blood glucose levels and the consequences of uncontrolled diabetes as well as self-monitoring represented a remarkable relationship with diabetes management. Nutritional education including familiarity with portion sizes of foods, glycemic index, adherence to diet specially weight loss dieting and follow-up by a nutritionist was significantly associated with better control of diabetes (Qin *et al.*, 2012). Moreover, this study showed that insurance coverage has a significant effect on management of this disease.

In a study by Aroke *et al.*, evaluating the efficacy of medical nutrition therapy and weight-loss questionnaire in type 2 diabetes, a significant improvement was observed in triglyceride, waist circumference, (WC), glycemic control and blood pressure which was along with this study (Aroke and Powell-Roach, 2020). Similarly, in a study by Franz et al, medical nutrition therapy for 3-6 months reduced HbA1c up to 2% in type 2 diabetes, which was equal to or more than treatment medication (Chawla *et al.*, 2019).

Table 2. Referral to a nutritionist based on some study variables.

Variable	Referral	No referral	P-value
Sex			
Male	30 (15.0)	60 (30.0)	0.40
Female	43 (21.5)	67 (33.5)	
Weight status			
Underweight	2 (2.7)	1 (0.8)	
Normal	11 (15.1)	25 (20.0)	0.59
Overweight	30 (41.1)	47 (37.6)	
Obese	30 (41.1)	52 (41.6)	
Education level			
Illiterate	26 (13.0)	55 (27.5)	
Elementary	16 (8.0)	28 (14.0)	0.26
Junior high school	15 (7.5)	13 (6.5)	
Senior high school	13 (6.5)	21 (10.5)	
University	3 (1.5)	10 (5.0)	
Insulin therapy			
Yes	19 (9.5)	36 (18.0)	0.72
No	54 (27.0)	91 (45.5)	
Hemoglobin A1c (%)			
≤7	17 (8.5)	28 (14.0)	
7.1-8	21 (10.5)	46 (23.0)	0.74
8.1-9	16 (8.0)	25 (12.5)	
9.1<	19 (9.5)	28 (14.0)	

Table 3. Frequency distribution of diabetes control status according to demographic variables.

Variable	Controlled	Uncontrolled	P-value
Sex			
Male	19 (21.1)	71 (78.9)	0.9
Female	24 (21.8)	86 (78.2)	
Education level			
Illiterate	11 (13.6)	70 (86.4)	
Elementary	8 (18.4)	36 (81.6)	0.001
Junior high school	4 (14.3)	24 (85.7)	
Senior high school	16 (41.7)	18 (58.3)	
University	4 (30.8)	9 (69.2)	
Marital status			
Single	40 (23.1)	133 (76.9)	0.158
Married	3 (11.1)	24 (88.9)	

Table 4. Frequency distribution of diabetes control status according to study variables.

Socio-economic variables.	Controlled	Uncontrolled	P-value
Residence			
Urban	39 (21.7)	141 (78.3)	0.863
Rural	4 (20.0)	16 (80.0)	
Employment status			
Employee	2 (13.3)	13 (87.7)	0.464
Retired	13 (32.5)	27 (67.5)	
Housewife	22 (21.4)	81 (78.6)	
Others	3 (12.0)	22 (88.0)	
Unemployed	3 (17.6)	14 (82.4)	
Insurance coverage			
Insured	42 (24.6)	129 (75.4)	0.01
No insurance	1 (3.4)	28 (96.9)	
Disease history variables			
Course of diabetes (y)	5.67 ± 4.39	8.47 ± 6.03	0.172
Family history of diabetes			
Yes	32 (24.6)	98 (75.4)	0.144
No	11 (15.7)	59 (84.3)	
Degree of family history of diabetes			
Grade 1	28 (23.3)	92 (76.7)	0.161
Grade 2	4 (36.4)	6 (63.6)	
Blood glucose monitoring variables			
Having a glucometer			
Yes	25 (20.3)	98 (79.7)	0.731
No	17 (22.4)	59 (77.6)	
Recording glucometer results			
Yes	3 (20.0)	12 (80.0)	0.883
No	40 (21.6)	145 (78.4)	
Being aware of the normal range of blood glucose			
Yes	14 (43.8)	18 (56.2)	0.001
No	29 (17.3)	139 (82.7)	
Being aware of the consequences of Uncontrolled levels with diabetes control			
Yes	18 (50.0)	18 (50;0)	<0.001
No	25 (15.2)	139 (84.8)	
HbA1c values with anthropometric indices and weight loss diet			
Overweight			
Yes	35 (22.0)	124 (78.0)	0.839
No	8 (20.5)	31 (79.5)	
Weight assessment in clinic			
Yes	24 (32.4)	50 (67.6)	0.004
No	19 (15.1)	107 (84.9)	
Receiving weight control recommendations			
Yes	22 (29.3)	53 (70.7)	0.037
No	21 (16.8)	104 (83.2)	
Weight loss diet			
Yes	9 (52.9)	8 (47.1)	0.001
No	26 (17.8)	120 (82.2)	
Adherence to diet			
More than a year	2 (66.7)	1 (33.3)	0.029
One year or less	4 (44.4)	5 (55.6)	
No diet	29 (19)	124 (81)	
Complete adherence to diet			
Yes	5 (71.4)	2 (28.6)	0.001
No	30 (19.0)	128 (81.0)	

Weight assessment times in one 1 or two years			
None	19 (14.7)	110(85.3)	<0.001
Once	17 (27.4)	45 (72.6)	
Twice and more	7 (77.8)	2 (22.2)	
Diet change after diabetes			
Yes	14 (41.2)	20 (58.8)	0.002
No	29 (17.5)	137 (82.5)	
Nutrition education			
Yes	21 (46.7)	24 (53.3)	<0.001
No	22 (14.2)	133 (85.8)	
Complete adherence to recommended diet			
Yes	7 (70.0)	3 (30.0)	<0.001
No	36 (18.9)	154 (81.1)	
Period of adherence to diet			
More than a year	4 (80.0)	1 (20.0)	0.002
One year or less	8 (29.6)	19 (70.4)	
No diet	31 (18.5)	137 (81.5)	
Periodic follow-up by a nutritionist			
Yes	5 (62.5)	3 (37.5)	0.004
No	38 (19.8)	154 (80.2)	
Familiarity with the exchange list of food groups			
Yes	8 (80.0)	2 (20.0)	<0.001
No	35 (18.4)	155 (81.6)	
Familiarity with portion sizes			
Yes	10 (45.5)	12 (54.5)	0.004
No	33 (18.5)	145 (81.5)	
Frequency of anthropometric measurements by a nutritionist in 1or 2 years			
None	35 (20.2)	138 (79.8)	
Once	5 (21.7)	18 (78.3)	0.031
Twice and more	3 (75.0)	1 (25.0)	
Familiarity with glycemic terms			
Yes	5 (83.3)	1 (16.7)	<0.001
No	38 (19.6)	156 (80.4)	

Likewise, in the study by Dobrow *et al.*, assessing the effect of registered dietitian nutritionists in healthy behavior interventions in older people with type2 diabetes, a significant improvement was observed in fasting blood glucose, HbA1c, blood pressure, low-density lipoprotein cholesterol (LDLc), BMI, lean body mass and self-efficacy (Dobrow *et al.*, 2022).

The present study has several limitations: 1) The retrospective observational design precludes causal inference; only associations between nutritional/therapeutic care and glycemic control can be reported, not cause–effect relationships; 2) All patients are from a single diabetes clinic in Kermanshah, which may limit generalizability to other regions, healthcare systems, and ethnic or socio-economic populations; 3) Reliance on medical records and self-reported questionnaires (e.g., DSMQ, diet adherence) introduces possible recall bias, reporting bias, and missing or incomplete data.

Conclusion

This study shows that evaluating the disease process through focusing on nutritional care and education will provide the basis for better and more effective care services in diabetes management from both quantitative and qualitative aspects.

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Authors' contributions

All authors contributed to study design, writing,

and interpretations of data; they agreed to be responsible for all aspects of this study.

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Conflicts of interests

The authors had no conflicts of interest.

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