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THE RELATIONSHIP BETWEEN NUTRITION KNOWLEDGE AND DEVELOPMENT OF COMPLICATIONS IN TYPE 2 DIABETIC PATIENTS

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Abstract

Background and Aims: *Diabetes is increasing rapidly in Turkey as most countries in the world. The prevention of complications which is the main aim in the treatment of diabetes can be accomplished partly with nutrition education. The aim of this study was to assess the relationship between nutrition knowledge (NK) and complications in patients with type 2 diabetes.* ***Materials and Methods:*** *280 patients with 8-20 years of diabetes duration who applied to diet outpatient clinic were recruited. The questionnaire was prepared by the investigators to assess the NK. A score was calculated on the scale of 100. The complications were determined based on hospital records and patients' self-report.* ***Results:*** *63.2% of participants were female and 36.8% were male. The most common complications in participants were retinopathy (56.1%) and neuropathy (42.9%). The mean NK score was 80.2±11.7. At least one complication was seen in 85.0% of the participants. There was no significant difference for having any complication in patients with adequate and inadequate NK. However the risk of diabetic foot, and coronary artery disease was significantly higher in women with inadequate NK.* ***Conclusion:*** *NK is quite high in long term diabetic patients. However no effect of the NK on the development of complications could be shown. The difference of effect between men and women could be due to the fact that food is mostly prepared by women thus not much chance of the knowledge of men to be reflected on his eating habits. The knowledge difference among female patients was seen in the results as; in women with inadequate NK, the prevalence of diabetic foot and CAD was significantly higher.*

key words: *type 2 diabetes, nutrition knowledge, complications of diabetes*

Background and Aims

World Health Organisation (WHO) defines diabetes as a chronic disease which occurs when pancreas does not produce enough insulin or produced insulin cannot be used efficiently and causes glucose concentration in the blood to increase [1]. Diabetes is one of the biggest global health threats of the 21st century. International Diabetes Federation (IDF) predicts

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that the number of individuals with diabetes will have reached 642 million by 2040, in comparison with 415 million in 2015 [2]. Nearly 80% of the diabetes patients live in low and middle-income countries. Diabetes prevalence was estimated as 8.3% by the IDF in 2011 and it is predicted to reach 9.9% in 2030 [3].

Diabetes spreads rapidly in Turkey as in the rest of the world [2]. Conducted between 1997 and 1998 on individuals older than 20, Turkish Diabetes Epidemiology Study I (TURDEP-I) detected diabetes prevalence as 7.2%. Moreover, according to the results of TURDEP-II study, which was reconducted in 2010, this prevalence reached 13.7%. With the increase in its prevalence in the last 12 years, diabetes has become a major health problem in Turkey [4,5].

That fast food has become widespread because of urbanization and rapid industrialization, individuals do not know how to manage their health with the new life style, their life has become sedentary as a result of smart phones, computers and TVs, while Turkish women traditionally spend most of their time at home. All these have an impact on the increase in overweight and diabetes [6]. Individuals with diabetes are under the risk of life-threatening health problems that affect heart and blood vessels, eyes, kidneys and nerves [2]. Microvascular complications (damage in small blood vessels) consist of eye injury (retinopathy) causing blindness, kidney injury (nephropathy) triggering renal failure, impotence and nerve injury (neuropathy) leading to diabetic foot injury. Macrovascular complications (damage in large blood vessels), on the other hand, include cardiovascular diseases such as ischaemic heart disease, stroke and peripheral artery disease [7].

The main element of diabetes treatment is providing an effective diabetes management since diabetes increases mortality and morbidity based on micro and macrovascular complications. Diabetes management require self-governance training, consultancy in smoking cessation, physical activity training, psycho-social care and medical nutrition threapy [8]. Nutrition therapy should be individualised considering the individual's eating preferences and habits, metabolic profile, treatment goals and desired results [9].

The aim of the nutrition therapy is to improve healthy eating habits, gain and preserve a healthy body weight, reach the individualized blood sugar, blood pressure and lipid goals, support the desire and ability of changing a behavior, prevent or delay complications and improve the general health [8,10]. With the help of nutrition therapy given to the diabetic individuals, it is aimed for them to acquire a sufficient and balanced diet and transform their healthy nutrition knowledge into a behavior in their daily routine. Thus, diabetic patients can be controlled in terms of active glycemic control and complications can be prevented or delayed [11].

This aim of this study was to evaluate the relationship between nutrition knowledge and diabetes chronic complications in patients with type 2 diabetes.

Materials and methods

The study population consists of type-2 diabetes patients aged 8-20 years who applied to the diet outpatient clinic in İzmir Katip Çelebi University Atatürk Training and Research Hospital. There was no sampling among the patients who applied to the clinic; instead, the patients who fulfilled the inclusion criteria have been included until having reached the target number of 280 patients.

The inclusion criteria were: type-2 diabetes patients aged 8-20 years, accepting the participation in the research, and having no communicative disorder; while the exclusion criteria are having type-1 diabetes or gestational diabetes, and being a lactating woman. It was

calculated by the bio-statistic expert that 280 patients needed to be involved in the study.

The complication status of the patients was established based on both the patient self-reports and the patient records in the hospital information management system. The ICD-10 codes encoded by the doctor(s) and the anamneses written by the doctor(s) in the patient records have been retrospectively analyzed. The existence of a complication at least once in the ICD-10 codes or in the patient records is accepted as the existence of the disease. In Table 1, we are detailing the ICD-10 codes encoded by the doctor(s) or previous diagnoses found in the patient records.

Table 1. ICD-10 codes used in defining the complications

Previous diagnoses found in the patient records or in the ICD-10 codes	The counter parting complications induced by diabetes
-Background retinopathy -Proliferative retinopathy -Diabetic retinopathy -Insulin-independent diabetes mellitus, with ophthalmic complications	Diabetic retinopathy
-Proteinuria -Chronic renal failure -Insulin-independent diabetes mellitus, with renal complications	Diabetic nephropathy
-Diabetic polyneuropathy -Diabetic mononeuropathy -Diabetic neuropathy -Insulin-independent diabetes mellitus, with neurological complications	Diabetic neuropathy
-Diabetic foot	Diabetic foot
-Organic impotence -Erectile dysfunction	Impotence
-Atherosclerotic cardiovascular disease -Atherosclerotic heart disease -Coronary artery disease	CAD
-Insulin-independent diabetes mellitus, with peripheral circulatory disorders -Peripheral arterial disease	PAD
Transient cerebral ischaemic attacks, Vascular syndromes of brain in cerebrovascular diseases, Cerebral infarction Cerebrovascular diseases	CVAD

Despite the fact that whether coronary artery disease (CAD), peripheral arterial disease (PAD), and cerebrovascular diseases (CVAD) developed before or after the diabetes has been questioned in the patient self-report; CAD, PAD, and CVAD have been accepted as diseases associated with diabetes because not every patient record included the data about the occurrence time of these diseases.

A questionnaire consisting of 23 info questions (including general dietary recommendations about number of meals, meal times, cooking methods; basic food groups like milk-yogurt group, meat group, bread group, oil group, vegetable group; and objectionable foods) developed by the research team has been used in order to determine the nutrition knowledge score in the data collection stage. The questionnaire form has been evaluated on the scale of a hundred, each question having an equal value (maximum score was 100, the score of each question was 4.35). An adequate nutrition knowledge score has been evaluated by taking the median score (82.6) of the participants as the cut-off point [12]. The nutrition knowledge of those who scored under 82.6 out of hundred has been identified as insufficient, while of those who scored 82.6 and above as sufficient.

The data have been collected by using face to face method after receiving the volunteer consents of the participants. Written consent was obtained from all participants at the beginning of study which was approved by the Ethics Committee of the Faculty of Medicine, Dokuz Eylul University, İzmir, Turkey (Approval number 02/05/2013-2013/16-10).

Statistical analysis

The data have been evaluated by using SPSS 15.0 and Epi Info 7 software. Because of the fact that the reflection of nutrition knowledge on behavior could be different for females and males, and this could affect the dependent variables, analysis has been performed separately for women and men. Pearson chi-square test, Fisher's exact test, multi-platform chi-square and chi-square test on slope have been used for the significance of difference between the groups with sufficient and insufficient nutrition knowledge. The t-test has been performed in independent groups for the significance of the nutrition knowledge points in males and females. Logistic regression analysis has been carried out for the complications (CVAD and diabetic foot) detected to have significant relationship with the nutrition knowledge score. If the obtained p value is lower than 0.05, then the difference is accepted to be significant.

Results

Socio-demographic features of the participants are shown in Table 2. Overall 280 individuals participated in the study (63.2% females, 36.8% males), with a mean age of 61.2±9.9 years and a mean diabetes duration of 13.2±4.0 years (data not shown).

The complication occurrence rates in the participants are shown in Table 3. The most frequent complication was retinopathy with an overall rate of 56.1%, followed by neuropathy with 42.9% and CAD with 37.9%.

Table 2. Sociodemographic features of participants

Variables	n	%
Gender		
Women	177	63.2
Men	103	36.8
Age groups (years)		
<50	37	13.2
50-59	90	32.1
60-69	99	35.4
≥70	54	19.3
Marital status		
Single	8	2.9
Married	202	72.1
Divorced	8	2.9
Widowed	62	22.1
Educational status		
Illiterate	40	14.3
Literate-primary school graduate	174	62.1
Secondary school graduate	22	7.9
High school graduate	30	10.7
Postgraduate	14	5.0

The descriptive features of nutrition knowledge have been displayed in Table 4. The mean nutrition knowledge score of participants was 80.2±11.7. There were no significant differences between males and females in terms of mean nutrition knowledge score.

The effect of nutrition knowledge on the presence of complications has been displayed in Table 5. 85.0% of the individuals with type 2 diabetes who participated in the research have developed at least one complication, whereas no

complication has occurred in 15.0% of the individuals. This ratio is 83.1% and 88.3% in females and males, respectively. There was no significant difference between those who have sufficient nutrition knowledge and those who do not in both women and men in terms of the complication occurrence.

Table 3. Prevalence of complications in participants

	Presence of complications					
	Women		Men		Total	
Complications	**n**	**%**	**n**	**%**	**n**	**%**
Retinopathy	95	53.7	62	60.2	157	56.1
Neuropathy	74	41.8	46	44.7	120	42.9
CAD	54	30.5	52	50.5	106	37.9
Nephropathy	45	25.4	38	36.9	83	29.6
PAD	29	16.4	34	33.0	63	22.5
CVAD	24	13.6	18	17.5	42	15.0
Diabetic foot	15	8.5	16	15.5	31	11.1
Impotence*	-	-	6	5.8	6	5.8

* Only males (n = 103) have been analyzed.

Table 4. Descriptive features of nutrition knowledge

Descriptive features	**Values**
Minimum	39.1
Maximum	100.0
Mean	80.2 (Women: 80.2±11.8 / Men: 80.2±11.5, p=0.976*)
Median	82.6
Standard deviation	11.7
Quarters	
%25	73.7 (Women: 73.7, Men: 69.6)
%50	82.6 (Women: 82.6, Men: 82.6)
%75	89.5 (Women: 88.2, Men: 89.5)

*Independent t test

Table 5. The effect of nutrition knowledge on overall complication presence

	Complications											
	Women				Men				Total			
Nutrition	**Present**		**Absent**		**Present**		**Absent**		**Present**		**Absent**	
Knowledge	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Insufficient	76	88.4	10	11.6	44	89.8	5	10.2	120	88.9	15	11.1
Sufficient	71	78.0	20	22.0	47	87.0	7	13.0	118	81.4	27	18.6
Total	147	83.1	30	16.9	91	88.3	12	11.7	238	85.0	42	15.0

χ^2_{women} = 3.365 p=0.067; χ^2_{men} = 0.19 p=0.663; χ^2_{total} = 3.09 p=0.079

The effect of nutrition knowledge on diabetic complications has been shown in Table 6. Diabetic foot was significantly higher in women with insufficient nutrition knowledge (14.0%) in comparison with women with sufficient knowledge (3.3%). However, there was no significant difference in terms of diabetic foot occurrence and nutrition knowledge among men.

Similarly, CVAD was significantly higher in women with insufficient nutrition knowledge (39.5%) in comparison with women with sufficient knowledge (22.0%), while no significant difference was found in terms of CVAD among men.

In the logistic regression analysis model an evaluation has been carried out regarding the effects of the variables such as education status,

diabetes duration, applied treatment and nutrition knowledge on the presence of diabetic foot.

Table 6. The effect of nutrition knowledge on diabetic complications

Complications		Sufficient Nutrition Knowledge						Insufficient Nutrition Knowledge					
		Men		Women		Total		Men		Women		Total	
		n	%	n	%	n	%	n	%	n	%	n	%
Retinopathy	Present	32	59.3	43	47.3	75	51.7	30	61.2	52	60.5	82	60.7
	Absent	22	40.7	48	52.7	70	48.3	19	38.8	34	39.5	53	39.3
		χ^2_{women} = 3.104 p=0.078				χ^2_{men} = 0.041 p=0.839		χ^2_{total} = 2.307 p=0.129					
Nephropathy	Present	19	35.2	22	24.2	41	28.3	19	38.8	23	26.7	42	31.1
	Absent	35	64.8	69	75.8	104	71.7	30	61.2	63	73.3	93	68.9
		χ^2_{women} = 0.154 p=0.695				χ^2_{men} = 0.142 p=0.706		χ^2_{total} = 0.269 p=0.604					
Neuropathy	Present	22	40.7	38	41.8	60	41.4	24	49.0	36	41.9	60	44.4
	Absent	32	59.3	53	58.2	85	58.6	25	51.0	50	58.1	75	55.6
		χ^2_{women} = 0.000 p=0.989				χ^2_{men} = 0.706 p=0.401		χ^2_{total} = 2.268 p=0.605					
Diabetic foot	Present	8	14.8	3	3.3	11	7.6	8	16.3	12	14.0	20	14.8
	Absent	46	85.2	88	96.7	134	92.4	41	83.7	74	86.0	115	85.2
		χ^2_{women} = 6.474 p=0.011				χ^2_{men} = 0.045 p=0.832		χ^2_{total} = 3.710 p=0.054					
CAD	Present	27	50.0	20	22.0	47	32.4	25	51.0	34	39.5	59	43.7
	Absent	27	50.0	71	78.0	98	67.6	24	49.0	52	60.5	76	56.3
		χ^2_{women} = 6.428 p=0.011				χ^2_{men} = 0.011 p=0.918		χ^2_{total} = 3.788 p=0.052					
PAD	Present	17	31.5	17	18.7	34	23.4	17	34.7	12	14.0	29	21.5
	Absent	37	68.5	74	81.3	111	76.6	32	65.3	74	86.0	106	78.5
		χ^2_{women} =0.721 p=0.396				χ^2_{men} = 0.120 p=0.729		χ^2_{total} = 0.155 p=0.694					
CVAD	Present	8	14.8	11	12.1	19	13.1	10	20.4	13	15.1	23	17.0
	Absent	46	85.2	80	87.9	126	86.9	39	79.6	73	84.9	112	83.0
		χ^2_{women} = 0.346 p=0.55				χ^2_{men} = 0.557 p=0.45		χ^2_{total} = 0.848 p=0.357					
Impotence	Present	2	3.7	-	-	54	100.0	4	8.2	-	-	49	100.0
	Absent	52	96.3	-	-			45	91.8	-	-		
		*Fisher exact test p=0.42											

Whereas in model 1 nutrition knowledge was significant at borderline, in model 2 when the treatment group was removed from the model due to the low number of cases, it has been observed that the nutrition knowledge has a significant effect on the diabetic foot in women. When the other variables are controlled, the diabetic foot frequency was 4.23 times higher in women with insufficient nutrition knowledge compared to those with sufficient knowledge. No significant relationship between diabetic foot and nutrition knowledge was found in men after logistic regression analysis (Table 7).

In Table 8, we are giving the results of the logistic regression analysis regarding the effects of nutrition knowledge, applied treatment, smoking and duration of diabetes on the presence of CAD.

Table 7. Factors affecting diabetic foot presence in women (logistic regression analysis)

	Model 1*			Model 2†		
Variables	**OR**	**95% CI**	**p**	**OR**	**95% CI**	**p**
Nutrition knowledge	3.86	0.99-14.98	0.051	4.23	1.10-16.28	0.036
Duration of diabetes	0.67	0.22-2.03	0.475	0.72	0.24-2.16	0.556
Educational status	1.75	0.20-15.40	0.614	1.83	0.21-15.83	0.585
Applied treatment	2.35	0.62-8.94	0.208	—	—	—

*Variables: Nutrition knowledge, duration of diabetes, educational status, applied treatment

† Variables: Nutrition knowledge, duration diabetes, educational status

Table 8. Factors affecting CAD presence in women (logistic regression analysis*)

Variables	β	p	OR	95% CI
Nutrition knowledge				
Sufficient (reference)				
Insufficient	0.80	0.021	2.23	1.13-4.40
Applied treatment				
Diet and OADT (reference)				
Insulin and Insulin+OADT	0.78	0.036	2.18	1.05-4.50
Smoking				
No (reference)				
Yes	-1.74	0.106	0.18	0.02-1.45
Cessation	0.32	0.500	1.38	0.55-3.47
Duration of diabetes				
8-14 years (reference)				
15-20 years	0.07	0.833	1.08	0.55-2.10

*Variables: Nutrition knowledge, applied treatment, smoking, duration of diabetes
OADT= Oral antidiabetic treatment

In the logistic regression model nutrition knowledge score has been observed to have significant effects on CAD presence in the women. When the other variables are controlled, the CAD frequency is 2.18 times higher in the women who had insulin treatment and insulin + OADT compared to those who had diet and OADT. When the other variables are controlled, the CAD frequency is 2.23 times higher in the women with insufficient nutrition knowledge compared to those with sufficient knowledge. In the logistic regression analysis carried out with women, no significant relationship has been identified between CAD and these variables.

Discussion

The prediction of the prevalence of diabetes complications plays a crucial role for both community and health organizations since people's attention would be drawn to the disease and its irreversible complications [13,14]. Moreover, in health care system, it would prompt the cooperation into not only preventing the disease, for it imposes expensive treatment on the patients, but also controlling it as it leads to irreversible complications and lowers the patient's workforce [15,16].

In this research, at least one chronic complication was detected in 85.0% of the patients whereas 15% of them had none. In comparison, in a multinational study which Litwak et al. [13] conducted to investigate the chronic complication frequency in individuals with type 2 diabetes, complication prevalence was found to be also high (27.2% had macrovascular complications and 53.5% had microvascular complications), a result similar with that of this study. Ghodsi et al. [17] on the other hand, observed diabetic complication in more than a half of their participants.

Reasons for higher complication frequency in this research may be that the hospital was visited generally by the diabetic patients whose diabetes control was spoilt and hospital monitoring was high, diabetics without glycemic control preferred tertiary health institutions and the complication rate increased in parallel with diabetes duration. In addition, complication scanning has improved in recent years and doctors refer the diabetics with bad glycemic controls to dietary polyclinics [18-20].

The most frequently encountered complication of diabetes in developed countries is retinopathy. Developing countries were reported to have 10-61% retinopathy in diabetes [21]. In an older study carried out in various regions of Iran, the retinopathy prevalence was reported in the range of 30-40% [22]. In this study, in compliance with the literature, it was

observed that the most prevalent complication was retinopathy with a prevalence of 56.1%. That the average diabetes duration was longer in this study and different diagnosis methods were used may have an impact on the high retinopathy and neuropathy prevalence.

In the "International Diabetes Mellitus Practice Study (IDMPS)" including type 2 diabetes patients and experts from Turkey, it was detected that 11-36% of the type 2 diabetes patients haven't been scanned in terms of complications for the last 2 years. It was also observed that the percentage of complications was higher than previously reported in the literature [23]. Differences in the frequency of complications may stem from diabetes duration, using various techniques in scanning, participants having different glycemic controls and different diagnoses through better scanning.

Diabetes Control and Complications Trial (DCCT) and U.K. Prospective Diabetes Study (UKPDS) showed the importance of glycemic control in preventing diabetes complications [24,25]. In the DCCT study, the role of diet behaviors was shown to have an important role in the diabetes control [26]. It was also detected that nutrition education improves metabolic outcomes and glycemic control in patients with type 2 diabetes mellitus [27,28]. In the present study, no significant difference was detected between diabetic patients with sufficient and insufficient nutrition knowledge in terms of complication presence. However, we did not find in the literature another research which analyzes the relationship between nutrition knowledge and complications in diabetic patients.

That this study could not detect a significant relationship between nutrition knowledge and complication presence can be explained by the fact that nutrition knowledge of the participants may have risen after the complications have developed. In addition, no validated and approved test was applied in order to evaluate the nutrition knowledge. This situation may cause misleading evaluation of the nutrition knowledge. Additionally, a rise in the knowledge may not affect eating habits as there is a weak relationship between the level of knowledge and behavior. Since nutrition knowledge influences complications indirectly by providing a change in the behavior, it may not lead to a significant result.

The average age of the participants' in this study was high. This makes it very hard for participants to change their long lasting eating habits and behaviors. The doctors may have hastened while choosing diagnosis codes as there was a limited time for each of the patients. Incomplete or incorrect codes and failure in receiving the patient's background may have an impact on the percentages of the complications. Diabetic patients in this study do not represent the general diabetes population as they consist only of the hospital population. The participants were observed to have very high complication incidences whereas the number of the ones without complications was low. This low number makes it difficult for nutrition knowledge to show its effect.

It was detected that nutrition knowledge had no significant relationship with any complications in males. While females' knowledge may directly affect their behavior, that of the males' may not be reflected on their behavior in the kitchen. Even if they have the knowledge, men usually may not transform it into a behavior and performance since they do not cook. In addition, factors such that women are more interested in a healthy diet, they watch health programs on TV and they talk about nutrition at their friend meetings may have influenced the result as those reasons do not apply to men.

In women, a significant relationship was observed between an adequate level of nutrition knowledge and CAD. It was also detected in the

regression analysis that CAD frequency was higher in women with insufficient nutrition knowledge than in ones with sufficient knowledge. After CAD develops, a series of lifestyle changes including smoking cessation and physical activity are recommended. Some recommendations such as eating a variety of fruits and vegetables, whole grains, low-fat dairy products, skinless poultry and fish, nuts and legumes and limiting saturated fat, trans fat, sodium, red meat, sweets, sugar-sweetened beverages and alcohol which are also compatible with diabetes are given to patients with heart diseases [29]. CAD patients may be following the nutrition recommendations to control risk factors for fear of getting physically unwell or fear of death because of the symptoms such as chest pain, difficulty in breathing, heart failure, palpitation and having difficulty in activities requiring physical power [30]. This situation may also affect the prospect of a significant relationship between nutrition knowledge and CAD. One of the most crucial risk factors in CAD is smoking [31]. The fact that men smoke more than women, smoking affects CAD directly and nutrition knowledge is therefore not the main risk factor may explain the absence of a significant relation between nutrition knowledge in men and CAD.

A significant relationship was observed between an adequate nutrition knowledge and diabetic foot in women. Moreover, in the regression analysis it was found that women with insufficient nutrition knowledge had significantly higher diabetic foot frequency than the ones with sufficient knowledge. Training given to such patients includes suggestions about choosing proper shoes, socks, daily control for the signs of trauma, basic first-aid skills for feet problems and self-care strategies [32]. Factors such that patients with a diabetic foot background have more regular polyclinical monitoring, patient trainings about diabetic foot care are held frequently by both the doctor and the nurse, and that foot care requires a regular and particular behavior like nutrition can be effective in determining a significant relationship between diabetic foot and nutrition knowledge in women.

Conclusion

Nutrition knowledge was quite high in this group of patients with long term diabetes. However there was almost no effect of the knowledge on the development of complications. The difference of effect between men and women could be due to the fact that food is mostly prepared by women, thus not much chance of the knowledge of men to be reflected on his eating habits. The nutrition knowledge in women made a difference in the prevalence of diabetic foot and CAD, both significantly higher in women with poor knowledge. All patients with diabetes should receive training about nutrition in diabetes periodically. Approaches to improve the effectiveness of education, patient's adherence to treatment and diet should be applied.

Conflicts of interest. The authors declare no conflicts of interest.

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