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Individual, Psycho-Social and Disease-Related Risk Factors in Diabetic Neuropathy

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Abstract

***Background*:** Neuropathy is the mostly prevalent of complications and the major cause of amputation, pain and disability in patients with diabetes. The purpose of this study was to investigate the role of individual, psycho-social, and disease-related risk factors in neuropathy of type 2 diabetes patients.

***Materials and Methods*:** In this retrospective cross-sectional study, 271 patients with type 2 diabetes were selected by convenience sampling in diabetic outpatient clinics of Tehran University of Medical Sciences and the Iranian Diabetic Association. The data were collected by demographical and disease characteristics questionnaires and DASS-42, QOLS, DSMS, and DKS scales. Then, the data were analyzed by *r* binary logistic regression along with PASW software.

***Results*:** Socio-economic status, glycosylated hemoglobin, body mass index, diabetes self-management, depression, quality of life, diabetes knowledge, and diabetes duration were significantly able to differentiate diabetic patients with neuropathy from diabetic patients without neuropathy ($p<0.001$). Gender, treatment type and patient age were not significantly able to differentiate two groups ($p>0.05$). The total regression model explained that 95.2% of cases were classified correctly.

***Conclusion*:** Inappropriate socio-economic status, glycosylated hemoglobin over 9%, being overweight and obesity, poor diabetes self-management, clinical depression, low quality of life, poor diabetes knowledge, and longer diabetes duration contribute to the incidence of neuropathy in patients with type 2 diabetes and attention must be paid to them for neuropathy prevention.

Introduction

Diabetic neuropathy is the earliest complication and the most common cause of hospitalization due to type 2 diabetes which increases per capita consumption of society health costs and affects approximately 10-50% of these patients [1, 2]. Several factors, such as obvious differences in gender physiology, differences in lifestyle, and disease-related factors are important associates of diabetic neuropathy incidence [3, 4]. Early detection of risk factors can prevent or delay the development of diabetic neuropathy [1].

According to studies, patients with lower socio-economic conditions are more prone to diabetic neuropathy due to health illiteracy and the reduction of self-caring behaviors [5]. In fact, older age, longer duration of the disease associated with low socio-economic status are diabetic neuropathy risk factors [1, 6, 7]. Also, according to results of other researches, the decrease of overall performance and the increase of depression symptoms are associated with the occurrence of diabetic neuropathy [8, 9]. Based on another study, intensive insulin therapy along with favorable psycho-social factors can reduce the complications of diabetes [10]. Associated with increased body mass index increase higher than 30 kg/m^2, the risk of diabetic neuropathy also increases [11]. Indeed, factors such as age, poor health knowledge, male gender, obesity and depression symptoms associated with a lower quality of life, are important predispositions to neuropathy occurrence [12]. In addition, body mass index along with insulin resistance and beta-cells dysfunction are poor controllers of blood sugar and predispose to neuropathy [13].

According to previous studies, aging, being overweight, and obesity, as well as prolonged diabetes duration are associated with at least one neuropathy symptom [14, 15]. Poor self-management and metabolic control, alone and other factors, lead to diabetic neuropathy [16, 17]. On the other hand, careful control of blood sugar reduces the progression of diabetic neuropathy in 45-65% of cases [16]. According to research background, these different variables together play a leading role in the genesis of diabetic neuropathy. For example, depression is considered a risk factor for neuropathy through accelerating the metabolic syndrome and insulin resistance [18]; its persistence is associated with the further extension of diabetes complications [19]. In this context, another group of studies emphasized the significant role of life quality when experiencing diabetic complications [1, 12]. Low or poor life quality has an important role in predicting the occurrence of diabetic neuropathy; on the other hand, the incidence of

neuropathy strongly decreases patients' quality of life [20]. Meanwhile, the increasing knowledge about symptoms and mode of control of diabetes will reduce the incidence of diabetic neuropathy through improving self-care behavior [2, 21]. Given the importance of controlling and delaying diabetes complications, the purpose of this research was to study the role of individual risk factors as well as psychosocial and disease-related factors in neuropathy of patients with type 2 diabetes.

Materials and Methods

In this retrospective cross-sectional survey, the statistical population consisted of adult men and women aged 30 to 57 with type 2 diabetes who had referred to the diabetes clinics of Shariati Hospital in Tehran and the Iranian Diabetes Society during the study (October until December of 2010) and were treated as outpatients.

The number of diabetic patients referring to these clinics and the Diabetes Society during the 3 months of data collection was almost 3,500, out of which 271 patients (127 male and 144 female) were selected through available sampling methods. The study inclusion criteria were the diagnosis of type 2 diabetes in the 30-57 age range at least one year before the research in order to be sure of the awareness and capability of patients in performing diabetes self-management, the ability to understand the Farsi language, informed desire and consent to take part in the research and completion of research ethical standards form, and also referring to one of physicians of Shariati Hospital diabetes clinics or the Iranian Diabetes Society, and having medical records with the treating physician.

Exclusion criteria from present study were diagnosis of other physical diseases, hospitalization of the patient during the study, and the diagnosis of psychological disorders. This research was based on the observation of ethical criteria like medical confidentiality, the convenience of subjects, and the satisfaction and anonymity of patients through the completion of a written consent, lack of interest conflict in clinical research and studies and the approval of the Research Ethics Committee. In this study, the data were collected using a questionnaire on demographic and disease characteristics, depression scales, anxiety and stress, life quality scales, diabetes self-management scales, and diabetes knowledge scales.

The demographic and disease characteristics questionnaire is a researcher-made tool for collecting demographic data including the patient's age, gender, and disease characteristics such as the duration of diabetes, the severity of the illness, side effects, type of diabetes and type of treatment (insulin and non-insulin treatment). The history of diabetes was evaluated through referring to patients' medical records, nursing staff comments, and questions from patients about the disease duration and treatment type (insulin treatment versus no insulin treatment); duration of the disease was measured by asking patients about the number of years of suffering from diabetes, and the type of treatment was assessed by asking patients about either getting insulin in order to control diabetes, or being treated with hypoglycemic pharmaceutical agents. The severity of the disease was assessed by measuring glycosylated hemoglobin (HbA_1c) and patient medical records in two categories; below 9% (mild and moderate) and above 9% (severe). Body weight was assessed through the body mass index (BMI) and its report in the patient's medical record in two categories; normal weight (BMI<25 kg/m^2) and overweight and obesity (BMI>25 kg/m^2). Diabetic neuropathy with two years experience was evaluated through two types of diabetic neuropathy, i.e. sensory-motor neuropathy and autonomic neuropathy, as well as the history of hospitalization due to them, the physician's diagnosis, and by referring to the medical file of the patient. Sensory-motor neuropathy included three categories: distal symmetric neuropathy, focal neuropathy (mononeuropathy, multiplex mononeuropathy), and diabetic amyotrophy. Autonomic neuropathy included five categories: cardiovascular system neuropathy, vasomotor neuropathy, sudomotor neuropathy, gastrointestinal tract autonomic neuropathy (gastric atony, constipation, diarrhea, fecal incontinence), and genitourinary tract autonomic neuropathy (bladder dysfunction, sexual dysfunction). The reliability of this study, obtained through the internal consistency method and calculating Cronbach's alpha (N=271), was equal to 0.86 for total demographic information and the disease characteristics questionnaire and 0.72 to 0.91 for its subsets, stating the appropriate internal consistency of the questionnaire. The face and content validity of this questionnaire was approved by three psychologist and 4 endocrinology and metabolism specialists, who confirmed the face and content validity of this tool.

To measure the depression in this study, the depression subscale of the Depression Anxiety Stress Scale (DASS-42) was used [22]. The depression subscale measures unhappy mood, lack of confidence, despair, worthlessness of life, lack of interest in conflicting affairs, to not enjoying life, and lack of energy and power. Subjects should read every item and grade its severity/frequency during the last week on a 4- degree scale (0 to 3). Each DASS-42 scale has 14 items. Subjects' scores on each scale is the sum of the scores they got for each phrase. The Cronbach's alpha for the DASS-42 depression subscale is 0.91 for the non-clinical population and 0.96 for the clinical population [23]. Test-retest coefficients for the questionnaire scales with two weeks interval were reported as 0.71-0.81 in a 20 patients sample with psychological disorders [23]. In the Persian version of the DASS-42, depression scales have 12 items. In the study done by Asghari Moghaddam et al., internal consistency coefficients for depression subscales and test-retest coefficients (with an interval of 3 weeks) were 0.93 and 0.84, respectively [24]. In addition, intra-class correlation between the two runs was obtained as 0.78 for the depression subscale. All these findings show the desirable reliability of the above scales.

To measure the life quality in this study, the World Health Organization Quality of Life Scale (QoLS) was

used. This tool contains 26 questions and measures patients' quality of life regarding the general sense of the person about his/her life quality (a question) and individuals' feelings and behavior in the last two weeks in aspects of health and physical health, psychological, social relationships, and social environment through a Likert spectrum of 1 to 5. Cronbach's alpha, and validity and reliability coefficients of this scale are acceptable to assess diabetic patients' quality of life [25, 26]. In their study (on a sample of 1167 people), Nejat et al. reported the test reliability through the test-retest method for physical health, mental health, social relations, and environment health domains as 0.77, 0.77, 0.75, and 0.84, respectively [27].

The Diabetes Self Management scale (DSMS) used in this study was prepared by Rahimian-Bugar [30], based on the items of the Diabetes Self Care Activities (SDSCA) scale [28], and six items of the Diabetes Self Management of China scale [29]. This tool includes 14 items on medical treatment and medication compliance, overall diet, exercise, glucose self-monitoring, the control of blood sugar reduction or increase, the control of eye, kidney, and cardiovascular complications and care of the feet.

Patients were asked about how many days they performed self-care activities during the last week. Higher scores indicated higher levels of self-care activities. In Rahimian Bugar's study, the internal consistency through Cronbach's alpha method was reported for weekly, monthly, and yearly self-management scales as 0.95, 0.86, and 0.67, respectively, and 0.95 for the total scale, which suggests the high internal consistency for the total scale and the monthly activities subscale as well as acceptable internal consistency for annual activities [30]. Four weeks test-retest reliability on 34 patients with diabetes for weekly, monthly and yearly self-management activities scale were 0.92, 0.90, and 0.97, respectively which show the excellent stability of the scale with time [30].

In this study, the Diabetes Knowledge Scale (DKS) was made based on items of the Xu scale [29], complied with general knowledge of diabetes especially for Iranian diabetic patients, and applied to measure this variable [30].

The diabetes-related knowledge questionnaire used in this study included 10 items and had an 11-point scale from zero percent (never) to 100% (always). Subjects should identify how aware they were of each item. Zero score meant lack of knowledge and a score of 100 meant perfect knowledge about the case. Scores ranged from 0 to 100. Higher scores indicated higher levels of diabetes-related knowledge. Internal consistency via Cronbach's alpha method in the original study (N=500) was obtained as 0.93 for diabetes-related knowledge scale which indicates high internal consistency of the scale. Four weeks test-retest reliability on 34 patients for diabetes-related knowledge was 0.95, which shows the excellent stability of the scale during time [30]. The collected data by the research tools were analyzed through descriptive statistics (frequency and percent), χ^2, independent *t*-test and logistic regression.

Results

The study subjects consisted of 127 males (46.9%) and 144 females (53.1%). The age range of the subjects was between 30 and 57, with a mean age of 45.36. Fifty-nine diabetic patients (21.8%) had neuropathy, whereas 212 patients (78.2%) did not. Type 2 diabetes duration was within 2 to 14 years with an average of 6.89 years. The specifications of the independent categorical variables of the subject (the risk factors for depression in diabetes) and the significancy of their differences are presented with a chi-square index (Table 1).

First, the study of the statistical assumptions of the logistic regression model analysis showed that there was no strong correlation (higher than 0.9) or multi-colinearity between the predictive variables used in the model; the variance estimations were also not raised. The highest correlation was -0.40 for life quality and disease severity. In addition, the study of the outlier data with the casewise list output showed that none of the remaining Z values were higher than 2. A review of evident outlier cases also indicated that all values fell between -2.5 to +2.5 and no data was outlier. The descriptive statistics of predictive variables or independent continuous (the risk factors for diabetic neuropathy) between the two groups of diabetic patients with neuropathy and without neuropathy and also their significant differences through *t* index have been provided (Table 2).

In this study, enter binary logistic regression analysis was used to test the assumption whether there were differences between the two groups of diabetic patients with and without neuropathy based on predictive variables. This model included 11 independent variables (gender, socio-economic status, and glycosylated hemoglobin, type of treatment, body mass index, age, diabetes self-care, diabetes duration, and depression, quality of life, and diabetes knowledge).

According to findings of table 3, eight predictive variables of socio-economic conditions, glycosylated hemoglobin, body mass index, diabetes self-care, diabetes duration, depression, quality of life, and diabetes knowledge had significant differences between the two groups of diabetic patients (p=0.001) and together, they had statistically correct significant contributions in the binary variable outcome of neuropathy, i.e. in diabetic patients with and without neuropathy (p=0.001). In the next step, the accuracy of logistic regression model was evaluated with respect to the coefficients of predictive variables in the equation to predict the incidence of neuropathy (Table 3). The evaluation of predictive variables coefficients showed that Wald's test with a freedom degree of 1 was statistically significant (p-value less than 0.05) for 8 socio-economic variables (p=0.031), glycosylated hemoglobin (p=0.003), body mass index (p=0.003), diabetic self-care (p=0.004), depression (p=0.017), quality of life (p=0.001), diabetes knowledge (p=0.001), and diabetes duration (p=0.030), and these variables are involved in the predictive ability of the model.

Therefore, in this study, the most important factors influencing the incidence of neuropathy in diabetic patients were: socio-economic status, glycosylated hemoglobin, body mass index, diabetes self-care, depression, quality of life, diabetes knowledge, and diabetes duration. Among these factors, gender, type of treatment, and patient age did not have a significant contribution in the prediction of the model.

An examination of the possibility of allocating one case to a specific category (neuropathy or lack of neuropathy) regarding to the beta values (β) indicates that a unit increase in categorical predictive variable of socio-economic status increased the logistic of neuropathy incidence in diabetic patients to a level of 1.729. In addition, glycosylated hemoglobin above 9%, overweight and obesity, and depression increased the logistic incidence rate of neuropathy as 2.248, 2.283, and 0.116, respectively. Diabetes self-care, quality of life, diabetes knowledge, and diabetes duration decreased the logistic incidence rate of neuropathy in diabetic patients as -0.092, -0.058, -0.043, and -0.075, respectively.

In this model, the odds ratio (OR) of patients with unfavorable socio-economical status to have diabetic neuropathy was 5.637 (1.169-27.174) times higher than that of patients with favorable socio-economic status. In this model, with a 95% confidence interval, the OR real value of this research society to have unfavorable socio-economical status was between 1.169 and 27.174, which is statistically significant at level $p<0.05$. Furthermore, the odds ratio for glycosylated hemoglobin above 9% was 9.471 (2.105-42.607), higher than 1 and indicating that by increasing glycosylated hemoglobin above 9%, the likelihood of neuropathy increases 9.5 times in them. In addition, the likelihood of neuropathy was increased or decreased 9.802 times (2.229-43.104) for each unit of increase or decrease in overweight and obesity. Increases or decreases in diabetic self-care also decreased or increased the probability of neuropathy incidence 0.912 (0.857-0.970) times, respectively. Increases or decreases in depression and diabetes duration, increased or decreased the probability of neuropathy incidence 1.123 (0.021-0.235) and 0.958 (0.921-0.996) times, respectively. Also, the odds ratio of increase or decrease in life quality and diabetic knowledge that led to increase or decrease in the incidence of diabetic neuropathy was equal to 0.943/0 (0.913-0.974) and 0.928 (0.886-0.971), respectively.

According to the findings of table 3, the strongest predictor of the incidence and experience of neuropathy in this model was the body mass index with an odds ratio of 9.802; thus, by controlling other factors in the model, people with overweight and obesity will experience neuropathy with about 10 times more likely than people with normal weight. Next to the overweight and obesity, glycosylated hemoglobin above 9%, undesirable socio-economic status, depression, diabetes duration, quality of life, diabetes knowledge, and diabetes self-care were the most powerful predictors and were affected neuropathy incidence with a likelihood of 9.471, 5.637, 1.123, 0.958, 0.943, 0.928, 0.0, 0.912, 0.547, and 0.532 times, respectively.

The full model included all significant predictors, p=0.001, which showed that it can distinguish neuropathic from non-neuropathic diabetic patients.

A study of the results of Hosmer-Lemeshow goodness of fit test, as the most reliable test of model fitness in logistic regression with a significance level 0.455, showed that this value was higher than 0.05 (cut point of model fitness) and high *p* value indicates a good fitness of model. Also, omnibus tests about the coefficients and summary of statistics model, other indicators of model test fitness, had high significant values (significancy value was less than 0.05). The test results are presented in table 4. Thus, the above model (with a set of predictor variables) was better than the initial hypothesis of the logistic regression model. In summary, the values of the squared Cox and Snell model (Cox & Snell R2) and the squared Nagelkerke (Nagelkerke R2) were 0.551 and 0.848, respectively, and showed that between 55% (squared Cox and Snell) and 84% (squared Nagelkerke) of the variability of the dependent variable or experience of neuropathy could be explained by this set of independent variables (Table 4).

In likelihood with a fixed number, the repeat process was completed by changing χ^2 below 0.001% in the second step, and in likelihood with all predictive variables, the repeat process was completed by changing χ^2 (-2LL) below 0.001% in the eighth step. According to the classification matrix, the presented model in this study was well able to predict the correct issue (diabetics with neuropathy and without neuropathy) through entering the constant in the equation and a shear rate of 0.500 (Table 5).

Table 1. Frequency (percent) of categorical variables in patients with and without diabetic neuropathy for logistic regression

Variables	Group	Patients with Diabetic Neuropathy		Patients without Diabetic Neuropathy	
		Frequency (%)	*p*-Value	Frequency (%)	*p*-Value
Gender	Male	30 (50.8%)	0.896	97 (45.8%)	0.216
	Female	29 (49.2%)		115 (54.2%)	
Socio-economic status	Inappropriate	55 (93.2%)	0.001	196 (92.5%)	0.001
	Appropriate	4 (6.8%)		16 (7.5%)	
Glycosylated hemoglobin	<9%	38 (64.4%)	0.027	39 (18.4%)	0.001
	>9%	21 (35.6%)		173 (81.6%)	
Treatment type	Drug	48 (81.4%)	0.001	115 (54.2%)	0.001
	Insulin	11 (18.6%)		97 (45.8%)	
Body mass index (kg/m^2)	<25	34 (57.6%)	0.241	51 (24.1%)	0.001
	>25	25 (42.4%)		161 (75.9%)	

Table 2. Descriptive statistics for patients with and without diabetic neuropathy for logistic regression analysis

Variable	Group	Mean±SD	*p*-Value
Age (yr)	Patients with diabetic neuropathy	44.32±5.34	0.136
	Patients without diabetic neuropathy	45.65±6.21	
Diabetes duration	Patients with diabetic neuropathy	8.79±2.83	0.001
	Patients without diabetic neuropathy	6.36±2.56	
Diabetes self-care	Patients with diabetic neuropathy	25.79±12.68	0.001
	Patients without diabetic neuropathy	44.15±13.80	
Depression	Patients with diabetic neuropathy	22.40±9.00	0.001
	Patients without diabetic neuropathy	12.31±6.04	
Quality of life	Patients with diabetic neuropathy	53.84±17.04	0.001
	Patients without diabetic neuropathy	80.83±21.00	
Diabetic knowledge	Patients with diabetic neuropathy	32.52±12.66	0.001
	Patients without diabetic neuropathy	58.56±12.21	

Table 3. Coefficient of predictor variables in the equation of logistic regression analysis for prediction of diabetic neuropathy (N =271)

Predictor	b	SE b	Wald	*p*-Value	Odds ratio	CI 95%
Gender	0.259	1.157	0.050	0.823	1.295	0.134-12.519
Socio-economic status	1.729	0.803	4.643	0.031	5.637	1.169-27.174
Glycosylated hemoglobin	2.248	0.767	8.586	0.003	9.471	2.105-42.607
Body mass index	2.283	0.756	9.125	0.003	9.802	2.229-43.104
Treatment type	-1.338	0.878	2.324	0.127	0.262	0.047-1.466
Age	-0.010	0.065	0.024	0.878	0.990	0.871-1.125
Diabetes self-care	-0.092	0.032	8.443	0.004	0.912	0.857-0.970
Depression	0.116	0.049	5.670	0/017	1.123	1.021-1.235
Quality of life	-0.058	0.017	12.341	0.001	0.943	0.913-0.974
Diabetic knowledge	-0.075	0.023	10.288	0.001	0.928	0.886-0.971
Diabetes duration	-0.043	0.020	4/720	0.030	0.958	0.921-0.996
Constant	7.267	3.534	4.229	0.040	32.838	

Table 4. Omnibus tests on the coefficients and the statistics of the regression analysis model

Omnibus Tests				Model Statistics			
	Chi-square	df	Sig.	-2 Log likelihood only with Constant	-2 Log likelihood with all predictor	Cox & Snell R^2	Nagelkerke R^2
Model	216.806	11	0.001	75.508	67.200	0.551	0.848

Table 5. The classification matrix of predictive variables for diabetic neuropathy (Yes) with a cutoff of .50

Observed	Predicted		% Correct
	Yes	No	
Yes	53	6	89.8
No	7	205	96.7
Overall % correct			95.2

Discussion

The overall results of this study showed that diabetic patients with neuropathy had undesirable socio-economic status, glycosylated hemoglobin above 9%, overweight and obesity, poor diabetes self-care, higher depression, lower quality of life, insufficient diabetes knowledge, and prolonged diabetes and these 8 key variables together, separate diabetic patients with neuropathy from diabetic patients without neuropathy. Previous studies in this field also led to such results [6, 15, 31]. Valensi et al. and Bondar and Shabelnikova's studies showed that undesirable socio-economic status, metabolic factors and obesity, diabetes duration, and glycosylated hemoglobin above 9% increased the probability of neuropathy occurrence in diabetic patients [7, 15].

In explaining these findings, one can reason that poor socio-economic status, high levels of glycosylated hemoglobin, and obesity or metabolic syndrome associated with long duration of disease increase the burden of the disease and reduce the quality of life and provide background for neuropathy occurrence through destruction of self-care behaviors. Moreover, as Spollett believes, it can be concluded that obesity and the severity of diabetes destroys the beta cells functions through behavioral and physiological mechanisms that eventually, along with disease prolongation, lead to the emergence of complications [1]. In fact, the disease characteristics are background variables which accelerate the process of neuropathy. Also, this study, consistent with previous research, has shown that poor self-management for control of diabetes increases the risk of neuropathy. The study conducted by Hall et al. also showed that poor self-care behaviors are risk factors for neuropathy occurrence [32].

Poor self-care behavior increases blood glucose and other biological indices such as blood pressure, disturbance in glycemic regulation, and also the reduction of consistency with diabetes symptoms which results in increased neuropathy incidence or other complications. Previous studies have also shown that depression and psychological distresses can exacerbate neuropathy and make treatment difficult [8]. Gonzalez et al. also showed that depression was a serious risk factor for neuropathy and diabetic foot ulcer [33]. It can be claimed that depression is associated with reduced diabetes self-efficacy that ultimately decreases self-care behavior and

increases the likelihood of neuropathic complications. The present study, consistent with researches conducted by Happich et al. and Van Acker et al. showed that low quality of life may accelerate neuropathy states and diabetic foot disorders [2, 12]. In this field, it can be reasoned that the low quality of life is an index for lack of correct self-management of diabetes which leads to complications and reversely is the consequence of complications occurrence. In fact, low life quality is interwoven with diabetic neuropathy and mutual relations exist between them. In this study, low diabetic health literacy was a significant risk factor for incident of diabetic neuropathy. Studies by Al-Wahbi and Mosnier-Pudar et al. have shown that diabetic knowledge is an important predictor of diabetic neuropathy [21, 34]. It can be claimed that low knowledge about diabetes and its management can increase negative consequences of the disease and subsequently the possibility of neuropathy and other complications of diabetes.

According to the structural relationships in this logistic regression model, these variables affected the occurrence of neuropathy, but since this study was neither experimental nor longitudinal, there was in fact no causal relationship between these factors and the incidence of diabetic neuropathy; this relationship is merely of the structural type. In other words, probably other variables not considered, such as biological indices, diabetes-specific quality of life, inflammatory variables, and neurological status are more effective in the emerging of neuropathy in diabetic patients. Furthermore, based on research background, neuropathy is a multifactorial disease and simultaneous attention to these factors is of more importance [2].

Regarding the analysis of the maximum likelihood of the predictive variable differences between the two groups of patients in this study, there were significant relationships between these variables and the standard variable. It is suggested that following logistic regression results in this study, target groups should be determined in order to prevent diabetic neuropathy through improving self-care behaviors and quality of life and reducing other variable risk factors such as changes in glycosylated hemoglobin and body mass index. According to logistic regression modeling, these variables altogether have an effective role in the occurrence or prevention of diabetic neuropathy; and simultaneous attention to these factors are the practical outcomes of this study in neuropathy prevention.

The present study showed that gender, treatment type, and age factors had no significant proportion in the prediction of the incidence of neuropathy in diabetic patients. These findings were inconsistent with some evidence and previous research findings. For example Schiel, Muller, and Kuroda et al. demonstrated in their research that age and type of treatment are important predictors of diabetic neuropathy in diabetic patients [10, 14]. To explain this inconsistent finding with previous researches, it can be reasoned that these variables lose their significancy near more important variables such as duration of the diabetes, quality of life, diabetes self-care, and other variables present in this model; thus, when designing interventions, one should give priority to these variables. In addition, difference in various measuring tools, and different projects and research societies, as well as different studied concepts may lead to inconsistent results.

Based on the final results of the study, unfavorable socio-economic status, glycosylated hemoglobin above 9%, overweight and obesity, poor diabetes self-care, higher depression, lower life quality, insufficient and low diabetic knowledge, and more prolonged diabetes are important in the incidence of neuropathy in diabetic patients. Therefore, considering these factors when preventing and treating diabetic neuropathy is among the most important applied outcomes of this study.

Besides its valuable outcomes, this study had some shortcomings that should be considered in the generalization and final deduction of the study. The limitation of the study location, the use of self-report scales for measuring psychological and social variables of the study, not investigating other important risk factors of diabetic neuropathy such as biological indices and health-related behaviors, as well as the limitation of domestic researches are of the most prominent defects of the present research. Despite these limitations, this study contained new findings and viewpoints about this group of risk factors of neuropathy. Therefore, considering the limitations of this study, the final conclusion of the research implies the importance of considering this group of predictive factors in the prevention, treatment, and postponing diabetic neuropathy. In addition, in order to reduce these defects, it is suggested that in future studies, biological indices, important health behaviors, other demographic variables, and their effects and interactions be investigated in mixed quantitative-qualitative projects.

Finally, based on these research findings, needs assessment and identification of the target society as the first step of designing the program for the prevention of diabetic neuropathy, as well as experimental studies in order to design appropriate interventions in this regard, have plentiful importance in the prevention and management of diabetic neuropathy.

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Authors' Contributions

All authors had equal role in design, work, statistical analysis and manuscript writing.

Conflict of Interest

The authors declare no conflict of interest.

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