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Original Article

The Prevalence of Diabetic Peripheral Neuropathy and Related Factors

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Abstract

Background: Diabetic peripheral neuropathy (DPN) accounts for 80% of diabetic foot ulceration; therefore neurologic examination plays a critical role in screening at risk patients. Our objective was assessment the prevalence of DPN and related factors based on clinical findings.

Methods: This cross-sectional study was conducted on 124 diabetics who were randomly recruited from Diabetes Clinic of Dr. Shariati University Hospital (Tehran/Iran) in 2004. After gathering demographic data and blood sampling for fasting blood sugar (FBS), the questionnaires United Kingdom (UK), Michigan, Diabetic Neuropathy Score (DNS), and 10-g monofilament testing were administered. Analysis tests were chi-square, pearson correlation and logistic regression.

Results: The patient's age ranged 17 -75 years; with 44% male. Ninety one percent suffered from type two diabetes and the mean duration of diabetes was 10 years. The mean FBS level was 181.5 mg/dl. While the prevalence of DPN based on Michigan, DNS, and monofilament testing was about 32-38%, some 54% were diagnosed by UK test. Tingling in the lower extremity was the most frequent complaint (42%). The strongest linear correlation was reported between Michigan and DNS (r= 0.7), and then between monofilament test and DNS (r= 0.6). The age > 50 years, length of diabetes > 10 years, and FBS >200 mg/dl were the main risk factors for DPN based on DNS.

Conclusion: It seems that the combination of Michigan and monofilament test can provide an accurate screening tool for detecting DPN. In addition, tight glucose control, regular assessment of the lower extremity, and to educate diabetics is urged in elderly diabetics, longer duration of diabetes, and those with high FBS.

Keywords: *Diabetic neuropathy, Prevalence, Risk factors of neuropathy, Monofilament*

Introduction

Diabetes is among the most common noncomunicable diseases not only in the world but also in the Eastern Mediterranean Region[1] (EMRO) countries. It is also considered as the main underlying cause of blindness, renal failure, lower extremity amputation and even death (1). The prevalence of diabetes in the adult population (aged over 20 yr) of this region is about 14.5% (1); for Iran, however, this rate is reported to be about 7.7% (3 million individuals) (2).

Although diabetic foot is a quite common complication among diabetics, it is frequently ignored (3), a condition which is not only associated with high costs of treatment and care due to it's prolong length of hospitalization stay and increase risk of amputation but also places a heavy burden on the society (1). Reports have revealed that neu-

[1] It includes some countries such as Saudi Arabia, Egypt, Iran, Iraq, Kuwait, and Bahrain.

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ropathy, diabetic foot and amputation account for some 18% of the overall burden - calculated using Disability Adjusted Life Years (DALYs)- placed on Iran in 2001 (4).

The prevalence rate of diabetic foot in the world and in Iran is about 4.6-12% (5, 6) and 3% (4), respectively. Accordingly, statistics show that a diabetic somewhere in the world loses his/her leg every thirty seconds (7). The foot ulceration is not only the most common complication of neuropathy but also among the preventable diabetes complications (1). Identifying at-risk patients, hence, can preclude the development of a large number of foot ulcerations.

Peripheral neuropathy is the most common risk factor for foot ulcers in diabetic patients contributing to higher than 80% of these ulcers (8-11). Therefore, neurologic examination should be considered as the first and the most critical screening tool in patients at-risk of developing foot ulcers. There are several different methods for the detection of peripheral neuropathy, ranging from quantitative methods, such as nerve conduction studies and vibration sense testing, to validated questionnaires such as United Kingdom screening test (based on the patients self-reported sensory neuropathy symptoms) (UK), and Michigan Neuropathy Screening Instrument (MNSI) (based on the physician's clinical examination) (12-14). Considering various accuracy of these techniques in detection of diabetic neuropathy, this study was designed to assess the prevalence of peripheral neuropathy in diabetic patients based on UK, MNSI, monofilament and Diabetic Neuropathy Score (DNS) and related factors to Diabetic peripheral neuropathy (DPN).

Materials and Methods

The present descriptive-analytical cross-sectional study was conducted on 124 diabetic patients. They were recruited randomly among those referred to the Diabetes Clinic of Dr. Shariati University Hospital in Tehran/ Iran in 2004.

Diabetic patients who were willing to participate in the study were enrolled. Exclusion criteria included patients with foot ulcer, lower extremity amputations, auto-immune diseases, severe osteoarthritis in lower extremity joints, congenital neuropathy, underlying conditions such as chronic uremia along with those on anticoagulation therapy or and tricycle antidepressants and other neuropathic treatment for more than a month.

After obtaining an informed consent, fasting blood sample was taken from all the participants. The FBS levels were analyzed by enzymatic method using an auto analyzer and Pars Azmoon Lab Kits in the Hormone laboratory of Endocrine & Metabolism Research Center (EMRC) of Dr. Shariati Hospital. The demographic data (gender, age, and the duration of diabetes) of the patients were thereafter gathered, and UK, MNSI, DNS, and 10-g monofilament testing were administered in the case of each subject.

The UK questionnaire consists of questions regarding the type, severity, and location of the complaints (symptoms) as well as the neuropathy signs (gathered through history taking). The MNSI, on the other hand, assesses four factors including the appearance of the foot (inspecting any signs of dry skin, callous formation, fissures, and deformities), ulcer formation, Achilles tendon reflex and vibration sensation tested using a 128 Hz tuning fork placed over great toe. Scores higher than two in each questionnaire of above mentioned was considered as the presence of neuropathy (15). As for DNS scoring system, the sensorimotor neuropathy testing using Semmes-Weinstein 10-g monofilament, 128 Hz tuning fork, pinprick sensation for assessment of superficial pain sensory by using pin, muscle tone testing, along with biceps, triceps, quadriceps and Achilles tendon reflex testing in both right and left lower extremities together provided a summated score. The final score higher than six was considered the presence of neuropathy (16). Ten- point monofilament testing was applied on 10 different points on the sole and dorsum of the foot; the absence of sensation in one or more of these points was considered as peripheral neuropathy (17).

The study was approved by the Ethical Board Committee of Tehran University of Medical Sciences.

The gathered data were entered in SPSS ver. 15 and analyzed using chi-square, pearson correlation and logistic regression tests. $P \leq 0.05$ was considered as statistically significant in analysis.

Results

In this cross-sectional study were enrolled 124 diabetic patients. We found as following results: The mean age of these patients was 53 yr (SD= 12), ranging from 17 to 75 yr. Males comprised 43.6% of these patients. The majority of them (91.4%) suffered from type-2 diabetes. The mean diabetes duration was about 10 yr (SD= 8) with range 0.3-40 yr. The mean FBS level was 181.5 mg/dl (SD= 91).

Tingling in the lower extremity was the most frequent complaint reported in 42% of our patients. Table 1 outlines the prevalence of peripheral neuropathy estimated using different diagnostic methods along with the impact of the potential risk factors of the condition.

Pearson correlation tests revealed a statistically significant correlation between the results of UK, Michigan, DNS and 10-point monofilament testing ($P< 0.001$). Table 2 shows the relative correlation between the systems used to diagnose neuropathy in diabetics after considering the effects of sex and age as control variables.

Table 1: The prevalence of neuropathy and the impact of influencing factors, based on UK, Michigan and DNS questionnaires, and 10-point Monofilament test in 124 diabetic patients referred to diabetes clinic of Shariati Hospital

Neuropathy Assessment Criteria	Diabetic Peripheral Neuropathy n (%)	Male Odds Ratio (95% CI)		Age > 50 yrs Odds Ratio (95% CI)		Diabetes Duration > 10 yr Odds Ratio (95% CI)		FBS> 200 mg/dl Odds Ratio (95% CI)	
		Crude Analysis	Adjusted Analysis	Crude Analysis	Adjusted Analysis	Crude Analysis	Adjusted Analysis	Crude Analysis	Adjusted Analysis
UK	61 (54%)	0.58 (0.27-1.22)	NS	1.99 (0.93-4.31)	NS	3.10* (1.38-6.97)	4.64* (1.18-18.21)	2.89 (0.94-8.86)	3.53* (1.05-11.83)
Michigan	36 (31.9%)	0.25* (0.10-0.61)	0.21* (0.05-0.97)	1.64 (0.70-3.81)	NS	4.04* (1.73-9.45)	4.88* (1.25-19.08)	2.01 (0.64-6.35)	NS
DNS	43 (38.1%)	0.23* (0.10-0.55)	0.19* (0.05-0.66)	2.51* (1.09-5.78)	NS	3.19* (1.43-7.15)	NS	1.09 (0.36-3.31)	NS
Monofilament test	33 (31.7%)	0.57 (0.24-1.35)	NS	1.61 (0.66-3.89)	NS	2.71* (1.14-6.45)	NS	0.68 (0.19-2.47)	NS

- The test used in crude analysis was chi-square and as for the adjusted analysis was logistic regression.
- NS: non significant
*$P \leq 0.05$ was considered statistically significant

Table 2: Assessment correlation between different techniques that used to detect neuropathy in the 124 samples

Neuropathy Diagnostic Method		Michigan	UK	DNS
UK	Correlation Rank	0.318		
	P-value	0.001*		
DNS	Correlation Rank	0.691	0.354	
	P-value	<0.001*	0.869	
Monofilament test	Correlation Rank	0.561	0.311	0.560
	P-value	<0.001*	0.002*	<0.001*

*$P \leq 0.05$ was considered statistically significant in Pearson Correlation Analytic Test.

Discussion

The present study reported the prevalence rate of peripheral neuropathy in our patients to be about 32-38% based on the MNSI and DNS questionnaires and 10-point monofilament testing, which is in accordance with the positive linear correlation between the results of these scoring systems. Using the UK questionnaire, the rate of DPN, however, was reported to be about 54%, which could be explained by the exaggeration of patients when describing their neuropathy-related complaints. The role of other unrelated complaints is another factor contributing to the higher prevalence of neuropathic cases detected based on UK questionnaire, as the underlying diseases such as osteoarthritis of the knee, hip and lumbar spine also influence the severity of the complaints reported by the patients (considering his/her age) even in their mild forms.

It should be noted that the prevalence of neuropathy in diabetics depends on the application of clinical examination and the electrophysiological criteria used in the administered diagnostic technique. In a 25- yr study performed on 4400 diabetics (1947-1973), the prevalence rate of neuropathy based on diagnostic criteria such as the absence of Achilles tendon reflex and the abnormal perception sensation was reported 7.5% at the baseline, reached up to 50% in the end of study (after 25 yr follow-up) (18). In the population-based Rochester Diabetic Neuropathy study, the prevalence of neuropathy diagnosed based on clinical examination, quantified tests for assessment of sensory neuropathy, nerve conduction velocity measurement, and autonomic nervous system testing, was about 54% and 45% in type 1 and type 2 diabetes, respectively (19). Many believe the overall prevalence of diabetic neuropathy at the time diagnosis of diabetes is about 10%, adding that the rate would reach up to 50% in 5 yr after the diagnosis is made (20).

Tingling in the lower extremity, the most frequent complaint in our patients (42%), was reported not to be an accurate tool in diagnosing diabetic neuropathy on its own due to its poor linear correlation with other factors used to diagnose the sensorimotor neuropathy (correlation rank (r)= 0.3). In a study performed to evaluate the accuracy of the patient's complaint as a screening tool, authors found nearly 90% of patients with aged less than 68 yr, didn't have any sign or symptom of diabetic polyneuropathy. Thus, they concluded that tingling could be used as a screening tool in younger patients but not in older ones. In general, the signs of sensory neuropathy not to be used as a diagnostic or screening tool as a sole; physicians, however, should ask for them in each annually performed foot examination (21).

In the guideline released by the American Diabetes Association (ADA) in 2011 (22), annual examination of the feet is recommended in every diabetic with the aim of detecting the risk factors of ulceration and amputation. Such examination consists of observation and the evaluation of the pulses and protection sensation in lower extremity (using a 10-g monofilament testing and one of the tests such as vibration sensation tested by means a 128 Hz tuning fork, pinprick test, ankle reflexes and vibration perception threshold). In view of this guideline, DNS scoring, which comprises all the above-mentioned tests, seemed it should be used as the most accurate test for detecting diabetic neuropathy.

Despite the fact that the present study was not designed to estimate the accuracy of different tools in detecting diabetic neuropathy and comparing them, it reported a statistically significant difference between the results reported about correlation the studied tools. The strongest correlation was reported between the MNSI and DNS scoring system (r= 0.7), then between 10-point monofilament test and DNS (r= 0.6). Considering the comprehensiveness of DNS scoring system, the MNSI seems not to be an accurate screening tool on its own. In other words, it is recommended to use a combination of MNSI and the 10-point monofilament test together in detecting neuropathic cases as these two tests are not only strongly linear correlated with DNS but also have a positive

and relatively strong linear correlation with each other (r= 0.6). Feldman (12) and France (21) reported that the diagnosis of neuropathy could not be made only depending on one's physical examination, adding that the MNSI in the absence of neurologic examination is not an accurate test in detecting the condition. On the other hand, the administration of all neurologic tests in the annual diabetic screening test is pricy and rather impossible. Certain studies (23-25) have considered the combination of vibration perception test and the 10-point monofilament test as an accurate diagnostic tool in the early diagnosis of DPN.

In a population-based study (14) conducted to compare the accuracy of these four tests; the vibration perception, monofilament, thermal sense and MNSI in detecting DPN, the monofilament test was reported as the most accurate screening test in detecting patients at-risk of developing neuropathy or foot ulceration, mainly due to its low cost and feasibility. Authors therefore considered this test as the first step which followed by the vibration perception test as reasonable and accurate test in the second step for detecting neuropathic patients (14).

Other studies have similarly played up the role of monofilament test and vibration perception test in screening diabetic neuropathy, stressing that these tests are not only less pricy but also easy to be performed even by non-physicians (9-11, 24-27). The difference reported in the accuracy of these tools can be explained by differing sample sizes of these studies as well as the variety of skills of the individuals responsible for performing these tests.

Different studies evaluating the effect of various factors on diabetic neuropathy have reported controversial results. In a case-control study conducted on some 110 diabetic patients in Dr. Shariati Hospital, Bouya et al. (28) assessed the prevalence of peripheral neuropathy and the factors influencing this rate using MNSI and the electro diagnostic methods (NCV, EMG). In this study, there was no statistically significant relation between smoking, the use of Angiotensin-Converting Enzyme inhibitors' drugs (ACEI drugs), hypertension, high cholesterol levels, diabetes treatment regimen and the prevalence of neuropathy; the influence of age, quality of diabetes control and duration of the disease on the development of neuropathy, however, was significant. The risk of developing neuropathy in men was 2.9 times higher than women. Poor controlled diabetes and every year increase in the duration of diabetes increased the risk of developing neuropathy by 0.3 and 1.1 times, respectively.

In the study performed on 3250 diabetics (29), there was a significant relation between ages, the duration of diabetes, height, diastolic blood pressure, smoking, high triglyceride level, low HDL level, and the status of diabetes control and the prevalence of peripheral neuropathy. Other studies, however, have not reported a significant relation between age, and the duration of the disease and neuropathy (28). In a study conducted on some 400 diabetics aged between 18 and 29 yr, the duration of diabetes and the status of its control were significantly related with the development of neuropathy (30). Several studies have reported the influence of the duration of the disease on the development of neuropathy. Two cohort studies (31, 32) reported a borderline predictive role for the duration of diabetes on the development of neuropathy.

While the correlation between male gender and diabetic neuropathy is reported in the DCCT study (33), the study assessing some 1477 diabetics in Bahrain (34) showed the influence of older age, poor controlled diabetes, longer duration of the disease, high cholesterol levels, smoking, high triglyceride levels, obesity, larger waist circumference and high blood pressure rather than gender on the development of diabetic neuropathy. In the study performed in Turkey (35), the prevalence of neuropathy was about 60%. Age, the duration of diabetes, and poor controlled diabetes were the main risk factors contributing to the condition. In the Nigeria study (36), however, the duration of diabetes, age, the status of diabetes control, high blood pressure, retinopathy, and HbA1c level were the main factors increasing the risk of diabetic neuropathy by 1.34 times (r= 0.295).

In the present study, we assessed some of the factors influencing the prevalence of neuropathy in our population, the results of which are outlined in Table 1. We reported that some of these factors are the risk factors of neuropathy depending on our administered screening tools.

We used the DNS scoring system in order to determine the influence of various factors on the development of neuropathy and reported that aged higher than 50 yr, diabetes duration more than 10 yr, and FBS level higher than 200 mg/dl are the main risk factors based on DNS criteria. In view of the fact that the majority of our patients were females, we were unable to determine the effect of male gender as a risk factor in the study. The male gender, older age, and the longer duration of diabetes were the factors significantly related with neuropathy in crude (chi square) analysis (P= 0.001, 0.03, 0.004, respectively). Following the adjusted (logistic regression) analysis, however, the male gender was reported to be the only factor significantly related with the condition (P= 0.009). The Odds Ratio of developing neuropathy in the older age, longer duration of diabetes and FBS higher than 200 mg/dl, therefore, were reported to be 2.49, 2.06, and 1.15 times higher in adjusted analysis, without any significant analytic difference.

We had some limitations in our study. One of the limitations was the place where the study took place. Considering the fact that we conducted the study in a university hospital known as a referral center for endocrinology disorders, the majority of our patients were elderly with a long history of diabetes and poorly controlled of diabetes. The lack of NCV, the definitive and standard technique for detecting neuropathy as the gold standard, was another limitation of the present study. It is recommended that further case control studies be performed with larger sample sizes while using NCV along with other diagnostic techniques, also evaluation the impact of more factors on the development of neuropathy.

The combination of the MNSI and the monofilament test can provide an accurate screening tool for detecting neuropathy in diabetes clinics. In addition, considering the impact of hyperglycemia as a critical treatable risk factor for diabetic neuropathy, tight glucose control is urged in diabetics. Moreover, it is suggested to conduct regular assessment of lower extremity and to educate diabetics, particularly elderly, patients with a long history of diabetes and those with high glucose levels, aiming to detect DPN in early stages.

Ethical Considerations

Ethical issues including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc. have been completely observed by the authors.

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References

1. Khatib O, Tabatabaei Malazy O (2007). Prevention and public approach to diabetic foot. *Iranian J of Diabetes & Lipid Disorders*, 7(2): 123-33.
2. Esteghamati A, Gouya MM, Abbasi M, Delavari A, Alikhani S, Alaedini F, et al. (2008). Prevalence of diabetes and impaired fasting glucose in the adult population of Iran: National Survey of Risk Factors for Non-Communicable Diseases of Iran. *Diabetes Care*, 31(1): 96-8.
3. Singh D (2006). Diabetic foot: It is time to share the burden. *Calicut Med J*, 4(3): e 4.
4. Abolhasani F, Mohajeri Tehrani MR, Tabatabaei Malazy O, Larijani B (2003). Burden of diabetes and its complications in Iran in Year 2000. *Iranian J of Diabetes & Lipid Disorders*, 5(1): 35- 48.
5. Songer TJ, Zimmet P (1995). Epidemiology of type 2 diabetes: an international prospective. *Pharmacoeconomics*, 1: 1-11.

6. Wild SH, Roglic G, Sicree R, Green A, King H (2002). Global burden Diabetes Mellitus in the year 2000. Available from: www.who.int.
7. Calle- Pascual AL, Redondo MJ, Ballesteros M, Martinez Salinas MA, Diaz JA, De Matias P, et al. (1997). Nontraumatic lower extremity amputations in diabetic and non-diabetic subjects in Madrid, Spain. *Diabetes Metab*, 23: 519-23.
8. Murray HJ, Young MJ, Mollis S, Boulton AJ (1996). The association between callus formation, high pressures and neuropathy in diabetic foot ulceration. *Diabet Med*, 13: 979-83.
9. Pecoraro RE, Reiber GE, Burgess EM (1990). Causal pathway to amputations: basis for prevention. *Diabetes Care*, 13: 513-21.
10. Reiber GE, Pecoraro RE, Koepsell TD (1992). Risk factors for amputation in patients with diabetes mellitus a: case-control study. *Ann Intern Med*, 117:97- 105.
11. Mc Neely MJ, Boyko EJ, Ahroni JH, Sensel VL, Reiber GE, Smith DG, et al. (1995). The independent contributions of diabetic neuropathy and vasculopathy in foot ulceration. How great are the risks? *Diabetes Care*, 18(2): 216-19.
12. Feldman EL, Stevens MJ, Thomas PK, Brown MB, Canal N, Green DA (1994). A practical two-step quantitative clinical and electrophysiological assessment for the diagnosis and staging of diabetic neuropathy. *Diabetes Care*, 17: 1281-89.
13. Young MJ, Boulton AJ, Macleod AF, Williams DR, Sonksen PH (1993). A multicenter study of the prevalence of diabetic peripheral neuropathy in the United Kingdom hospital clinical population. *Diabetologia*, 36:150.
14. Rahman M, Griffin SJ, Rathmann W, Wareham NJ (2003). How should peripheral neuropathy be assessed in people with diabetes in primary care? A population-based comparison of four measures. *Diabet Med*, 20(5): 368-74.
15. Endocrinology and Metabolism Research Center, Tehran University of Medical Sciences (2009). *National-Regional diabetic foot guideline*. 1st ed. Vista, Iran, p. 5 Available from: http://emri.tums.ac.ir/dmfoot-en.
16. Lunetta M, Le Moli R, Grasso G, Sangiorgio L (1998). A simplified diagnostic test for ambulatory screening of peripheral diabetic neuropathy. *Diabetes Res Clin Pract*, 39:165-72.
17. Armstrong DG (2000): The 10-g monofilament: the diagnostic diving rod for the diabetic foot? [Editorial].*Diabetes Care*, 23:887.
18. Pirart J (1978). Diabetes mellitus and its degenerative complications: a prospective study of 4400 patients observed between 1947 and 1973. *Diabetes Care*, 1:168-88.
19. Dyck PJ, Katz KM, Karnes JL, Litchy WJ, Klein R, Pach JM, et al. (1993). The prevalence by staged severity of various types of diabetic neuropathy, retinopathy, and nephropathy in a population-based cohort: the Rochester Diabetic Neuropathy Study. *Neurology*, 43: 817-24.
20. Little AA, Edwards JL, Feldman EL (2007). Diabetic neuropathies. *Pract Neurol*, 7: 82-92.
21. Franse LV, Valk GD, Dekker JH, Heine RJ, van Eijk JTM (2000). Numbness of the feet is a poor indicator for polyneuropathy in type 2 diabetic patients. *Diabetic Med*, 17:105-10.
22. American Diabetes Association (2011). Standards of medical care in diabetes-2011. *Diabetes Care*, 34 (Suppl 1):S11-S61.
23. Young MJ, Breddy JL, Veres A, Bulton AJ (1994). The prediction of diabetic neuropathic foot ulceration using vibration perception thresholds. A prospective study. *Diabetes Care*, 17: 557 -60.
24. Kumar S, Fernando DJ, Veves A, Knowles EA, Young MJ, Boulton AJ (1991). Semmes-Weinstein monofilaments: a simple, effective and inexpensive screening device for identifying diabetic patients at risk of foot ulceration. *Diabetes Res Clin Pract*, 13:63 – 67.
25. Olmos PR, Cataland S, O'Dorisio TM, Casey CA, Smead WL, Simon SR (1995). The Semmes-Weinstein monofilament as a potential predictor of foot ulceration in patients with noninsulin- dependent diabetes. *Am J Med Sci*, 309: 76-82.
26. Brike J, Cornwall MA, Jackson M (1988). Relationship between hallux limitus and ulceration of the great toe. *Sports Phys Ther Orthop*, 10: 172-76.
27. Lavery LA, Armstrong DG, Vela SA, Quebedeaux TL, Fleischli JG (1998). Practical criteria for screening patients at high risk for diabetic foot ulceration. *Arch Intern Med*, 158: 157-62.
28. Bouya F, Bandarian F, Larijani B, Pajouhi M, Noraei M, Lotfi J (2005). Potential risk factors

for diabetic neuropathy: a case-control study. *BMC Neurol* (open access):5, 24.

29.29-Tesfaye S, Stevens LK, Stephenson JM, Fuller JH, Plater M, Ionescu-Tirgoviste C, et al. (1996). And the EURODIAB IDDM Study Group. Prevalence of diabetic peripheral neuropathy and its relation to glycemic control and potential risk factors: the EURODIAB IDDM Complications Study. *Diabetologia*, 39: 1377–84.

30.Maser RE, Steenkiste AR, Dorman JS, Nielsen VK, Bass EB, Manjoo Q, et al. (1989). Epidemiological correlates of diabetic neuropathy. Report from Pittsburgh Epidemiology of Diabetes Complications Study. *Diabetes*, 38(11): 1456-61.

31.Boyko EJ, Ahroni JH, Stensel B, Forsberg RC, Davignon DR, Smith DG (1999). A prospective study of risk factors for diabetic foot ulcer. The Seatlle Diabetic Foot Study. *Diabetes Care*, 22:1036-42.

32.Pham H, Armstrong DG, Harvey C, Harkless LB, Giurini JM, Veves A (2000). Screening techniques to identify people at high risk for diabetic foot ulceration: a prospective multicenter trial. *Diabetes Care*, 23:606-11.

33.The DCCT Research Group (1998). Factors in the development of diabetic neuropathy in feasibility phase of Diabetes Control and Complications Trial (DCCT). *Diabetes*, 37: 476-81.

34.Al-Mahroos F, Al-Roomi K (2007). Diabetic neuropathy, Foot ulceration, Peripheral vascular disease and potential risk factors among patients with diabetes in Bahrain: a nationwide primary care diabetes clinic- based study. *Ann Saudi Med*, 27(1): 25-31.

35.Boru Ut, Alp R, Sargn H, Kocer A, Sargn , Luleci A, et al (2006). Prevalence of peripheral neuropathy in type 2 diabetic patients attending a diabetes center in Turkey. Available from: www.cababstractsplus.org

36.Ugoya SO, Ugoya TA, Puepet FH, Agaba EI, Ogunniyi AO (2008). Risk determinants of diabetic peripheral neuropathy in Jos, North. Central Nigeria. *J of Chinese Clinical Medicine*, 3(5):285 -91.