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# Diabetic Peripheral Neuropathy: A Common Complication in Diabetic Patients

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**Background: Diabetic Peripheral Neuropathy (DPN) is a common condition among people with diabetes mellitus (DM), which could result in foot ulceration and amputation.**

**Objective: To evaluate Diabetic Peripheral Neuropathy among diabetic patients.**

**Design: A Cross-Sectional Study.**

**Setting: Royal Medical Services Bahrain Defence Force Hospital.**

**Method: Five hundred randomly selected patients diagnosed with DM were included in the study from April 2012 to June 2012. Thorough neurological assessment (Neuropathy Symptom Score (NSS), Neuropathy Disability Score (NDS) and Vibration Perception Threshold (VPT)) was performed.**

**Result: Five hundred were included in the study, 242 (48%) were males and 258 (52%) were females. The mean age was 55±14 years and the mean BMI was 35±9. Type I DM was present in 38 (8%) patients compared to 462 (92%) type II DM. Three hundred thirty-one (66%) patients had medical complications; the most common was DPN 186 (37%) followed by vascular insufficiency 141 (28%). Sixty (12%) DPN patients were undiagnosed.**

**Conclusion: The study revealed that many DM patients have neuropathic complications and at substantial risk of developing foot ulceration. A number of patients with neuropathy were unaware of their condition.**

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Diabetes mellitus (DM) is a common health problem which has reached epidemic proportions due to the rapidly increasing rates of this disease worldwide[1]. Both the World Health Organization (WHO) and the International Diabetes Federation (IDF) consider DM is the 21st century's leading health care challenge[2]. The overall burden of DM is immense with a worldwide population of approximately 382 million in 2013[1]. In the MENA region, 32.8 million people have been diagnosed with the disease and it has been estimated that the

number of DM will increase by 94% between 2010 and 2030[3]. In 2030, it is estimated that nearly 4% of all deaths in the MENA region will be caused by DM and its complications[1,3].

Diabetic peripheral neuropathy, especially painful DPN is associated with a high degree of functional impairment which affects health-related quality of life[4,5]. Approximately 15% of DM patients develop at least one foot ulcer during their lifetime; although vascular disease plays a role in the pathogenesis of diabetic foot ulcers, approximately 60%-70% of diabetic foot ulcers are primarily neuropathic in origin[6-8].

Although epidemiological studies have continuously shown a high prevalence of DM in Arab countries, the control of DM is still poor and complications of DM are common in Bahrain[9]. Studies conducted in the Middle East region report high rates of painful DPN, ranging from 35% to 65%[10]. Patients with DPN account for more hospital admissions than all other DM complications combined, and are responsible for 50%-75% of non-traumatic amputations[11].

Al-Mahroos et al found that DM and impaired glucose tolerance (IGT) were estimated to be prevalent in 18% and 30% of the population, respectively[12]. DM was prevalent in 55-59 years age group. Furthermore, 35% of Bahraini patients with DM between the ages of 40 and 69 years were previously undiagnosed with DM.

A cross-sectional study by Al-Mahroos et al found that DPN was present in 36.6% of the population, foot ulceration in 5.9% and peripheral vascular disease (PVD) in 11.8%[9].

DM and its complications within the MER are rising. Previous clinic-based studies on Bahraini patients with DM demonstrated that a large proportion of the DM patients have neuropathic complications and were at substantial risk of developing foot complications[9].

The aim of this study is to evaluate diabetic peripheral neuropathy among diabetic patients.

## METHOD

Five hundred patients diagnosed with type I and type II DM from April 2012 to June 2012 were included in the study.

The following were documented: age, gender, race, type of DM, duration, medical history, random blood glucose (mmol/l), medications, height (cm), weight (kg), BMI (kg/m²), blood pressure measurement, and previous available laboratory investigations (HbA1c, CBC, LFT, LDL and LDH).

All patients had neurological assessment to investigate undiagnosed DPN. Neuropathic symptoms were evaluated using a Neuropathy Symptom Score (NSS) based on the system proposed by Dyck et al, and the clinical signs by using a Neuropathy Disability Score (NDS) as described in Pham et al[13,14]. The evaluation of the NSS included the following symptoms in the lower limbs: 1) pins and needles; 2) abnormal cold or hot sensations; 3) lancinating or stabbing pain; 4) deep aching pain; 5) burning pain; and 6) irritation of the feet or legs by the bedclothes at night (hyperesthesia). Each symptom was scored with one point if it was present and two points if nocturnal exacerbation was present. A score of four or more points was considered to be abnormal.

NDS was used to quantify the severity of diabetic neuropathy on clinical examination[15,16]. The sensations of pain, touch, cold, pressure and vibration were tested in both legs and were scored according to the level up to which the sensation was impaired. A score was given according to the anatomical location in which the patient could not identify the stimuli introduced. If the patient perceived the stimulus at all levels, then a score of 0 was given. A score of 1 was given if the patient failed to perceive the stimulus at the base of the toe, 2 was given if the patient failed to perceive the sensory at the midfoot, 3 was given if the patient failed to perceive the stimulus at the heel, 4 was given if the patient failed to perceive the stimulus at the lower leg and 5 was given if the patient failed to perceive the stimulus at the knee. The average score of both feet was entered as the sensory score. Reflexes were scored in every leg as normal (0), present with reinforcement (1), and absent (2). The total sum represented the reflex score. If the NDS was greater than 5 (maximum, 28) it was considered abnormal[17]. The summation of reflex and sensory scores for each modality was entered as the NDS. An NDS of ≥5 was indicative of the existence of neuropathy.

Sensory tests included a pinprick with a NeuroTip using a NeuroPen, light touch with a strip of cotton ball, temperature perception with a Bailey's Tip-Therm temperature sensitivity device, pressure with Semmes-Weinstein 5.07 SWF monofilaments and vibration with a Neurothesiometer[18,19]. The mean values after three readings were recorded according to the methods of Bloom et al[20]. Peripheral neuropathy was confirmed when at least two of the three quantitative measurements (NSS, NDS and VPT) were abnormal. Combinations of more than one test have ≥87% sensitivity in detecting DPN[21].

BMI values were classified according to WHO standards: <18.5 underweight, 18.5-25.0 normal weight, 25.0-30.0 overweight, and >30.0 obese[22].

The analysis of data was performed by multivariate techniques and modelling the data through descriptive statistics using frequency distributions, box-plots, means and standard deviations.

## RESULT

All patients were Bahrainis diagnosed with either type I or type II DM; 242 (48%) were males and 258 (52%) were females, see table 1. The mean age was 55±14 years. The mean Body Mass Index (BMI) was 35 with a standard deviation of ±9. Figure 1 demonstrates the differences in the percentages of DM population according to their BMI classification. Three hundred twenty-four (64.8%) were classified as obese, 110 (22.0%) were overweight, 65 (13.0%) were within the normal BMI range, and 1 (0.2%) was underweight. The mean duration of DM was 8±7 years. The majority of patients were diagnosed with DM within the last 10 years, see figure 2.

**Table 1: Patients' Characteristics (Age, BMI, BP, RBG and Duration of DM)**

| | Mean | SD |
|---|---|---|
| **Age (years)** | 55 | 14 |
| **BMI (kg/m²)** | 35 | 9 |
| **Systolic BP Last Visit (mmHg)*** | 147 | 21 |
| **Diastolic BP Last Visit (mmHg)*** | 73 | 15 |
| **RBG (mmol/l)**** | 10 | 4 |
| **Duration (years)** | 8 | 7 |

*Normal blood pressure for an adult age 20 or over should be less than 120 systolic and less than 80 diastolic. A value of less than 140 systolic and 90 diastolic is considered normal in people over 60 years (AHA 2012)
**Random Blood glucose taken from non-fasting sample (normal range in adults is between 4.4 and 7.8 mmol/l)

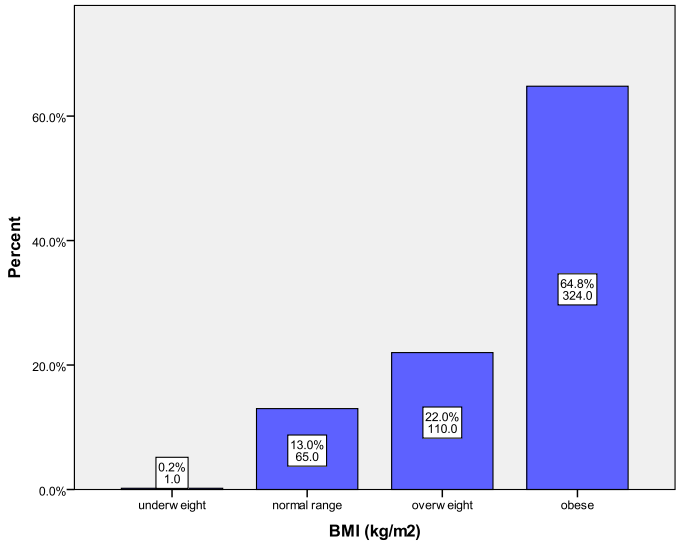


**Figure 1: Differences Between DM Population According to the WHO (2013) BMI Classifications**

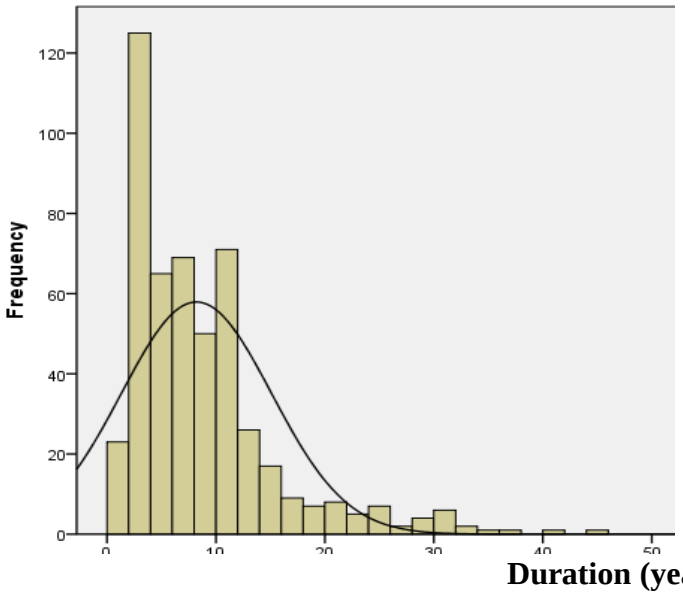


**Figure 2: Distribution of DM Duration (Years)**

Random Blood Glucose (RBG) was 10±4 mmol/L, which is above the normal range (4-7 mmol/L according to the ADA guidelines)[23]. The mean systolic BP was slightly higher than the normal values according to the American Heart Association[24]. The mean of diastolic BP was within the normal range, see table 1[24].

Type I DM was seen in 38 (8%) patients, while type II DM was seen in 462 (92%), see figure 3. There is an obvious increase in the percentages of patients diagnosed with type II DM in both genders in comparison to patients diagnosed with type I DM. Female patients diagnosed with type II DM was 235 (47%) compared to 23 (5%) female patients with type I DM. Two hundred twenty-seven (45%) male patients were diagnosed with type II DM compared to 15 (3%) male patients with type I DM. No obvious gender differences in relation to type of DM

were noted, see figure 3. Figure 4 represents a bar chart demonstrating the percentages of DM with associated DM complications. Hundred sixty-nine (34%) had no complications. More than half of the patients had different complications associated with DM, 186 (37%) had peripheral neuropathy, 141 (28%) vascular insufficiency and 45 (9%) had cardiac complications.

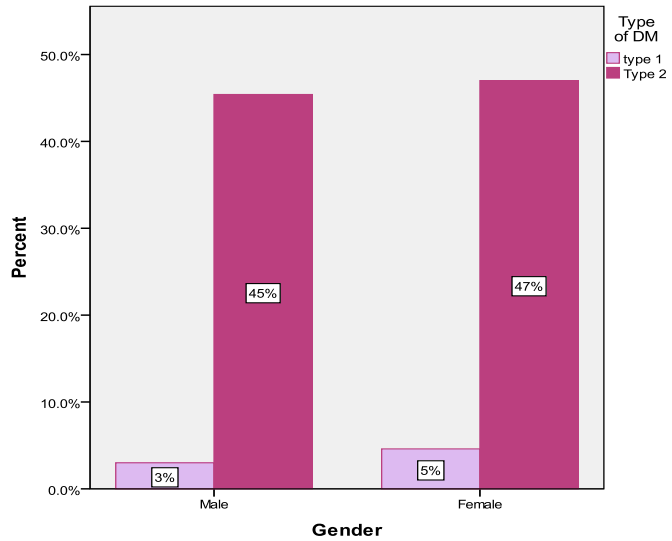


**Figure 3: Patients Diagnosed with Type I and Type II DM**

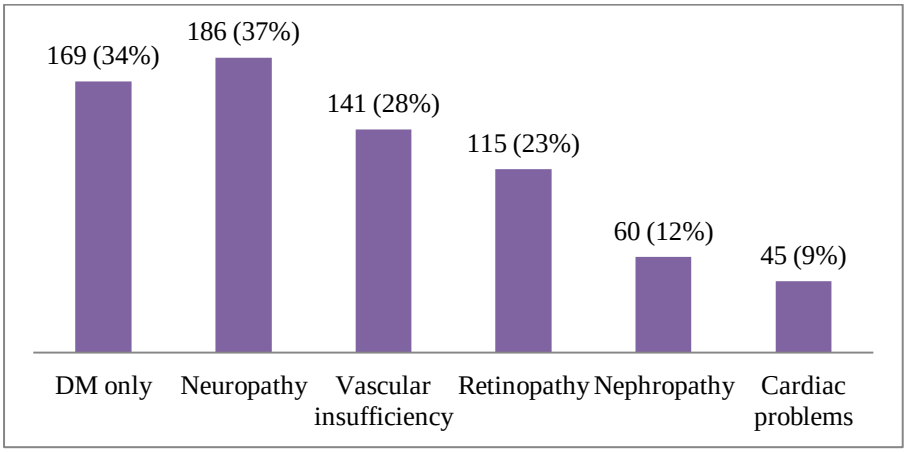


**Figure 4: Medical Complications Associated with Diabetes Mellitus**

Neuropathy investigations revealed that 284 (56%) scored positive for NSS, 148 (29%) scored positive for NDS and 200 (40%) scored positive for VPT, see table 2. DPN was positive in 245 (49%) which scored positive in two out of three neuropathy tests. Sixty (12%) patients positive DPN have not been previously diagnosed with DPN.

**Table 2: Neuropathy Manifestations in the DM Sample (n=500)**

| Neuropathy Tests | Positive Test Values |
|---|---|
| NSS | 284 (56%) |
| NDS | 148 (29%) |
| VPT | 200 (40%) |

NDS: Neuropathy Disability Score, VPT: Vibration Perception Threshold

## DISCUSSION

The clinical characteristics of the DM presented a noticeable difference percentages of type I and type II DM. It is similar to an epidemiological study conducted by Al-Mahroos et al, in which 93% of the DM patients had type II DM[9]. This supports the evidence that type II DM may be one of the lead causes of adult morbidity in the Arabian Peninsula[1].

Complications associated with DM were observed in more than half of the patients; the highest was peripheral neuropathy followed by vascular insufficiency. This was similar to the findings of Al-Mahroos et al where the overall prevalence rate of diabetic neuropathy was 32.3% in males and 38.1% in females, and the rate of peripheral vascular disease was 12.1% in males and 11.6% in females[9].

The prevalence rate of DPN in Bahrain is considered high and similar to rates observed in other countries in the MER. The highest incidence in Egypt (61.3%) followed by Jordan (57.5%), Lebanon (53.9%) and the Gulf countries (37.1%)[25]. These prevalence rates were higher than those from Western countries (United Kingdom and the United States), which reported prevalence rates of 15%-20%[26-29]. This might reflect proper healthcare management of DM in Western countries. DM populations in the MER might differ from Western populations in key clinical features that constitute risk factors for DPN development. For example, poor glycemic control has been reported to be a significant risk factor for diabetic neuropathy in general and for painful DPN in Western countries and in the MER[9,30-32]. Poor glycemic control is a risk factor for diabetic neuropathy and foot ulcerations among Bahrainis[33].

Several studies have reported that diabetes-related knowledge is low and poor glycemic control is common among patients with DM in the MER[34-36]. Among Bahrainis glycated hemoglobin remained a significant risk factor for diabetic neuropathy, even after adjustment for all other risk factors in the multivariate analysis[9].

Most of the patients diagnosed with DM complications had a body mass index of more than 30 (classified as obese). Obesity accompanying type II DM and hypertension are known to be closely linked with insulin resistance and elevated sympathetic nervous activity. It was documented that obesity, hypertension and DM are risk factors for subsequent cardiovascular, renal and neurological complications in DM[37]. Obesity was not a significant risk factor for DPN in logistic regression analysis conducted by Katulanda et al who investigated prevalence, patterns, and predictors of DPN in developing countries[38]. Several studies from Asian countries have also reported similar results or no association between obesity and presence of DPN[39]. Hence, further studies are required to define the role of body weight in DPN in the Asian population.

In this study, fifty-six percent had neuropathic symptoms related to painful DPN, and the number of patients diagnosed with DPN based on clinical examinations (49%) was higher than the number of DPN patients previously diagnosed according to their record cards (37%). This indicates that around 12% of DPN patients were undiagnosed and unaware of having this disease. This could be a result of inappropriate neuropathy testing performed by medical physicians, lack of awareness within patients and health professionals, and lack of foot assessment performed by qualified specialist.

The prevalence rates of these complications in Bahrain and the MER region are still higher than rates observed in studies from Western countries. The socioeconomic development in GCC allowed for higher income and increased consumption of unhealthy diet. Socio-cultural changes may have also contributed to the high calorie intake.

The rising rates of obesity and diabetes mellitus constitute a real challenge in the Arab region[9]. In order to alleviate the burden of DM, preventive strategies are needed, based essentially on healthy diet and regular exercise. Early diagnosis is advised to avoid complications, mortality and morbidity and the increased loss of economic productivity.

## CONCLUSION

**This study revealed that many DM patients have neuropathic complications and are at substantial risk of developing foot ulceration. In addition, a number of DPN patients are still unaware of this disease and its consequences on foot amputation. The study also identified some important risk factors for DM neuropathy, including poor glycemic control, long duration of DM and obesity. Further research involving multiple centers and larger sample size is required in order to estimate the prevalence of DPN in the Kingdom of Bahrain.**

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