



# Diabetic Neuropathy as the Commonest Diabetic Complication in Patients Attending the Diabetes Center in Arar, Northern Saudi Arabia

Abdelrahman Mohamed Ahmed Abukanna<sup>1</sup>, Manal Nashi O Alshammari<sup>2\*</sup>, Bashir Faza M Alhazmi<sup>2</sup>, Yousef Abdulhadi I Alanazi<sup>2</sup>, Nwaf Shabram Alsabi Alenezi<sup>2</sup>

<sup>1</sup> Associate prof. of Internal Medicine, Faculty of Medicine, Northern Border University, Arar, KSA.

<sup>2</sup> Undergraduate Medical student, Faculty of Medicine, Northern Border University, Arar, KSA.

## ABSTRACT

**Background:** Previous literature estimates that 50 to 66 percent of DM patients would ultimately experience PN at some points in their lifespan. **Objectives:** To evaluate the prevalence of diabetic neuropathy and its associated risk factors in patients with diabetes mellitus attending the diabetes center in Arar, Saudi Arabia. **Methods:** A hospital-based cross-sectional study was carried out in the diabetes center in Arar, Saudi Arabia. Data were collected by personal interviews with the diabetic patients attending the diabetes center, and filling a predesigned questionnaire that included the following items; patient's code, department of residency, sex, age, marital status, educational level, occupation, compliance to DM treatment, fasting blood glucose level, diagnosis of diabetic neuropathy, type of received treatment, manifestations of DNP if found, and vital status. **Results:** DNP was reported in 26.4% of the studied DM patients. The most common DNP manifestations reported by the patients were inability to feel the feet while walking in 85.5%, pain in legs or feet in 78.2%, and weakness of the limbs in 70.9%, numbness and tingling in the legs or feet in 69.1% and 65.5%. More than half the patients (58.2%) had muscle spasms in the legs or feet, 52.7% suffered from dryness and cracking of the skin of the feet, 61.8% reported that symptoms worsen at night. Leg amputation was reported in 6 (10.9%) of patients. **Conclusion:** In our study, DNP was reported in 26.4% of the studied DM patients. DNP showed a statistically significant relation with BMI group, chronic hypertension, the period of DM, compliance with DM treatment, type of DM treatment, physical exercise, and fasting blood glucose level. On the other hand, DNP showed a statistically insignificant relation with gender, age group, and smoking.

**Key Words:** diabetic neuropathy, associated risk factors, diabetic patients, diabetes center, Arar, Saudi Arabia.

eIJPPR 2020; 10(5):104-109

**HOW TO CITE THIS ARTICLE:** Abdelrahman Mohamed Ahmed Abukanna, Manal Nashi O Alshammari, Bashir Faza M Alhazmi, Yousef Abdulhadi I Alanazi, Nwaf Shabram Alsabi Alenezi (2020). "Diabetic Neuropathy as the Commonest Diabetic Complication in Patients Attending the Diabetes Center in Arar, Northern Saudi Arabia", International Journal of Pharmaceutical and Phytopharmacological Research, 10(5), pp.104-109.

## INTRODUCTION

Diabetes has been increasing in recent years [1]. Diabetic neuropathy (DNP) is the most troublesome and common complication in patients with diabetes mellitus and is defined as peripheral nerve dysfunction in diabetics in whom other causes of peripheral nerve dysfunction have been excluded [2]. DNP may be the reason for the highest mortality rate and lead to a heavy economic burden on diabetes care [3, 4]. It is the most common reason for hospitalization in diabetics than all the other diabetic

complications and is responsible for 50-75% of non-traumatic amputations [4, 5].

The commonest clinical form of diabetic neuropathy is the distal symmetrical polyneuropathy, affecting more than 90% of the patients [6]. It generally affects the distal foot and toes, but gradually progresses proximally and involves the legs and feet in a stocking distribution. In addition, it is characterized by a gradual loss of nerve fibers that affect both the somatic and autonomic divisions, resulting in diabetic nephropathy and retinopathy [6, 7]. The main clinical consequences are painful neuropathy and foot

**Corresponding author:** Manal Nashi O Alshammari

**Address:** Undergraduate Medical student, NBU, Arar, KSA.

**E-mail:** ✉ manalnash1@gmail.com

**Relevant conflicts of interest/financial disclosures:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

**Received:** 29 April 2020; **Revised:** 09 October 2020; **Accepted:** 11 October 2020



ulceration with higher mortality and morbidity [8]. Neuropathic pain is a major disabling symptom of patients with diabetic neuropathy. It is a difficult condition to treat and therefore causes significant patient suffering and societal burden. Diabetic neuropathic pain is usually moderate to severe and often worsens at night, causing sleeping disturbances. The pain is characterized by lancinating, shooting, sharp, burning, tingling, and even electric shock sensations [6, 9]. It not only causes pain but also is associated with a high degree of functional impairment in health-related quality of life and activities of daily living [10, 11]. Although DNP may be asymptomatic, the symptomatic form affects 10% to 26% of the diabetic population [12, 13]. Frequently, patients look for medical help only when pain appears [14].

The exact mechanisms involved in different pain sensations are still unknown, however, some evidence points to abnormal discharges from diseased peripheral neurons as the main cause of this pain [15, 16]. Others point to the role of spontaneous activity in the peripheral nociceptor system in stimulating the central nervous system leading to hyperalgesia and allodynia [15, 16].

The risk of DNP was found to be associated with age, duration of DM, glycemic control (high level of HbA1c), gender, and smoking [17]. This study aimed to evaluate the prevalence of DNP and its risk factors in patients with diabetes mellitus attending primary healthcare (PHC) in Arar city, KSA.

### Rationale

According to the changes in the quality of life and the health hazards of patients who suffer from diabetic neuropathy, it is important to address the current burden in Arar, KSA.

### Aim of the Study

To study the prevalence, risk factors, and treatment outcomes of the DNP in the diabetic center in Arar, KSA.

## METHODS AND PARTICIPANTS

### Study design and setting

A hospital-based cross-sectional study was carried out in the diabetic center in Arar, Saudi Arabia. The study was during the period from April 1, 2020 to June 31, 2020.

All consenting diabetic patients attending the center were interviewed.

Inclusions criteria included Saudi patients diagnosed with DM.

Exclusion criteria included non-Saudi patients, patients with neurological disorders, and refusing patients.

### Sample Size

The sample size was calculated using the following formula:

$$N = Z^2 \times P(1-P)/E^2$$

Where:

N = sample size

Z<sup>2</sup> = 1.96 (The critical value that divides the central 95% of the Z distribution from the 5% in the tail)

P=Prevalence of diabetic neuropathy among Saudi diabetics attending the diabetes center in Arar, Northern KSA.

E<sup>2</sup> = the margin of error (=width of confidence interval)

So, by calculation, the sample size is equal to 184 cases with a 10% drop-out rate, so the total sample size will be 208 cases.

### Sampling Technique

The cases were selected using a systematic random sampling technique. First, one case was chosen randomly from the attendees of the center. Second, every 2<sup>nd</sup> case was included until the end of the sample (208 cases).

### Data collection

Data were collected by a personal interview with the diabetic patients attending the diabetes center, and filling a predesigned questionnaire that included the following items; patient code, department of residency, sex, age, marital status, educational level, occupation, compliance to DM treatment, fasting blood glucose level, diagnosis of diabetic neuropathy, type of received treatment, manifestations of DNP if found, and vital status.

### Ethical considerations

Approval to carry out the study was obtained from the Research Ethics Committee of the Northern Border University. Data was anonymous for patient confidentiality and the data was kept safely.

### Data management and Statistical analysis

The collected data was entered and analyzed using the SPSS software (SPSS Inc. Chicago, IL, USA) version 23. Descriptive statistics were performed. Percentages were given for qualitative variables. The determinant factors were determined using the Chi-square test. P-value was considered significant if P <0.05.

## RESULTS

The Socio-demographic characteristics of the included DM patients are shown in Table 1. 60.6% of participants were females, 37.5% were between 41 and 60 years old, and 26.9% were elderly. Regards body mass index (BMI) group, 36.1% were overweight and 33.2% suffered

obesity. Most of the participants were married (80.3%). 40.4% had a university degree, however, 63.0% were non-employed. Among the participants, 12% were smokers, and 21.2% suffered from chronic hypertension.

Table 2 shows DNP and its possible risk factors in the participants. DNP was reported in 26.4% of the studied DM patients. The period of DM was from 5 to 10 years in 39.9%, and more than 10 years in 33.7% of the participants. 76% reported that they are compliant with their DM treatment. DM treatment was only oral pills at 61.5%. Fasting blood glucose level was normal in 71.2% of the participants, and 66.8% do not perform physical exercise.

Table 3 shows the DNP manifestations among DNP patients. The most common DNP manifestations reported by the patients were inability to feel the feet while walking (85.5%), pain in legs or feet (78.2%), and weakness of the limbs (70.9%). Tingling and numbness in the legs or feet were reported in 69.1% and 65.5%, respectively. More than half of the patients (58.2%) had muscle spasms in the legs or feet, and 52.7% suffered from dryness and cracking of the skin of the feet. 61.8% said that symptoms were worse at night. Leg amputation was reported in 6 patients (10.9%).

Table 4 illustrates the relation between DNP and other factors. DNP showed a statistically significant relation with BMI group, chronic hypertension, period of DM, compliance with DM treatment, type of DM treatment, physical exercise, and fasting blood glucose level. On the other hand, DNP showed a statistically insignificant relation with gender, age group, and smoking.

**Table 1. Socio-demographic characteristics of the participants, 2020 (N=208).**

| Variables                | Frequency (N=208) | Percent (%) |
|--------------------------|-------------------|-------------|
| <b>Sex</b>               |                   |             |
| Male                     | 82                | 39.4        |
| Female                   | 126               | 60.6        |
| <b>Age group</b>         |                   |             |
| 18 years or younger      | 5                 | 2.4         |
| 19 – 40 years            | 69                | 33.2        |
| 41 – 60 years            | 78                | 37.5        |
| 61 years or older        | 56                | 26.9        |
| <b>BMI group</b>         |                   |             |
| Low                      | 7                 | 3.4         |
| Normal                   | 57                | 27.4        |
| Overweight               | 75                | 36.1        |
| Obese                    | 69                | 33.2        |
| <b>Marital status</b>    |                   |             |
| Married                  | 167               | 80.3        |
| Unmarried                | 41                | 19.7        |
| <b>Educational level</b> |                   |             |
| Introductory             | 29                | 13.9        |

|                             |     |      |
|-----------------------------|-----|------|
| Secondary                   | 45  | 21.6 |
| University degree           | 84  | 40.4 |
| Illiterate                  | 50  | 24.0 |
| <b>Employment</b>           |     |      |
| Employed                    | 77  | 37.0 |
| Non-employed                | 131 | 63.0 |
| <b>Smoking status</b>       |     |      |
| Current smoker              | 25  | 12.0 |
| Non-smoker                  | 183 | 88   |
| <b>Chronic hypertension</b> |     |      |
| Yes                         | 44  | 21.2 |
| No                          | 164 | 78.8 |

**Table 2. Diabetic neuropathy and its risk factors.**

| Variables                          | Frequency (N=208) | Percent (%) |
|------------------------------------|-------------------|-------------|
| <b>Diabetic neuropathy</b>         |                   |             |
| Yes                                | 55                | 26.4        |
| No                                 | 153               | 73.6        |
| <b>Period of DM</b>                |                   |             |
| Less than 5 years                  | 55                | 26.4        |
| 5 – 10 years                       | 83                | 39.9        |
| More than 10 years                 | 70                | 33.7        |
| <b>Compliance to DM treatment</b>  |                   |             |
| Yes                                | 158               | 76.0        |
| No                                 | 50                | 24.0        |
| <b>Type of DM treatment</b>        |                   |             |
| Oral pills                         | 128               | 61.5        |
| Insulin injection                  | 42                | 20.2        |
| Both                               | 15                | 7.2         |
| Only dietary changes               | 23                | 11.1        |
| <b>Fasting blood glucose level</b> |                   |             |
| High                               | 60                | 28.8        |
| Normal                             | 148               | 71.2        |
| <b>Physical exercise</b>           |                   |             |
| Regularly                          | 14                | 6.7         |
| Not regularly                      | 55                | 26.4        |
| No physical exercise               | 139               | 66.8        |

**Table 3. Manifestations of DNP among DNP patients. (N=55)**

| Manifestation   | Frequency (N=55) | Percentage (%) |
|---|------------------|----------------|
| Numbness in the legs or                               | 36               | 65.5           |
| Pain in the legs or feet                              | 43               | 78.2           |
| Higher touch sensitivity in legs                      | 23               | 41.8           |
| Muscle spasms in the legs or feet                     | 32               | 58.2           |
| Tingling in the legs or feet                          | 38               | 69.1           |
| Pain on touching the bed sheets                       | 11               | 20.0           |
| Undifferentiation between hot and cold-water bathroom | 8                | 14.5           |

|  |    |      |
|--|----|------|
| Open ulcer on the feet                       | 15 | 27.3 |
| Weakness of the limbs                        | 39 | 70.9 |
| Symptoms are worse at night                  | 34 | 61.8 |
| Inability to feel the feet while walking     | 47 | 85.5 |
| Dryness and cracking of the skin of the feet | 29 | 52.7 |
| Leg amputation                               | 6  | 10.9 |

|                             |                      |       |       |       |       |
|-----------------------------|----------------------|-------|-------|-------|-------|
| Fasting blood glucose level | Irregularly          | 21    | 34    | 55    | 0.001 |
|                             |                      | 38.2% | 22.2% | 26.4% |       |
|                             | No physical exercise | 28    | 111   | 139   |       |
|                             |                      | 50.9% | 72.5% | 66.8% |       |
|                             | High                 | 26    | 34    | 60    |       |
|                             |                      | 47.3% | 22.2% | 28.8% |       |
| Normal                      | 29                   | 119   | 148   |       |       |
|                             | 52.7%                | 77.8% | 71.2% |       |       |

**Table 4. Relation between DNP and other factors**

|                         |                     | Diabetic neuropathy |            | Total (N=208) | P-value |
|-------------------------|---------------------|---------------------|------------|---------------|---------|
|                         |                     | Yes (N=55)          | No (N=153) |               |         |
| Gender                  | Male                | 21                  | 61         | 82            | 0.479   |
|                         |                     | 38.2%               | 39.9%      | 39.4%         |         |
|                         | Female              | 34                  | 92         | 126           |         |
|                         |                     | 61.8%               | 60.1%      | 60.6%         |         |
| Age group               | 18 years or younger | 1                   | 4          | 5             | 0.790   |
|                         |                     | 1.8%                | 2.6%       | 2.4%          |         |
|                         | 19 – 40 years       | 19                  | 50         | 69            |         |
|                         |                     | 34.5%               | 32.7%      | 33.2%         |         |
|                         | 41 – 60 years       | 18                  | 60         | 78            |         |
|                         | 32.7%               | 39.2%               | 37.5%      |               |         |
|                         | More than 60 years  | 17                  | 39         | 56            |         |
|                         |                     | 30.9%               | 25.5%      | 26.9%         |         |
| BMI group               | Low weight          | 1                   | 6          | 7             | 0.001   |
|                         |                     | 1.8%                | 3.9%       | 3.4%          |         |
|                         | Normal              | 30                  | 27         | 57            |         |
|                         |                     | 54.5%               | 17.6%      | 27.4%         |         |
|                         | Overweight          | 11                  | 64         | 75            |         |
|                         |                     | 20.0%               | 41.8%      | 36.1%         |         |
| Obese                   | 13                  | 56                  | 69         |               |         |
|                         |                     | 23.6%               | 36.6%      | 33.2%         |         |
| Smoking status          | Current smoker      | 7                   | 18         | 25            | 0.509   |
|                         |                     | 12.7%               | 11.8%      | 12.0%         |         |
|                         | Non-smoker          | 48                  | 135        | 183           |         |
|                         |                     | 87.3%               | 88.2%      | 88.0%         |         |
| Chronic hypertension    | Yes                 | 17                  | 27         | 44            | 0.033   |
|                         |                     | 30.9%               | 17.6%      | 21.2%         |         |
|                         | No                  | 38                  | 126        | 164           |         |
|                         |                     | 69.1%               | 82.4%      | 78.8%         |         |
| Period of DM            | Less than 5 years   | 13                  | 42         | 55            | 0.038   |
|                         |                     | 23.6%               | 27.5%      | 26.4%         |         |
|                         | 5 – 10 years        | 16                  | 67         | 83            |         |
|                         |                     | 29.1%               | 43.8%      | 39.9%         |         |
|                         | More than 10 years  | 26                  | 44         | 70            |         |
| 47.3%                   |                     | 28.8%               | 33.7%      |               |         |
| Compliance to treatment | Yes                 | 35                  | 123        | 158           | 0.012   |
|                         |                     | 63.6%               | 80.4%      | 76.0%         |         |
|                         | No                  | 20                  | 30         | 50            |         |
|                         |                     | 36.4%               | 19.6%      | 24.0%         |         |
| Type of DM treatment    | Oral pills          | 29                  | 99         | 128           | 0.012   |
|                         |                     | 52.7%               | 64.7%      | 61.5%         |         |
|                         | Insulin injection   | 13                  | 29         | 42            |         |
|                         |                     | 23.6%               | 19.0%      | 20.2%         |         |
|                         | Both                | 9                   | 6          | 15            |         |
|                         |                     | 16.4%               | 3.9%       | 7.2%          |         |
| Only dietary changes    | 4                   | 19                  | 23         |               |         |
|                         |                     | 7.3%                | 12.4%      | 11.1%         |         |
| Physical exercise       | Regularly           | 6                   | 8          | 14            | 0.013   |
|                         |                     | 10.9%               | 5.2%       | 6.7%          |         |

## DISCUSSION

Owing to dramatic shifts in lifestyle and diet in recent decades, Saudi Arabia (SA) ranked 7th-largest adult diabetes (24.0 percent) in the world by 2011[18]. Previous literature estimates that 50 to 66 percent of DM patients would ultimately experience PN at some points in their lifespan. This cross-sectional study assessed the prevalence of diabetic neuropathy and its associated risk factors in patients with diabetes mellitus attending the diabetes center in Arar, Saudi Arabia.

Real prevalence is not documented, and estimates range from 10% to 90% in diabetic patients, based on the parameters and methods used to describe neuropathy[19]. In our study; the reported prevalence of DNP was 26.4%.

In a previous study; 25% of patients attending a diabetes clinic volunteered symptoms (50% of them have neuropathy) [20]. This was higher than the findings of a Saudi study, which reported a prevalence of 19.9% [21] and was higher than a worldwide estimate of DPN prevalence among diabetics (8.1% – 12.2%) [22]. In Saudi Arabia, a prevalence of 65.3% has been previously reported for painful DPN in a nationally representative diabetic population [23]. Another study in KSA showed a prevalence of only 2.5% [24]. This was much lower than another study in KSA that reported an overall prevalence of 29.1% [25]. A higher prevalence rate was reported in KSA with the overall prevalence of PDPN among the study participants being 34.71% [26]. A study in Qassim, KSA reported a prevalence of diabetic neuropathy to be 38.2% [27]. Our population had a higher compliance level of 76% than lower compliance (2.9%) reported in another region in KSA [27]. The prevalence rates of painful DPN in Middle East were 61.3%, 57.5%, 53.9%, and 37.1% for Egyptian, Jordanian, Lebanese, and Gulf States populations, respectively [28]. In the USA, the reported prevalence was 28.5% [29].

Regarding the symptoms of DNP, the most common symptoms were 65.5% numbness in the legs or feet, 78.2% pain in feet or legs, 58.2% muscles spasm in legs or feet, 69.1% tingling sensation in the legs or feet, 78.2% leg pain while walking, 85.5% inability to feel the feet while walking and 621.8% reported symptoms worsening at night. This was higher than that of another Saudi study, which reported symptoms as tingling (26.7%), hypoaesthesia to touch (23.3%), and pins and needles (23%)

[25]. Common symptoms reported in the prevalence sample in another previous Saudi study were “burning pain in legs and/or feet” (91.7%), “prickling feelings in legs or feet,” (79.8%), and “symptoms worsening at night” (63.1%) [26].

In our study, there was a significant and positive association between DNP and duration of diabetes, fasting blood glucose level, compliance with treatment, hypertension, and BMI index group. There was no correlation between DNP and age, sex, muscular exercise, and smoking status. This was on the line with results of another study reported that; participants with a diabetes duration of >20 years presented a 12.19-fold odds of DPN when compared with those with a diabetes duration of 2–5 years but they suggested that abdominal obesity had a significant and independent correlation with DPN, whereas general obesity (BMI  $\geq 30$  kg/m<sup>2</sup>) was not significant after multivariate adjustment [21]. Another study found that the prevalence of DPN significantly increased with increased in the age and all the age groups had a higher prevalence of DPN compared to the age group of 18–25 years ( $P < 0.05$ ) and the prevalence of DPN significantly increased with increase in the duration of DM ( $P < 0.05$ ). They also found that patients with uncontrolled A1C had a higher prevalence of DPN (39.4%) compared to patients with controlled A1C (14.9%) [13]. In a study conducted in the KSA, the prevalence of PDPN was significantly associated with glycemic control, as we observed that a higher level of HbA1c and poor compliance with treatments was significantly associated with higher odds of PDPN. They also observed no significant association between PDPN and gender, BMI, and smoking status, which supported the results of some studies [21].

In the results of another study, the odds ratio of PDN significantly increased in patients who had diabetes for more than 10 years, hypertension, and cardiovascular disease; it significantly decreases with glycemic control. HbA1c was positively associated with PDN; better glycemic control, hypertension as a co-existing disease was prevalent in this study population, but more significantly prevalent in PDN (73.7%) than in non-PDN patients (50.55) [30]. Another study of 136 diabetes patients, found that duration, insulin use, and glycemic control were the most important risk factors associated with diabetic neuropathy [31].

## CONCLUSION AND RECOMMENDATIONS

In our study, DNP was reported in 26.4% of the studied DM patients. DNP showed a statistically significant relation with BMI group, chronic hypertension, the period of DM, compliance with DM treatment, type of DM treatment, physical exercise, and fasting blood glucose level. On the other hand, DNP showed a statistically

insignificant relation with gender, age group, and smoking. So, health education for diabetic patients is necessary to guard against non-adherence to diabetes treatment and the necessity of muscular exercise. Large-scale national researches are needed to include all diabetic patients in Saudi Arabia.

**Conflict of interest:** The authors declare that there is no conflict of interest.

**Budget:** No funding institutions, this study is self-funded.

## REFERENCES

- [1] Alfahmi H, Aldawood L, Baz B, Elrggal M, Alsharif H, Alkahtani S. Quality of methodological reporting of randomized clinical trials of sodium-glucose cotransporter-2 (sglt2) inhibitors. *Archives of Pharmacy Practice*. 2017 Apr 1;8(2):78-81.
- [2] Al Abboud SA, Ahmad S, Bidin MB, Ismail NE. Translation and Psychometric Analysis of the Malaysian Version of Medication Understanding and Use Self-Efficacy Scale (M-MUSE) for Diabetes Mellitus. *Arch Pharma Pract*. 2017;8(2):64-9.
- [3] Vinik AI, Mitchell BD, Leichter SB, Wagner AL, O'Brian JT, Georges LP: Epidemiology of the Complications of Diabetes. In *Diabetes: Clinical Science in Practice*. Leslie RDG, Robbins DC, Eds. Cambridge, United Kingdom, Cambridge University Press, 1995, p. 221-287
- [4] Holzer SE, Camerota A, Martens L, Cuedon T, Crystal-Peters J, Zagari M. Costs and duration of care for lower extremity ulcers in patients with diabetes. *Clinical therapeutics*. 1998 Jan 1;20(1):169-81.
- [5] Caputo GM, Cavanagh PR, Ulbrecht JS, Gibbons GW, Karchmer AW. Assessment and management of foot disease in patients with diabetes. *New England Journal of Medicine*. 1994 Sep 29;331(13):854-60.
- [6] Tesfaye S, Boulton AJ, Dickenson AH. Mechanisms and management of diabetic painful distal symmetrical polyneuropathy. *Diabetes care*. 2013 Sep 1;36(9):2456-65.
- [7] Zhi Han L, Hui Yin Y, Makmor Bakry M. Medication handling Challenges among Visually Impaired Population. *Arch Pharma Pract*. 2017;8(1):8-14.
- [8] Boulton AJ, Kirsner RS, Vileikyte L. Neuropathic diabetic foot ulcers. *New England Journal of Medicine*. 2004 Jul 1;351(1):48-55.
- [9] Bansal V, Kalita J, Misra UK. Diabetic neuropathy. *Postgraduate medical journal*. 2006 Feb 1;82(964):95-100.
- [10] Galer BS, Gianas A, Jensen MP. Painful diabetic polyneuropathy: epidemiology, pain description, and

- quality of life. *Diabetes research and clinical practice*. 2000 Feb 1;47(2):123-8.
- [11] Gordois A, Scuffham P, Shearer A, Oglesby A, Tobian JA. The health care costs of diabetic peripheral neuropathy in the US. *Diabetes care*. 2003 Jun 1;26(6):1790-5.
- [12] Low PA, Dotson RM. Symptomatic treatment of painful neuropathy. *Jama*. 1998 Dec 2;280(21):1863-4.
- [13] Harris M, Eastman R, Cowie C. Symptoms of sensory neuropathy in adults with NIDDM in the US population. *Diabetes care*. 1993 Nov 1;16(11):1446-52.
- [14] Tesfaye S, Chaturvedi N, Eaton SE, Ward JD, Manes C, Ionescu-Tirgoviste C, Witte DR, Fuller JH. Vascular risk factors and diabetic neuropathy. *New England Journal of Medicine*. 2005 Jan 27;352(4):341-50.
- [15] Yasuda H, Terada M, Maeda K, Kogawa S, Sanada M, Haneda M, Kashiwagi A, Kikkawa R. Diabetic neuropathy and nerve regeneration. *Progress in neurobiology*. 2003 Mar 1;69(4):229-85.
- [16] Brownrigg JR, de Lusignan S, McGovern A, Hughes C, Thompson MM, Ray KK, Hinchliffe RJ. Peripheral neuropathy and the risk of cardiovascular events in type 2 diabetes mellitus. *Heart*. 2014 Dec 1;100(23):1837-43.
- [17] Algeffari MA. Painful diabetic peripheral neuropathy among Saudi diabetic patients is common but under-recognized: multicenter cross-sectional study at primary health care setting. *Journal of family & community medicine*. 2018 Jan;25(1):43.
- [18] International Diabetes Federation. *Diabetes Atlas. Sixth Edition International Diabetes Federation*. 2013.
- [19] Herman WH, Kennedy L. Underdiagnosis of peripheral neuropathy in type 2 diabetes. *Diabetes care*. 2005 Jun 1;28(6):1480-1.
- [20] Vinik AI. Diabetic neuropathy: pathogenesis and therapy. *The American journal of medicine*. 1999 Aug 30;107(2):17-26.
- [21] Wang DD, Bakhotmah BA, Hu FB, Alzahrani HA. Prevalence and correlates of diabetic peripheral neuropathy in a Saudi Arabic population: a cross-sectional study. *PloS one*. 2014 Sep 3;9(9):e106935.
- [22] Said G. Diabetic neuropathy—a review. *Nature clinical practice Neurology*. 2007 Jun;3(6):331-40.
- [23] Halawa MR, Karawagh A, Zeidan A, Mahmoud AE, Sakr M, Hegazy A, painful diabetic peripheral neuropathy study group. Prevalence of painful diabetic peripheral neuropathy among patients suffering from diabetes mellitus in Saudi Arabia. *Current medical research and opinion*. 2010 Feb 1;26(2):337-43.
- [24] Elhadd TA, Al-Amoudi AA, Alzahrani AS. Epidemiology, clinical and complications profile of diabetes in Saudi Arabia: a review. *Annals of Saudi medicine*. 2007 Jul;27(4):241-50.
- [25] Sendi RA, Mahrus AM, Saeed RM, Mohammed MA, Al-Dubai SA. Diabetic peripheral neuropathy among Saudi diabetic patients: A multicenter cross-sectional study at primary health care setting. *Journal of Family Medicine and Primary Care*. 2020 Jan;9(1):197.
- [26] Algeffari MA. Painful diabetic peripheral neuropathy among Saudi diabetic patients is common but under-recognized: multicenter cross-sectional study at primary health care setting. *Journal of family & community medicine*. 2018 Jan;25(1):43.
- [27] Almohisen AA, Almuhsayen LM, Alhatlany KK, Alghalith RH, Almutairi AM, Almarzogy FA, Alghasham HA, Almohaysen GM. Prevalence and risk factors of diabetic neuropathy in Qassim, Saudi Arabia. *Majmaah Journal of Health Sciences*. 2020;8(2):23-31.
- [28] Jambart S, Ammache Z, Haddad F, Younes A, Hassoun A, Abdalla K, Selwan CA, Sunna N, Wajsbrot D, Youseif E. Prevalence of painful diabetic peripheral neuropathy among patients with diabetes mellitus in the Middle East region. *Journal of International Medical Research*. 2011 Apr;39(2):366-77.
- [29] Gregg EW, Sorlie P, Paulose-Ram R, Gu Q, Eberhardt MS, Wolz M, Burt V, Curtin L, Engelgau M, Geiss L. Prevalence of lower-extremity disease in the US adult population ≥ 40 years of age with and without diabetes: 1999–2000 national health and nutrition examination survey. *Diabetes care*. 2004 Jul 1;27(7):1591-7.
- [30] AlQuliti KW. Predictors of Painful Diabetic Neuropathy in Saudi Patients with Type 2 Diabetes: A Case-Control Study. *J Pain Relief*. 2015; 4(3):181-4. doi: 10.4172/2167-0846.1000181
- [31] Akbar DH, Board A, Board S. Diabetic neuropathy: discordance between symptoms and electrophysiological testing in Saudi diabetics. *Bahrain Medical Bulletin*. 2002 Mar;24(1):10-2.