

## Prevalence of Sensory Ataxia in Type 2 Diabetic Polyneuropathy: Case Control Study

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### ABSTRACT

**Background:** Recent studies have shown that type 2 diabetes is associated with elevated risk of polyneuropathy, which is, in turn, a significant risk factor for sensory ataxia. However, the prevalence of sensory ataxia among patients with type 2 diabetic polyneuropathy has not been investigated in the Saudi context. The present study is an effort aiming to address this research gap.

**Aims:** The present study aimed to assess the prevalence of sensory ataxia among patients with type 2 diabetic polyneuropathy in Jeddah, Saudi Arabia, during the period between December 2023 and February 2024.

**Methods:** A case-control study was conducted among 15 patients with type 2 diabetes and 15 control participants attending the Neurology Clinic in one large private hospital in Jeddah, Saudi Arabia. All participants were invited to sign a written informed consent. After obtaining informed consent from all participants, the researcher interviewed each one of them. The researcher adopted a semi-structured pattern of interview questions.

**Results:** Members of the case group reported inability to sense the turning fork. It was also found that they had high levels of cholesterol. Moreover, findings show sensory ataxia was highly prevalent among members of case group, thereby indicating a strong correlation between sensory ataxia in type 2 diabetic polyneuropathy.

**Conclusion:** Sensory ataxia was found to be prevalent among patients with type 2 diabetic polyneuropathy. It is recommended to conduct further research in order to obtain new findings that can be generalized to the Saudi context.

**Keywords:** Sensory ataxia, type 2 diabetes, polyneuropathy.

## **What this study adds:**

### **1. What is known about this subject?**

Polyneuropathy is a common and debilitating complication among patients with type 2 diabetic polyneuropathy. It significantly impacts tactile sensing and proprioception, leading to the development of sensory ataxia, which is characterized by a lack of coordination and balance due to impaired sensory nerves.<sup>12</sup> This condition can severely affect a patient's quality of life, contributing to increased morbidity and healthcare costs.<sup>3</sup> Despite its prevalence, the extent of sensory ataxia among patients with type 2 diabetic polyneuropathy in the context of the Kingdom of Saudi Arabia remains largely unexplored, representing a significant gap in contemporary medical research.<sup>45</sup>

In addition to the direct neurological impact, polyneuropathy has been associated with other indirect problems, such as an increased risk of falls and injuries in diabetic patients due to resulting in the loss of proprioception and balance.<sup>6</sup> This can lead to further complications such as fractures and hospitalizations, exacerbating the overall burden on healthcare systems.<sup>7</sup> These aspects highlight the multifaceted impact of polyneuropathy and the importance of establishing and implementing comprehensive management strategies.<sup>8</sup>

### **2. What new information is offered in this study?**

Sensory ataxia is highly prevalent among patients with type 2 diabetic polyneuropathy and is correlated with levels of cholesterol.

The present study provides new and crucial information regarding the prevalence of sensory ataxia among patients with type 2 diabetic polyneuropathy in the Kingdom of Saudi Arabia. Our findings indicate that sensory ataxia is highly prevalent in this population and is significantly correlated with elevated cholesterol levels. This correlation underscores the importance of comprehensive lipid management in patients with type 2 diabetes to mitigate the risk of developing sensory ataxia.<sup>6</sup> These findings contribute to the growing body of evidence suggesting that lipid abnormalities can exacerbate diabetic complications, including neuropathies.<sup>7</sup>

### **3. What are the implications for research, policy, or practice?**

The present study recommends conducting similar studies in various healthcare institutions and regions across Saudi Arabia to gather more comprehensive data that can be generalized to the broader Saudi context. Such research is essential to understand the regional variations in the prevalence and impact of sensory ataxia.<sup>910</sup> These findings can inform healthcare policies aimed at improving diabetes management and reducing complications such as sensory ataxia. Additionally, the study advocates for promoting increased awareness and education among healthcare providers and patients regarding the risks associated with diabetic polyneuropathy and sensory ataxia.<sup>11</sup>

## **Background:**

Diabetes mellitus is among the most significant global health challenges. The number of patients with this disease reached 422 million in 2022. The disease is responsible for approximately 1.5 deaths every year. There are several types of diabetes mellitus, and the most prevalent among them is type 2 diabetes mellitus, which is a metabolic problem that results in high blood sugar levels due to problems in insulin resistance as well as impaired metabolism of proteins, fats, and carbohydrates. Type 2 diabetes is a significant risk factor that can result in the emergence of other complicated health problems, such as kidney failure, blindness, stroke, heart disease, and immune suppression.<sup>1213</sup>

In Saudi Arabia, diabetes mellitus is a serious public health issue. The prevalence rate of the disease in the country is approximately 25%, which is among the highest globally. In fact, according to the World Health Organization (WHO), the prevalence rate of diabetes mellitus in Saudi Arabia ranks second among countries of the Middle East region and seventh on the global level.<sup>14</sup>

Diabetic polyneuropathy is a medical condition commonly developing among type 2 diabetes patients that is not caused by other factors associated with peripheral neuropathy. It develops in the peripheral nervous system, particularly in the autonomic and/or somatic parts of the system.

The most common form of diabetic polyneuropathy is diabetic sensorimotor axonal polyneuropathy with evidence of secondary demyelination, which is found among approximately 30% of people with diabetes.<sup>15</sup>

Associated with diabetic polyneuropathy is the development of other health problems, notably including sensory ataxia. The development of sensory ataxia is gradual among patients with diabetic polyneuropathy. Early stages of diabetic polyneuropathy are characterized by the emergence of sensory symptoms, which occur as a result of sensory fibers being relatively long and highly susceptible to microvascular and metabolic damage. At later stages of diabetic polyneuropathy, sensory ataxia develops alongside forms of motor weakness.<sup>16</sup>

Thus, it is evident that type 2 diabetes is associated with elevated risk of polyneuropathy, which is, in turn, associated with sensory ataxia. The investigation of the relationship between sensory ataxia in type 2 diabetic polyneuropathy is crucial for the development of prevention strategies that can prevent or at least mitigate the development of sensory problems among type 2 diabetes patients. This is the rationale for conducting the present study. In the present study, we assessed the prevalence of sensory ataxia in patients with type 2 diabetic polyneuropathy in the Kingdom of Saudi Arabia.

## **Method:**

The present study adopted the case-control research methodology. The study was conducted at the Neurology Clinic in one large private hospital in Jeddah, Saudi Arabia, during the period between January

and February 2024. The hospital in which the study was conducted is a member of a network of large hospitals located across several regions of the Kingdom of Saudi Arabia. The Neurology Clinic provides a variety of services that cater to the needs of patients with diverse neurological health problems and needs.

The population of the study consisted of all patients who visited the clinic during the target period of study. The study focused on patients who complained from problems/symptoms ruled out as related to polyneuropathy. Patients with other medical conditions associated with elevated risk of the pathogenesis of polyneuropathy (e.g., cancer, certain infections, etc.) were excluded from the sample selection process. A total of 230 patients visited the Neurology Clinic during the target period of investigation.

Sample members of the case group included 15 patients who were diagnosed with type 2 diabetic polyneuropathy. Thus, the selected sample represents approximately 6.5% of the total number of patients with diabetes who visited the clinic during the period of investigation.

The study adopted a list of inclusion and exclusion criteria, which are outlined, in detail, in Table 1. Moreover, most of the patients in this group have vitamin B12 replacements due to metformin.

A control group of 15 participants were selected, matched for sex and age. Members of the control group were selected from among the patients who visited the Neurology Clinic during the target period of investigation, but had only mild and temporary neurological health problems.

All 30 participants were invited to sign a written informed consent. After obtaining informed consent from all participants, the researcher interviewed each one of them. The researcher adopted a semi-structured pattern of interview questions. In order to understand patterns of prevalence of sensory ataxia and their association with type 2 diabetic polyneuropathy, interview questions focused on certain topics, including perceived manifestation of sensory ataxia-related symptoms (e.g., unsteadiness of walking, difficulties in speaking, poor physical coordination, etc.), sensation associated with the tuning fork test, and levels of cholesterol.

In order to analyze the qualitative data obtained from interviews, the researcher followed the steps outlined below:

1. Transcribe the interview recordings.
2. Annotate the transcripts.
3. Aligning the data with the main themes.
4. Segmenting the data.
5. Analysis of the main themes.
6. Writing the results of the analysis.

## **Results and Discussion:**

- **Reported Sensations:**

Members of the control group reported having normal sensation in tuning fork tests. However, on the other hand, members of the case group reported feeling no sensation associated with the tuning fork test. This finding is in line with the theoretical discussion provided by another recent study<sup>17</sup> that indicates that polyneuropathy is associated with loss of proprioception. In particular, the study indicates that polyneuropathy is associated with a variety of symptoms, some of which involve sensory fibers. Large-fiber sensory dysfunction is likely to result in proprioception loss, which may, in turn, cause impairment of gait. A study that provides a morphometric overview of diabetic peripheral neuropathies<sup>18</sup> indicates that large-fiber type symmetric polyneuropathies are associated with a variety of problems, such as sensory ataxia, decreased vibratory and position senses, and ankle reflex loss. Moreover, a recent study that discusses diagnosis and management of sensory polyneuropathy<sup>19</sup> indicates that sensory ataxia is among a group of disorders that result in impairments in proprioception and vibratory sensation; as a result, patients with sensory ataxia often experience symptoms such as gait imbalance, paresthesia, and sensory loss.

Members of the case group reported their own perceptions of sensations they experienced in the latest fork tests. The following is a discussion sample members' reports of pinprick sensation and vibration sensation.

- **Pinprick Sensation:**

All 15 members of the case group reported that the treatments they received help in reducing pinprick sensation up until above the knee.

- **Vibration Sensation:**

Perceptions of vibration sensation varied, depending on the location. Case group members' perceptions of vibration sensation are summed up as follows:

1. All 15 participants reported diminishing vibration sensation distally at the big toe.
2. Nine participants reported that vibration sensation diminished up to the knees.
3. Four participants reported that vibration sensation was reduced up to the pelvis.
4. Three participants felt that treatment helped in reducing vibration sensation up to the hip.

- **Levels of Cholesterol:**

Members of the control group reported having low levels of cholesterol. However, on the other hand, members of the case group reported having high levels of cholesterol.

This finding is partially in line with the general conclusions achieved by a recent systematic review of the role of serum lipid profile in prediction of diabetic neuropathy.<sup>20</sup> According to the study, previous studies show varying findings on the relationship between levels of total cholesterol and the incidence of diabetic

neuropathy among patients with diabetes, as some studies found a positive correlation, while others indicated the absence of such a correlation or even the existence of a negative one.

A study that investigates the association between hyperlipidemia, lipid-lowering drugs, and diabetic peripheral neuropathy in patients with type 2 diabetes mellitus<sup>21</sup> also indicates that studies are inconclusive on the relationship between levels of cholesterol and diabetic peripheral neuropathy; while many studies found that total cholesterol is associated with stronger risk of diabetic peripheral neuropathy, other studies have shown that the risk is actually heightened with lower levels of low-density lipoprotein cholesterol or total cholesterol.

Finally, a case control study that examines the clinical relationship between oxidized low-density lipoproteins and diabetic peripheral neuropathy<sup>22</sup> presents findings that support the existence of a negative correlation.

The study's findings show that although type 2 diabetes is associated with elevated risk of diabetic complications, including diabetic polyneuropathy, patients with type 2 diabetic polyneuropathy have generally lower levels of cholesterol compared to healthy persons. This finding is in line with those of another case-control study<sup>23</sup> that discussed a similar topic and that also indicates that the level of total cholesterol is not associated with the worsening of diabetic peripheral neuropathy.

Through the findings discussed above, it can be stated that the present study shows the potentiality of existence of a positive correlation between sensory ataxia and incidence of type 2 diabetic polyneuropathy. However, the inconclusive link between this correlated and cholesterol levels in patients with type 2 diabetes warrants further investigations, particularly in the Saudi context.

## **Conclusion:**

Sensory ataxia was found to be prevalent among members of the case group, which consisted of patients with type 2 diabetic polyneuropathy attending the Neurology Clinic in one large private hospital in Jeddah, Saudi Arabia.

The study achieved inconclusive findings, as some findings are in line with those obtained by previous studies, while others are incongruent and warrant further investigation. First, patients with type 2 diabetic polyneuropathy reported not sensing the tuning fork; this is an indication that patients have proprioception loss, which is, in turn, a sign often associated with sensory ataxia. This finding is in line with those obtained by previous relevant studies, which indicate that polyneuropathies in general are associated with a variety of problems, including mainly sensory ataxia. With regards to the role of cholesterol levels in the relationship between sensory ataxia and type 2 diabetic polyneuropathy, the present study obtained findings that are notably different from those obtained by previous relevant studies. Members of the case group reported having high levels of cholesterol. Thus, there is a correlation



observed between levels of cholesterol and diabetic peripheral neuropathy, as both issues were reported by sample members to be prevalent among them. This finding is strikingly different from those found by other studies, which show that although published results of many clinical trials have shown that levels of cholesterol are associated with higher risk of incidence of type 2 diabetic polyneuropathy, many other studies report a nonexistent or even negative correlation, especially the latter.

Due to the inconclusiveness of the obtained findings, the present study recommends conducting other similar studies in other healthcare institutions and regions across Saudi Arabia in order to arrive at new, more generalizable findings.

The study also recommends that hospitals, especially neurology departments and clinics, work on raising the awareness among patients with type 2 diabetic polyneuropathy on the risk of developing sensory ataxia.

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**Table 1: Exclusion criteria of sample members (case group)**

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| <ol style="list-style-type: none"><li>1. Ataxia before the diagnosis onset of diabetes.</li><li>2. Ataxia due to vitamin B12 deficiency.</li><li>3. Ataxia due to vitamin B6 toxicity.</li><li>4. Ataxia due to vitamin E deficiency.</li><li>5. Hereditary ataxia</li><li>6. Triglycerides, which may cause burning sensation and small-fiber neuropathy.</li><li>7. Major surgeries in the lower extremities that affect walking and balance.</li></ol> |
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