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Research Article

Association between Serum Vitamin D Levels and Diabetic Peripheral Neuropathy among Patients Attending Chandka Teaching Hospital Larkana

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ABSTRACT

Background: Diabetes mellitus (DM) is a metabolic disease which is complicated by occurrence of diabetic peripheral neuropathy (DPN). Vitamin D deficiency contributes to the etiology and progression of type 2 DM and development of micro-vascular complications. This study aimed to compare exercise habits, sunlight exposure, glycated hemoglobin (HbA1c), and vitamin D levels between controlled and uncontrolled DPN patients.

Methods: A comparative analysis was conducted among patients with controlled and uncontrolled DPN. Data regarding regular exercise habits, daily sunlight exposure, HbA1c levels, and serum vitamin D concentrations were collected and analyzed using descriptive statistical methods.

Results: Gender-based differences in regular exercise were observed between the groups. In the controlled DPN group, 84% of regular exercisers were male and 16% were female, whereas in the uncontrolled DPN group, 42% were male and 58% were female. Regarding sunlight exposure, 53.5% of participants reported 1–3 hours of daily exposure, 36.8% reported 4–6 hours, and 9.72% reported 7–10 hours. Uncontrolled DPN patients had significantly higher HbA1c levels (8.72 ± 1.54%) compared with controlled DPN patients (6.81 ± 0.32%). The uncontrolled group also demonstrated greater variability in HbA1c values, indicating poorer glycemic control. Vitamin D levels were notably lower in uncontrolled DPN patients (20.7 ± 2.56 ng/mL) than in controlled DPN patients (27.75 ± 3.12 ng/mL). The median and mode values further supported the consistently higher vitamin D status among controlled DPN patients.

Conclusion: Controlled DPN patients exhibited better glycemic control, higher vitamin D levels, and more stable metabolic profiles compared with uncontrolled DPN patients. Lower vitamin D concentrations and elevated HbA1c levels were associated with uncontrolled DPN, suggesting that adequate vitamin D status and effective glycemic management may play important roles in reducing the severity and progression of diabetic peripheral neuropathy. Further studies are recommended to explore the therapeutic benefits of vitamin D supplementation and lifestyle interventions in DPN management.

Keywords: Diabetic Peripheral Neuropathy, Vitamin D, HbA1c, Glycemic Control, Sunlight Exposure, Exercise Habits, Diabetes Mellitus.

INTRODUCTION

Diabetes, which is a significant lifestyle-related disease, has turned into a worldwide burden. Diabetes is becoming increasingly common in developing nations. In numerous developing nations, the largest contributor to diabetes is China, with India following closely behind [1]. Type 2 diabetes (T2DM) has emerged as a significant global health concern, with reports indicating a worrying rise in its incidence.[2]. As the economy has developed rapidly and industrialization has accelerated, lifestyle changes and demographic aging have contributed to a sharp increase in diabetes prevalence in China. After cardiovascular diseases and tumors, it has emerged as a significant chronic non-communicable disease that poses a serious threat to public health. The

World Health Organization reports that from 2005 to 2015, China incurred economic losses amounting to 557.7 billion dollars due to diabetes and associated cardiovascular diseases [3]. The global prevalence of diabetes has surged recently, hitting 8.3% in 2014, equivalent to 3.87 million patients [4].Vitamin D, which is a steroid hormone, is mainly found in two forms: vitamin D2 (ergocalciferol) and vitamin D3 (cholecalciferol). Nuclear receptors for vitamin D have been identified in neurons and glial cells in prior research, indicating its involvement in the production of neurotrophic factors and enzymes. The results suggest that vitamin D could slow the advancement of DPN via various mechanisms. Lowered vitamin D levels have been linked to a heightened risk of DPN among individuals with diabetes. Results from a large-scale clinical study carried out overseas showed that about 81% of diabetes patients are vitamin D deficient, a condition that is closely linked to the onset of DPN [5].According to clinical studies, patients with diabetes are more frequently found to be deficient in vitamin D, which is a significant factor in the development of diabetic neuropathies [6, 7]. Clinical observational studies demonstrated a significant association between vitamin D deficiency in patients and symptoms of neuropathic pain [8], neurological deficits, autonomic dysfunction [9], as well as findings from electrophysiological studies in diabetic patients [10]. Diabetics who exhibit symptoms of distal symmetrical polyneuropathy are more frequently found to be deficient in vitamin D [11]. A recent study found that in a nationally representative sample of adults diagnosed with diabetes, there was an association between vitamin D insufficiency and self-reported symptoms of peripheral neuropathy [12]. It has been reported more recently that a lack of vitamin D is a separate risk factor for diabetic peripheral neuropathy in individuals with type 2 diabetes. This was validated by those who identified a link between a lack of vitamin D and diabetic peripheral neuropathy [13,14]. It has also been proposed that vitamin D supplementation can serve as an effective "analgesic" for alleviating neuropathic pain in diabetic patients [11, 15]. As a result, several studies involving different ethnic groups have suggested a causal link between a lack of vitamin D and a heightened risk of diabetic peripheral neuropathy [16].

MATERIALS AND METHODS

Study Design: Cross Sectional Comparative study

Study Settings: Present study was carried out in the medicine, by the Department of Medicine, endocrinology and neurology at CMC Hospital Larkana after approval from Institutional Review Board and Scientific Committee of SMBB-Medical University Larkana. Study comprised Type 2 Diabetes Mellitus who had neuropathy.

Study Population: Adult patients with diabetes mellitus Type-II who visited outpatient clinics

Sample Size: Sample size was designed using the WHO sample size calculator for case–control studies, considering a confidence interval of 95%, power of 80%, and prevalence estimates from earlier studies. Based on these assumptions. The 152 participants were included, with equal representation of cases and controls.

Blood Sample Collection: A blood sample was drawn from the antecubital vein using disposable syringes for the procedure. To allow for clot formation, 5 ml of blood was placed in a gel tube with clot activator and allowed to sit at room temperature for 5 to 10 minutes. After removing the clot, serum was extracted using centrifugation for five minutes at 3000–4000 rpm and five to ten minutes at room temperature. Following this procedure, the serum was refrigerated until analysis. Additionally, the samples were labeled with specific numbers of subjects.

Estimation of Vitamin D: Stored serum was used for determination of vitamin D. Serum was taken and before analysis sample was allowed to attain room temperature then analyzed by performed on chemiluminescence [17].

Analysis: The data is shown as correlations, frequencies, percentages, means, and standard deviations.

RESULT

Present study was conducted on controlled DPN patients exhibited better glycemic control, higher vitamin D levels, and more stable metabolic profiles compared with uncontrolled DPN patients. Lower vitamin D concentrations and elevated HbA1c levels were associated with uncontrolled DPN.

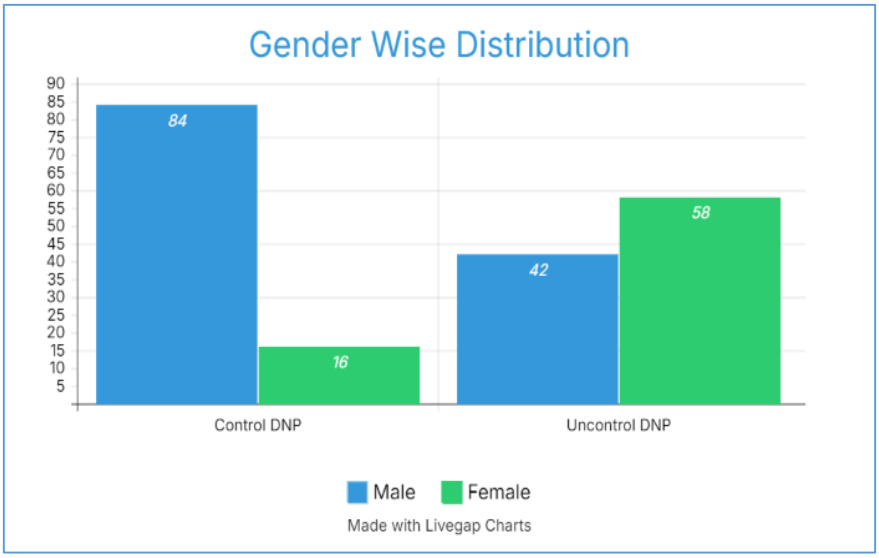

Figure 1: Gender-Wise Distribution of Diabetic Neuropathy Patients

In the analysis of regular exercise habits by gender among DNP patients, a striking difference was observed between the control and uncontrolled groups. In the control DNP group, 84% of those who exercised regularly were male, while only 16% were female. In contrast, in the uncontrolled DNP group, the proportion was reversed, with 42% male and 58% female. This indicates that in the controlled DNP population, men were far more likely to engage in regular exercise than women, whereas in the uncontrolled group, women predominated among regular exercisers. Such gender disparities may be influenced by cultural, social, and lifestyle factors, as well as differences in health awareness and physical activity opportunities.

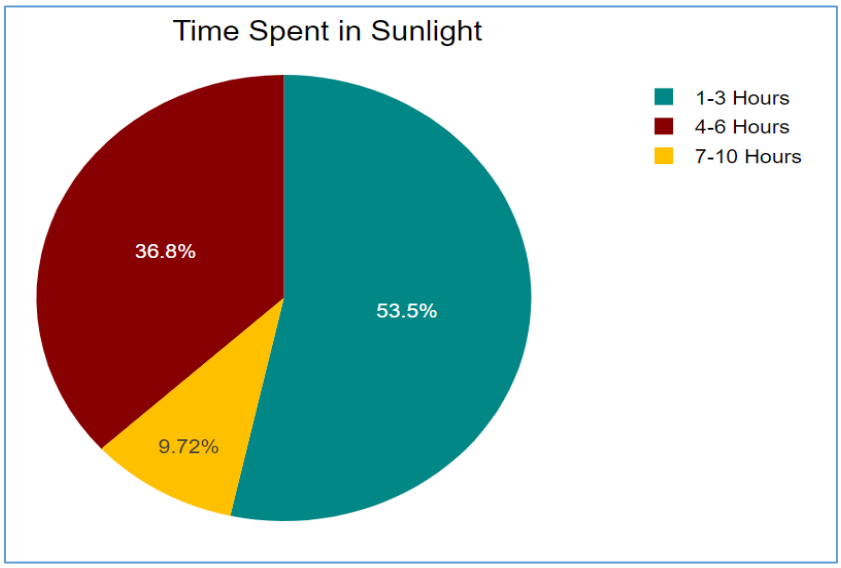

Figure 2: Distribution of Diabetic Neuropathy Patients (DNP) According to Time Spent in Sunlight"

Among the study participants, 53.5% reported spending 1–3 hours in sunlight daily, representing the largest proportion. A further 36.8% spent 4–6 hours outdoors, while only 9.72%were exposed to sunlight for 7–10 hours. This distribution indicates that more than half of the participants had moderate sun exposure, with a smaller fraction experiencing prolonged exposure, which could have implications for vitamin D synthesis, skin health, and overall well-being.

Table 1: Hba1c Comparison in the Between Controlled and Uncontrolled Diabetic Neuropathy Patients

	Uncontrolled DNP	Control DNP
Mean	8.72	6.81
Median	8.4	6.8
Mode	7.8	7
Variance	2.37	0.1
Minimum	7.14	6.1
Maximum	14.8	8
Range	7.66	1.9
Number of valid values	73	72
95% Confidence interval of Mean	8.36 - 9.08	6.73 - 6.88
Mean ± Std.	8.72 ± 1.54	0.32

The statistical analysis of HbA1c levels shows a distinct difference between uncontrolled and controlled DNP patients. Uncontrolled DNP group had a mean HbA1c of 8.72 ± 1.54, with values ranging from 7.14 to 14.8. The median (8.4) and mode (7.8) are consistent with elevated glycemic levels. The variance (2.37) and wide range (7.66) reflect considerable variability in HbA1c among patients, indicating poor glycemic control. The 95% confidence interval (8.36 – 9.08) confirms that mean HbA1c in this group is significantly above the recommended threshold. Controlled DNP group had a mean HbA1c of 6.81 ± 0.32, with values ranging from 6.1 to 8.0. The median (6.8) and mode (7.0) indicate stable glycemic levels near the optimal range. The variance (0.1) and narrow range (1.9) suggest minimal fluctuations in HbA1c, showing good glycemic stability. The 95% confidence interval (6.73 – 6.88) lies within a tightly controlled range, further supporting effective glucose regulation. These findings demonstrate that controlled DNP patients maintain HbA1c within near-normal and stable ranges, minimizing risks of diabetes-related complications. In contrast, uncontrolled DNP patients exhibit significantly higher and more variable HbA1c levels, reflecting poor glycemic management and an increased likelihood of neuropathic and systemic complications.

Table 2: Vitamin D Levels Between Controlled and Uncontrolled Diabetic Neuropathy Patients

Serial No.	Statistical Parameters	Vitamin D ng/mL	
		Uncontrolled DNP	Control DNP
1	Minimum	14.5	20.5
2	Maximum	28.8	35.8
3	Range	14.3	15.3
4	Mean	20.7	27.75
5	Median	20.5	28
6	Mode	20	29
7	Standard Deviation	2.56	3.12

The table summarizes the descriptive statistical parameters of Vitamin D levels **(**ng/mL in Uncontrolled DNP and Control DNP patients. In the Uncontrolled DNP group, Vitamin D levels ranged from 14.5ng/mL (minimum) to 28.8ng/mL (maximum), with a range of 14.3ng/mL . The mean level was 20.7 ± 2.56 ng/mL, with a median of 20.5 ng/mL and a mode of 20 ng/mL. In the Control DNP group, Vitamin D values ranged from 20.5 ng/L to 35.8ng/mL, resulting in a slightly wider range of 15.3ng/mL. The mean was 27.75 **±** 3.12ng/mL , with a median of 28 ng/mL and a mode of 29ng/mL Overall, Control DNP patients showed consistently higher Vitamin D levels compared to Uncontrolled DNP patients.

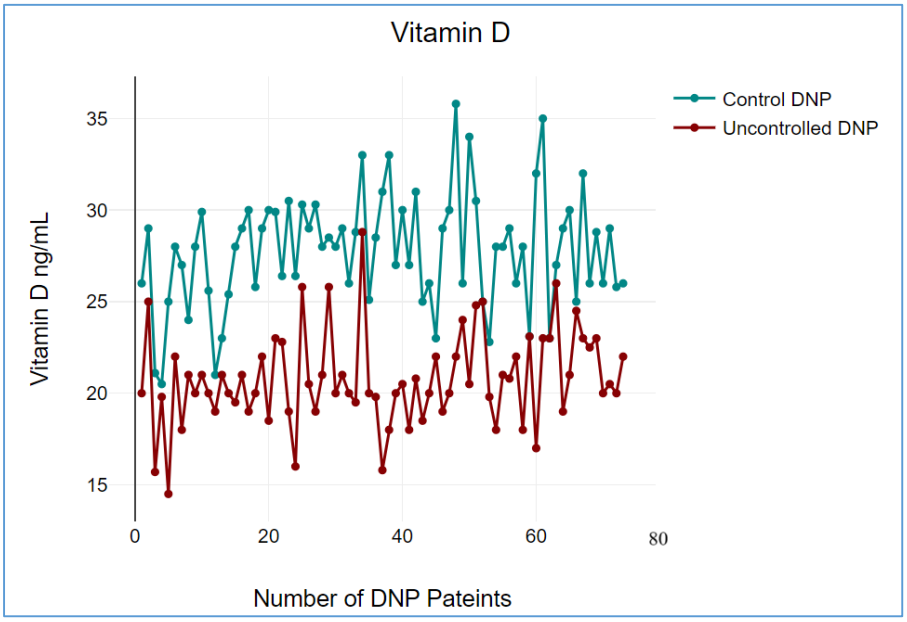

Figure 3: Vitamin D Levels Between Controlled and Uncontrolled Diabetic Neuropathy Patients

The figure illustrates the serum Vitamin D levels (ng/mL) among Diabetic Neuropathy Patients (DNP), comparing Controlled DNP (blue line) and Uncontrolled DNP (red line). The x-axis represents the number of patients, while the y-axis shows the Vitamin D concentration. Patients with Controlled DNP generally exhibit higher Vitamin D levels, ranging between approximately 25–36 ng/mL. In contrast, patients with Uncontrolled DNP show consistently lower Vitamin D levels, mostly between15–25 ng/mL. The data suggest a clear difference, indicating that Vitamin D levels are better maintained in controlled cases compared to uncontrolled cases.

DISCUSSION

This research has linked lower serum vitamin D levels to elevated HbA1c [18]. Nonetheless, the impact of vitamin D supplementation on HbA1c levels is a matter of debate. The SUNNY Trial found that a large intermittent vitamin D supplementation (50,000 IU per month for 6 months) aimed at optimizing vitamin D levels did not enhance glycemic control in individuals with type 2 diabetes [19].Our study found that baseline HbA1c levels were higher than those of patients with well-controlled type 2 diabetes in the SUNNY trial. The glycemic effect of vitamin D may manifest in patients with poorly controlled type 2 diabetes [19]. Another study that aligns with ours found that high-dose vitamin D in patients with painful diabetic neuropathy was linked to a significant reduction in HbA1c levels and the symptoms of painful diabetic neuropathy [20]. Another study demonstrated a significant improvement in neuropathy severity after normalizing vitamin D levels, as assessed by the Toronto Clinical Neuropathy Scoring System (including Symptom scores, Reflex scores, and Sensory test scores).Nonetheless, following vitamin D correction, there was an enhancement in nerve conduction studies for mild diabetic peripheral neuropathy, but no such effect was observed in moderate and severe cases. The trial lasted three months, similar to our study, and had no control group [21]. Furthermore, symptoms are evaluated and a physical examination is conducted as part of this Toronto Clinical Neuropathy Scoring System. Thus, it aligns with our research owing to the enhancement of both symptoms and signs [21]. Another multicenter, randomized, double-blind study assessed the effectiveness and safety of intramuscular vitamin D2 supplementation in individuals with type 2 diabetes and peripheral neuropathy. Clinical symptoms and nerve conduction velocity showed improvement after one year of follow-up in this trial [22].

CONCLUSION

The findings of this study demonstrate that patients with uncontrolled diabetic peripheral neuropathy (DPN) had significantly higher HbA1c levels and lower vitamin D concentrations compared with controlled DPN patients. Controlled DPN patients maintained better glycemic stability and exhibited consistently higher vitamin D status. Moderate sunlight exposure was

reported by the majority of participants, while notable gender differences were observed in regular exercise habits between the two groups. These results suggest that poor glycemic control and vitamin D deficiency may be associated with the progression and severity of diabetic peripheral neuropathy. Therefore, maintaining optimal blood glucose levels, ensuring adequate vitamin D status, and promoting healthy lifestyle practices, including regular physical activity and appropriate sunlight exposure, may contribute to improved management and reduced complications of DPN.

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