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# The association of vitamin D level with diabetic peripheral neuropathy: A comparative cross-sectional study

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## *Abstract*

*Background & Objective:* Diabetic peripheral neuropathy (DPN) is a common complication of type 2 diabetes mellitus (DM). Vitamin D deficiency has been shown to be prevalent among patients with type 2 DM, particularly in those with DPN. This study aimed to look at the association of serum vitamin D level with peripheral neuropathy in patients with type 2 DM. *Methods:* This was a comparative cross-sectional study conducted in a tertiary hospital in Malaysia. Fifty diabetic patients with DPN and fifty diabetic patients without DPN were recruited. Serum vitamin D level was determined by measuring 25-hydroxyvitamin D [25(OH)D] level. The patients were clinically assessed and screened with Diabetic Neuropathy Symptoms score. Nerve conduction study was performed for patients with DPN. *Results:* The serum 25(OH)D level was significantly lower in patients with DPN (11.81 [9.09-18.06] vs 18.63 [11.25-22.63] ng/ml; p=0.006). Multiple logistic regression analysis showed that DPN was significantly associated with higher BMI, longer duration of DM, insulin usage and serum 25(OH)D level. The usage of fibrates had negative association with DPN. Subgroup analysis of the DPN group showed that patients with painful DPN had significant lower serum 25(OH)D level (p<0.001) and the clinical severity of DPN negatively correlated with serum 25(OH)D level (p=0.015).
*Conclusion:* Vitamin D deficiency is associated with DPN in patients with type 2 DM. In addition, patients with painful DPN tend to have significantly lower serum 25(OH)D level.

*Keywords:* Diabetic peripheral neuropathy, painful neuropathy, serum vitamin D level, 25-hydroxyvitamin D, nerve conduction study

## INTRODUCTION

Diabetes mellitus (DM) is an independent risk factor and one of the most common causes of peripheral neuropathy. According to the American Diabetes Association, diabetic peripheral neuropathy (DPN) affects 10%–15% of patients with newly diagnosed type 2 DM and up to 50% over the10 years of disease duration.[1] The clinical presentation of DPN may be variable, ranging from mild numbness in the early stage to disabling painful neuropathy or unsteadiness with significant functional impairment.[2] Diabetic neuropathy may remain asymptomatic up to 50% of cases.[3] The prevalence of neuropathy in patients with diabetes is approximately 30% but up to 50% eventually develop neuropathy during disease progression.[4,5] DPN is thought to result from diabetic microvascular injury involving small blood vessels that supply nerves (vasa nervorum) and increases the risk of diabetic foot ulcers, limb amputation and sepsis.

There are different clinical phenotypes of DPN including distal symmetric polyneuropathy, diabetic radiculoplexus neuropathy, multiple mononeuropathy, mononeuropathy, treatment-induced neuropathy in diabetes (TIND) and autonomic neuropathy. Distal symmetric polyneuropathy is the most common type. Typically, it develops over months or years and firstly affects lower limbs in a symmetrically length-dependent manner.[6] Distal symmetric polyneuropathy mostly affects long fiber nerves resulting in impairment of vibration and joint

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position sense. It also affects the small-fibre nerves which impair the pain and temperature sensation and autonomic function.[7]

The commonly known risk factors of DPN include long duration of DM, poorly control DM with high glycated hemoglobin (HbA1c), obesity and hypertension.[8] Vitamin D deficiency is very common among diabetic patients. Low levels of Vitamin D are associated with sensory neuropathy in DM.[9] According to National Health and Nutrition Examination Survey, adults more than 40 years old with diabetes showed an association of vitamin D insufficiency with peripheral neuropathy symptoms.[10] In addition, FIELD study involving a total of 9,795 patients with type 2 DM showed that vitamin D deficiency was present in up to 50% of the patients.[11] A meta-analysis demonstrated that Asians with type 2 DM and vitamin D deficiency were at 1.22 times high risk to suffer from DPN compared with those with normal vitamin D level.[12]

Currently, the therapeutic treatment for DPN is limited to symptomatic relief. Available treatments including anti-seizures drug (e.g., gabapentin, pregabalin), anti-depressants (e.g., amitriptyline, duloxetine) and opioids (e.g., tramadol) only improve the painful symptoms. Till date, there has not been any proven disease modifying treatment for DPN or DPN with negative sensory symptoms. Recently, some studies showed improvement of neuropathic symptoms with vitamin D supplements in patients with DPN. A prospective, non-randomized, double-blind, placebo-controlled trial in patients with DPN with vitamin D deficiency showed significantly reduced neuropathic pain with oral capsules of vitamin D3 (cholecalciferol, 50000 IU) once weekly for eight weeks.[9] Another prospective open-labeled study showed a significant reduction in positive symptoms of all pain scores in patients with a single intramuscular dose of 600000 IU vitamin D3.[13] These findings suggest that vitamin D deficiency may play a role in the pathogenesis of DPN. Hence, treating vitamin D deficiency may be a meaningful therapeutic modality especially with symptomatic and painful DPN. We embark on this study to determine the association of serum vitamin D level with peripheral neuropathy in patients with type 2 DM.

## METHODS

This was a comparative cross-sectional study conducted in a single tertiary care medical center (Universiti Kebangsaan Malaysia Medical Centre) in Kuala Lumpur, Malaysia. A total number of 100 participants were recruited from November 2019 to November 2020 from medical wards and outpatient clinics (endocrinology and neurology). This study was approved by Research and Ethics Committee (FF-2019-471) of Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia.

### *Data collection*

All participants were recruited with the established diagnosis of type 2 DM aged 18 years or above. We excluded patients with type 1 DM, pregnant women, peripheral neuropathy due to other diseases (e.g., inflammatory immune-mediated diseases, inherited neuropathy, radiculopathy, paraneoplastic neuropathy, hyperparathyroidism, alcoholism, vitamin B-12 deficiency, and drug-induced neuropathy), patients with other causes of pain (peripheral arterial disease or infection), patients taking vitamin D supplements, severe cognitive or psychiatric illness.

After obtaining informed consent, the participants were interviewed for demographic data, screened clinically and with Diabetic Neuropathy Symptom (DNS) score questionnaire. The DNS score questionnaire is a validated four-item based symptom score with high predictive value to screen distal symmetric polyneuropathy. It includes symptoms of numbness, unsteadiness while walking, pricking sensation and burning sensation or aching pain in legs or feet. Each elicited symptom scores one point and any participant having one point or higher were concluded having DPN.[14] The first two items of DNS score were considered negative symptoms whereas the latter two items were positive symptoms.

Neurological examination was performed in all participants. Sensory modalities of the limbs were assessed with pinprick, proprioception and vibration sense with 128 Hz tuning fork. The participants were then categorized into two groups named non-DPN and DPN. Participants with DNS score of "zero" and no clinical sign of neuropathy were categorized to non-DPN group whereas participants with DNS score of one and above and with or without clinical sign of neuropathy were categorized to DPN group. We pre-determined and selected DPN with clinical phenotype of distal symmetric polyneuropathy. Other patterns of diabetic-related neuropathies such as diabetic radiculoplexus neuropathy, multiple mononeuropathy, TIND and pure autonomic neuropathy were excluded as the underlying pathological mechanism may be different.

*Anthropometric and biochemical measurements*

Data on gender, age, duration of diabetes, presence of DPN, co-morbidities (chronic kidney disease, coronary artery disease, hypertension, dyslipidemia), treatments (anti-hypertensive, anti-diabetic and lipid-lowering agents) were obtained. Weight and height were measured using a stadiometer. The estimated glomerular filtration rates (eGFR) were calculated from measured serum creatinine using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation. Chronic kidney disease was defined as an eGFR <60 mL/min/1.73 $m^2$. For biochemical measurements, morning fasting blood samples were collected from the antecubital veins to measure serum vitamin D level, fasting serum lipid, fasting blood sugar and HbA1c. Blood samples were centrifuged within 4 hours for 15 min @3500 RPM to collect the serum and stored in a refrigerator at −20°C prior to analysis. Serum vitamin D was measured by total serum 25-hydroxyvitamin D [25(OH) D] assay kits manufactured by Roche and analyzer 'Roche Cobas e411' manufactured by HITACHI, Japan. A serum level of 25(OH)D at least 20 ng/ml is considered sufficient, and 12 to 20 ng/ml is considered insufficient. Vitamin D deficiency is defined as a serum level of less than 12 ng/ml (15). All tests were conducted in the central laboratory of UKM Medical Centre.

*Electrodiagnostic study*

All participants in DPN group were subjected to nerve conduction study (NCS) to determine the neurophysiological pattern and severity. The NCS were performed using standardised techniques and temperature. We studied median and ulnar nerve (sensory and motor) in upper limbs and sural sensory nerves, peroneal motor and tibial motor nerves in lower limbs. Distal latency, conduction velocity, compound muscle action potential (CMAP) amplitude, sensory nerve action potential (SNAP) amplitude and minimum F-wave latency were recorded. Participants with normal routine NCS had additional bilateral soleus-H reflexes performed. The neurophysiologic parameters were compared to the local laboratory reference range.

*Statistical analysis*

All statistical analyses were performed using SPSS 26.0 (SPSS Inc., Chicago, IL, USA). Variables with normal distribution were expressed as mean ± standard deviation. Variables with non-normal distribution were expressed as median and interquartile range, since majority of the continuous variables including 25(OH) D data were not normally distributed (using Kolmogorov-Smirnov test, skewness, and kurtosis). Non-parametric tests were used in all analyses. Categorical variables were expressed as frequency and percentage, and the difference in the categorical variables was determined. The relationship of vitamin D with DM and DPN, and other indicators were analyzed using Mann-Whitney U, Chi-Square, Fischer's Exact test and Kruskal Wallis test. Binary logistic regression analysis was performed to for determination of odds ratio (OR). A two-tailed p value of <0.05 was considered statistically significant.

## RESULTS

A total of 100 participants were recruited, (male=52, female=48) with median age of 59 years (IQR=52-65). Table 1 shows the demographic and clinical characteristics of participants in non-DPN and DPN groups. Both groups were matched for gender (54% male and 45% female vs. 62% male and 38% female) and race (Malay 58%, Chinese 18%, and Indian 24% vs. Malay 54%, Chinese 10% and Indian 36%) respectively. The DPN group had significantly higher BMI (28.1 vs 26; p <0.001), longer duration of DM (88% vs. 46% more than 10 years; p<0.001), insulin usage (86% vs 40%; p<0.001), higher LDL level (3.96 vs 2.65; p=0.037) and smoking (32% vs 14%; p=0.32). Although the HbA1c was higher in the DPN group (8.2%) compared to non-DPN group (7.7%), this finding was not statistically significant (p=0.211). Both groups were comparable with respect to the proportion of hypertension, ischaemic heart disease and dyslipidemia.

Table 2 shows that vitamin D deficiency was seen in both groups, however the porportion is much higher in DPN group (50%) than non-DPN group (28%). Despite the scattered distribution of serum 25(OH)D level across both groups, the DPN group had significantly lower level compared to non-DPN group (11.81 [8.97] vs 18.63 [11.37], p=0.006). The subgroup analysis of the DPN group showed that patients with painful DPN had significant lower serum 25(OH)D level as compared to those without painful symptoms (8.96 [6.7-10.16] vs 15.27, [10.41-20.43]; p<0.001). Similarly, the clinical severity of the DPN based on DNS score also correlated with lower serum 25(OH) D level (r= -.0308; p value=0.015). (Figure 1)

**Table 1: Demographic and clinical characteristics of the study participants**

| Characteristics | Total Participants (n=100) | | p value |
|---|---|---|---|
| | Non-DPN (n=50) | DPN (n=50) | |
| Age (years) | 58.5 (17) | 61.00 (13) | 0.198 |
| Gender | | | |
| Male | 27 (54.0%) | 31 (62.0%) | 0.418 |
| Female | 23 (46.0%) | 19 (38.0%) | |
| Race | | | |
| Malay | 29 (58.0%) | 27 (54.0%) | 0.299 |
| Chinese | 9 (18.0%) | 5 (10.0%) | |
| Indian | 12 (24.0%) | 18 (36.0%) | |
| **BMI (kg/m2)** | **26.00 (2.8)** | **28.10 (2.3)** | **<0.001** |
| **Duration (years)** | | | |
| **<10** | **27 (54.0%)** | **6 (12.0%)** | **<0.001** |
| **>10** | **23 (46.0%)** | **44 (88.0%)** | |
| Hypertension | 42 (84.0%) | 46 (92.0%) | 0.218 |
| Ischemic heart disease | 17 (34.0%) | 19 (38.0%) | 0.677 |
| Dyslipidaemia | 46 (92.0%) | 48 (98.0%) | 0.678 |
| **Smoking** | **7 (14.0%)** | **16 (32.0%)** | **0.032** |
| Alcohol | 4 (8.0%) | 0 (0%) | 0.117 |
| HbA1c (%) | 7.70 (3.13) | 8.20 (2.50) | 0.211 |
| Serum Creatinine ($\mu$mol/L) | 81.00 (33.00) | 87.00 (33.25) | 0.137 |
| Total cholesterol (mmol/L) | 4.52 (1.99) | 4.60 (1.870) | 0.263 |
| Triglyceride | 1.54 (1.19) | 1.61 (0.90) | 0.624 |
| **Low-density lipoprotein** | **2.65 (1.26)** | **3.06 (1.92)** | **0.037** |
| High-density lipoprotein | 1.10 (0.37) | 1.03 (0.37) | 0.712 |
| Anti-hypertensive agents | | | |
| ACE-i/ARB | 43 (86.0%) | 48 (96.0%) | 0.155 |
| Beta-blocker | 16 (32.0%) | 21 (42.0%) | 0.3 |
| Statin * | 47(94%) | 50(100%) | 0.376 |
| **Fibrate** | **12 (24.0%)** | **3 (6.0%)** | **0.012** |
| **Insulin** | **20 (40.0%)** | **43 (86.0%)** | **<0.001** |
| OAD | 45 (90.0%) | 50 (100%) | 0.056 |

Non-DPN Group=Non-diabetic peripheral neuropathy group; DPN Group=Diabetic peripheral neuropathy group; IQR=Interquartile range; BMI=Body mass index; HbA1c=glycated hemoglobin; ACE-i=Angiotensin-converting enzyme inhibitor; ARB=Angiotensin receptor blocker; OAD=Oral anti-diabetic agent.
*Atorvastatin, simvastatin and rosuvastatin

Results of multiple logistic regression are shown in Table 3. Higher BMI (OR 1.538, 95% CI 1.118-2.117; p=0.008), longer duration of DM (OR 4.901, 95% CI 1.402-17.129;p=0.013), insulin usage (OR 8.466, 95% CI 2.369-30.261; p=0.001) and serum 25(OH)D level (OR 0.914, 95% CI 0.846-0.987; p=0.021) were found to be significantly associated with the presence of DPN. The use of fibrates as lipid lowering agents showed a negative association with DPN (OR 7.516, 95% 1.465-38.57, p=0.016). However, there was no significant association with smoking and serum LDL level.

Forty-nine participants (98%) in the DPN group had nerve conduction study performed (Table 4). One participant could not complete the study due to pain intolerance. Overall, the majority (54%) had sensorimotor neuropathy and 24% had pure sensory neuropathy. Twenty percent had a normal routine NCS. However, 70% among these patients with normal routine study had absent H reflexes recording soleus muscles bilaterally. There were no patients with pure motor neuropathy in our cohort. The neurophysiological study in the DPN group showed 50% of purely

**Table 2: Comparison of serum 25(OH)D level in DPN and non-DPN groups**

| Parameters | Non-DPN Group n=50 (100.0%) | DPN Group n=50 (100.0%) | | *p* value |
|---|---|---|---|---|
| Vitamin D Category | | | | |
| Sufficient (>20 ng/ml) | 19 (38.0%) | 15 (30.0%) | | |
| Insufficient (12-20 ng/ml) | 17 (34.0%) | 10 (20.0%) | | |
| Deficient (<12 ng/ml) | 14 (28.0%) | 25 (50.0%) | | |
| Serum 25(OH)D | | | | |
| Median (IQR) | 18.63 (11.25-22.63) | 11.81 (9.09-18.06) | | **0.006** |
| | | **Painful DPN n=15 (30.0%)** | **Non-Painful DPN n=35 (70.0%)** | |
| Serum 25(OH)D | | | | |
| Median (IQR) | | 8.96 (6.7-10.16) | 15.37 (10.41-20.43) | **<0.001** |

axonal changes, 18% of axonal with secondary demyelination, 10% of primarily demyelination and 20% of normal routine study. All patients with primarily demyelination had moderate prolongation of minimum F-wave latency of tibial nerves, with mean latency of 65.1 ms. There was no conduction block or temporal dispersion. None of these patients fulfilled the EFNS/PNS 2010 criteria for chronic inflammatory demyelinating polyradiculoneuropathy. Across all electrophysiological subtypes, there were no significant association with serum 25(OH)D level.

## DISCUSSION

Patients with type 2 DM with DPN had significantly lower serum 25(OH)D level in this study. This finding was consistent with previous studies which showed that vitamin D deficiency was associated with DPN.[10,16-18] Additionally, we found that higher BMI, longer duration of DM, and insulin usage were significantly associated with the presence of DPN.

Several mechanisms may explain the association of peripheral neuropathy with

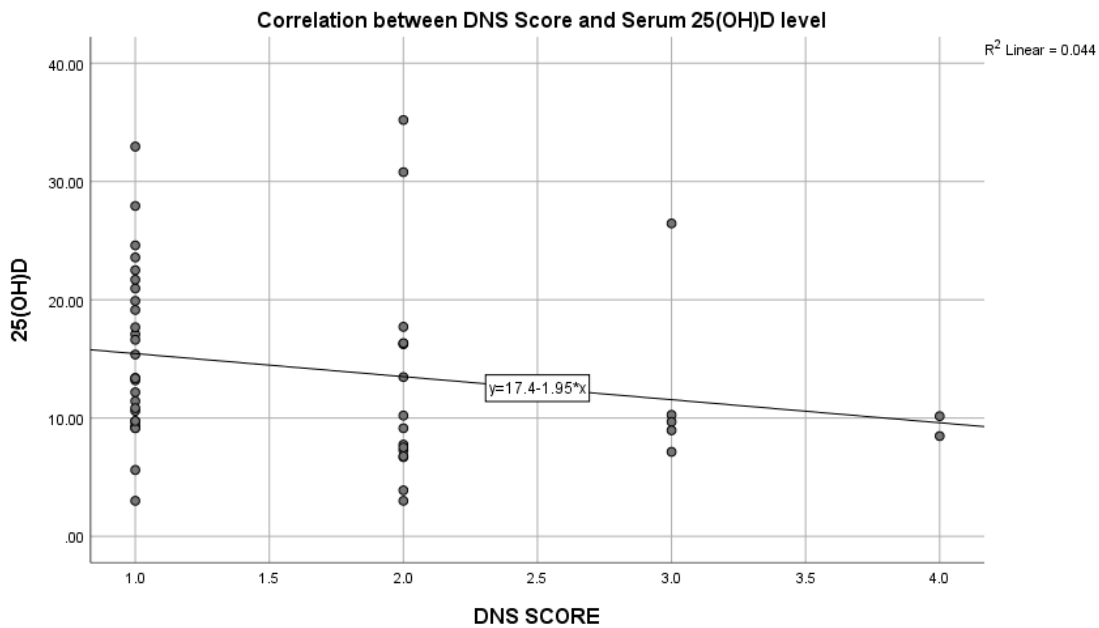


Figure 1. Correlation graph between DNS and serum 25 (OH)D level showed higher DNS score is correlated with lower vitamin D level. Negative Spearman's correlation roe value with p value less than 0.05

** rs= Spearman's rho

**Table 3: Multiple logistic regression analysis for risk factors of diabetic peripheral neuropathy**

| Factors | *p*-value | Adj OR | 95% C.I. for Adj OR | |
|---|---|---|---|---|
| | | | Lower | Upper |
| **BMI** | 0.008 | 1.538 | 1.118 | 2.117 |
| **Serum 25(OH)D** | 0.021 | 0.914 | 0.846 | 0.987 |
| **Fibrates** | 0.016 | 7.516 | 1.465 | 38.57 |
| **Insulin usage** | 0.001 | 8.466 | 2.369 | 30.261 |
| **Duration of diabetes** | 0.013 | 4.901 | 1.402 | 17.129 |
| **Smoking** | 0.069 | 4.673 | 886 | 24.63 |
| **LDL** | 0.279 | 1.414 | 0.755 | 2.65 |

Abbreviation: CI=Confidence interval, Adj OR= Adjusted odds ratio

vitamin D deficiency among DM. Vitamin D is a potent inducer of neurotrophins. It upregulates vitamin D receptor and induces nerve growth factor production, a protein required for the development and maintenance of neurons in the peripheral nervous system.[19,20] Furthermore, vitamin D deficiency has been shown to result in increased numbers of axons containing calcitonin gene-related peptide (CGRP), which mediates the development of painful DPN.[20] Previous studies showed that vitamin D deficiency played a role in glycaemic control through its effects on β-cell function. Vitamin D deficiency reduces serum calcium, which regulates insulin synthesis and secretion. In addition, improvement of insulin secretion and better glycemic control had been shown with vitamin D treatment.[22,23] Patients with vitamin D deficiency also had higher risk of insulin resistance and metabolic syndrome.[24] This clearly showed a significant association of vitamin D in type 2 DM and its underlying pathomechanism.

Vitamin D deficiency is known to be prevalent among Caucasians. It has been found that people living in both Central and Western Europe had lower serum 25(OH)D level. One of the reasons is that solar UVB, being the primary source of vitamin D, is limited for most Central European populations.[25,26] However, our findings of low serum 25(OH)D level across both groups suggest that vitamin D deficiency might be as common despite a tropical country. There may be many other factors contributing to vitamin D deficiency in addition to inadequate sunlight exposure.

Obesity has been recognized as a predictor for peripheral neuropathy.[27,28] DM has a complex mechanism that causes metabolic insults, including early vasa nervorum functional changes, endothelial dysfunction due to protein C kinase activation and omega-6 essential fatty acid dysmetabolism, reduced nerve perfusion and function.[29] Many other studies showed that neuropathic pain was higher in the high-BMI patients with more severe occasional paroxysmal pain.[30,31] A meta-analysis showed that BMI and duration of DM in different ethnics and multiracial population group increased the risk for DPN.[32] We found that duration of DM of more than ten years was significantly associated with DPN. In addition, insulin usage increased the risk of DPN by eightfold. Several research revealed that

**Table 4: Association of serum 25(OH)D level with electrophysiological study in DPN group**

| Nerve involvement | DPN, n=50(%) | Median 25(OH)D level (IQR) | *p*-value |
|---|---|---|---|
| Normal | 10 (20.0%) | 16.96 (10.68-27.53) | |
| Pure sensory | 12 (24.0%) | 13.27 (9.86-22.11) | 0.21 |
| Sensorimotor | 27 (54.0%) | 9.86 (7.26-16.34) | |
| Not available | 1 (2.0%) | . | |
| **Electrophysiological pattern** | | | |
| Normal | 10 (20.0%) | 16.96 (10.68-27.53) | |
| Axonal | 25 (50.0%) | 13.19 (9.42-19.52) | |
| Axonal and demyelinating | 9 (18.0%) | 9.14 (7.20-16.48) | 0.5 |
| Demyelinating | 5 (10.0%) | 7.76 (6.56-16.27) | |
| Not available | 1 (2.0%) | . | |

insulin was one of the growth factors for neurons, and its receptor was widely expressed in nervous system.[33] Chronic stimulation for insulin secretion for long duration causes insulin resistance and attenuate the neurotrophic effect of insulin and potentially lead to neuropathy.[34] These findings are similar to the study by Abolfotouh which showed that duration of DM and insulin usage were the most important risk factors associated with diabetic neuropathy.[35] Higher HbA1c is a known risk factor for DPN from many previous studies.[36] However, there was no significant association with HbA1c between both groups in our study. The high frequency of insulin usage in DPN group suggested that they would have had poorer glycemic control in the past. The use of insulin had resulted to a relatively lower HbA1c, hence the insignificant statistical difference in this study. Interestingly, our study showed that the use of fibrates is associated with type 2 DM without neuropathy. Fibrates are mainly used alone or in combination with statin for the management of hypertriglyceridemia. Studies have shown that hypertriglyceridemia is a predictor for peripheral neuropathy.[37-39] However, we did not find a significant difference in the serum triglycerides between both groups. It is plausible that the patients in non-DPN group had been more aggressively treated with fibrates hence the lower risk of developing DPN. Nonetheless, the number of patients using fibrates were small in this cohort and larger sample size is needed to evaluate their correlation. Previous study found a significant association between smoking with DPN.40 However, this finding was not replicated in our study. This may be due to the small number of patients in our cohort.

The majority (78%) of patients had sensorimotor axonal polyneuropathy. Previous studies showed that NCS is sensitive to detect early neuropathy changes.[41] A recent retrospective study revealed though various tests have been used to confirm the neuropathy and to grade the severity of neuropathy, nerve conduction velocity remains the gold standard for diagnosis of neuropathy.[42] However, there were 20% in our cohort who had normal routine NCS. Nonetheless, we found that seven patients (70%) of those with normal routine NCS had absent H reflexes recording soleus muscles. These findings represent early changes in polyneuropathy. The sensitivity of NCS to diagnose DPN increased to 96% by testing H reflex in addition to routine study. The remaining three patients had normal routine NCS and H reflexes. These patients had clinical symptoms of neuropathy and they likely had small fiber neuropathy which was not assessed in this study.

To date, there are no recommendations for testing serum vitamin D level or treating vitamin D deficiency in patients with type 2 DM or DPN. Currently, the treatment of painful DPN is largely symptomatic with medications. Most patients did not improve significantly and suffered the side effects from the medications. An interventional study with three-months oral vitamin $D_3$ supplements at the mean dose of 2,059 IU resulted in significant reduction of pain score.[43] Oral capsules of 50,000 IU cholecalciferol given once weekly for 8 weeks had also been proven to improve the painful symptoms of neuropathy in patients with type 2 diabetes.[9] Although the causal relationship of vitamin D in DPN is largely unclear, recent evidence have clearly demonstrated that it does play a role in the disease process. Serum vitamin D testing is a simple blood test, and it should be incorporated into routine investigations of type 2 DM and DPN. Early recognition and correction of vitamin D deficiency may potentially retard the development of DPN and reduce painful symptoms. The main limitation of our study is a small sample size. A larger number of patients will improve the statistical power. A prospective longitudinal study will be able to demonstrate if vitamin D deficiency is an independent predictor of DPN. This may also determine if vitamin D replacement is a potential disease-modifying treatment in DPN.

In conclusion, although vitamin D insufficiency and deficiency were seen in both DPN and non-DPN group, we showed that lower serum vitamin D level is significantly associated with DPN and painful DPN. Routine vitamin D level testing in patients with type 2 DM may be considered especially in those with symptomatic neuropathy. Our study highlights the importance of incorporation of vitamin D level as part of the investigations in type 2 DM and DPN. Early identification of risk factors of DPN such as low vitamin D level, higher BMI, longer duration of DM and requirement of insulin will help in the stratification of management.

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## DISCLOSURE

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