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Assessment of drug utilization pattern and risk factors for the development of diabetic neuropathy among type 2 diabetic patients in a south Indian hospital: A cross-sectional observational study

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ABSTRACT

Diabetic peripheral neuropathy (DPN) is a well-known microvascular complication of type 2 diabetes mellitus (T2DM). DPN is defined as peripheral nerve dysfunction in diabetics after exclusion of other causes. To assess the prevalence of peripheral neuropathy in T2DM and the associated risk factors among in outpatients department in a south Indian hospital. A cross-sectional observational study was conducted on 868 subjects (509 with DPN and 359 without DPN). Prevalence of diabetic peripheral neuropathy was measured and risk factors for the development of diabetic peripheral neuropathy were determined by calculating odds ratios and drug utilization pattern was assessed. The prevalence of DPN in T2DM was significantly higher in the subjects who are married, uneducated, housewives, and urban residents. Many associated risk factors could affect T2DM leading to DPN such as hypertension, other diseases, endocrine diseases, history of cardiovascular diseases (CVD), >9 HbA1c, low high-density lipoproteins (HDL), high serum creatinine, long duration of diabetes, physical inactivity, and habit of taking junk foods (weekly once and weekly twice, soft drinks occasionally). The present study revealed that risk factors for the development of DPN were hypertension, endocrine diseases, history of CVD, poor glycemic control (>9 HbA1c), low HDL, high serum creatinine, long duration of diabetes, physical inactivity, habit of taking junk foods and soft drinks. Early detection of the identification of DPN in T2DM is needed in order to slow progression and complications. Metformin (40.47%), combination of glimepiride and metformin (29.93%), combination of human insulin and insulin isophane (22.7%) were mostly given to the T2DM patients with neuropathy.

INTRODUCTION

With 387 million people diagnosed with diabetes mellitus worldwide and a prevalence of 8.2% as per the Diabetes atlas 2014 (Joaoda *et al*., 2016). Diabetic peripheral neuropathy (DPN) is a well-known microvascular complication of type 2 diabetes mellitus (T2DM) and is defined as peripheral nerve dysfunction in diabetics (Boulton *et al*., 1998; Candrilli *et al*., 2007; Sumner *et al*., 2003; William and Laurence, 2005). Some of the risk factors of DPN include age > 60 years, females, obesity, and hypertension (Bruce *et al*., 2008). Regular consumption of even a moderate amount of alcohol interferes with blood glucose and increases the risk of peripheral neuropathy (Emanuele *et al*., 1998). Similarly, smoking and long duration of diabetes mellitus are found to increase the risk of DPN. One hundred and ten million people worldwide are estimated to be likely affected by DPN (Tesfaye, 2004). The prevalence of DPN varies largely across regions from 5% to 60% (Davies *et al*., 2006; Tesfaye and Selvarajah, 2012; Tesfaye *et al*., 1996; Young *et al*., 1993).

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The World Health Organization defines "drug utilization" as the marketing, distribution, prescription, and use of the drugs in a society considering its medical, social, and economic consequences (Amit *et al*., 2017). Drug utilization studies help to assess whether the drug treatment is rational or not and to determine rational drug use especially in poorer and rural populations (Sekhar *et al*., 2016). The objective of the present study was to assess the drug utilization pattern, prevalence, and risk factors which are responsible for the development of DPN and to assess the drug utilization pattern.

METHODS

A cross-sectional observational study was conducted on patients with or without T2DM at outpatients department of Dr. Pinnamaneni Siddhartha Institute of Medical Sciences, Vijayawada, Andhra Pradesh, India from Dec 1, 2017 to May 31, 2018. The study protocol was approved by the Ethical Committee of KVSR Siddhartha College of Pharmaceutical Sciences (SCOPS), Vijayawada, India with KVSRSCOPS/IEC/PG/231/2017 approval number.

Participants selection

Patients with or without T2DM complications of both sexes and agreeable to take part in the planned study was included. A total of 868 patients (359 patients with T2DM and 509 patients with DPN) were enrolled in the study.

Inclusion criteria

Patients who are visiting the public endocrine hospital in the duration of 6 months would be recruited.

Exclusion criteria

Patients with incomplete case reports, gestational, type 1, and maturity onset diabetes were excluded.

Data collection

Biochemical, clinical data, demographics, socioeconomic (using modified Kuppuswamy's scale), and lifestyle characteristics were collected with the prior consent of the participant. DPN was assessed using sensations of a pinprick, reflexes of ankles, and vibration perception threshold test. Data were collected from a total of 868 patients (359 patients with T2DM and 509 patients with DPN).

Statistical analysis

In the descriptive statistical analysis, categorical variables were expressed as numbers and percentages. For categorical variables, the tests of significance analysis, we applied a Chi-Square test using Graph Pad Prism Software (Version 5.0). $p < 0.05$ was considered significant. Odds ratio with 95% confidence intervals was calculated using multivariate regression analysis using statistical package for the social sciences software.

RESULTS

A total of 868 subjects (359 with type 2 diabetes and 509 with DPN) data were presented in Table 1. Tables 2 and 3 show the socio demographics and life style characteristics of subjects with and without DPN, respectively. The prevalence of diabetic peripheral neuropathy was found to be 41.24%. The prevalence of DPN was significantly higher in the subjects who are married (99.4%, $p = 0.0001$), uneducated (66.8%, $p < 0.0001$), nature of work (housewives), urban residents (61.5%, $p = 0.0048$), co-morbidities like hypertension (40.41%, $p < 0.0001$), other diseases (25.2%, $p < 0.0001$), endocrine diseases (11.64%, $p = 0.0068$), history of cardiovascular diseases (8.21%, $p < 0.0001$), no physical activity (62%), habit of taking junk foods (weakly once $p < 0.0001$, weakly twice $p = 0.0010$), soft drinks (taking occasionally 26.4%, $p = 0.0010$), HbA1c (7%–9%, >9% $p < 0.0001$), low high-density lipoproteins (HDL) (23%, $p = 0.0206$), high serum creatinine (14.6%, $p < 0.0001$), duration of diabetes (>10 years, 37.6%, $p < 0.0001$; 5–10 years, 35.4%, $p < 0.0001$). Gender, age, body mass index (BMI), body weight, monthly income, and blood glucose levels are not significantly associated with the development of DPN.

The odds ratios for risk factors in patients with T2DM and DPN were presented in Table 4. The analysis showed that married (OR, 7.868; 95% CI, 2.275–27.22, $p = 0.0001$), poorly educated (OR, 0.2856; 95% CI, 0.2151–0.3791, $p < 0.0001$), housewives (OR, 0.5254; 95% CI, 0.3477–0.7938, $p = 0.0021$), urban residents (OR, 0.6602; 95% CI, 0.4944–0.8815, $p = 0.0048$), hypertension (OR, 2.642; 95% CI, 1.906–3.661, $p < 0.0001$), other diseases (OR, 2.030; 95% CI, 1.434–2.874, $p< 0.0001$), Endocrine diseases (OR, 1.780; 95% CI, 1.170–2.708, $p = 0.0068$) history of cardiovascular diseases (CVD) (OR, 10.59; 95% CI, 4.648–24.14, $p < 0.0001$), HbA1c (OR, 2.001; 95% CI, 1.432–2.796, $p < 0.0001$), low HDL (OR, 0.5934; 95% CI, 0.3807–0.9251, $p = 0.0206$), high serum creatinine (OR, 11.10; 95% CI, 3.320–37.11, $p < 0.0001$), long duration of diabetes (OR, 3.155; 95% CI, 2.228–4.468), physical inactivity(OR, 0.5874;95% CI, 0.44670.7723, $p = 0.0001$), junk foods weekly once (OR, 2.732; 95% CI, 1.729–4.319, $p < 0.0001$) and weekly twice (OR, 2.385; 95% CI, 1.4102–4.036, $p = 0.0010$), and soft drinks occasionally (OR, 1.776; 95% CI, 1.260–2.505, $p = 0.0010$). Drug utilization pattern details were summarized in Table 5. Metformin, combination of glimepiride and metformin, combination of human insulin and insulin isophane were mostly given to the T2DM patients with DPN.

DISCUSSION

Prevalence, risk factors for DPN, and drug utilization pattern were assessed in an outpatients department at a tertiary care hospital. The present study results suggested that subjects who are married, uneducated, housewives, urban residents, and risk factors were co-morbidities (hypertension, history of cardiovascular diseases, endocrine diseases, and other diseases), no physical activity, habit of taking junk foods (weekly once, weekly twice), soft drinks (taking occasionally), poor glycemic control, low HDL, and serum creatinine are major risk factors for DPN. The results are consistent with the following studies.

The risk factors and prevalence of DPN among patients with T2DM were assessed by Nahla *et al*. (2018). The case of Jordan and concluded that marital status was one of the significant risk factors associated with the development of diabetic neuropathy (Nahla *et al*., 2018). In the current study also marital status (99.4%, $p = 0.0001$) was associated and was the major risk factor for DPN (OR, 7.868; 95% CI, 2.275–27.22).

Table 1. Biochemical and clinical characteristics of patients with type 2 diabetes mellitus (*N* = 359).

Variable	Patients with T2DM *N* (%)
Gender	
Male	155 (43.2)
Female	204 (56.8)
Age (Years)	
0–20 years	1 (0.3)
21–40 years	83 (23.2)
41–60 years	217 (60.6)
Above 60 years	57 (15.9)
Marital status	
Unmarried	16 (4.5)
Married	343 (95.5)
Education	
Uneducated	131 (36.5)
Educated	228 (63.5)
BMI(kg/m^2)	
<25 kg/m^2	114 (31.8)
≥25 kg/m^2	245 (68.2)
Body weight (kg)	
<50	5 (1.3)
50–70	161 (45)
>70	192 (53.6)
Nature of work	
Not working any where	41 (11.4)
Private job	93 (25.9)
Govt. job	39 (10.8)
Daily labor	38 (10.6)
Housewife	148 (41.3)
Locality	
Rural	105 (29.2)
Urban	254 (70.7)
Monthly income	
No income	170 (47.5)
Below 25,000	115 (32.1)
Above 25,000	73 (20.4)
Co-morbidities	
No	131 (29.4)
HTN	138 (30.8)
History of CVDs	7 (1.56)
Endocrine diseases	59 (13.2)
Other diseases	112 (25.1)
Systolic blood pressure	
<140 mmHg	259 (72.1)
≥140 mmHg	100 (27.9)
Diastolic blood pressure	
<90 mmHg	281 (78.3)
≥90 mmHg	78 (21.7)
HbA1C	
<7	141 (44.2)
7–9	109 (34.2)
>9	69 (21.6)
Fasting blood glucose (mg/dl)	
70–80	10 (3)
80–120	92 (27.6)
121–160	107 (32)
161–200	71 (21.3)
>200	54 (16.2)
Postprandial blood glucose levels (mg/dl)	
90–110	3 (1)
111–130	9 (3)
131–150	33 (10.9)
151–200	165 (54.6)
>200	92 (30.5)
Random blood glucose (mg/dl)	
80–100	0
101–120	0
121–140	0
141–160	2 (13.3)
161–200	1 (6.7)
>200	12 (80)
HDL (mg/dl)	
Not available	54 (20.1)
Normal	130 (48.3)
Low	55 (20.4)
High	30 (11.2)
Triglycerides (mg/dl)	
Not available	54 (20.5)
Normal	109 (41.5)
Low	8 (3)
High	92 (35)
Total cholesterol (mg/dl)	
Not available	54 (19.6)
Normal	151 (54.7)
Low	6 (2.2)
High	65 (23.6)
LDL (mg/dl)	
Not available	57 (20.8)
Normal	163 (59.4)
Low	9 (3.3)
High	45 (16.5)
Urea (mg/dl)	
Not available	72 (36.4)
Normal	78 (39.4)

(*Continued*)

Table 1. (Continued)

(*Continued*)

Table 1. (Continued)

Variable	Patients with T2DM *N* (%)
Low	0
High	48 (24.2)
Serum creatinine (mg/dl)	
Not available	45 (12.6)
Normal	305 (85.2)
Low	5 (1.4)
High =	3 (0.8)
Duration of T2DM (years)	
<5	172 (47.9)
5–10	111 (30.9)
>10	76 (21.2)
Following T2DM education	
Yes	282 (79.2)
No	74 (20.8)

T2DM = type 2 diabetes mellitus, BMI = body mass index, HTN = hypertension, CVDs = cardiovascular diseases, HbA1C = glycated hemoglobin, HDL = high-density lipoproteins, LDL = low-density lipoproteins.

Table 2. Socio-demographic characteristics of diabetic patients with ($N = 509$) or without diabetic peripheral neuropathy ($N = 359$).

Variable	Patients with T2DM *N* (%)	Patients with T2DM and DPN *N* (%)	*p*-Value
Gender			
Male	155 (43.2)	199 (39.1)	Ref
Female	204 (56.8)	310 (60.9)	0.2284
Age			
0–20 years	1 (0.3)	—	Ref
21–40 years	83 (23.2)	41 (8.1)	0.4830
41–60 years	217 (60.6)	318 (62.5)	0.2267
Above 60 years	57 (15.9)	150 (29.5)	0.1070
Marital status			
Unmarried	16 (4.5)	3 (0.6)	Ref
Married	343 (95.5)	506 (99.4)	0.0001***
Education			
Uneducated	131 (36.5)	340 (66.8)	Ref
Educated	228 (63.5)	169 (33.2)	<0.0001***
BMI (kg/m^2)			
<25 kg/m^2	114 (31.8)	132 (25.9)	Ref
≥25 kg/m^2	245 (68.2)	377 (74.1)	0.0609
Body weight (kg)			
<50	5 (1.3)	14 (2.8)	Ref
50–70	161 (45)	240 (47.3)	0.2281
>70	192 (53.7)	254 (50)	0.1483
Nature of work			
Not working anywhere	41 (11.4)	116 (22.8)	Ref
Private job	93 (25.9)	111 (21.8)	0.0001***
Govt. job	39 (10.8)	24 (4.8)	<0.0001***
Daily labor	38 (10.6)	38 (7.5)	0.0003***
Housewife	148 (41.2)	220 (43.2)	0.0021**
Locality			
Rural	105 (29.2)	196 (38.5)	Ref
Urban	254 (70.8)	313 (61.5)	0.0048**
Monthly income			
No income	170 (47.5)	315 (62)	Ref
Below 25,000	115 (32.1)	159 (31.3)	0.0587
Above 25,000	73 (20.4)	34 (6.6)	<0.0001***
Co-morbidities			
No	131 (29.4)	106 (14.52)	Ref
HTN	138 (30.8)	295 (40.41)	<0.0001***
History of CVDs	7 (1.56)	60 (8.21)	<0.0001***
Endocrine diseases	59 (13.2)	85 (11.64)	0.0068**
Other diseases	112 (25.1)	184 (25.2)	<0.0001***
Systolic blood pressure			
<140 mmHg	259 (72.1)	327 (64.5)	Ref
≥140 mmHg	100 (27.9)	180 (35.5)	0.0178*
Diastolic blood pressure			
<90 mmHg	281 (78.3)	386 (75.8)	Ref
≥90 mmHg	78 (21.7)	123 (24.1)	0.4017
HbA1C (%)			
<7	141 (44.2)	128 (27.9)	Ref
7–9	109 (34.2)	198 (43.1)	<0.0001***
>9	69 (21.6)	133 (29)	<0.0001***
Fasting blood glucose (mg/dl)			
70–80	10 (3)	12 (2.5)	Ref
81–120	92 (27.6)	119 (24.7)	0.8676
121–160	107 (32)	156 (32.4)	0.6622
161–200	71 (21.3)	84 (17.5)	0.9753
>200	54 (16.2)	110 (22.9)	0.2455
Postprandial blood glucose levels (mg/dl)			
90–110	3 (1)	5 (1.1)	0.8274
111–130	9 (3)	18 (4.1)	0.6043
131–150	33 (10.9)	37 (8.4)	0.4425
151–200	165 (54.6)	157 (35.8)	0.6155
>200	92 (30.5)	222 (50.6)	Ref
Random blood glucose (mg/dl)			
80–100	0	6 (5)	0.3359
101–120	0	6 (5)	0.3359
121–140	0	6 (5)	0.3359
141–160	2 (13.3)	9 (7.5)	0.6718

(*Continued*)

(*Continued*)

Table 2. (Continued)

Variable	Patients with T2DM *N* (%)	Patients with T2DM and DPN *N* (%)	*p*-Value
161–200	1 (6.7)	16 (13.3)	0.3813
>200	12 (80)	77 (64.2)	Ref
HDL (mg/dl)			
Not available	54 (20.1)	182 (38)	Ref
Normal	130 (48.3)	140 (29.2)	<0.0001***
Low	55 (20.4)	110 (23)	0.0206*
High	30 (11.2)	47 (9.9)	0.0057**
Triglycerides (mg/dl)			
Not available	54 (20.5)	181 (37.7)	Ref
Normal	109 (41.5)	146 (30.4)	<0.0001***
Low	8 (3)	12 (2.5)	0.0885
High	92 (35)	141 (29.4)	0.0001***
Total cholesterol (mg/dl)			
Not available	54 (19.6)	178 (37.1)	Ref
Normal	151 (54.7)	203 (42.3)	<0.0001***
Low	6 (2.2)	5 (1)	0.0188*
High	65 (23.6)	94 (19.6)	0.0002***
LDL (mg/dl)			
Not available	57 (20.8)	184 (38.4)	Ref
Normal	163 (59.4)	173 (36.1)	<0.0001***
Low	9 (3.3)	12 (2.5)	0.0518
High	45 (16.5)	110 (23)	0.2321
Urea (mg/dl)			
Not available	72 (36.4)	224 (50)	Ref
Normal	78 (39.4)	88 (19.6)	<0.0001***
Low	0	3 (0.7)	0.3269
High	48 (24.2)	133 (29.6)	0.5919
Serum creatinine (mg/dl)			
Not available	45 (12.6)	100 (19.6)	Ref
Normal	305 (85.2)	332 (65.2)	0.0002***
Low	5 (1.4)	3 (0.6)	0.0647
High	3 (0.8)	74 (14.6)	<0.0001***
Duration of T2DM (years)			
<5	172 (47.9)	137 (27)	Ref
5–10	111 (30.9)	180 (35.4)	<0.0001***
>10	76 (21.2)	191 (37.6)	<0.0001***
Following T2DM education			
Yes	282 (79.2)	341 (67.5)	Ref
No	74 (20.8)	164 (32.5)	0.0002***

T2DM = type 2 diabetes mellitus, DPN = Diabetic peripheral neuropathy, BMI = body mass index, HTN = hypertension, CVDs = cardiovascular diseases, HbA1C = Glycated hemoglobin, HDL = high-density lipoproteins, LDL = low-density lipoproteins.

Table 3. Food and lifestyle characteristics of diabetic patients with (*N* = 509) or without diabetic peripheral neuropathy (*N* = 359).

Variable	Patients with T2DM *N* (%)	Patients with T2DM and DPN *N* (%)	*p*-value
Food habits			
Vegetarian	60 (16.7)	85 (16.7)	Ref
Mixed	299 (83.3)	424 (83.3)	0.9958
Physical activity			
No physical activity	176 (49)	316 (62)	Ref
Regular exercise	183 (50.9)	193 (37.9)	0.0001***
Habit of smoking			
No	320 (89.1)	442 (87)	Ref
Yes	22 (6.1)	32 (6.3)	0.8568
Past smoker	17 (4.7)	34 (6.7)	0.2242
Habit of drinking alcohol			
No	304 (85.1)	448 (88)	Ref
Yes	44 (12.3)	43 (8.4)	0.0689
Past alcoholic	9 (2.5)	18 (3.5)	0.4602
Habit of taking junk foods			
No	180 (50.3)	187 (36.7)	Ref
Weekly once	31 (8.7)	88 (17.3)	<0.0001***
Weekly twice	23 (6.4)	57 (11.2)	0.0010***
Weekly thrice and more	28 (7.8)	39 (7.7)	0.2743
Occasionally	96 (26.8)	138 (27.1)	0.0544
Habit of taking fruits/fruit juices			
No	66 (18.5)	116 (22.7)	Ref
Weekly once	27 (7.5)	54 (10.6)	0.6463
Weekly twice	35 (9.8)	50 (9.8)	0.4406
Weekly thrice & more	125 (34.9)	118 (23.2)	0.0019**
Occasionally	105 (29.3)	171 (33.6)	0.7000
Habit of taking soft drinks			
No	272 (76.2)	342 (67.5)	Ref
Weekly once	6 (1.7)	11 (2.2)	0.4607
Weekly twice	5 (1.4)	11 (2.2)	0.2992
Weekly thrice & more	14 (4)	8 (1.6)	0.0732
Occasionally	60 (16.8)	134 (26.4)	0.0010***
Habit of taking tea/ coffee			
No	55 (15.3)	64 (12.6)	Ref
Daily once without sugar	54 (15)	82 (16.1)	0.2943
Daily twice without sugar	110 (30.6)	191 (37.5)	0.0674

(*Continued*)

Table 3. (Continued)

Variable	Patients with T2DM *N* (%)	Patients with T2DM and DPN *N* (%)	*p*-value
Daily thrice without sugar	58 (16.2)	93 (18.3)	0.1966
Daily once with sugar	25 (6.9)	23 (4.5)	0.4923
Daily twice with sugar	37 (10.3)	36 (7.1)	0.5476
Daily thrice with sugar	20 (5.6)	20 (3.9)	0.6785
Situations at working places			
No stress	181 (50.4)	261 (51.3)	Ref
Stress	178 (49.6)	248 (48.7)	0.8031

DPN = Diabetic peripheral neuropathy.

Table 4. Multivariate regression analysis of modifiable and non-modifiable risk factors for the development of diabetic peripheral neuropathy in patients with type 2 diabetes mellitus.

Variable	OR (95% CI)	*p*-value
Gender		
Male	1	Ref
Female	1.184 (0.8995–1.557)	0.2284
Age		
0–20 years	1	Ref
21–40 years	1.491 (0.05940–37.43)	0.4830
41–60 years	4.393 (0.1780–108.4)	0.2267
Above 60 years	7.852 (0.3151–195.7)	0.1070
Marital status		
Unmarried	1	Ref
Married	7.868 (2.275–27.22)	0.0001***
Education		
Uneducated	1	Ref
Educated	0.2856 (0.2151–0.3791)	<0.0001***
BMI (Kg/m^2)		
<25 kg/m^2	1	Ref
≥25 Kg/m^2	1.329 (0.9866–1.790)	0.0609
Body weight (kg)		
<50	1	Ref
50–70	0.5324 (0.1880–1.507)	0.2281
>70	0.4725 (0.1673–1.335)	0.1483
Nature of work		
Not working anywhere	1	Ref
Private job	0.4219 (0.2689–0.6618)	0.0001***
Govt. job	0.2175 (0.1169 –0.4047)	<0.0001***
Daily labor	0.3534 (0.1991–0.6273)	0.0003***
Housewife	0.5254 (0.3477–0.7938)	0.0021**
Locality		
Rural	1	Ref
Urban	0.6602 (0.4944–0.8815)	0.0048**
Monthly income		
No income	1	Ref
Below 25,000	0.7462 (0.5506–1.011)	0.0587
Above 25,000	0.2514 (0.1606–0.3933)	<0.0001***
Co-morbidities		
No	1	Ref
HTN	2.642 (1.906–3.661)	<0.0001***
History of CVDs	10.59 (4.648–24.14)	<0.0001***
Endocrine diseases	1.780 (1.170–2.708)	0.0068**
Other diseases	2.030 (1.434–2.874)	<0.0001***
Systolic blood pressure		
<140 mmHg	1	Ref
≥140 mmHg	1.426 (1.063–1.913)	0.0178*
Diastolic blood pressure		
<90 mmHg	1	Ref
≥90 mmHg	1.148 (0.8313–1.585)	0.4017
HbA1C (%)		
<7	1	Ref
7–9	2.001 (1.432–2.796)	<0.0001***
>9	2.123 (1.457–3.095)	<0.0001***
Fasting blood glucose (mg/dl)		
70–80	1	Ref
80–120	1.078 (0.4460–2.605)	0.8676
121–160	1.215 (0.5066–2.914)	0.6622
161–200	0.9859 (0.4021–2.418)	0.9753
>200	1.698 (0.6899–4.177)	0.2455
Postprandial blood glucose levels (mg/dl)		
90–110	1	Ref
111–130	1.200 (0.2327–6.188)	0.8274
131–150	0.6727 (0.1491–3.035)	0.6043
151–200	0.5709 (0.1341–2.430)	0.4425
>200	1.448 (0.3389–6.186)	0.6155
Random blood glucose (mg/dl)		
80–100	2.097 (0.1110–39.60)	0.3359
101–120	2.097 (0.1110–39.60)	0.3359
121–140	2.097 (0.1110–39.60)	0.3359
141–160	0.7013 (0.1348–3.648)	0.6718
161–200	2.494 (0.3022–20.58)	0.3813
>200	1	Ref
HDL (mg/dl)		
Not available	1	Ref
Normal	0.3195 (0.2171–0.4702)	<0.0001***
Low	0.5934 (0.3807–0.9251)	0.0206*
High	0.4648 (0.2683–0.8054)	0.0057**
Triglycerides (mg/dl)		
Not available	1	Ref
Normal	0.3996 (0.2699–0.5917)	<0.0001***
Low	0.4475 (0.1739–1.151)	0.0885
High	0.4572 (0.3059–0.6834)	0.0001***

(*Continued*)

Table 4. (Continued)

(*Continued*)

Table 4. (Continued)

Variable	OR (95% CI)	*p*-value
Total cholesterol (mg/dl)		
Not available	1	Ref
Normal	0.4078 (0.2816–0.5906)	<0.0001***
Low	0.2528 (0.07422 –0.8611)	0.0188*
High	0.4387 (0.2828–0.6806)	0.0002***
LDL (mg/dl)		
Not available	1	Ref
Normal	0.3288 (0.2280–0.4742)	<0.0001***
Low	0.4130 (0.1656–1.030)	0.0518
High	0.7572 (0.4796–1.196)	0.2321
Urea (mg/dl)		
Not available	1	Ref
Normal	0.3626 (0.2420–0.5433)	<0.0001***
Low	2.261 (0.1153–44.32)	0.3269
High	0.8906 (0.5830–1.360)	0.5919
Serum creatinine(mg/dl)		
Not available	1	Ref
Normal	0.4898 (0.3334–0.7197)	0.0002***
Low	0.2700 (0.06181–1.179)	0.0647
High	11.10 (3.320–37.11)	<0.0001***
Duration of T2DM (years)		
<5	1	Ref
5–10	2.036 (1.469–2.821)	<0.0001***
>10	3.155 (2.228–4.468)	<0.0001***
Following T2DM education		
Yes	1	Ref
No	1.833 (1.335–2.516)	0.0002***
Food habits		
Vegetarian	1	Ref
Mixed	1.001 (0.6968–1.438)	0.9958
Physical activity		
No physical activity	1	Ref
Regular exercise	0.5874 (0.4467–0.7723)	0.0001***
Habit of smoking		
No	1	Ref
Yes	1.053 (0.6005–1.847)	0.8568
Past smoker	1.448 (0.7948–2.638)	0.2242
Habit of drinking alcohol		
No	1	Ref
Yes	0.6631 (0.4250–1.035)	0.0689
Past alcoholic	1.357 (0.6016–3.061)	0.4602
Habit of taking junk foods		
No	1	Ref
Weakly once	2.732 (1.729–4.319)	<0.0001***
Weekly twice	2.385 (1.410–4.036)	0.0010***
Weekly thrice and more	1.341 (0.7915–2.271)	0.2743
Occasionally	1.384 (0.9934–1.927)	0.0544
Habit of taking fruits/fruit juices		
No	1	Ref
Weekly once	1.138 (0.6551–1.977)	0.6463
Weekly twice	0.8128 (0.4797–1.377)	0.4406
Weekly thrice & more	0.5371 (0.3625–0.7959)	0.0019**
Occasionally	0.9266 (0.6287–1.366)	0.7000
Habit of taking soft drinks		
No	1	Ref
Weekly once	1.458 (0.5323–3.994)	0.4607
Weekly twice	1.750 (0.6006–5.098)	0.2992
Weekly thrice & more	0.4545 (0.1879–1.099)	0.0732
Occasionally	1.776 (1.260–2.505)	0.0010***
Habit of taking tea/coffee		
No	1	Ref
Daily once without sugar	1.305 (0.7931–2.147)	0.2943
Daily twice without sugar	1.492 (0.9706–2.294)	0.0674
Daily thrice without sugar	1.378 (0.8464–2.243)	0.1966
Daily once with sugar	0.7906 (0.4040–1.547)	0.4923
Daily twice with sugar	0.8361 (0.4665–1.499)	0.5476
Daily thrice with sugar	0.8594 (0.4195–1.760)	0.6785
Situations at working places		
No stress	1	Ref
Stress	0.9662 (0.7374–1.266)	0.8031

T2DM = type 2 diabetes mellitus, BMI = body mass index, HTN = hypertension, CVDs = cardiovascular diseases, HbA1C = glycated hemoglobin, HDL = high-density lipoproteins, LDL = low-density lipoproteins.

Education is one of the risk factors for the development of DPN. Kiani *et al*. (2013) conducted a study on the prevalence and associated risk factors of DPN in Hamedan, Iran, and concluded that education qualification was significantly related to the presence of diabetic neuropathy (Kiani *et al*., 2013). In this study, educational status was associated with DPN (66.8%, $p < 0.0001$) and a risk factor for the development of DPN. In the current study, housewives (43.2%, $p = 0.0021$) were associated with DPN and they are at high risk for DPN (OR, 0.5254; 95% CI, 0.3477–0.7938). Previous reports are not available on this variable.

The present study results revealed that urban residents (61.5%, $p = 0.0048$) were significantly associated and are at high risk for DPN (OR, 0.6602; 95% CI, 0.4944–0.8815). Previous reports are not available on this variable. Hypertension ($p < 0.0001$) was positively associated with DPN. Dipika *et al*., (2014) conducted a study on prevalence and risk factors of development of DPN in T2DM in a tertiary care setting and concluded that hypertension was found significant for neuropathy in T2DM patients (Dipika *et al*., 2014). In the current study also hypertension (40.41%, $p < 0.0001$) was a risk factor for DPN (OR, 2.642; 95% CI, 1.906–3.661).

Table 5. Medication given for the patients with diabetic peripheral neuropathy.

S. No	Generic name of drugs	*N* (%)
1	Metformin	119 (40.47)
2	Glimepiride + Metformin	88 (29.93)
3	Isophane Insulin + Regular Insulin	67 (22.7)
4	Glimepiride	27 (9.18)
5	Gliclazide + Metformin	25 (8.50)
6	Insulin Glargine	21 (7.14)
7	Insulin Aspart	17 (5.78)
8	Pioglitazone	15 (5.10)
9	Teneligliptin	13 (4.4)
10	Gliclazide	12 (4.08)
11	Sitagliptin + Metformin	10 (3.40)
12	Insulin Lispro + Protamine Insulin	10 (3.40)
13	Teneligliptin + Metformin	6 (2.04)
14	Glipizide + Metformin	6 (2.04)
15	Voglibose	6 (2.04)
16	Acarbose	5 (1.70)
17	Insulin Aspart + Protamine Insulin	5 (1.70)
18	Sitagliptin	4 (1.36)
19	Metformin + Vildagliptin	4 (1.36)
20	Pioglitazone + Metformin	4 (1.36)
21	Dapagliflozin	3 (1.02)
22	Metformin + Voglibose	3 (1.02)
23	Empagliflozin	2 (0.68)
24	Vildagliptin	2 (0.68)
25	Glipizide	2 (0.68)
26	Repaglinide	2 (0.68)
27	Glibenclamide + Metformin	2 (0.68)
28	Canagliflozin	1 (0.34)
29	Linagliptin	1 (0.34)
30	Insulin Degludec + Insulin Aspart	1 (0.34)
31	Lantus Insulin	1 (0.34)
32	Acarbose + Metformin	1 (0.34)
33	Linagliptin + Metformin	1 (0.34)
34	Glimepiride + Metformin + Voglibose	1 (0.34)
35	Glimepiride + Metformin + Pioglitazone	1 (0.34)

Harry *et al*. (2017) conducted a study on risk factors for neuropathic pain in diabetes mellitus and concluded that physical inactivity was found significant for neuropathy in T2DM patients. The present study results also revealed that physical inactivity (62%, $p < 0.0001$) was associated and is the major risk factor for DPN. The present study results revealed that habit of taking junk foods weekly once (17.3%, $p < 0.0001$), weekly twice (11.2%, $p = 0.0010$) was significantly associated and are the major risk factor for DPN (weekly once OR, 2.732; 95% CI, 1.729–4.319) and weekly twice (OR, 2.385; 95% CI, 1.4102–4.036).

The present study results revealed that the habit of taking soft drinks occasionally (26.4%, $p = 0.0010$) was associated and was the major risk factor for DPN (OR, 1.776; 95% CI, 1.260–2.505). Therefore, further studies are needed to evaluate the exact impact of the habit of taking junk foods on risk for DPN. Poor glycemic control was significantly associated with the development of DPN. A study conducted by Dong *et al*. on the prevalence of DPN in a Saudi Population and concluded that duration of diabetes and glycemic control were strongly associated with DPN (Wang *et al*., 2014). In this study also poor glycemic control (43.1%, $p < 0.0001$) was a risk factor for the development of DPN (OR, 2.001; 95% CI, 1.432–2.796). Another study was conducted by Muhammad *et al*., (2015) on the association of DPN with duration of T2DM and glycemic control and concluded that DPN was a problematic complication of diabetes.,. Our findings are also in the same line with the findings of Jiali *et al*. (2015) and Dipika *et al*. (2014).

Harry *et al*. (2017) conducted a study on risk factors for neuropathic pain in diabetes mellitus and concluded that low HDL levels were found significant for neuropathy in T2DM patients. The present study results revealed that low HDL levels (23%, $p = 0.0206$) were significantly associated and were the major risk factor for DPN (OR, 0.5934; 95% CI, 0.3807–0.9251). Wang *et al*. (2014) conducted a study on the prevalence of DPN and concluded that a novel clinical marker (creatinine) was also identified, which may contribute to the risk prediction of DPN. In the current study also high serum creatinine levels (14.6%, $p < 0.0001$) was a risk factor for DPN (OR, 11.10; 95% CI, 3.320–37.11).

Monisha *et al*., (2015) conducted a study on DPN and concluded that the burden of DPN is high among diabetics with a long duration of T2DM. These results were supported by the present study (37.6%, OR, 3.155; 95% CI, 2.228–4.468). Other relevant studies conducted by Muhammad *et al*. (2015), Kiani *et al*. (2013), and Jiali (2015) also concluded that long duration of diabetes significantly associated with DPN.

Sekhar *et al*. (2016) conducted a study and identified that metformin was the widely used drug followed by glimepiride and metformin combination). Our present study results also revealed that metformin was the widely used drug followed by glimepiride and metformin combination.

CONCLUSION

The present study revealed that hypertension, endocrine diseases, history of CVDs, poor glycemic control (>9 HbA1c), low HDL, high serum creatinine, long duration of diabetes, physical inactivity, habit of taking junk foods and soft drinks were the significant risk factors for the development of DPN. Early detection of the identification of DPN in T2DM is needed in order to slow progression and complications. Metformin (40.47%), combination of glimepiride and metformin (29.93%), combination of human insulin and insulin isophane (22.7%) were mostly given to the T2DM patients with neuropathy.

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CONFLICT OF INTEREST

The authors declared that they have no conflict of interests.

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