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# Prevalence of Peripheral Neuropathy and Associated Factors among Adults with Type 2 Diabetes In Tibebe Ghion Comprehensive Specialized Hospital, Northwest Ethiopia 2025.

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Bahir Dar University

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BAHIR DAR UNIVERSITY  
COLLEGE OF MEDICINE AND HEALTH SCIENCES  
SCHOOL OF MEDICINE  
DEPARTMENT OF INTERNAL MEDICINE

PREVALENCE OF PERIPHERAL NEUROPATHY AND  
ASSOCIATED FACTORS AMONG ADULTS WITH TYPE 2  
DIABETES IN TIBEBE GHION COMPREHENSIVE SPECIALIZED  
HOSPITAL, NORTHWEST ETHIOPIA 2025.

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COLLEGE OF MEDICINE AND HEALTH SCIENCES  
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## ABSTRACT

**Background:** Diabetic peripheral neuropathy is a leading microvascular complication causing significant morbidity, yet data in Northwest Ethiopia remains limited. Timely identification is essential to prevent ulcers and amputations.

**Objective:** The aim of this study is to assess the prevalence of peripheral neuropathy and associated factors among adults with Type 2 diabetes at referral clinic in Tibebe Ghion Comprehensive Specialized Hospital, Northwest Ethiopia 2025.

**Methods:** A hospital-based cross-sectional study was conducted at Tibebe Ghion Comprehensive Specialized Hospital diabetes follow up clinic on 403 type2 diabetic patients. Data were collected by using pretested structured questioner and checked and exported to SPSS version 27 for analysis. Both bivariate and multivariate binary logistic regressions were employed to identify factors associated with diabetic peripheral neuropathy. A variable having a *p* value of  $< 0.25$  in the bivariate model was subjected to multivariate analysis to avoid confounding variable's effect. Adjusted odds ratios were calculated at 95% confidence interval and considered significant with a *p* value of  $\leq 0.05$ .

**Results:** This study finding showed that the prevalence of DPN was 28.5% (95% CI: 24.1% – 33%) among study participants. According to the multivariate logistic, Drinking of alcohol now or in the past (AOR =4.33; (95% CI: 1.71, 11.00), no formal education (AOR =10.98; (95% CI: 1.66, 72.62), attending up to primary education (AOR =24.80; 95% CI:3.25, 189.32), physical inactivity (AOR =2.02; 95% CI: 1.14, 3.55), Good foot self-care practice (AOR =0.36; 95% CI:0.17, 0.77), the presence of HTN (AOR=4.63; 95% CI: 2.14, 9.99), Dyslipidemia (AOR =2.79; 95% CI: 1.01, 7.66), Diabetic retinopathy (AOR=8.04; 95% CI: 1.53, 52.83), Diabetes Kidney disease (AOR=8.98; 95% CI: 2.09, 30.91) and participants on only insulin therapy (AOR=3.66; 95% CI: 1.32, 10.11) were independent predictors of diabetic peripheral neuropathy among study participants.

**Conclusion:** Lower educational level, the presence of comorbidities and other microvascular complications were strongly associated with it. Targeted early screening and intensive management of comorbidities, alongside promoting foot self-care, alcohol cession and physical activity, are crucial to reducing the burden of diabetic peripheral neuropathy.

**Key words:** Diabetes, Diabetic Peripheral Neuropathy, Prevalence, Determinant

## ACRONYMS/ABBREVIATION

|             |                                                   |
|-------------|---------------------------------------------------|
| ACCORD..... | Action to control cardiovascular risk in diabetes |
| ADA.....    | American diabetic Association                     |
| AOR.....    | Adjusted odd ratio                                |
| CI.....     | Confidence interval                               |
| DM.....     | Diabetes Mellitus                                 |
| DNS.....    | Diabetic Neuropathy Screening                     |
| DPN.....    | Diabetic Peripheral Neuropathy                    |
| DRP.....    | Diabetic retinopathy                              |
| FBS.....    | Fasting blood sugar                               |
| HTN.....    | Hypertension                                      |
| JUMC.....   | Jimma university medical center                   |
| KDM.....    | Known Diabetes Mellitus                           |
| MNSI.....   | Michigan Neuropathy Screening Instrument          |
| MRC.....    | Medical Referral Clinic                           |
| NDDM.....   | Newly Diagnosed Diabetes Mellitus                 |
| OPD.....    | Out Patient Department                            |
| OR.....     | Odd ratio                                         |
| TGSH.....   | Tibebe Ghion Specialized Hospital                 |
| WHO.....    | World Health Organization                         |

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# 1. INTRODUCTION

## 1.1 Background

Diabetes mellitus is one of the most common metabolic disorders and is a major health problem throughout the world. The most common and distressing of all the chronic complications of Diabetes mellitus are diabetic peripheral neuropathy. It comprise a heterogeneous group of disorders resulting from damage to the peripheral nervous system, frequently manifesting as pain and/or impaired sensations in the extremities(1, 2). It is a main cause of impairment as a result of foot ulceration, disruption of the gait, neuropathic pain and frequent hospitalizations(3, 4). Prolonged hyperglycemia, oxidative and inflammatory stress, and dyslipidemia (in type 2 diabetes) are thought to be key factors in pathogenesis and disease progression(1).

The most common type is distal symmetrical polyneuropathy (often synonymous with the term diabetic peripheral neuropathy); and less common types include cardiovascular autonomic neuropathy, gastrointestinal autonomic neuropathy, urogenital autonomic neuropathy, sudomotor dysfunction, diabetic radiculo plexus neuropathy, thoracic radiculopathy, treatment-induced neuropathy, and mononeuropathies (1).

As with other complications of DM, the development of neuropathy correlates with the duration of diabetes and glycemic control (5). Additional risk factors are body mass index (BMI) (the greater the BMI, the greater the risk of neuropathy), smoking, the presence of CVD, elevated triglycerides, and hypertension is also associated with diabetic peripheral neuropathy (5, 6). Both myelinated and unmyelinated nerve fibers are lost. Because the clinical features of diabetic neuropathy are similar to those of other neuropathies, the diagnosis of diabetic neuropathy should be made only after other possible etiologies are excluded. The early recognition and appropriate management of neuropathy in people with diabetes is important and creating awareness points to be one of the management parts (7)(8).

Screening using validated tools for diabetic peripheral neuropathy is crucial to prevent consequent complications. One of the useful tools for its screening in clinical practice is the Michigan Neuropathy Screening Instrument.

## 1.2 Statement of the problem

Globally, diabetes mellitus (DM) is now one of the most common non-communicable diseases and is the leading cause of death in most developed countries (2). It was estimated that in 2017 there are 451 million (age 18–99 years) people with diabetes worldwide. These figures were expected to increase to 693 million by 2045. It was estimated that almost half of all people (49.7%) living with diabetes are undiagnosed (3). Diabetes mellitus (DM) has reached epidemic proportions worldwide. Historically, diabetes was considered a disease confined to developed countries and affluent people. However, recent estimates suggest that the prevalence of diabetes is rising globally, particularly in developing countries (4).

World health organization (WHO) estimates the number of cases of diabetics in Ethiopia to be about 800,000 in 2000 and projected that it would increase to about 1.8 million by the year 2030 (5). DM is the main underlying cause of blindness, renal failure, peripheral neuropathy with subsequent lower extremity amputation, and even death (6, 7).

Diabetic peripheral neuropathy is defined as, “the presence of symptoms and/or signs of peripheral nerve dysfunction in people with diabetes after the exclusion of other causes” (8). The diagnosis relies on both clinical signs as well as quantitative testing and may be present despite a lack of reported symptoms (8). While peripheral neuropathy can occur in adults without diabetes, the prevention and management of peripheral neuropathy in diabetes is largely focused on glycemic control. Pain management also remains an important component in the management of diabetic neuropathy (8), and there is an emerging focus on lifestyle interventions including weight loss and physical activity (8), (9).

Diabetic peripheral neuropathy (DPN) is the most common complication of DM, and it is estimated that 30% to 50% of diabetes patients are affected by this disorder (10, 11). The Toronto Consensus Panel defined DPN as a symmetrical, length-dependent sensorimotor polyneuropathy attributable to metabolic and micro vessel alterations as a result of chronic hyperglycemia exposure after other causes of peripheral neuropathy excluded (9). DPN occurs in 60–70% of the 347 million people living with DM worldwide (12).

In Africa, the prevalence is higher due to late diagnosis, scarcity of screening and diagnostic resources, poor control of blood sugar, and other precipitating factors (13), (14). DPN leads to a number of impairments and functional limitations, including foot ulceration and subsequent

lower extremity amputation, fifteen times increase of the falling risk, inability to work due to physical limitations, and frequent hospitalizations (11), (15). In the presence of neuropathy the annual incidence of foot ulceration has demonstrated an approximately 10-fold increase (16).

### **1.3. Justification of the Study**

Diabetic Peripheral Neuropathy (DPN) is a primary driver of morbidity, accounting for more hospitalizations than all other diabetes complications combined and contributing to major cause of non-traumatic amputations. therefore, clinical symptoms alone are insufficient for diagnosis. Despite the American Diabetes Association (ADA) recommending annual screening, systematic screening remains neglected in resource-limited settings. In Ethiopia, and specifically at this study's referral site, there is a significant lack of compiled data using validated, low-cost tools like the Michigan Neuropathy Screening Instrument (MNSI). Therefore this study addresses this gap by establishing the prevalence and identifying specific local risk factors for DPN. The findings will provide baseline data for healthcare policy and future research, improve clinical efficiency by helping physicians identify "high-risk" profiles, allowing for targeted screening in high-volume clinics and inform early intervention strategies to mitigate the devastating physical and economic costs of advanced diabetic foot complications.

## 2. LITERATURE REVIEW

Diabetic peripheral neuropathy is the most common form of neuropathy worldwide (17). In a landmark historical cohort study of 4400 adults with diabetes from France who were followed prospectively from 1947 to 1973, 50% of participants developed peripheral neuropathy by the end of the 25 years of follow-up (18).

More recent cross-sectional studies from the USA and Europe have reported a prevalence of diabetic peripheral neuropathy ranging from 65 to 70% depending on the population studied [(19), (18)]. The prevalence of diabetes peripheral neuropathy is somewhat higher among persons with type 2 diabetes, In the SEARCH for Diabetes in Youth Study, peripheral neuropathy was present in 26% of youths with type 2 diabetes (20).

In the Action to Control Cardiovascular Risk in Diabetes (ACCORD) trial, peripheral neuropathy was present in 42% of adults with type 2 diabetes at baseline (21). This is similar to the 39% prevalence reported in the Veteran Affairs Diabetes Trial (22).

In the Bypass Angioplasty Revascularization Investigation 2 Diabetes (BARI 2D) trial, 51% of adults with type 2 diabetes had a history of peripheral neuropathy at baseline (23). There is some evidence to suggest that diabetic peripheral neuropathy may occur less frequently in Asian populations, although this finding has not been consistent (18).

Prevalence of diabetic peripheral neuropathy in developing country south Asia (Sri Lanka), Out of the 5000 invited subjects, the prevalence of DPN according to the DNS score among all patients, patients with already established, diabetes and newly diagnosed patients was 48.1% (n = 254), 59.1% (n = 199) and 28.8% (n = 55) respectively. The most common symptom among newly diagnosed subjects were burning, aching pain or tenderness of feet (n = 30, 15.7%), followed by numbness of feet (n = 24, 12.6%), prickling sensation of feet (n = 22, 11.5%) and unsteadiness in walking (n = 20, 10.5%) (24).

A study done in type 2 diabetic outpatients at the BIRDEM hospital, Bangladesh (south Asia), two hundred and ninety-four (139 men, 155 women) type 2 diabetic outpatients were studied. The overall DPN prevalence was 19.7 %; male (20.9%), female (18.7 %). The prevalence increased with age (from 11.1% in the 23-40-year-old group to 32.3% in the 60-80-year-old group) and duration of diabetes (from 14.1% in patients with five years to 29.2% in patients with

9-11 years duration). Age > 60 years (OR 4.2, 95% CI 1.4-12.3), low/normal WHR (OR 3.8, 95% CI 1.6-9.3), income < 800 TK (OR 3.1, 95% CI 1.1-9.3) and insulin treatment (OR 2.0, 95% CI 1.0-4.0) were independent, significant risk factors. Longer duration of diabetes (OR 1.2, 95% CI 1.0-1.4), and higher HbA1c (OR 1.1, 95% CI 1.0-1.3) were marginally independent, significant risk factors for DPN. (25).

A cross-sectional study was carried out in a tertiary care hospital north India, a total of 586 participants were found to have DPN, accounting for 29.2% (95% confidence interval [CI] 27.2–31.2) prevalence. The higher prevalence was observed in KDM compared with NDDM 33.7% (95% CI 31.42–36.01) vs 9.2% (95% CI 6.3–12.2;  $P < 0.001$ ). Prevalence of mild, moderate, and severe neuropathies was 8.06, 14.55 and 6.63%, respectively. Regression analysis showed age ( $P < 0.001$ ), duration of diabetes ( $P < 0.001$ ), dyslipidemia ( $P = 0.03$ ), glycated hemoglobin ( $P < 0.001$ ), the presence of other micro vascular complications ( $P < 0.001$ ), macro vascular complications ( $P = 0.003$ ) and alcoholic status ( $P < 0.033$ ) to be associated. No sex-specific differences were observed in the mean age at diagnosis of diabetes, mean age at the diagnosis of neuropathy, and duration taken for the DPN development among females and males (26).

A multicentric facility-based cross-sectional study done south rural India, the prevalence of the DPN was 39.3% among them 28.9% in males and 10.4% in females, respectively. The other determinants of the participants, 264 (78.6%) had the Glycated hemoglobin (HbA1c) >7, 205 (61%) had a burning foot sensation, 124 (36.9%) of them were had numbness of the foot, almost 50% of them had pricking sensation in the foot and more than one-third (130) of them had callosity over foot (27).

A prospective hospital based cross-sectional study was conducted from October 2017 to March 2018 at Kilimanjaro Christian Medical Center (KCMC) referral and teaching hospital in Northern Tanzania. out of 327 participants, overall prevalence of DPN was 72.2 %, males were 67.9%, and females were 74.4%, respectively. A high prevalence was obtained in patients aged above 60 years 84.8% ( $p = < 0.001$ ), being overweight 77% and obesity 83.8% ( $p = < 0.001$ ), and in those using OHGA 77.5% ( $p = < 0.004$ ). In addition, a high prevalence of DPN was found in patients with HTN 81.2% ( $p = < 0.001$ ) and with DM duration >7 years >70% ( $p = < 0.011$ ). The majority of type 2 DM patients with DPN 75.3% were using OHGA treatment, in which 135

(78.9%) were on treatment for duration  $\geq 10$  years ( $p = 0.009$ ) with 1.9 OR and 95% CI (1.2 to 3.2) (28).

A cross-sectional study was conducted among 248 newly diagnosed adult diabetic patients at Mulago hospital Uganda, the overall prevalence of DPN was 29.4 %. Nearly sixteen percent had moderate neuropathy and only five percent had severe neuropathy. Age above 60 years was significantly associated with the presence of DPN; (OR 3.72; 95% CI 1.25 – 11.03;  $p = 0.018$ ). The history of ever having a foot ulcer was significantly associated with peripheral neuropathy (OR 2.59; 95% CI: 1.03 – 6.49,  $p = 0.042$ ) (29).

A study included 124 patients with diabetes mellitus conducted at Aden Diabetes Center Cairo Egypt during the study period from 1st January to 30<sup>th</sup> June 2015. the prevalence of DPN based on NSS and NDS was 60.48%. Risk factors significantly associated with DPN were age ( $p = 0.015$ ), educational level ( $p = 0.013$ ), type 2 diabetes ( $p = 0.022$ ), and duration of diabetes ( $p = 0.001$ ), dyslipidemia ( $p = 0.009$ ), abdominal obesity ( $p = 0.001$ ), body mass index ( $p = 0.036$ ) and retinopathy ( $p = 0.035$ ). Female gender, hypertension, elevated glycated hemoglobin and the presence of albuminuria were associated with higher frequency of DPN although this relation was statistically non-significant. Logistic regression analysis revealed that Illiteracy (OR 8.75, 95% CI 2.23- 34.33), dyslipidemia (OR 1.97, 95% CI 1.04-24.44), long standing of diabetes (OR 1.14, 95% CI 1.05-1.23), and abdominal obesity (OR 1.05, 95% CI 1.01-1.09) were significantly associated with DPN (30).

A Systematic Review and Meta-Analysis done in Ethiopia including 38 articles with 14029 total patients with diabetes mellitus were found suitable for the review. Except for three (retrospective cohort study), all studies were cross-sectional. The overall pooled prevalence of diabetic peripheral neuropathy was 22% (95% CI 18% to 26%). The subgroup analysis of diabetic peripheral neuropathy among patients with diabetes in the different regions was 23% (95% CI 17% to 29%) in Addis Ababa, 27% (95% CI 16% to 38%) in Oromia, 16% (95% CI 14% to 18%) in South nation and nationalities, and 15% (95% CI 6% to 24%) in Amhara (31).

An institution-based cross-sectional study was conducted on 366 type 2 diabetic patients on follow up at JUMC, Southwest Ethiopia, from September 1 to November 30, 2019. Michigan neuropathy screening instrument (MNSI) was used to evaluate the presence of DPN the overall prevalence of DPN among the study population was 53.6% (seen in 196 out of 366, in almost

half of the respondents). Based on the symptom score alone, the prevalence of DPN was 69 (18.9%), while that of the sign score was 187 (51.1%). age above 40 years, diabetes duration of above 5 years, physical inactivity, and smoking were significantly associated with DPN (32).

An Institution based cross-sectional study was conducted from February 2016 to June 30 2016. The study was done at the diabetes unit of chronic illness clinic from 408 diabetic patients of Felege Hiwot Referral Hospital, North West Ethiopia. using Michigan neuropathy screening instrument tool for diabetic peripheral sensory neuropathy, the overall prevalence of Peripheral Sensory Neuropathy was found to be 52.2%. The major associated factors identified by multivariate analysis were age >50 years: AOR: 3.0 CI [1.11, 7.89]; overweight and obese: AOR: 7.3 CI [3.57, 14.99]; duration of DM: AOR: 3.4 CI [1.75, 6.60]; not involved in physical exercise: AOR: 4.8 CI [1.90, 7.89]; male gender: AOR: 2.4 CI [1.18, 5.05] (33).

An Institution-based cross-sectional study was conducted in the Amhara region referral hospitals, in 2022, including four referral institutional hospitals by using a systematic random sampling technique, a total of 627 respondents were included. The overall prevalence of diabetic peripheral neuropathy among the study participants was 48.2% (95% CI; 44.2, 52.1). Aged between 40 and 60 years (AOR = 4:27; 95% CI 2.62, 6.94), and 60 years and older (AOR = 4:47; 95% CI 2.40, 8.35), participants who have lived alone (AOR = 2:14; 95% CI 1.21, 3.79), patients with comorbidity (AOR = 1:83; 95% CI 1.22, 2.76), and being physically inactive (AOR = 1:69; 95% CI 1.14, 2.49) were significantly associated with Diabetic peripheral neuropathy (34).

A facility-based cross-sectional study was conducted in adama among 293 adult type 2 diabetic patients who were on treatment and follow-up from May to June 31, 2023. The magnitude of diabetic peripheral neuropathy was 14.3% (95% CI 10.4–18.0). It was 13.4% (95% CI 8.4–19.1) among males and 15.4% (95% CI 10.1–22.2) among females. Age above 60 years (AOR = 5.06, 95% CI 1.60–15.96), being rural resident (AOR = 2.41; 95% CI 1.15–5.06), duration of diabetes above 5 years (AOR = 2.48, 95% CI 1.16–5.27) and having comorbid hypertension (AOR = 2.56, 95% CI 1.24–5.28) were independently associated with diabetic peripheral neuropathy (35).

A retrospective follow up study done at Jimma University Medical center (JUMC) and Mettu Karl Comprehensive and Specialized Hospital (MKCSH) south west Ethiopia to assess the incidence DPN and its predictors among T2DM patients from September 9, 2013 to February march, 2021 Overall, of 567 DM patients 119 developed DPN with an incidence rate of 3.75, 95%CI [3.13, 4.49] per 100 PY. About 15.13% and 69% of DPN cases occurred within 2 and 5 years of DM diagnosis, respectively. In the multivariable Gompertz PH model, being female [AHR = 1.47; 95% CI (1.01, 2.15)], T2DM [AHR = 3.49 95% CI (1.82, 6.71)], having diabetic retinopathy [AHR = 1.9 95% CI (1.25, 2.91)], positive proteinuria [AHR = 2.22 95% CI (1.35, 3.65)], being obese [AHR = 3.94 95% CI (1.2, 12.89)] and overweight [AHR = 3.34 95% CI (1.09, 10.25)] significantly predicts the future risk of DPN (36).

An institution based unmatched case control study was conducted from April to May 2019 in Gamo and Gofa zones southern Ethiopia. Among 528 randomly selected participants using a pre-tested, interviewer-administered, and structured questionnaire, the odds of being an urban dweller was 2.67 times higher among cases than controls [AOR = 2.67 (1.27, 5.63)]. The likelihood of fasting blood glucose level between 203 and 282 and 282 and above was 2.55 and 3.88 times higher among cases than controls [AOR = 2.55 (1.91, 7.16)] and [AOR = 3.88 (1.42, 10.60)] respectively. the probability of living with diabetes mellitus for 10 and more years was 3.88 times higher among cases than controls [AOR = 3.88 (1.42, 10.60)]. The odds of controlling glucose level after developing symptom was 5.33 times higher among cases than controls [AOR = 5.33 (1.28, 12.24)]. The probability of having high blood pressure was 2.36 times higher among cases than controls [AOR = 2.36 (1.26, 4.43)]. The likelihood of having a family history of complication from diabetes mellitus was 5.60 times higher among cases than controls [AOR = 5.60 (2.03, 15.43)]. The odds of exercising 3 times per week for 15 to 30 minutes and for less than 15 minutes were 2.96 and 4.92 times higher among cases than controls respectively [AOR = 2.96 (1.32, 6.61)] and AOR = 4.92, 95% CI (1.85, 13.04) respectively. The likelihood of having a waist circumference greater than or equal to 40 inch was 2.72 times higher among cases than controls [AOR = 2.72 (1.07, 6.94)]. Were found to be determinant of diabetic peripheral neuropathy (37).

### 3. CONCEPTUAL FRAMEWORK

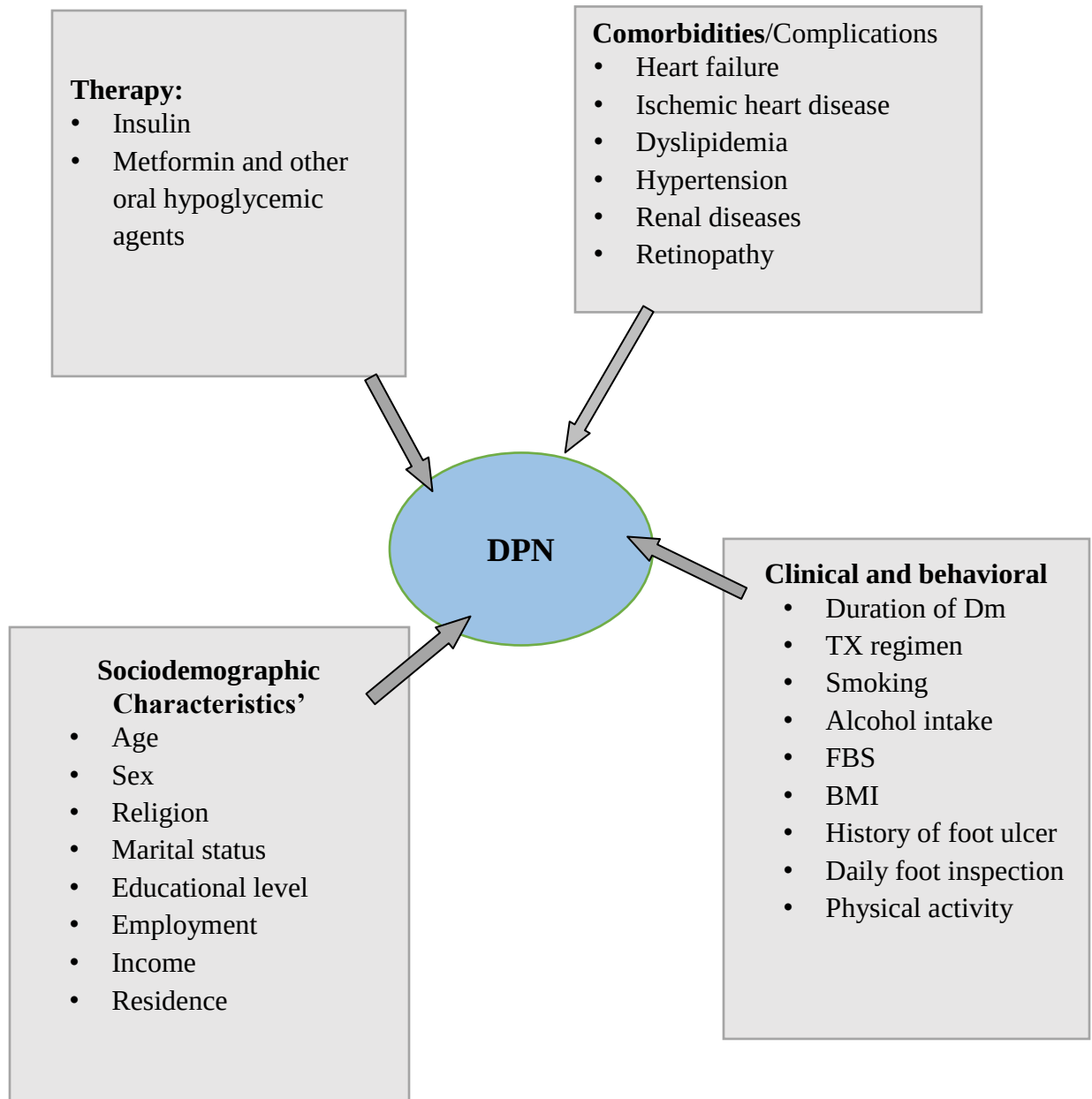


Figure 1 *Conceptual framework*

## **4. OBJECTIVE OF THE STUDY**

### **4.1 General objective**

To assess prevalence of peripheral neuropathy and associated factors among adult with type 2 diabetes at Tibebe Ghion Comprehensive Specialized Hospital Northwest Ethiopia, from September to December 2025.

### **4.2 Specific objectives**

To assess the prevalence of diabetic peripheral neuropathy among type 2 diabetes patients.

To identify factors associated with diabetic peripheral neuropathy among type 2 diabetes patients.

## **5. METHODOLOGY**

### **5.1 Study area and setting**

The study was conducted at Tibebe Ghion Comprehensive Specialized Hospital, in Bahir Dar town, the capital of the Amhara Regional State, Ethiopia. The hospital is situated approximately 550 km from the capital city, Addis Ababa, and is at an elevation of 2,133 meters above sea level. According to the information from the administration office, the hospital established in 2019 G.C, serves as a referral hospital for neighboring hospitals and health centers in the catchment area, includes the whole Amhara regional state, majority of Bahir Dar city, Gojjam and South Gondar, and sometimes from Benishangul Gumuz regional states which providing services to around seven million people.

The hospital has four major departments: Pediatrics, Internal Medicine, Surgery, and Gynecology and Obstetrics and other departments. The Internal Medicine inpatient department is divided into medical wards, Medical ICU and Medical Emergency unit. Ward is further divided into specialized units, like Cardiac, Renal and Endocrine care. The outpatient unit consists of medical outpatient department (MOPD) and medical referral clinic (MRC) which consists different specialty cares. The study specifically focused on the Chronic Illness Follow-up/Diabetic Clinic, which is led by an endocrinologist and supported by residents and nursing staff, providing longitudinal care for a high volume of patients from the regional catchment area.

### **5.2. Study design and period**

A Hospital based cross sectional study were conducted on type 2 diabetes patients visiting at Tibebe Ghion Comprehensive Specialized Hospital at chronic diabetes follow up clinic from September to December 2025.

### **5.3 Source population**

All adult type 2 diabetic patients who had been under routine follow-up clinic of at Tibebe Ghion Comprehensive Specialized Hospital during study period.

## 5.4 Study population

Type 2 diabetic patients who had been under routine follow-up clinic at Tibebe Ghion Comprehensive Specialized Hospital who was fulfill the inclusion criteria.

## 5.5 Eligibility criteria

### 5.5.1 Inclusion criteria

Type 2 DM and Age greater than or equal to 18 years.

### 5.5.2 Exclusion criteria

Those who are critically ill, T2 DM patients with HIV, leprosy, peripheral nerve injury, who had other documented cause like alcohol, B12 deficiency, unable to hear and see, and bilateral lower extremity amputees were excluded based on medical chart, physical assessment, history, and laboratory test.

## 5.6. Sample size and sampling procedures

### 5.6.1. Sample size

Considering the prevalence of diabetic neuropathy to be 53.6 % based on a study in a similar set up at JUMC in 2019(32), using a single population proportion sample size calculation formula with the following assumptions: an assumed 53.6% prevalence of peripheral neuropathy among diabetes patients; a confidence level of 95%; a marginal error of 5%.

$$n = \frac{(Z \alpha/2)^2 P(1 - P)}{d^2(0.05)^2} = \frac{(1.96)^2 \cdot (0.5) \cdot (0.5)}{0.05^2} = 383$$

Where: n = the required sample size.

Z = the standard score corresponding to 95% CI, and is equal to 1.96.

$P$  = the proportion of diabetic neuropathy among patients with diagnosis of T2DM; which is assumed to be 53.6%.

$d$  = level of precision (margin of error) which is taken 5%.

And with 5 % nonresponse rate it became 403.

### 5.6.2. Sampling procedure

The study participants were recruited using Consecutive Sampling technique. An average of 200 type 2 DM patients per month are visited chronic illness follow-up clinic from institutional records. So, a total of 4 months period is needed to get study population by assuming non respondents and high number of patients are visited in monthly interval, intentionally excluded patients not affect the quality of data. During the sampling, if a patient who was selected as a participant in his/her previous visit was encountered they were skipped and the next patient were recruited. So to ensure data independence, participants were enrolled only once during their initial visit within the study period, verified by their unique medical record numbers.

## 5.7 Study variables

**5.7.1 Dependent variable:** Presence of diabetic peripheral neuropathy

**5.7.2 Independent variables:** Socio demographic (Age, gender, religion, marital status, educational status, employment, income, residence)

Clinical and behavioral (duration of DM, alcohol intake, physical activity, smoking, daily foot inspection, foot ulcer, FBS, HgA1c, BMI, comorbidities and other diabetic complications and treatment regimen).

## 5.8. Operational Definition

**Type 2 diabetes patients:** Patients diagnosed with T2DM who were on follow-up at MRC of TGSH.

**Diabetic Peripheral Neuropathy:** Was present if the patient's history version of MNSI questionnaire score was  $\geq 7$  abnormal responses in the legs and/or if the lower extremity examination version of MNSI scores was  $\geq 2.5$  (40).

**Good glycemic control:** When a patient had HbA1c<7% (1, 37).

**Uncontrolled Blood Sugar:** Poor glycemic control is considered when a patient has HbA1c  $\geq 7\%$  (1, 37).

**Controlled fasting blood sugar:** Fasting blood sugar (FBS) of 80–130 mg/dl (1, 37).

**Hypertension:** Participants with a pre-existing diagnosis of high blood pressure, as verified by documentation in their medical records as HTN.

**Dyslipidemia:** Participants with a documented history of abnormal lipid profile in their medical charts as dyslipidemia.

**Alcohol use disorder:** In this study was defined as consumption of >6 standard drinks and >4 standard drinks on a single occasion in men and women respectively. Standard drink: is any drink containing about 10 gram of alcohol (38).

**Smoking status:** Ever smoking of any type of smoke (response will be either "yes" or "no") and the frequency of smoking will be used to evaluate the smoking status. Participants who answered "almost every day and 3–4 times a week" will be coded as frequent smokers; "once or twice a week" will be included as less-frequent smoker; and "once or twice a month" will be regarded as barely smoker (42).

**Past Smoker:** Has smoked at least once in their lifetime but has not smoked any in the last 30 days prior to the survey (42).

**Alcohol consumption:** Ever drinking of any type of alcohol (response will be either "yes" or "no") and the frequency of drinking beer or other alcohol will be used to evaluate the drinking status. Participants who answered "almost every day and 3–4 times a week" will be coded as frequent drinkers; "once or twice a week" will be included as less-frequent drinkers; and "once or twice a month" will be regarded as barely drinking (42).

**Alcohol took in the past:** Has consumed alcohol at least once in their lifetime but has not consumed any alcohol in the 12 months prior to the survey (42).

**Amputation.** Amputation is the surgical removal of the whole or a part of the limb including its distal end.

**Critically Ill.** Patients who are unable to communicate, in cardiorespiratory distress and abnormal conscious are considered critically ill.

**DM Duration.** The duration of DM was calculated as age at data collection minus age at onset of DM.

**Physically Inactive.** Patients performing moderate intensity activity less than 150 minutes per week were considered physically inactive.

**Physically Active.** Patients performing moderate intensity more than 150 minutes per week were considered physically active.

## **5.9. Data Collection Tool and Procedure.**

Data were collected by using a structured questionnaire through face-to-face interviews, patient record reviews, and physical examination. The questionnaire is adapted from WHO stepwise approach for surveillance of chronic disease risk factors and from different scientific journals(38). The questionnaire contains socio-demographic factors, Michigan neuropathy screening instrument, behavioral variables, and clinical variables. Michigan neuropathy screening instrument (MNSI) is used to evaluate the presence of DPN. It is a well-known instrument used to assess peripheral neuropathy among patients with type 2DM with a sensitivity of 80% and a specificity of 95%. It is a validated, noninvasive, and inexpensive measurement tool that evaluates sensory and motor components of neuropathy which contains history and physical assessment parts(39, 40). and in addition to the standard Michigan Neuropathy Screening Instrument (MNSI) physical assessment by using 10g monofilament test, the Ipswich Touch Test (IpTT) was employed to evaluate the loss of protective sensation in resource limited settings .

## **5.10 Measurement**

### **5.10.1 MNSI History Version.**

It contains 15 items of which 12 items assess symptoms of DPN with exclusion of the three distractor questions, hence were not include in scoring. Finally it contains 12 items which was administered by the interviewer, of which 10 items assess symptoms of DPN. ‘Yes’ responses to questions 1–5, 7, 8, 9, 10 and 12 was each counted as one point and ‘No’ responses to questions

6 and 11 likewise counted as one point. The total score ranges from 0 to 12 points and a score of  $\geq 7$  indicated the presence of DPN (40).

### **5.10.2 MNSI Examination Version Procedure and Scoring**

It assessed the following five variables on each foot which is performed by data collectors:

- (1) Each foot were inspected for deformities, dry skin, and calluses or infections, and each foot with any abnormality received a score of one and if not 0
- (2) Each foot were inspected for ulcer, and each foot with an ulcer received a score of 1 and if not 0
- (3) Examination of vibration sense by tuning fork 128 hertz

A 128-hertz (HZ) C-tuning fork made in USA is used to detect loss of vibration. Vibration sensation is tested in the great toe and the score is designated as follows for each foot. Vibration is present and scored 0 if the examiner senses the vibration on his finger for  $<10$  seconds, 0.5 score when the examiner felt the vibration for  $\geq 10$  seconds after the patient stopped to feel it at the great toe, and 1 point for absent vibration.

- (4) Detection of the ankle reflex

Ankle reflex function is detected using standard triangular rubber-headed hummer made in China. If ankle reflex is present, it was scored as 0, while if absent the patient was asked to perform the Jendrassic - maneuver and if present it designated present with reinforcement and scored 0.5.

Finally, if absent with the Jendrassic maneuver, the reflex is designated absent and scored 1.

- (5) Monofilament test

A 5.07/10g monofilament made in China is used to detect loss of pressure sensation on the feet. It is an objective instrument used in screening the diabetic foot for loss of protective sensation. Each monofilament is used to test 10 patients to avoid diagnosing error. The participant, whose eyes is closed, was asked to respond yes if he/she felt the filament. Nine sites on the plantar surface of the foot and one on the dorsum is tested. 8 correct responses out of 10 applications is

considered normal and scored 0, 1-7 correct responses indicates reduced sensation and scored 0.5, and no correct answers translated into absent sensation and scored 1. Both feet were independently assessed and the scores for both feet were added together. After summing up all the components, the patient was considered to have DPN if the Score is  $\geq 2.5$  out of the 10-point scale on examination version of MNSI.

#### (6)The Ipswich Touch Test (IpTT)

The Ipswich Touch Test (IpTT) is a simplified, validated screening method where the examiner uses their index finger to lightly touch the tips of the 1st, 3rd, and 5th toes of both feet. A positive result for DPN is recorded if the patient fails to sense two or more out of the six touches and scored as 1. This tool was utilized as a reliable, non-equipment-based alternative to the 10g monofilament test to identify patients at risk for foot ulceration."

#### (7)Body mass index (BMI)

Weight was measured using a standard weight scale in kg approximated to the nearest 0.1kg reading each subject. Height was measured using a standard height measurement scale in meters with upright standing position and was approximated to the nearest 0.1cm reading. Behavioral variables were assessed based on the WHO stepwise approach for chronic disease risk factor surveillance (28). Body mass index (BMI) was calculated as weight (kg)/height (m<sup>2</sup>). Patient records (charts) was used to take clinical variables.

### **5.11 Data Quality Management and confidentiality**

Data quality were been ensured through standardized data collection materials and the English version of questionnaire was translated to Amharic version for interviewing and back to English after data collection. The original and translated questionnaires was compared, and the discrepancies were reviewed and resolved accordingly. Pretest from 5% of the sample population were been conducted and amendment of the questionnaire was done. After analyzing pretest results, necessary modifications and corrections was made

Training was given for data collectors about the aim of the study, on the ways of data collection, and how to measure, observe, and record readings before data collection is undertaken. Continuous follow-up and supervision was made by the principal investigator throughout the data collection period. The collected data was checked on daily basis for accuracy and

completeness by principal investigator. To minimize intra-and inter examiner variation on physical examination, at first there was a detailed training on each step of the physical examination procedure; all the data collectors were informed to strictly follow the guideline during procedure; continuous supervision was conducted. Information obtained with the patients' permission from interview or their medical records was not be disclosed to any third person without their informed consent.

### **5.12. Data analysis**

Data was checked for consistency and cleaned by the investigator. Then it was coded and then exported to SPSS version 27 for further analysis. The result were summarized by using frequency, tables and graphs. A 95% confidence interval odds ratio (OR) was computed and considered variables having p - value less than 0.05 in the multi variable model as significantly associated with the dependent variable.

### **5.13. Ethical Considerations**

Study participants were recruited only after informed verbal consent is obtained from them. Those patients who may have reduced level of autonomy were not considered for participation. All data obtained were treated confidentially. During the data collection process, those patients who are found to have neurologic problems was taken care of as per the recommendations of diabetes mellitus guidelines, and advice on preventive measures were given to all participants. In addition, ethical approval was obtained from the institutional review board of the College of Medicine and Health Sciences, Bahir Dar University, and permission was obtained from hospital administrators.

### **5.14. Dissemination of result**

The paper will be submitted to BDU CMHS, public health and internal medicine departments. The study will be disseminated to the TGSB administrative office and other concerned governmental and NGOs. It will be sent for publication in peer reviewed journal and presentations shall be made in scientific conferences.

## 6. RESULT

### 6.1 Socio-demographic characteristics of type 2 diabetes mellitus patients

A total of 403 type 2 adult DM patients were participated in this study giving a response rate of 100%. The mean age of the participants was 55.63 (SD:  $\pm 10.23$ ) years. Of the total participants, 238 (59.1%) were males, 326 (80.9%) urban residents, 330 (81.9%) married, 151 (37.5%) housewife and 130 (32.3%) were employed, 152 (37.7%) no formal education and 139 (34.5%) attend college and above, and Majority of the participants were orthodox Christians (92.3%) (table 1).

*Table 1 Sociodemographic Characteristics of type 2 diabetes mellitus patients on follow-up at TGSH, Bahir Dar, Ethiopia, 2026 (n = 403).*

| Variables          | Category                         | Frequency | Percentage |
|--------------------|----------------------------------|-----------|------------|
| Age                | $\leq 40$                        | 39        | 9.7%       |
|                    | 41-60                            | 236       | 58.6%      |
|                    | $> 60$                           | 128       | 31.8%      |
|                    | Mean 55.63 (SD: $\pm 10.225$ )   |           |            |
| Sex                | Female                           | 165       | 40.9%      |
|                    | Male                             | 238       | 59.1%      |
| Occupation         | Farmer                           | 67        | 16.6%      |
|                    | Employed                         | 130       | 32.3%      |
|                    | Housewife                        | 151       | 37.5%      |
|                    | Merchant                         | 33        | 8.2%       |
|                    | Retired and others/daily laborer | 22        | 5.5%       |
|                    |                                  |           |            |
| Educational Status | No formal education              | 152       | 37.7%      |
|                    | Primary                          | 42        | 10.4%      |
|                    | Secondary                        | 70        | 17.4%      |
|                    | College and above                | 139       | 34.5%      |
| Religion           | Muslim                           | 28        | 6.9%       |
|                    | Orthodox                         | 372       | 92.3%      |
|                    | Protestant                       | 3         | 0.7%       |
| Marital status     | Divorced                         | 6         | 1.5%       |
|                    | Married                          | 330       | 81.9%      |
|                    | Single                           | 8         | 2.0%       |
|                    | Widowed                          | 59        | 14.6%      |
| Residence          | Rural                            | 77        | 19.1%      |
|                    | Urban                            | 326       | 80.9%      |
| Monthly Income     | $< 5000$                         | 57        | 14.2%      |
|                    | 5000-10000                       | 131       | 32.5%      |
|                    | $> 10000$                        | 215       | 53.3%      |

## 6.2. Behavioral and clinical characteristics of type 2 diabetes mellitus patients

Among the participants included in this study, two-third of them diagnosed type T2DM five and more years apart. The majority of DM patients, 245 (60.8%), had poor glycemic control. The mean FBS level was 145mg/dl (Min 68 and Max 455). Just over half (51.9%) and nearly half (43.9%) of the participants were had normal and overweight respectively.

Among the participants included in this study, 264 (65.5%) were taking oral hypoglycemic agents and 10.7% took insulin only, and of the participants, 364 (85.9%) of the participants engaged in at least 150 min of physical exercise every week and 82.9% participants had good foot self-care practice (daily inspection) of foot. Majority of participants, 80.4% were took alcohol some in the past or now.

In this study, hypertension 168 (41.7%) was the most common comorbidity, followed by Dyslipidemia 68(16.9%), chronic heart disease 46 (11.7%), and 102 (25.6%) of the participants had other diabetic related complications the main one is Diabetic retinopathy 37(9.2%) and chronic kidney disease 21 (5.2%). (Table 2).

*Table 2 Behavioral and clinical characteristics of type 2 diabetes mellitus patients on follow-up at TGSH in Bahir Dar, Ethiopia, 2026 (n = 403).*

| Variables                  | Category  | Frequency | Percentage |
|----------------------------|-----------|-----------|------------|
| Duration of DM             | <5        | 155       | 38.5%      |
|                            | ≥5        | 248       | 61.5%      |
| FBS                        | ≤130      | 158       | 39.2%      |
|                            | >130      | 245       | 60.8%      |
| HgA1c                      | ≤7        | 184       | 45.7%      |
|                            | >7        | 219       | 54.3%      |
| BMI                        | <18.5     | 2         | 0.5%       |
|                            | 18.5-24.5 | 209       | 51.9%      |
|                            | 25-29.9   | 177       | 43.9%      |
|                            | ≥30       | 15        | 3.7%       |
| Presence of other diabetic | No        | 300       | 74.4%      |

|                                            |                     |     |       |
|--------------------------------------------|---------------------|-----|-------|
| complications                              | Yes                 | 103 | 25.6% |
| If yes for other diabetic complications    | DKD                 | 21  | 5.2%  |
|                                            | DRP                 | 37  | 9.2%  |
|                                            | Ischemic Stroke     | 10  | 2.5%  |
|                                            | IHD                 | 34  | 8.7%  |
| Alcohol intake                             | No                  | 79  | 19.6% |
|                                            | Yes                 | 324 | 80.4% |
| If yes..                                   | Took in the past    | 215 | 53.4% |
|                                            | Take occasionally   | 104 | 25.8% |
|                                            | Fairly often        | 5   | 1.2%  |
| Foot self-care practice (daily inspection) | No                  | 69  | 17.1% |
|                                            | Yes                 | 334 | 82.9% |
| History of foot ulcer                      | No                  | 386 | 95.8% |
|                                            | Yes                 | 17  | 4.2%  |
| History of Smoking                         | Yes                 | 8   | 2.0%  |
|                                            | No                  | 395 | 98.0% |
| Physical exercise                          | Physically active   | 346 | 85.9% |
|                                            | Physically inactive | 57  | 14.1% |
| Treatment regimen                          | Oral medication     | 264 | 65.5% |
|                                            | Insulin only        | 43  | 10.7% |
|                                            | Mixed/both          | 96  | 23.8% |
| Presence of Comorbidity                    | No                  | 155 | 38.5% |
|                                            | HTN                 | 168 | 41.7% |
|                                            | Dyslipidemia        | 68  | 16.9% |
|                                            | CHF                 | 12  | 3.0%  |

### 6.3 Prevalence of diabetic peripheral neuropathy and associated factors

In this study the overall prevalence of diabetic peripheral neuropathy was 28.5% (95% CI: 24.1% – 33%) among the study population. 18.5% of participants were had feet appearance abnormality and the most common abnormalities are dry skin, callus formation and deformities.

Following bivariate analysis, nine variables with a p-value less than 0.25 were selected as candidates for multivariable logistic regression analysis.

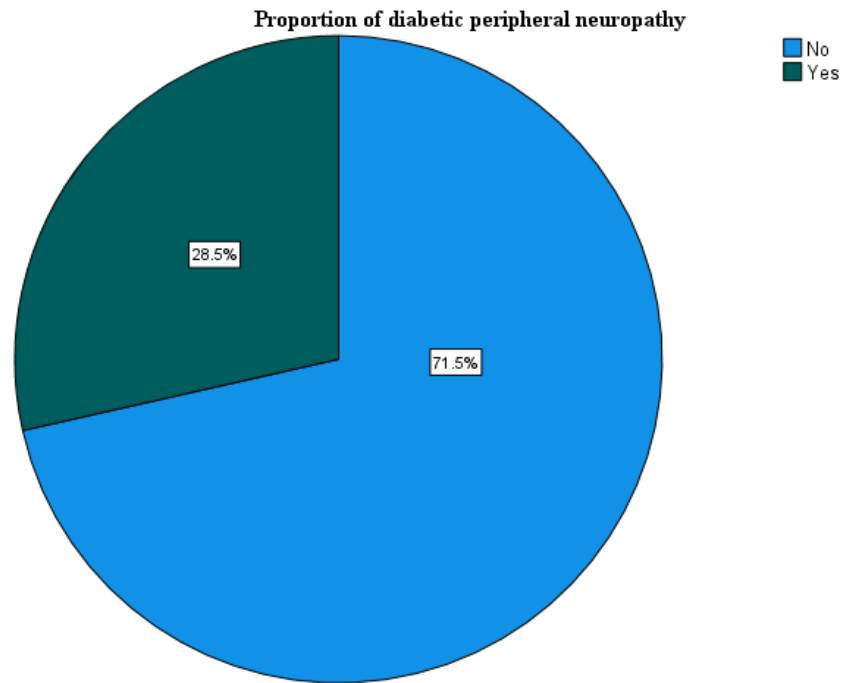
In multivariate logistic regression analysis, participants' educational status, alcohol consumption history, foot self-care practice (daily foot inspection), other diabetic complications, comorbidity, treatment regimen and physical activity status all had a statistically significant relationship with DPN.

Participants who consume Alcohol now or in the past were 4.33 times more likely to have DPN than individuals who never consume (95% CI: 1.71, 11.00). and physical inactivity were 3.22times more likely to develop DPN than those with physically active participants (95% CI: 1.23, 8.43).

Participants who had no formal education and attending up to primary education were 10.98 and 24.80 times more likely to develop DPN than those who attend college and above (95% CI: 1.66, 72.62) and (95% CI:3.25, 189.32) respectively. Participants who had Foot self-care practice (daily inspection) where reduced the risk to develop DPN by 64% than who were not.

Similarly, diabetic patients with comorbidity with HTN and Dyslipidemia were 4.63 and 2.79 times more likely to develop DPN than those with no comorbidity (95% CI: 2.14, 9.99) and (95% CI: 1.01, 7.66) respectively.

Finally, participants who had other complications like Diabetic retinopathy and DKD 8.04 and 8.98 times more likely to develop DPN than no other complications (95% CI: 1.53, 52.83) and (95% CI: 2.09, 30.91) respectively. and participants who is on insulin therapy only were 3.66 times more likely to develop DPN than who is on both insulin and oral hypoglycemic agents (95% CI: 1.32, 10.11).(Table 3).



*Figure 2 Proportion of diabetes peripheral neuropathy of type 2 diabetes mellitus patients on follow-up at TGSB in Bahir Dar, Ethiopia, 2026 (n = 403).*

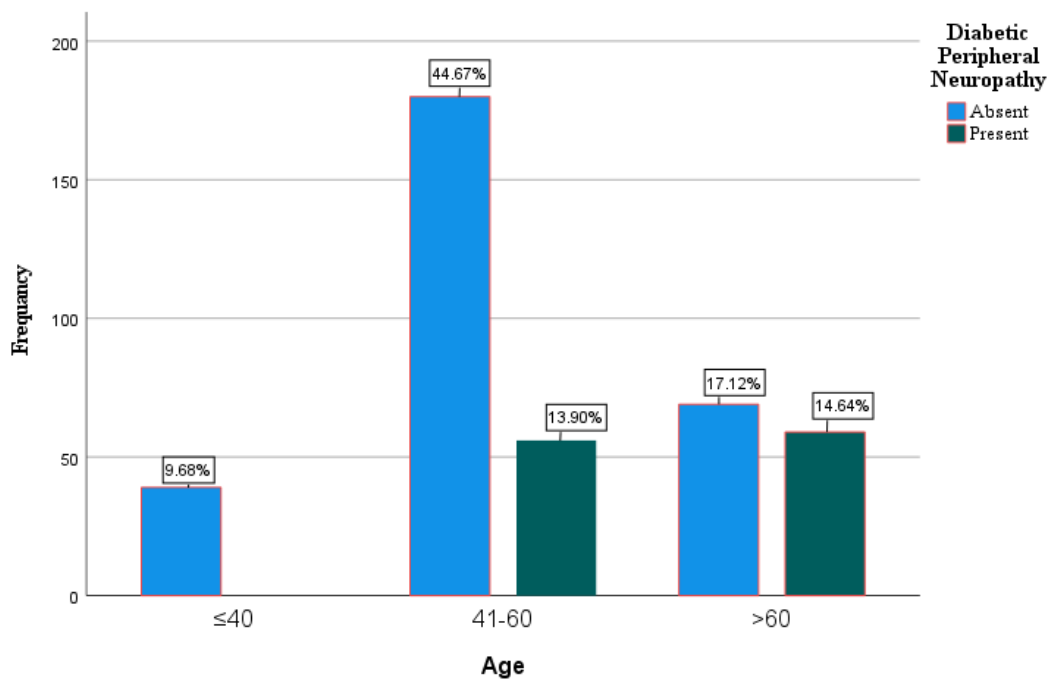


Figure 3 The age proportion of diabetic peripheral neuropathy among type 2 diabetes mellitus patients on follow-up at TGSB in Bahir Dar, Ethiopia, 2026 (n = 403).

Table 3 Factors associated with DPN in type 2 diabetes mellitus patients on follow-up at TGSH in Bahir Dar, Ethiopia, 2026 (n = 403).

| Characteristic<br>s                               | DPN         |             | COR [95%CI]          | AOR[95%CI]                     |
|---------------------------------------------------|-------------|-------------|----------------------|--------------------------------|
|                                                   | Yes (n=115) | No (n=288)  |                      |                                |
| <b>Sex</b>                                        |             |             |                      |                                |
| Male                                              | 77 (32.4%)  | 161 (67.6%) | 1.60 [1.02, 2.51] *  | 0.73[0.24,2.2]                 |
| Female                                            | 38 (23.0%)  | 127 (77.0%) | R                    | R                              |
| <b>Other Complications</b>                        |             |             |                      |                                |
| Yes                                               | 53 (51.5%)  | 50 (48.5%)  | 4.07[2.53, 6.56]***  | 0.67[0.22, 2.08]               |
| DKD                                               | 18 (85.7%)  | 3 (14.3%)   | 23.03[2.90, 49.7]*** | <b>8.98</b> [1.53, 52.83]*     |
| DRP                                               | 22(59.5%)   | 15 (40.5%)  | 5.63[1.10, 7.80]     | <b>8.04</b> [2.09, 30.91]**    |
| I. Stroke                                         | 2(20%)      | 8(80%)      | 0.96[0.20, 4.63]     |                                |
| IHD                                               | 11(33.3%)   | 22(66.7%)   | 1.92[0.88, 4.17]     | 0.70[0.08, 6.04]               |
| No                                                | 62 (20.7%)  | 238 (79.3%) | R                    | R                              |
| <b>Duration of DM</b>                             |             |             |                      |                                |
| ≥5                                                | 88 (35.5%)  | 160 (64.5%) | 2.61 [1.60, 4.26]*** | 1.83[0.95, 3.52]               |
| <5                                                | 27(17.4%)   | 128(82.6%)  | R                    | R                              |
| <b>Alcohol consumption</b>                        |             |             |                      |                                |
| Yes                                               | 102(31.5%)  | 222(68.5%)  | 2.33 [1.23, 4.42]**  | <b>4.33</b> [1.71, 11.00]**    |
| No                                                | 13(16.5%)   | 66(83.5%)   | R                    | R                              |
| <b>Foot self-care practice (daily inspection)</b> |             |             |                      |                                |
| Yes                                               | 82(24.6%)   | 252(75.4%)  | 0.36[0.21, 0.61]***  | <b>0.36</b> [0.17, 0.77]**     |
| No                                                | 33(47.8%)   | 36(52.2)    | R                    | R                              |
| <b>Physical exercise/Activity</b>                 |             |             |                      |                                |
| Active                                            | 78(22.5%)   | 268(77.5%)  | R                    | R                              |
| Inactive                                          | 37(64.9%)   | 20(35.1%)   | 6.36[3.50, 11.58]*** | <b>3.22</b> [1.23, 8.43]*      |
| <b>Treatment regimen</b>                          |             |             |                      |                                |
| OHA                                               | 66(25.0%)   | 198(75.0%)  | 0.77[0.46, 1.30]     | 0.68[0.30, 1.54]               |
| Insulin                                           | 20(46.5%)   | 23(53.5%)   | 2.01[0.96, 4.21]     | <b>3.66</b> [1.32, 10.11]*     |
| Mixed                                             | 29(30.5%)   | 67(69.8%)   | R                    | R                              |
| <b>Comorbidity</b>                                |             |             |                      |                                |
| No                                                | 18(11.6%)   | 137(88.4%)  | R                    | R                              |
| HTN                                               | 66(39.3%)   | 102(60.7%)  | 4.92[2.76, 8.80]***  | <b>4.63</b> [2.14, 9.99]***    |
| Dyslipidemia                                      | 23(33.8%)   | 45(66.2%)   | 3.89[1.93, 7.86]***  | <b>2.79</b> [1.01, 7.66]*      |
| HF                                                | 8(66.7%)    | 4(33.3%)    | 15.22[4.16,55.68]*** | 3.61[0.63, 20.55]              |
| <b>Educational Status</b>                         |             |             |                      |                                |
| No formal                                         | 39(25.7%)   | 113(74.3%)  | 1.07[0.63, 1.81]     | <b>10.98</b> [1.66, 72.62]*    |
| Primary                                           | 22(52.4%)   | 20(47.6%)   | 3.40[1.66, 6.97]***  | <b>24.80</b> [3.25, 189.32]*** |
| Secondary                                         | 20(28.6%)   | 50(71.4%)   | 1.24[0.65, 2.36]     | 2.57[0.83, 7.95]               |
| Higher Edu.                                       | 34(24.5%)   | 105 (75.5%) | R                    | R                              |

\*P value < 0.05; \*\*P value < 0.01; \*\*\*P value < 0.001

## 6. DISCUSSION

This health facility-based cross-sectional study intended to determine the prevalence of DPN and its correlates in adult patients with type 2DM. The overall prevalence of DPN among the study participants based on MNSI was 28.5% (95% CI: 24.1% – 33%) from the total of 403 participants.

This study result was in line with a study done in a tertiary care hospital in north India and Mulago hospital Uganda the overall prevalence of DPN was 29.2% and 29.4 % respectively (26, 29). The possible explanation for similarity of our study result with the study done in Uganda and India could be due to the use of the same tool and with the same study design.

On the other hand, the present study finding was higher than a study conducted in bangladesh, adama and a systematic review and meta-analysis done in Ethiopia which was 19%, 14.3% and 22% respectively (25, 31, 35). This variability might be due to small sample size for those study and difference in genetic predisposition and difference in health care qualities for bangladesh (south Asia).

However, the current study showed lower prevalence of DPN when compared to other studies reported from France, USA, Tanzania, Egypt, Jimma, Bahirdar (FHRH) and a multicenter study in Amhara Ethiopia with DPN prevalence of 50%, 65-75%, and 72.2%, 60.5%, 53.6%, 52.2% and 48.2% respectively (18, 19, 28, 30, 32-34). The higher prevalence of those studies could be due to difference in study settings, study period, sample size, study tool used, study design, divergence in socioeconomic status and genetic predisposition.

In agreement with other reports, this data showed that physical inactivity was found to be an independent predictor of DPN (32, 33, 34). The possible reason for this association might be that physical exercise can increase microvascular circulation, for release of neurotropic factors, attenuation of oxidative stress, and for physiological well-being of the body.

The finding of this study indicated that the odds of DPN were greater among DM patients with comorbidities like hypertension, dyslipidemia and diabetic related other complications, like diabetes retinopathy and nephropathy. This finding result was supported by previous studies (26, 28, 30, 34-36). It can be explained by the multifactorial nature of diabetes and its complications. Comorbid conditions such as hypertension, hyperlipidemia, and cardiovascular diseases often coexist with diabetes and contribute to the development and progression of DPN through various mechanisms. This may be due to increased oxidative stress, inflammation, activation of the

sympathetic nervous system, stimulation of the renin–angiotensin–aldosterone system, endothelial cell dysfunction, vascular rigidity leading to reduced blood supply to the nerve cell, slowed conduction, and axonal atrophy—each of these factors may contribute to the increased susceptibility to developing DPN as a result of comorbidities like hypertension and other macro and micro vascular complications of diabetes

The finding of this study indicated that the odds of DPN were greater among DM patients with low level of education as compared to who attend college and above (30). This could be explained by the difference in level of awareness about the nature of the disease, understanding diabetes self-care practice like unmanaged hyperglycemia and less frequent checkup.

The finding of this study indicated that the odds of DPN were greater among DM patients with who took alcohol now or in the past as compared to individuals who didn't drink (26). This is due to direct neurotoxic effects and worsening of glycemic control.

In line with other reports this study indicated that the odds of DPN were greater among DM patients with insulin only therapy than oral hypoglycemic therapy or both (25). This is likely due to insulin threatened diabetes usually have longer duration of disease, poor controlled disease, chronic hyperglycemia and high risk of microvascular damage.

Finally individuals who had good foot care practice or daily inspection had lower the risk of developing DPN than who hadn't. This is possibly due to early detection of minor injuries, prevents foot ulceration and infections.

While the 10g monofilament is considered the gold standard for assessing loss of protective sensation (LOPS), the Ipswich Touch Test (IpTT) was used in this study due to its documented strong correlation and high level of agreement with monofilament results. Research indicates that as sensation detected by the monofilament decreases, the ability to perceive the light touch of the IpTT similarly diminishes, making the IpTT a reliable surrogate in resource-limited settings.

## **7. STRENGTHS OF THE STUDY**

The study utilized the Michigan Neuropathy Screening Instrument (MNSI), a globally validated and reliable tool. This ensures that the results are comparable to other international and national studies. Conducted at a major academic and referral hub, the study captures a diverse patient. The study achieved a high participant response rate, which minimizes non-response bias and enhances the representativeness of the findings. Unlike studies that focus solely on clinical factors, this research integrated a broad range of predictors including socio-demographic, behavioral, and self-care factors offering a comprehensive view of DPN beyond just clinical markers.

## **8. LIMITATION OF THE STUDY**

Inferring casual association is difficult due to the cross-sectional nature of the study and lack of nerve conduction testing, which is the gold standard diagnostic test for confirmation of DPN diagnosis. The duration of diabetes as measured in this study might not reflect the true duration of the disease, but the time since diagnosis and actual diabetes onset might precede diagnosis in type 2 DM. The patient recall bias may be affecting the performance of the MNSI symptom score, lack of tuning fork and lack of standard 10g monofilament test tool.

## **9. CONCLUSION**

This study shows a notably prevalence of Diabetic Peripheral Neuropathy (DPN) of 28.5% among the studied population. The findings highlight a significant association between DPN and various predictors, specifically participants' educational status, alcohol consumption, the presence of comorbidities and other complications of diabetes, daily foot care practice and levels of physical activity. These relationships suggest that targeted strategies addressing these variables could be important in managing and potentially mitigating the impact of DPN.

## **10. RECOMMENDATION**

This study gives a clue to the magnitude and factors associated with diabetic peripheral neuropathy, so further studies need to be done both at hospital and population level. Clinicians should focus on screening and management of DPN to reduce the symptom burden and to prevent its complications. Finally endocrinology units should focus on prevention, screening, diagnosis and treatment of DPN. To overcome the current lack of 10g monofilament tools, the clinic should adopt the Ipswich Touch Test (IpTT) as a standard, no-cost screening alternative.

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## 12. ANNEXES

### 12.1. Annex I-Information sheet

Prevalence of peripheral neuropathy and associated factors among adults with type 2 diabetes in Tibebe Ghion comprehensive specialized hospital, northwest Ethiopia 2025.

**Name of Investigator:** Dr, Misganaw Mequaninet (Final year internal medicine Resident)

**Name of the Organization:** TGSH, Bahir Dar, Ethiopia.

**Introduction:** This information sheet is prepared for Tibebe Ghion comprehensive Specialized Referral Hospital so as to make the office clear about the purpose of research, data collection procedures and get permission to conduct the research.

**Purpose of the Research Project:** To study the Prevalence and associated factors of peripheral neuropathy among adult Type 2 diabetes patients at Tibebe Ghion comprehensive Specialized Hospital, Northwest Ethiopia, institutional based cross- sectional study 2025.

**Procedure:** In order to address the objectives, the data will be collected from patients' medical records and patient themselves (history and physical examination) after approval has been obtained from the institutional review board of the College of Medicine and Health Sciences, Bahir Dar University.

**Risk and/or Discomfort:** There is no risk or discomforts concern for study participants while the study is going to be obtained.

**Benefits:** The finding of the study will contribute to early screening and treating DPN among type 2 DM patients, ultimately leading to better patient outcomes.

**Confidentiality:** Confidentiality will be maintained at all levels of the study and personal identifiers won't be revealed at any point.

**Person to contact:** This research project will be reviewed and approved by the IRB of the College of Medicine and Health Sciences, Bahir Dar University. If you have any question, you can contact the principal investigator at any time with the following address.

Email: E-mail: [hareguamisga2020@gmail.com](mailto:hareguamisga2020@gmail.com)

Phone: +2519 18 12 99 77

## 12.2 Informed consent form

My name is \_\_\_\_\_ I am conducting research on prevalence of peripheral neuropathy and associated factors among adults with type 2 diabetes in Tibebe Ghion comprehensive specialized hospital, northwest Ethiopia 2025.

The research project is approved by the research ethics committee of school of medicine. Your participation is purely based on willingness and you have the right to choose not to participate in this study. If you choose to take part, you have the right to stop at any time.

If you agree to participate in this study, you will be asked to answer some questions about yourself and the information that you provide will be kept confidential by using only code numbers and locking the data.

Based on the understanding of the information I gave you, are you willing to participate in this study?

Yes

\_\_\_\_\_

No

### 12.3. Checklist used during data collection

#### Section1. Socio-demographic characteristics Card No \_\_\_\_\_

| S. No | Questions          | Response and Coding                                                                                          |
|-------|--------------------|--------------------------------------------------------------------------------------------------------------|
| 1     | Age in years       | _____                                                                                                        |
| 2     | Sex                | 1. Male<br>2. Female                                                                                         |
| 3     | Residence          | 1. Rural<br>2. Urban                                                                                         |
| 4     | Occupation         | 1. Student<br>2. Government employee<br>3. Merchant<br>4. Housewife<br>5. Farmer<br>6. Retired /daily worked |
| 5     | Educational status | 1. No formal education<br>2. Primary<br>3. Secondary<br>4. College and above                                 |
| 6     | Marital status     | 1. Single<br>2. Married<br>3. Divorced<br>4. Widowed                                                         |
| 7     | Monthly In come    | .....In Birr                                                                                                 |
| 8     | Religion           | 1. Orthodox<br>2. Muslim<br>3. Protestant<br>4. Others                                                       |

## Section 2: Clinical and behavioral data

| S. No     | Questions                                        | Response and Coding                                                                                                        |
|-----------|--------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| 9         | Duration of DM                                   | ----- in yrs.                                                                                                              |
| 10        | FBS                                              | -----mg/dl                                                                                                                 |
| 11        | <b>HgA1c</b>                                     | -----%                                                                                                                     |
| <b>12</b> | Presence of other Diabetic related Complications | 1. Yes<br>2. No                                                                                                            |
| <b>13</b> | If yes for Q12                                   | .....                                                                                                                      |
| 14        | Alcohol consumption                              | 1. Never consumed<br>2. Took some in the past (not now)<br>3. Takes occasionally (now)<br>4. Fairly often<br>5. Very often |
| <b>15</b> | Foot self-care practice (Daily inspection)       | 1. Yes<br>2. No                                                                                                            |
| <b>16</b> | History of foot ulcer                            | 1. Yes<br>2. No                                                                                                            |

|           |                   |                                                                                                                                       |
|-----------|-------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| <b>17</b> | Smoking history   | 1. Never<br>smoked<br>2. Smoked in<br>the past (not<br>now)<br>3. Smokes<br>occasionally<br>(now)<br>4. Fairly often<br>5. Very often |
| <b>18</b> | BMI               | ..... Kg/m <sup>2</sup>                                                                                                               |
| <b>19</b> | Physical exercise | 1, Physically active<br>2. Physically inactive                                                                                        |
| <b>20</b> | Treatment regimen | 1. Oral<br>hypoglycemic<br>agents<br>2. Insulin<br>3. Both                                                                            |
| <b>21</b> | Comorbidities     | 1. HTN<br>2. Dyslipidemia<br>3. Chronic heart<br>failure<br>4. Others....                                                             |

## Appendix A: Michigan Neuropathy Screening Instrument

### A. History to be completed by the person with diabetes

Please take a few minutes to answer the following questions about the feeling in your legs and feet.

Check yes or no based on how you usually feel. Thank you.

| No  | Questions                                                                                | Yes | No |
|-----|------------------------------------------------------------------------------------------|-----|----|
| 1.  | Are your legs and/or feet numb?                                                          |     |    |
| 2.  | Do you ever have any burning pain in your legs and /or feet?                             |     |    |
| 3.  | Are your feet too sensitive to touch?                                                    |     |    |
| 4.  | Do you ever have any prickling feelings in your legs or feet?                            |     |    |
| 5.  | Does it hurt when the bed covers touch your skin?                                        |     |    |
| 6.  | When you get into the tub or shower, are you able to tell the hot water from cold water? |     |    |
| 7.  | Have you ever had any open sore on your feet?                                            |     |    |
| 8.  | Has your doctor ever told you that you have diabetic neuropathy                          |     |    |
| 9.  | Are your symptoms worse at night?                                                        |     |    |
| 10. | Do your legs hurt when you walk?                                                         |     |    |
| 11. | Are you able to sense your feet when you walk?                                           |     |    |
| 12. | Is the skin on your feet so dry that it cracks open?                                     |     |    |

## B. Physical examination version

### Foot Examination Form

|                                                                |                                                                                                              |                  |                                                                                                              |
|----------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|------------------|--------------------------------------------------------------------------------------------------------------|
| 1. Appearance of Feet                                          |                                                                                                              |                  |                                                                                                              |
| <b>Right Foot:</b>                                             | 1. Appearance of Right foot.<br>A. Normal<br>B. No                                                           | <b>Left Foot</b> | 1. Appearance of Left foot.<br>C. Normal<br>D. No                                                            |
|                                                                | B. If no, check all that apply:<br>Deformities<br>Dry skin, callus<br>Infection<br>Fissure<br>Other (Specify |                  | B. If no, check all that apply:<br>Deformities<br>Dry skin, callus<br>Infection<br>Fissure<br>Other (Specify |
| 2. Ulceration                                                  |                                                                                                              |                  |                                                                                                              |
| Rt                                                             | 1. Absent<br>2. Present                                                                                      | Lt               | 1. Absent<br>2. Present                                                                                      |
| 3 Ankle Reflexes                                               |                                                                                                              |                  |                                                                                                              |
| Rt                                                             | 1. Present<br>2. Present with reinforcement<br>3. Absent                                                     | Lt               | 1. Present<br>2. Present with reinforcement<br>3. Absent                                                     |
| 4. Vibration (Perception at great toe)                         |                                                                                                              |                  |                                                                                                              |
| Rt                                                             | 1. Present<br>2. Reduced<br>3. Absent                                                                        | Lt               | 1. Present<br>2. Reduced<br>3. Absent                                                                        |
| 5,10g Monofilament (Number of applications detected out of 10) |                                                                                                              |                  |                                                                                                              |
| Rt                                                             | 1. Present ( $\geq 8$ )<br>2. Reduced (1–7)<br>3. Absent (0)                                                 | Lt               | 1. Present ( $\geq 8$ )<br>2. Reduced (1–7)<br>3. Absent (0)                                                 |

Name of data collector: \_\_\_\_\_

Signature: \_\_\_\_\_

Date of data collection: \_\_\_\_\_

I, the under signed, declared that this is my original work, has never been presented in this or any other University, and that all the resources and materials used for the research, have been fully acknowledged.

Principal investigator

Name: Dr. Misganaw Mequanint Demeke/Final year IMR/

Signature: [Signature]

Date: 02/02/17

Advisors

Name: Dr. Tewodros Ayenew (MD, Internist)

Signature: [Signature]

Date: 7/8/2018

