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ORIGINAL RESEARCH

Prevalence and Associated Factors of Carpal Tunnel Syndrome Among Diabetic Patients in Arba Minch General Hospital, South West Ethiopia, 2021

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Purpose of the Study: This study aimed to assess the prevalence of carpal tunnel syndrome and associated factors among diabetic patients in Arba Minch General Hospital, Southwest Ethiopia. Carpal tunnel syndrome (CTS) is the second most common cause of absence from work which causes functional loss of the hands and leads to disability. However, it is understudied among diabetic patients in Ethiopia.

Patients and Materials: An institution-based cross-sectional study was conducted from May 1 to October 1, 2021. Systematic random sampling method was used to select 353 study participants. CTS-6 Evaluation tool was applied to assess carpal tunnel syndrome. The data was coded and entered into Epi-Data version 3.1 statistical packages and exported to SPSS version 25 for analysis. Binary logistic regression model was applied to assess the association between outcome variable and independent variables. Odds ratio (OR) with 95% CI and p-values <0.05 were used to identify significantly associated factors with an outcome variable.

Results: The study was conducted among 353 diabetic patients. The cumulative prevalence of carpal tunnel syndrome among diabetes was 3.1%. CTS was statistically significantly associated with high body mass index; AOR=0.34 (0.12, 0.97, 95% CI) (p=0.04. Majority of participants 322 (91.2%) had type 2 DM. Mean fasting blood sugar level ± standard error of study participants was 157.52 ± 1.91 mg/dl.

Conclusion: The prevalence of carpal tunnel syndrome was relatively low. High body mass index (BMI) was significantly but negatively associated with carpal tunnel syndrome compared to diabetic patients with normal BMI. Diabetic patients with normal BMI should be screened for CTS for early management of the disease and prevention of further complications. Further investigations are recommended.

Keywords: diabetes, carpal tunnel syndrome, body mass index, musculoskeletal disorder

Introduction

Diabetes mellitus describes a group of metabolic disorders characterised by high blood glucose levels. Diabetes mellitus is a major public health problem worldwide which is resulting in higher medical care costs, reduced quality of life and increased mortality. The major driver of diabetes costs is the treatment of the related complications. Musculoskeletal complications have been reported in about 36–75% of diabetic patients.[1,2]

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Carpal tunnel syndrome is one of musculoskeletal disorder associated with diabetes next to shoulder capsulitis, Dupuytren's contracture and limited joint mobility.[3] Carpal tunnel syndrome (CTS) is a constellation of symptoms and signs resulting from the compression of the median nerve inside the carpal tunnel at the wrist, which results in functional impairment and local ischemia of the nerve within the tunnel. It is common condition in patients with type 1 and type 2 diabetic patients.[4,5]

The origin of CTS is often unknown in many cases. Symptoms of CTS include pain, paraesthesia and weakness in the hand, especially in the first three fingers at nights which may travel up the arm toward the shoulder.[6]

According to the US Bureau of Labor Statistics, there were 16,440 cases of CTS involving lost work days in 2005. It comprised the second most common cause of absence from work.[7] A study conducted by Rochester in Minnesota on Conditions associated with carpal tunnel syndrome had estimated that standardized morbidity ratio of Carpal Tunnel Syndrome was 2.3 for diabetes mellitus.[8]

Studies conducted in United Kingdom, Dhaka, India, Saudi, Moroccan and Gondar, Ethiopia showed the prevalence of carpal tunnel syndrome among diabetes was 20%, 26%, 19.8%. 6.7%, 8.8% and 29.2% respectively.[9–14]

A study conducted in Turkey on Carpal tunnel syndrome and metabolic syndrome had shown that CTS was commonly associated with conditions such as obesity, diabetes mellitus, smoking, overuse-type injuries caused by repetitive motion, pregnancy, hormonal replacement therapy and corticosteroid use.[15,16] According to a cross-sectional study conducted at the National Center for Diabetes, Endocrinology and Genetics in Amman, Jordan, female gender, old age, duration of diabetes, hypertension were significantly associated with hand disorders in T2DM (2).

But the issue of CTS is understudied in Ethiopia particularly regarding the prevalence of carpal tunnel syndrome among diabetes and its determinants. So, this study aimed to assess the prevalence of carpal tunnel syndrome and its associated factors among diabetic patients.

Methods

Study Area and Period

This study was conducted at Arba Minch General Hospital, Southern Ethiopia. Arba Minch town is the capital city of Gamo zone. The town is located at a distance of 275 Km and 505 km from the regional city, Hawassa and the country capital city, Addis Ababa respectively.

Arba Minch General Hospital serves approximately two million people and provides services such as outpatient treatment, inpatient, emergency, ophthalmic, dental, obstetrics and gynecology with different diagnostic modalities. It also provides chronic disease follow-up services, which include routine diabetics and hypertension case follow up. This study was conducted from May 1 to October 1, 2021.

Study Design

Institutional based cross-sectional study design was applied.

Population

The source populations of the study were all diabetic patients who have follow up at diabetic clinic of Arba Minch General Hospital and the study populations were all selected diabetics patient who have follow up at diabetic clinic during data collection period and met inclusion criteria. All diabetic patients who have had routine follow up for 6 months and above at Diabetes Clinic of Arba Minch General Hospital were included in the study. However, DM patients whose age was less than 18 years, patients with a history of hand trauma, epilepsy, chronic liver disease, family history of DC, recent fracture or injuries, patients who had comorbidities that can cause similar symptoms with CTS, like lesion in the CNS, cervical region, ulnar nerve, or radial nerve and patients previously undergone surgery to the shoulder and non-conscious subjects were excluded.

Sample Size Determination and Sampling Procedure

Sample Size Determination

The sample size was determined using single population proportion statistical formula at 95% of confidence interval with prevalence of carpal tunnel syndrome, (p= 29.2%) and d=5%.[14] After adding 10% non-response rate; the final sample size was 353.

Sampling Technique and Procedure

Study subjects were selected by using systematic random sampling technique. Initially, there were 800 diabetic patients who have had chronic diseases follow up of 6 months and above at Arba Minch Hospital. Fortunately, all of (800) diabetic patients fulfilled the inclusion criteria of the study. Due to budget or resource constraint we have been facing, we randomly selected 353 study subjects using systematic random sampling interval formula;

K=N/n=800/353 =2.3 =2, where "K" is an interval of random selection of study samples; "N" is source of population, which the study samples drawn from and "n" is the calculated sample size for this study. As a result, study subjects were selected at every second interval of patients coming to diabetic clinic for follow up. The first study participant was selected randomly by lottery method.

Variables

Dependent Variable

Carpal tunnel syndrome (yes or no)

Independent Variables

- Socio demographic: Age, sex, occupation, residence, religion, education.
- Diabetic related factors: Type of diabetes, duration of DM, FBS, type of medication/therapy.
- Other factors: Cardiovascular illness, body mass index (BMI), physical exercise.

Data collection tools and procedures

Semi-structured questionnaire, checklist and CTS-6 Evaluation tool were used to collect data. CTS-6 Evaluation tool was used to assess carpal tunnel syndrome which was confirmed by a trained physician. The CTS tool contains two components such as symptoms and history of CTS and physical examination sections. These were scored out of 26 total points. Patients with total score >12/26 without comorbidities that can cause similar symptoms with CTS were considered as positive for carpal tunnel syndrome.[22] Socio-demographic data and physical exercise status of all study participants were collected using interviewer administered questionnaire Document review of every study participant was also done to collect data related to concomitant disease and diabetic related conditions like medication type, duration of DM and type of DM. One BSC nurses, two laboratory technicians, one health officer, and a physician were recruited for data collection.

After we got consent from study participants for laboratory measurements, the laboratory technician has drawn three rounds of 5mL blood after overnight fasting of 8–10 hour for determination of FBS; then average FBS was taken. Lipid panel (Total cholesterol, HDL-c and Triglyceride) was also determined. Sample was collected by an experienced laboratory technician. Laboratory analysis was carried out by senior laboratory technician.

Measurement

Weight was measured using WHO standard weighing scale at precision of 0.1 kg with study subjects dressed light clothes. Height was measured using stadiometer in centimeters in erect position at precision of 0.1 cm without shoe. Then BMI was calculated by the formula; mass (kg)/height^2 (m).

Data Quality Control

Two day intensive training was given for data collectors on the data collection tool and how to review documents. An internist was assigned as a supervisor. The collected data was repeatedly entered into Epi data software version 3.1. With

two data clerks independently and the investigator checked consistency between the two data sets. Pretest was done among 5% sample size at Jinka hospital to test the consistency of the questionnaire and checklist.

Operational Definitions

Carpal tunnel syndrome positive; are patients who scored >12/26 for CTS-6 evaluation tool and without comorbidities that can cause similar symptoms with CTS.[22]

- Body Mass Index –was assessed according to WHO (2020) standard that describe underweight (when BMI is <18.49 kg/m^2), normal body weight (when BMI is 18.5–24.9 kg/m2), Pre-obesity (when BMI of 25–30 kg/m 2), and obesity (when BMI ≥30 kg/m ^{2}).

Data Processing Analysis Procedures

The collected data was checked for its completeness, coded and entered into Epi-Data version 3.1 statistical packages then exported to SPSS version 20 for further analysis. Inconsistent values were double checked against the filled data extract format and corrected as necessary. Bivariate logistic regression analysis was applied to determine independent variables associated with CTS. Independent variables which were found to have association with CTS with p-value <0.25 and/or variables showed association with CTS in previous studies were transferred to multivariable logistic regression to control for the effect of confounders. Finally, significantly associated independent variables at p-values < 0.05 were identified based on the adjusted odds ratio (AOR), with 95% CI.

Ethical Consideration

Ethical clearance was obtained from Institutional Ethics Review Board of college of medicine and health sciences; Arba Minch University. This ethical clearance and support letter was submitted to selected hospitals.

Study participants were informed about the purpose of the study. Verbal consent was obtained from each study subjects before collection of blood samples and other relevant clinical information. Study participants were recruited only based on their consent and the inclusion and exclusion criteria apart from any form of discrimination. Security and confidentiality of detail clinical and laboratory finding data was kept carefully by using code for identification. The study complies with the Declaration of Helsinki.

The participants were ensured to be free from any coercion, under inducement, influence or intimidation. The only potential risk was a little pain due to vein puncture and consumption of time of participant during the data collection. The participants have had the right to withdraw from the study whenever they feel inconveniences.

The results of participants with CTS were linked to the attending physician for appropriate treatment and management. The leftover sample of the participants was decontaminated and disposed according to waste disposal protocol of respective laboratories immediately after investigation of the research parameters.

Result

Socio-Demographic Characteristics

Data was collected from 353 study subjects; of which 195 (55.2%) were female. The mean age (± standard deviation) of study subjects was 51.34 (± 14.07) years. Most of the participants; 227 (64.3%) were urban dwellers and 113 (32.0%) of participants did not have completed formal education. The majority of the study subjects; 146 (41.4%) were house wives (Table 1).

DM Related and BMI Characteristics of Study Participants

Almost majority of study participants; 322 (91.2%) had type 2 DM. The mean duration of diagnosis for diabetes was 4 (± 4.95) years. 289 (81.9%) of these study participants have less than 10 years of duration since diagnosed with DM. The mean fasting blood sugar (FBS) (± standard error) of study participants was 157.52 (± 1.91) mg/dl; 276 (78.2%) of subjects have FBS leve l ≥130 mm/dl, which implies that more than two-third of subjects have uncontrolled serum glucose (Table 2).

Table 1 Socio-Demographic Characteristics of Study Subjects for Prevalence and Associated Factors of Carpal Tunnel Syndrome Among Diabetic Patients on Follow-Up in Arba Minch General Hospital, Southwest, Ethiopia, 2021

Variables	Frequency	Percent
Sex		
Female	195	55.2
Male	158	44.8
Total	353	100
Age in years		
< 45	105	29.7
≥ 45	248	70.3
Total	353	100
Residence		
Rural	126	35.7
Urban	227	64.3
Education		
No formal education	113	32.0
Primary education	97	27.5
Secondary education	66	18.7
College and above	77	21.8
Total	353	100.0
Occupation		
Farmer	43	12.2
Government employer	101	28.6
House wife	146	41.4
Private	41	11.6
Unemployed	22	6.2

More than two-third; (75.9%) of the study subjects were using oral hypoglycemic medications followed by insulin; 59 (16.7%) and combined (oral hypoglycemic medications and insulin) 25 (7.1%). Out of the total study subjects; 82 (23.2%) had diagnosed with cardiovascular complications. More than half of study participants 187 (53.0%) were overweight (Figure 1).

Most of study participants 309 (87.5%) have not physical exercise of 15 minute or more a day per one week (Figure 2). Approximately all subjects 349 (98.9%) were right hand dominant.

Prevalence of Carpal Tunnel Syndrome in the Study Participants

The overall cumulative prevalence of carpal tunnel syndrome among study participants was 3.1%. CTS was prevalent among type 2 diabetic patients 11 (3.1%). The age specific prevalence of CTS was noted in age group of forty five years and above 7 (1.9%).

The prevalence of CTS was 2.5%, 2.2%, 1.9% and 1.6% among study participants with less than 10 year duration of DM diagnosis, female, serum FBS level greater than 130mg/dl and house wives respectively (Table 2).

All independent variables in this study were included in a bivariate logistic regression analysis model and they were tested for their crude association with CTS. Sex, age, educational status, duration of diabetes illness and FBS level were associated with Carpal tunnel syndrome in the previous studies and high BMI showed crude association with Carpal

Table 2 Diabetic and Other Health Related Characteristics of Study Subjects for Prevalence and Associated Factors of Carpal Tunnel Syndrome Among Diabetic Patients on Follow-Up in Arba Minch General Hospital, Southwest, Ethiopia, 2021

Variables	Frequency	Percent
Type of diabetic mellitus		
Type 2	322	91.2
Type one	31	8.8
Type of medication		
Oral drug	268	75.9
Both	25	7.1
Insulin	59	16.7
Duration of DM		
<10 years	289	81.9
10–19.99 years	57	16.1
≥20 years	7	2.0
Total	353	100.0
CVD complication		
Yes	82	23.2
No	271	76.8
Total	353	100.0
Average FBS		
80–129.99	77	21.8
≥130	276	78.2
Total	353	100.0

tunnel syndrome at ($p<0.25$). However, among these variables included into multivariate logistic regression analysis, high BMI was statistically significantly associated with CTS; ($p<0.04$); AOR=0.34 (0.12, 0.97, 95% CI) (Table 3).

Discussion

Diabetes mellitus has been linked to a variety of musculoskeletal disorders. These disorders have paid less attention mostly, yet they could be marker of severe micro vascular complications.[2]

The carpal tunnel syndrome is one of the major problems in diabetes mellitus characterized by paresthesia, pain, and burning sensation over the median nerve cutaneous distribution of the thumb, index, middle, and lateral half of the ring fingers, which is often worse at night and relieved by hanging the arm down or shaking the hand.[17] Swelling within the carpal tunnel can cause compression of the median nerve and resultant inflammation causes further nerve compression. Carpal tunnel syndrome is one of the most frequent entrapment neuropathies of the upper limb.[10] The clinical carpal tunnel syndrome-6 (CTS-6) diagnostic tool was used in this study.

According to this study, the prevalence of carpal tunnel syndrome among diabetic patients was 3.1%. This result is lower than studies conducted in Amman, Jordan and Iran which included 1000 patients with T2DM (5.5%) (2) and 432 diabetic patients (8.56%)[18] respectively. These variations might be due to large number of sample sizes used in the

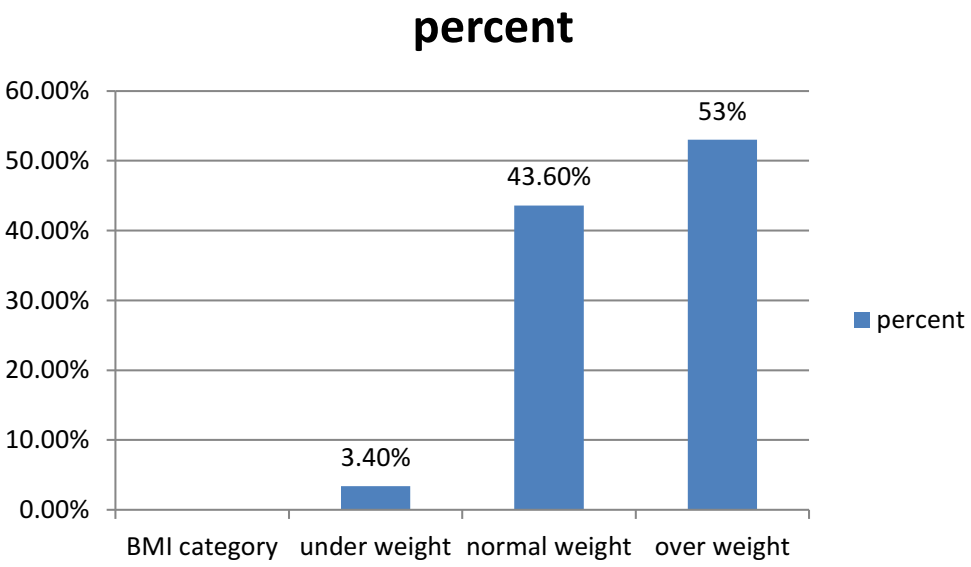

Figure 1 BMI category of study subjects for prevalence and associated factors of carpel tunnel syndrome among diabetic patients on follow-up in Arba Minch General Hospital, Southwest, Ethiopia, 2021.

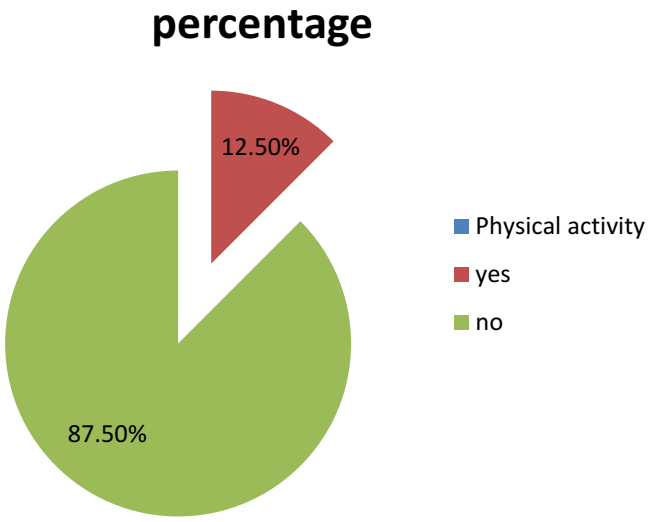

Figure 2 Physical activity status of study subjects for prevalence and associated factors of carpel tunnel syndrome among diabetic patients on follow-up in Arba Minch General Hospital, Southwest, Ethiopia, 2021.

previous study could increase the prevalence of CTS as compared to the current one which has included 352 diabetic patients.

Similarly other studies conducted in United Kingdom, Saudi Arabia, India, Bangladesh and Ethiopia among 96,252,106,354 and 301 diabetic patients respectively, the prevalence of CTS was (20%),(6.7%),((19.8%),(26%) and (29.2%) respectively[9–12,14.] All these results showed a higher prevalence than the current study prevalence. These variations might be due to the CTS evaluation tools or diagnostic criteria used in this study might underestimate the prevalence of CTS. The genetic variations and life style differences among peoples of Ethiopia and these nations might be also the possible cause of variation.

In contrast, the prevalence of CTS in this study was higher than studies conducted in Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia (1%).[3] This variation might be due to use of the less specific diagnostic tests (Tinel's or Phalen's sign) of CTS in the previous study may under estimate the prevalence of CTS.

Table 3 Multivariable Logistic Regression Model of Prevalence and Associated Factors of Carpal Tunnel Syndrome Among Diabetic Patients on Followup in Arba Minch General Hospital, Southwest, Ethiopia, 2021

Variables	COR (95% CI)	AOR (95% CI)	P-value
Sex			
Female	0.45(0.1,1.74)	2.8(0.64, 12.12)	0.17
Male	1	1	
Age in years			
< 45	1	1	
≥ 45	0.99(0.94,1.03)	0.92(0.22, 3.77)	0.91
Education			
No formal education	0.19(0.02,1.81)	1.7 (0.16, 17.95)	0.16
Primary education	0.55(0.13,2.29)	0.94(0.07,12.04)	0.96
Secondary education	0.32(0.08,1.83)	5.1(0.52,5.2)	0.15
College and above	1	1	
Serum FBS			
FBS average	0.43(0.12,1.57)	1(0.98,1.02)	0.2
Body mass index			
High BMI	0.39(1.02,1.6)	0.34(0.12,0.97) **	0.04
Normal BMI	1	1	
Duration of DM			
DM duration	0.33(0.19,2.31)	0.9(0.22, 3.98)	0.92

Notes: Foot note; COR (95% CI); crude odds ratio at 95% confidence interval, AOR (95% CI); adjusted odds ratio at 95% confidence interval, **Statistically significant variable at p-value <0.05.

Abbreviations: AC, Adhesive capsulitis; BMI, Body Mass Index; CTS, Carpal Tunnel Syndrome; CTS-6, Carpal tunnel syndrome-6; DC, Dupuytren's contracture; DPN, diabetic polyneuropathy; DM, Diabetes mellitus; FBG, Fasting blood glucose; IDF, International Diabetic Federation; MSD, musculoskeletal disorder; MSS, Musculoskeletal; OPD, outpatient department; SC, shoulder capsulitis; TG, Trigger finger; WHO, World Health Organization.

According to the current study finding, high BMI was significantly but negatively associated with carpal tunnel syndrome among diabetes. This finding is in contrast with a study conducted in Bangladesh among 354 diabetes which showed that BMI was significantly ($p < 0.05$) positively associated with CTS[10] and a study conducted in Italy among 117 CTS cases found a close positive association between BMI and CTS ($p = 0.005$).[19] These differences possibly might be due the clinical diagnostic tool used in the current study may fail to diagnose CTS cases among subjects with normal BMI might results this associations. Moreover, study subjects of this study lies in the age range of 45 years and above, who might be vulnerable to degeneration of carpal ligaments; this may causes compression and entrapments of median nerve. This might cause the CTS among patients with normal BMI. However, it needs further investigations.

In contrast to the present study finding, another case control study conducted on 514 patients who underwent a carpal tunnel release procedure also showed that CTS was significantly high among patients who were obese ($p = 0.02$; odds ratio, 1.77).[20] This might be due to the fact that the previous study might have included large number of obese patients with CTS. Moreover, this association might occur due to diagnosis tool used in this study might underestimate CTS cases among obese patients.

Another large scale study in UK showed that obesity (OR = 2.06) was a risk factor associated with CTS[21] which contradicts the present study. These might be due to the previous study has included 3391 confirmed CTS cases of which 72% were women this might increase the frequency of obese subjects with CTS. In contrast to present study, a study in India among 106 DM patients also showed that BMI was not associated with CTS.[11] This difference might be due to small sample sizes used in the previous study, which may alter the frequency of occurrence of the case (CTS) with respect to predictor variable (BMI).

The present study finding does not showed any association between CTS and age, sex and duration of DM. In contrast to this finding, a study conducted in Iran among 432 diabetic patients showed that CTS was significantly associated with advanced age ($p<0.032$, female sex ($p<0.002$) and duration of DM ($p<0.007$)[18]. These differences might be due to high sample sizes used in the previous study.

Besides, a similar study showed that CTS was significantly associated with poor glycemic control at $p<0.0003$,[18] which opposes the current study, which might be due to large sample size used in the previous study compared to the current.

However, in line with the present study, a study conducted in India showed that duration of DM was not associated with CTS ($p=0.13$).[11] These similarities might be due to average duration of DM among most of the study subjects in both studies ranges from 5 to 10 years; when the CTS might be at its asymptomatic stage in these study subjects.

According to studies conducted in Gondar, Ethiopia among 301 subjects with DM and Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia, sex of male ($p<0.05$), type 1 DM ($p=0.009$), and greater than 10 years duration of diabetes showed significant association with musculoskeletal disorders among diabetic patients[3,14] which contradicts the current study finding showing that all these variables did not show any association with CTS. All of the variations might be due to the fact that the previous studies have included all musculoskeletal disorders as outcome variables so that the association between CTS and risk factors may be affected by other outcome variables.

Besides almost all study subjects in the current study were type 2 diabetes unlike the two previous studies and the proportion of study subjects who have greater than 10 years duration of diabetes were low in the current study.

Limitations of the Study

- This study was limited to use clinical diagnosis method of CTS which did not included electrophysiological confirmatory diagnosis method of CTS due to unavailability of the test in the study area.
- This study does not show cause-and-effect relationship between BMI and CTS.
- Resource or budget constraints.
- Diagnostic tool related bias.

Conclusion

The prevalence of carpal tunnel syndrome among diabetic patients was low. High body mass index (BMI) was significantly but negatively associated with Carpal tunnel syndrome compared to diabetic patients with normal BMI. So, high BMI was associated with a less likelihood of developing carpal tunnel syndrome among diabetic patients in this study. This implies diabetic patients with normal BMI are likely to be affected by CTS. So that they should be screened for CTS in routine diabetic follow ups to identify patients at high risk of developing CTS for early management and prevention of further complications. Further investigations are needed to see the relationship between CTS and BMI.

Ethical Approval

The study complies with the Declaration of Helsinki and it was approved by the Institutional Ethics Review Board of Arba Minch University. The study participants were informed about the purpose of the study and informed verbal consent for participation and blood sample donation was obtained from study subjects before commencement of the study.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest for this work.

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