Micro Vascular Complications and Associated Factors Among Type Two Diabetic Patients in Adigrat and Wkuro General Hospitals, Northern Ethiopia: A Retrospective Cross-Sectional Study

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ABSTRACT

Background: Diabetes mellitus is the primary reason of death in developed countries and becoming an epidemic with serious complications in developing countries. Therefore, the aim of this study was to assess micro vascular complications and associated factors among type two diabetic patients in Adigrat and wkuro general hospitals, Northern Ethiopia.

Methods: An institutional based retrospective cross-sectional study design with record review of 420 diabetic patients was conducted at Adigrat and wkuro general hospitals from April –June/2019. Simple random sampling technique was used. Binary and multivariable logistic regression analysis were used to see the association of independent variables to the outcome variable at a $P < 0.05$.

Results: A total of 420 study participants were included in the study. The prevalence of micro vascular complications of type two diabetic patients was 19.5%. The predictor variables for micro vascular complications were sex [AOR (95%CI): 0.44(0.25, 0.77)], systolic blood pressure >140mmhg [AOR (95%CI): 6.9(1.71, 27.71)], LDL-C >100 mg/dl [AOR (95%CI): 3.7(2.002, 6.76)], positive protein urea [AOR (95%CI): 3.2(1.74, 5.99)] and TGL>150 mg/dl [AOR (95%CI): 2.2(1.04, 4.58)].

Conclusion: The prevalence of micro vascular complications was burden of public health. The health care providers should be control the identified factors through effective interventions.

Keywords: Micro vascular; Type two DM; DM patients

Abbreviations: CI: Confidence Interval; DM: Diabetes Mellitus: SPSS: Statistical Package for Social Sciences; ORS: Odds Ratios

BACKGROUND

Diabetes mellitus (DM) is a serious public health problem and one of the speedily increasing chronic diseases worldwide [1]. DM is not only the primary reason of death in developed countries, but it is also becoming an epidemic with serious complications in many resource-limited settings [2]. A person living with type 2 diabetes suffers from different problems such as morbidity and mortality risks, which are due to cardiovascular, renal and neurologic complications that affect multiple physiological systems [3]. Micro vascular complications include neuropathy, nephropathy and retinopathy [4]. It is the initial point for other macro vascular complications. The management of diabetes and its risk factors is reasonably simple and inexpensive. Treating complications, however, is costly, requiring providers with a high level of skill and specialized equipment. Therefore, prevention of complications is highly important [5]

DM is a major reason for blindness, kidney failure, heart attacks, stroke and lower limb amputation and almost 50% of all deaths attributable to high blood glucose occur before the age of 70 years in the United States [6]. According to W.H.O report, the number of adults with diabetes in the world is predicted to increase from one hundred fifty million in 2000 to three hundred million in

2025. In western countries, the number of diabetics will increase by about one third between 2000 and 2025, while in developing countries that number will be more than double. In 2025, more than three fourth of the world's diabetic population will be living in developing countries [7].

"Africa, like the rest of the world, is experiencing an increasing prevalence of diabetes alongside other non-communicable diseases, mainly as a result of urbanization, sedentary lifestyles, obesity and population growth and ageing." The largest increase of the population with diabetes will occur in sub-Saharan Africa, with an estimated growth of one hundred ten percent, from twenty million in 2013 to forty million in 2035 [8]. In Ethiopia, the prevalence of DM was 3.8% and it attributed to 1% death to all causes of death [9].

Studies showed that diabetes and its complications are among the common reasons for inpatient admissions, accounting for about 4.4% and 32.5% [10] total deaths. The prevalence of diabetic retinopathy ranges from 2.7% [11] to 13 % [12], nephropathy 20.5% [13] and neuropathy 14.4% [14] with the incidence of retinopathy 18.4, nephropathy and neuropathy 18.9 cases per 100-person year of observation [3] in Ethiopia.

Some of the common risk factors for the occurrence of vascular complications were gender [3,10,11,15,16], older age [9,12,13,16-18], long duration with diabetes [9,12,13,15-19,20], Hypertriglyceridemia [3,11,17,19], Impaired glucose tolerance [13,17,19], LDL & HDL [3,19], total cholesterol [16,17], hypertension [3,12,13,15,20], BMI [17,18,21,18,13], less physical activity (15,16,21), Protein urea [3,11], Smoking [15,16] and Family history [12, 17]. However, studies regarding complications and its related factors among type 2 diabetes in general and micro vascular in particular is highly scarce in Ethiopia. Therefore, the aim of this study was micro vascular complications and associated factors among adult type two diabetic patients in Adigrat general hospital, northern Ethiopia. This study will have a great contribution in developing prevention strategies to address the factors that increases the development of micro vascular complications among type 2 diabetic patients.

MATERIALS AND METHODS

Study area and period

The study was conducted in Eastern zone of Tigray Regional state, North Ethiopia. Tigray is bordered by Eritrea to the North, Sudan to the west, Afar Region to the east and Amhara Region to the south. According to the projected census of 2007, the Region had a total population of 4,806,843 of these; 2,441158 (50.8%) were women. In Eastern Zone, there were a total population of 755,343, of these, 395,705 were women. In eastern zone, there are two general hospitals that had a chronic follow up clinic (Adigrat and wkuro general hospitals) and seven primary hospitals. The hospitals give services for about 2.4 million people and there are about 1,620 diabetic patients following treatment monthly in the two general hospitals [35]. The study was conducted from April – June/2019among the selected health facilities.

Study design and population

A facility based cross sectional study was employed among type two diabetic patients. The source population for this study was all type two diabetic patients who had been attending at Adigrat and wkuro General Hospitals of Eastern zone, Tigray regional state. All randomly selected new type two DM patients who were free from micro vascular complications at treatment enrolment were the

study population. All type two diabetic patients who were newly diagnosed between December 30, 2008 and January1, 2019 and they were free from any micro vascular complications at start of treatment were the inclusion criteria. Type two diabetic patients who had incomplete medical records (missing>20%) and those who were developed vascular complications at starting of treatment were the exclusion criteria.

Sample size calculation and sampling technique

Sample s$_{n = \frac{(Za/2)^2 p(1-p)}{d^2}}$| using single population proportion formula, by considering the proportion of low density lipoprotein, p= 45.5%__46% [14], 95% level of confidence and 5% margin of error. By adding 10% of none response rate, the final sample size needed for the study was 420. Two general hospitals that had chronic follow up clinic in Eastern zone of Tigray regional state was selected purposively; namely wukro and Adigrat general hospitals. After taking a medical record number of diabetic patients from chronic follow up clinic, patient folder was taken from card room and HMIS record data by the health information technician. A total of 420 newly diagnosed type two diabetic patients who were free from micro vascular complications at start of treatment were selected by using consecutive sampling technique.

Study variables

The outcome variable for this study was micro vascular complications (Yes/No) and Socio-demographic and economic factors like (age, sex, marital status, residence, family history of DM), clinical and physiological characteristics: (Type of medication, Diabetic duration, high and low cholesterol level, blood pressure level, Level of glycemic control, BMI, protein urea, high and low density lipoprotein, cholesterol level and medication adherence were the independent variables.

Data collection tools and procedures

The questionnaire had socio demographic and economic conditions, clinical and physiological characteristics, behavioral related variables and micro vascular variables. The questionnaire was adapted from reviewing different literatures and considering the local situation of the study subjects. After taking a medical record number of diabetic patients from chronic follow up clinic, patient folder was taken from card room and HMIS record data by the health information technician. The data were collected using record reviews. The record reviews were done by four nurses and facilitated by two supervisors. Data of cohorts was extracted from medical records by using structured checklist. After completing data extraction, it was transferred to SPSS version 23 for cleaning, categorization and to check completeness and consistence.

Data quality control

The principal investigator trained the data extractors and supervisors for two consecutive days on instruction for the method; how to take informed written consent, how to approach participants, ethical procedure, and general information on micro vascular complications of type two DM and the objective of the study. The questionnaire was translated in to local language Tigrigna and back translated in to English by translators who were blind to the original questionnaire. The questionnaire was pre-tested on 5% of the study population in the non-selected institution to ensure clarity, wordings, logical sequence and skip patterns of the questions. After data collection, data were stored in a secured place to maintain confidentiality and backup of the data were stored in

different areas not to lose the data.

Statistical analysis

The collected data was coded, entered, cleaned and analyzed using SPSS version 23. Descriptive statistics was used to describe micro vascular complications among type two diabetic patients. Frequencies and percentages were used to present categorical data. To select the candidate variables, crude ORs and their 95% CI with the P<0.2 were estimated in the bivariate logistic regression analysis to include in the multivariable logistic regression model. After adjusted for confounders odds ratio with 95% confidence interval and p-value <0.05 were considered to declare statistically significant. Before inclusion of predictors to the final logistic regression model, the multicollinearity was checked using variance inflation factor (VIF) <10/Tolerance tests >0.1. The goodness of fit of the final logistic model was tested using Hosmer and lemeshow test at a value of >0.05.

Operational definitions: Micro Vascular complications: was dichotomized into having any micro vascular complications (Y=1) and not having any micro vascular complications (Y=0) if the type two diabetic patient is free of any vascular complication during the follow up period; Nephropathy: Is a kidney disease and the cause of renal failure, Neuropathy: the disease peripheral nervous system like sensory loss in the feet and Retinopathy: is a disease eye that causes vision problem or visual loss.

Body Mass Index (BMI): is measurement of Height-for-Weight Square can be divided as; Under- weight <18.5 kg/m2, Normal -weight 24-24.99 kg/m^2, Over-weight 25-29.99 kg/m^2, Obesity ≥ 30 kg/m2

Medication adherence: taking from patients' medical record having good medication adherence or poor medication adherence according the record.

Blood samples: are bloods taking for laboratory examination, which is used to know health status of type two patients of blood plasma glucose level. Glycemic control: Good glycemic control is defined as fasting blood sugar (FBS) <126 mg/dl.

Hypertension: the blood pressure level ≥ 140/90 mmHg taken from secondary data on Hospital medical records. High-density lipoproteins (HDL) cholesterol level <40 mg/dl or ≥ 40 mg/dl measurement. Low density lipoproteins (LDL-C) cholesterol level ≤ 100 mg/dl or >100 mg/dl measurement. **Blood glucose level:** Fasting is defined as no caloric intake for at least 8with plasma glucose (FPG) ≥ 126 mg/dl or random plasma glucose ≥ 200 mg/dl is recorded as poor glycemic control and fasting blood sugar (FBS) <126 mg/dl or random plasma glucose <200 mg/dl is recorded as good glycemic control measurements.

Ethical consideration

Adigrat University College of health sciences was approved the study and formal letter of permission was obtained from Tigray Health Bureau. Official letter of co-operation from the above organization was written to the respective facility. There is no potential risk that may cause any harm to respondents. The importance of the study was explained to the participation of the study and informed consent was requested from the institution before data collection.

RESULTS

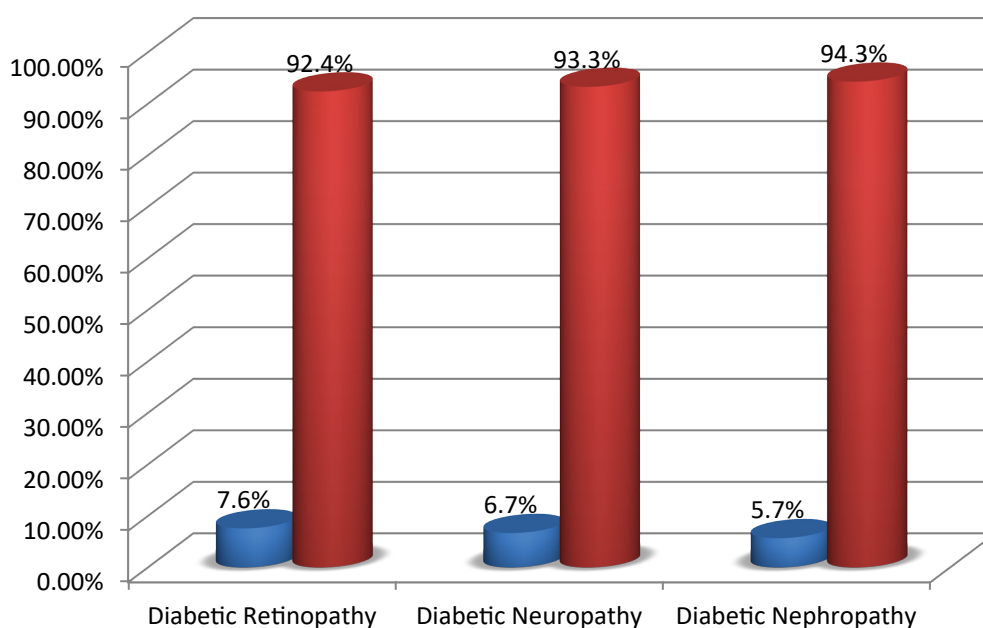## Characteristics of type two diabetic patients

A total of 420 study participants were included in the study with a report data completes of 100%. Two hundred nineteen (52.1%) of the study participants were female. One hundred seventy two (40.9%) of respondents were urban residence. About 411(97.9%) of the study participants were on oral hypoglycemic agents. Seventy (16.7%) of the patients had positive protein urea. About 366(87.1%) of the patients had HDL-C level >40 mg/dl and 102(24.3%) had LDL-C >100 mg/dl. Sixty (14.3%) of the study participants had triglyceride level >150 mg/dl (Table 1).

Micro vascular complications of type two diabetic patients

Table 1: Sociodemographic, clinical and physiological characteristics of respondents, Adigrat and Wkuro General Hospital, Tigray Region, North Ethiopia, 2019.

Variables		Micro vascular complications	
		Yes	No
Sex	Male	50 (24.9%)	151 (75.1%)
	Female	32 (14.6%)	187 (85.4%)
Age	≤ 60 years	46 (17.9%)	211 (82.1%)
	>60 years	36 (22.1%)	127 (77.9%)
Residence	Urban	34 (19.8%)	138 (80.2%)
	Rural	48 (19.4%)	200 (80.6%)
Marital status	Single	19 (16.8%)	94 (83.2%)
	Married	63 (20.5%)	244 (79.5%)
Systolic BP	≤ 140 mmhg	43 (14.5%)	253 (85.5%)
	>140 mmhg	39 (31.5%)	85 (68.5%)
Diastolic BP	≤ 90 mmhg	48 (15.7%)	257 (84.3%)
	>90 mmhg	34 (29.6%)	81 (70.4%)
Family history of DM	Yes	31 (34.4%)	59 (65.5%)
	No	40 (16.4%)	204 (83.6%)
Treatment	Insulin	0 (0.0%)	5 (1%)
	OHA	81 (19.7%)	330 (80.3%)
	OHA+Insulin	1 (0.3%)	3 (0.7%)

HDL level	≤ 40mg/dl	20 (37%)	34 (63%)
	>40 mg/dl	62 (17%)	304 (83%)
LDL level	≤ 100 mg/dl	38 (12%)	280 (88%)
	>100 mg/dl	44 (43%)	58 (57%)
Triglycerides level	≤ 150 mg/dl	53 (14.7%)	307 (85.3%)
	>150 mg/dl	29 (48.3%)	31 (51.7%)
Cholesterol level	≤ 200 mg/dl	63 (16.9%)	310 (83.1%)
	>200 mg/dl	19 (40.4%)	28 (59.6%)
Proteinuria	Negative	52 (14.9%)	298 (85.1%)
	Positive	30 (42.9%)	40 (57.1%)
Glycemic FPG	<126 mg/dl	0 (0.0%)	3 (1%)
	≥ 126 mg/dl	72 (17.3%)	345 (82.7%)
Glycemic RPG	<200 mg/dl	2 (0.4%)	3 (0.6%)
	≥ 200 mg/dl	80 (19.3%)	335 (80.7%)
BMI	<18.5 kg/m^2	0 (0.0%)	3 (1%)
	18.5-24.99 kg/m^2	62 (17.3%)	297 (82.7%)
	25-29.99 kg/m^2	20 (35.1%)	37 (64.9%)
	≥ 30 kg/m^2	0 (0.0%)	1 (1%)
Medication adherence	Poor	30 (14%)	184 (86%)
	Good	52 (25%)	154 (75%)

Figure 1: Micro vascular complications of type two diabetic patients in Adigrat and Wkuro general hospitals, Eastern Zone, Tigray Regional state, North Ethiopia, 2019.

Table 2: Factors significantly associated with micro vascular complications of type two diabetic patients, Adigrat and wkuro General Hospital, Tigray, North Ethiopia, 2019.

Variables		Crud OR (CI95%)	P-value	Adjusted OR (CI95%)	P-value
Sex	Male	1		1	
	Female	0.5 (0.31, 0.82)*	0.006	0.44 (0.25, 0.77)*	0.004
Age	≤ 60 years			1	
	>60 years	1.3 (0.81, 2.13)	0.27	0.76 (0.42, 1.36)	0.35
Systolic BP	≤ 140 mmhg	1		1	
	>140 mmhg	3 (1.83, 4.94)	<0.001	**6.9 (1.71, 27.71)**	**0.007**
Diastolic BP	≤ 90 mmhg	1		1	
	>90 mmhg	2.5 (1.51, 4.14)	<0.001	0.32 (0.08, 1.29)	0.109

Family history of DM	Yes	1		1	
	No	0.4 (0.23, 0.69)*	0.001	0.63 (0.33, 1.19)	0.16
HDL level	≤ 40mg/dl	1		1	
	>40 mg/dl	0.32 (0.17, 0.59)*	<0.001	0.92 (1.04, 2.01)	0.83
LDL level	≤ 100 mg/dl	1		1	
	>100 mg/dl	5.1 (3.064, 8.46)*	<0.001	3.7 (2.002, 6.76)*	<0.001
Triglycerides level (TGL)	≤ 150 mg/dl	1		1	
	>150 mg/dl	4.4 (2.49, 7.59)*	<0.001	2.2 (1.04, 4.58)*	0.04
Cholesterol level	≤ 200 mg/dl	1		1	
	>200 mg/dl	3.7 (1.92, 6.94)*	<0.001	1.3 (0.56, 3.03)	0.54
Proteinuria	Negative	1		1	
	Positive	3.7 (2.13, 6.27)*	<0.001	3.2 (1.74, 5.99)*	<0.001

Among 420 study participants, 82(19.5%) of type two diabetic patients had micro vascular complications. The prevalence of diabetic retinopathy among type two diabetic patients was 32(7.6%) (Figure 1). The final outcome of vascular complications among type two DM patients were 92(21.9%) loss to follow up followed by 4(1%) death, 3(0.7%) blindness and alive 420(76.4%).

Factors significantly associated with micro vascular complications of type two diabetic patients

The multivariable logistic regression analysis showed that; the risk of developing micro vascular complications among female type two DM patients [AHR (95%CI): 0.44(0.25, 0.77)] were decreased by 66% than male type two DM patients. Those type two diabetic patients having systolic blood pressure >140 mmhg [AOR (95%CI): 6.9(1.71, 27.71)] were 6.9 times higher risk of developing micro vascular complications than patients having a systolic blood pressure<=140 mmhg. The risk of developing micro vascular complications among type two diabetic patients were 3.7 times higher in LDL-C >100 mg/dl [AHR (95%CI): 3.7(2.002, 6.76)] than LDL-C ≤ 100 mg/dl. The risk of developing micro vascular complications among type two diabetic patients were 2.2 times higher in TGL>150 mg/dl [AHR (95%CI): 2.2(1.04, 4.58)] than TGL ≤ 150 mg/dl. Those type two diabetic patients having a positive protein urea result [AHR (95%CI): 3.2(1.74, 5.99)] were 3.2 times at higher risk of developing micro vascular complications than patients with negative protein urea (Table 2).

DISCUSSION

The aim of this study was to assess the micro vascular complications and associated factors among type two diabetic patients. Based on this we found that, sex, hypertension (systolic BP>140mmhg), LDL-C >100mg/dl, triglyceride >150 mg/dl and positive protein urea were the factors significantly associated with micro vascular complications. Many type two DM patients were affected by the factors identified. Therefore, the rational for this study was to help policy makers and programmers to have a clear picture about the micro vascular complications of type two DM patients and associated factors in Adigrat and wkuro general hospitals to make evidence based decision and mobilize resources for the prevention of micro vascular complication in the Tigray regional state. It will also guide for the heath care providers working in DM clinic to make evidence based decisions for the prevention of micro vascular complications.

In our study, the prevalence of micro vascular complications was 19.5%. In this study, the prevalence of diabetic retinopathy,

neuropathy and nephropathy were 7.6%, 6.7% and 5.7% respectively. The finding was lower than with a study conducted in Ghana [22] and Nigeria [23]. This might be due to the sample size difference and design used. This study revealed that, the overall micro vascular complications of type two diabetic patients was 19.5%. The prevalence of neuropathy was 6.7%. This finding was lower than with a study conducted in Southwest Ethiopia [24] and Jimma, Ethiopia [25]. This difference might be due to the sample size. In this study, the prevalence of diabetic retinopathy was 7.6%. This finding was lower than a study conducted in Arbaminch, Ethiopia [12].

This study revealed that, female type two diabetic patients were found to have lower risk of developing micro vascular complications than male type two diabetic patients. This finding was supported a study conducted in Ethiopia [26] and India [27]. This might be due to the hormonal difference. This study showed that, those type two diabetic patients who have history of hypertension was found to be at risk of developing micro vascular complications than who had no history of hypertension. This finding was inline with other studies conducted in Gondar [4], India [28], Ireland [29] and Japan [30]. This might be due to the effect of hypertension on endothelial cell structure and function, which leads to increase growth and vasoconstriction [31].

In our study, increasing triglyceride level >150 mg/dl and LDL-C >100 mg/dl were found to be the risk of developing micro vascular complications among type two diabetic patients. This result was consistent with other studies conducted in Gondar [4], Zimbabwe [32] and India [33]. This might be due to their function. This study showed that, Type two diabetic patients with positive protein urea were at high risk of developing micro vascular complications. This result was inline with a study conducted in Gondar [4] and [34,35]. This might be due to the fact which protein urea is an early sign of kidney damage.

The importance of this study was to provide information for health care providers and patients on factors associated with risk of developing of micro vascular complications of type two diabetic patients.

The limitation of this study was the use of secondary data, which results incompleteness (Like behavioral factors, physical activity and diet). This study showed that, all micro vascular complications are caused by type two diabetes mellitus and considered micro vascular complications of the outcome for diabetic retinopathy, neuropathy and nephropathy.

CONCLUSION

The prevalence of micro vascular complications was lower as compared with other similar studies. Sex, Hypertension, LDL-C >100 mg/dl, Triglyceride>150 mg/dl and positive protein urea were associated with high risk of getting micro vascular complications of type two diabetic patients. Tigray Regional Health Bureau and district health offices should use this evidence to prevent the micro complications of type two diabetic patients in collaboration with other stakeholders. Health care providers and patients with the identified problems should strictly control their LDL-C level, blood pressure level, triglycerides level and protein urea. Micro vascular type two diabetic prevalence is projected to increase; effective preventive strategies are urgently needed to reduce the future burden of micro vascular complications in Tigray regional state, Ethiopia.

ACKNOWLEDGEMENT

DECLARATIONS

Ethics approval and consent to participate

Adigrat university institutional review board approved the study and formal letter of permission was obtained from Adigrat University and Tigray Regional Health Bureau. Official letter of co-operation from the above organization was written to the respective health facilities. There was no potential risk that might cause any harm to respondents. The importance of the study was explained to the participation of the study and informed written consent was requested immediately before the data collection and written informed consent was also obtained from a parents/guardians for participants under 16 years old.

Consent for publication

Not applicable

Availability of data and material

The datasets used and/or analyzed during this study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

HG was the principal investigator who contributed to the conception and design of the study, collected, entered, analyzed, interpreted the data, prepared the manuscript and acted as corresponding author. HG and BG were contributed to interpretation and drafted the manuscript. All authors read and approved the final manuscript.

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