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ORIGINAL RESEARCH

Prevalence of Diabetes Mellitus, Prediabetes and Its Associated Factors in Dessie Town, Northeast Ethiopia: A Community-Based Study

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Background: Diabetes mellitus is becoming an epidemic public health problem in developing countries such as Ethiopia. As the International Diabetes Federation indicates, the number of adults living with diabetes globally has been increasing from time to time. If early screening and follow-up are done, diabetes is a manageable disease. However, diabetes study at the community level in Ethiopia is limited and scarce. Therefore, the present study was conducted to assess the current prevalence of DM, prediabetes and its associated factors in Dessie Town, Northeast Ethiopia.

Methods: A community-based cross-sectional study was conducted from January to March 2019 among people aged 18 years and above in Dessie Town, Northeast Ethiopia. A multistage sampling technique was used to select a total of 587 study participants. Sociodemographic and behavioral characteristic data were collected using a pretested semi-structured questionnaire. Venous blood samples were used to determine the level of blood glucose and lipid profile. Diagnosis and classification of diabetes mellitus and prediabetes were based on the criteria of the American Diabetes Association.

Results: The prevalence of diabetes mellitus and prediabetes was 6.8% (95% CI 4.9–9.0) and 15.7% (95% CI 12.9–18.7), respectively. The prevalence of previously undiagnosed diabetes mellitus was 72.5%. Positive family history of diabetes mellitus (AOR: 20.24, 95% CI 4.74–86.43), smoking habit (AOR: 12.12, 95% CI 2.30–63.73), overweight (AOR: 21.95, 95% CI 6.73–71.603), systolic hypertension (AOR: 4.61, 95% CI 1.09–19.50) and hypercholesterolemia (AOR: 8.97, 95% CI 2.05–39.23) were significantly associated with diabetes mellitus. Prediabetes was associated with advanced age (AOR: 3.55, 95% CI 1.16–10.79), marital status (single) (AOR: 3.06, 95% CI 1.40–6.67), educational status (illiterate) (AOR: 2.35, 95% CI 1.04–5.35) and overweight (AOR: 2.11, 95% CI 1.05–4.23).

Conclusion: There was a higher prevalence of diabetes mellitus and prediabetes. In addition, the prevalence of undiagnosed diabetes mellitus was high in our study area. Therefore, targeting the control and prevention strategy to such modifiable risk factors associated with diabetes and prediabetes may contribute to the reduction of the prevalence and further complications of diabetes mellitus.

Keywords: associated factors, diabetes mellitus, prediabetes, prevalence

Introduction

Diabetes mellitus (DM) is a metabolic disorder characterized by chronic hyperglycemia that causes carbohydrate, protein and fat metabolism disorders. It is resulting from an absolute or relative deficiency of insulin.[1] Individuals with prediabetes are indicating a relatively high risk of future diabetes development.[1,2] Additionally,

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people with prediabetes are at risk for the development of diabetes complication and cardiovascular disease.[3]

Diabetes currently has no known single cause; however, some factors such as advanced age, obesity, dyslipidemia, sedentary lifestyle and genetical factors are likely to play important role in the development of DM in most populations. The American Diabetes Association recommended that people with body mass index (BMI) higher than 25kg/m2, regardless of age, should be screen for diabetes. In addition, peoples with high blood pressure, a sedentary lifestyle, have a family history of diabetes mellitus (FHDM), over 45 years of age and anyone diagnosed with prediabetes should be screened for DM every year.[4]

Chronic hyperglycemia is associated with long-term microvascular (retinopathy, nephropathy, neuropathy) and macrovascular (ischemic heart disease, stroke, peripheral vascular disease) complications.[5] The complications of DM become very severe in the absence of an early diagnosis.[6] Comorbidities of DM lead to a substantial decrease in the patients' quality of life as well as socioeconomic consequences.[7] Diabetes-related complications are the major cause of premature deaths and disability in the world, which is 2–4 times more prevalent in patients with DM than in the general population.[1,8]

The global prevalence of diabetes in adults has been increasing, according to the 2017 International Diabetes Federation Atlas (IDFA) report, there are 451 million people with diabetes worldwide. These figures were expected to rise to 693 million by 2045. Nearly half of all people living with diabetes (49.7%) were estimated to be undiagnosed. In addition, approximately 5 million deaths worldwide were attributable to diabetes in the 20–99 year age range.[9] The number of people living with diabetes in urban area is higher than in rural areas, and in 2015 there were 172 million people living with diabetes in urban areas, while 119 million lives in rural areas.[10]

Around 80% of people with diabetes and about five million diabetes-related deaths were reported in low-income and middle-income countries.[9] In Africa, DM affected 21.5 million (5.1%) people in 2014 and is expected to rise to 41.5 million by 2035, with an increase of 93%. Moreover, about 13.4 million (62.3%) of peoples with the DM do not know they had been affected by the disease in 2014.[2,11]

Ethiopia is one of the top five countries with the highest number of people affected by DM in Sub Saharan Africa.[12] According to the 2014 IDFA report, the number of adults aged 20–79 years living with DM was 2.135 million (4.8%) and the total diabetes-associated death was 34,262 in the country. In addition, Ethiopia has three-quarters (75.1%) of persons with undiagnosed diabetes mellitus (UDM), which accounts for about 1,603,100 people in the 2014 estimates.[2,11] No studies have shown the prevalence of DM, prediabetes and populations requiring long-term care and management among populations in Dessie Town, Ethiopia. The current study, along with other limited community studies in Ethiopia, has different socio-demographic, population size and lifestyles such as khat chewing habit and physical activity. Therefore, the present study was conducted to assess the current prevalence of DM, prediabetes and its associated factors in Dessie Town, Northeast Ethiopia.

Methods

Study Area, Study Design and Study Period

A community-based cross-sectional study was conducted from January to March 2019 in Dessie Town, Northeast, Ethiopia. Dessie town is located at 401 km from the capital of Ethiopia, Addis Ababa. Based on the 2007 national census conducted by the Central Statistical Agency of Ethiopia (CSA), Dessie town has a total population of 151,174, of which 72,932 are male and 78,242 are female.

Study Population

Study participants aged 18 years and above and who were voluntary to participate and sign the study informed consent were our inclusion criteria. Of the total study population, the following participants were excluded: critical patients who were unable to communicate, pregnant women and individuals <18 years of age to avoid the possible impacts on anthropometric and laboratory measurements. Diagnosis of diabetes was based on the previous history of diabetes or on American Diabetes Association criteria for the classification of DM and prediabetes. FBG levels below 100 mg/dl, without a history of diabetic medication, refer to normal FBG. Prediabetes (IFG) refers to a level of blood glucose between 100 and 125 mg/dl with no diabetic medication. Diabetes manifests when the FBG level equals or greater than 126 mg/dl, or there is a history of diabetic medication. UDM is defined as unknowingly having an elevated glucose level that meets the definition of DM.[13]

Sampling Methods

The sample size was determined using the single population proportion formula by considering 6.5% prevalence of DM in Mizan-Aman town, southwest Ethiopia[14] 95% confidence interval (CI), 10% of non-response rate, 0.03 desired precision and a design effect of 2. Thus, a total of 598 participants were included in the study using Fisher's statistical formula. The multistage sampling technique was used to select study participants. In general, there are five sub-cities in Dessie town. Out of the five sub-cities, we selected three sub-cities (Menafesha sub-city, Hote sub-city, and Arada sub-city) using a simple random sampling technique. Then, we used a stratified sampling technique to assign the sample size proportional to the size of the households in the selected sub-cities. Finally, we selected a study participant from the eligible households using the lottery method.

Data Collection and Measurements

Demographic and Behavioral Characteristic Data

The world health organization (WHO) stepwise approach for noncommunicable disease surveillance was used to collect the data by three categories. Socio-demographic data including age, sex, gender, educational level, FHDM, marital status, ethnicity and religion and behavioral characteristics including khat chewing, smoking, alcohol consumption and physical activity were collected under the supervision of the principal investigator. In addition, socio-demographic and behavioral characteristics information was collected through face-to-face interviews using a pretested and semi-structured Amharic version questionnaire.

Anthropometric and Biochemical Measurements

Following the interview, participants were instructed to be on overnight fasting for at least 8 hrs and 3–5 mL of venous blood was collected the next morning using a plain vacutainer tube. The blood sample was left to be clotted at room temperature and centrifuged at 3000 rpm for 10 min and tested in Dessie Referral Hospital Clinical Chemistry Laboratory. Fasting blood glucose (FBG) level was determined using the glucose oxidase method. In addition, total cholesterol and triglycerides were measured using the enzymatic colorimetric method by Auto Chemistry Analyzer (DIRUI CS-T240, China).

Anthropometric parameters were measured for each participant using standardized techniques and calibrated equipment. Weight was measured to the nearest 0.1 kilogram using a person scale when the participants were wearing light clothes and bare feet. Height was measured by a stadiometer nearest to 0.01 meter when the participants were in an upright standing position on a flat surface without shoes. BMI was then calculated by dividing weight in kilograms by the height square in meters. Obesity, overweight and normal weight were generally defined as a BMI of 30 kg/m^2 and higher, a BMI between 25 and 30 kg/m^2 and a BMI 18.5–24.9 kg/m^2 respectively.[15,16]

WC measured by elastic-plastic tape at the approximate center between the lower margin of the last palpable rib and the top of the iliac crest.[17] Each participant's systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured in sitting position on the right arm using an electronic blood pressure monitor (Jiangsu Folee Medical Equipment CO, LTD). Two measurements were taken 5 mins apart and the mean was taken as the final reading of BP. Systolic hypertension was defined as SBP ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg. The WC values of >94 and >80 cm for men and women were considered to be high, respectively, according to WHO.[18]

Individuals considered to be active (vigorous) were those who fulfilled the recommendations for vigorous activity ≥3 days per week for ≥20 mins per session. In addition, moderate activity or walking ≥5 days per week for ≥30 mins per session; or any activity added ≥5 days per week, ≥150 mins per week (walking plus moderate activity plus vigorous activity), reaching a minimum of 600 MET per week. And, individuals considered to be inactive were those who did not perform any physical activity for at least 10 continuous minutes during the week.[19]

Data Quality Assurance

The quality of data was assured through the use of a pretested semi-structured questionnaire, providing data collector training, and active involvement of the principal investigator in the data collection process. The questionnaires were checked for consistency, completeness, clarity and accuracy at the end of each data collection day.

Physical measurements were taken twice and in some instances three times to minimize observer bias in the measurement and recording. In addition, the blood pressure and weight scale instruments were compared daily for accuracy against a standard calibrated instrument. Moreover, the DIRUI CS-T240 Auto chemistry analyzer was calibrated using a calibrator (AutoCal). The normal (HumaTrol N) and pathological (HumaTrol P) quality control samples were run each day before running our study samples.

Statistical Analysis

The data were checked for completeness and then analyzed using SPSS version 20.0. The overall prevalence and associated factors were determined and recorded using the descriptive and inferential method of data analysis. Residuals were normally distributed and there was little multicollinearity between the independent variables that could satisfy the assumptions of multiple logistic regression. Descriptive statistics were used to summarize the characteristics of study participants. Bivariate and multivariable analyses were used to assess the association between the explanatory variables and the outcome variable to control the effect of confounding and to see the independent effect of each variable on diabetes and prediabetes. The Hosmer and Lemeshow goodness test was used to assess the fitness of the model. The magnitude of the association was measured using the AOR and 95% CI. A p-value <0.05 was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from the Research and Ethical Review Committee of School of Biomedical and Laboratory Sciences, University of Gondar. Moreover, a letter of support was secured from the Dessie Town Administration, the Dessie Town Kebele Administration, Dessie Town health office and Dessie Referral Hospital. In addition, prior to data collection, written informed consent was obtained from each study participant following an explanation of the purpose and the possible risks of the study.

Results

Socio-Demographic Characteristics of the Study Participants

A total of 587 participants were involved in the study with a response rate of 98.2%. Four individuals were disagreed to participate in this study because of the fear of vein puncture in the blood sample collection. In addition, seven study participants were excluded from the study due to insufficient blood samples for laboratory analysis.

The mean age of the study participants was 44.17 ± 13.36 years. The majority, 354 (60.3%) of the participants were females and 388 (66.1%) were married. In addition, 21 (3.6%) of participants had a positive FHDM, and 90 (15.3%) were unable to read and write (Table 1).

Table 1 Socio-Demographic Characteristics of the Study Participants in Dessie Town, Northeast Ethiopia, 2019 (n=587)

Variable	Category	Frequency (n)	Percent (%)
Sex	Male	233	39.7
	Female	354	60.3
Age (years)	20–29	88	15.0
	30–39	162	27.6
	40–49	171	29.1
	50–59	83	14.1
	≥60	83	14.1
Religion	Orthodox	269	45.8
	Protestant	33	5.6
	Muslim	285	48.6
Marital Status	Married	388	66.1
	Single	111	18.9
	Widowed	53	9.0
	Divorced	35	6.0
Ethnicity	Amhara	507	86.4
	Oromo	23	3.9
	Tigre	46	7.8
	Gurage	11	1.9
Education status	Cannot read and write	90	15.3
	Primary school	189	4.8
	Secondary school	63	10.7
	Higher education	245	41.7
FHDM	Yes	21	3.6
	No	566	96.4

Behavioral Characteristics, Anthropometric and Biochemical Measurements of the Study Participants

Of the total participants, about 15 (2.6%) of were smokers, 131 (22.3%) were alcohol drinkers, 317 (54%) were physically inactive and 113 (19.3%) were khat chewers (Table 2).

The majority of the study participants, 479 (81.6%) had normal BMI and 526 (89.6%) had normal SBP. Furthermore, 23 (3.9%) of participants were hypercholesterolemic, 61 (10.4%) had systolic hypertension and 251 (42.8%) had high WC (Table 3).

Prevalence of Diabetes Mellitus and Prediabetes

The prevalence of DM was 6.8% (95% CI 4.9–9.0), while 15.7% (95% CI 12.9–18.7) of the participants were prediabetes. Of participants who were found to be diabetic, 72.5%

Table 2 Behavioral Characteristics of Study Participants in Dessie Town, Northeast Ethiopia, 2019 (n=587)

Variable	Category	Frequency	Percent
Smoking habit	Nonsmoker Smoker	572 15	97.4 2.6
Alcohol consumption	Nondrinker Drinker	456 131	77.7 22.3
Physical activity	Vigorous Moderate Inactive	150 120 317	25.6 20.4 54.0
Khat chewing	Khat chewer Not at all Ex-chewer	113 460 14	19.3 78.4 2.4

were newly diagnosed or UDM. The prevalence of DM was higher in males (3.6%) and in the 40–59 age group (3.2%). Whereas prediabetes prevalence was higher in females (9.9%) and above 60 years of age (6.3%) (Table 4).

The prevalence of DM was 12 (52.2%) and 18 (23.4%) among hypercholesterolemic and diastolic hypertensive study participants, respectively. In addition, the prevalence of prediabetes was 45 (19.8%) and 25 (33.7%) among high WC and BMI study participants, respectively (Table 4).

Factors Associated with Diabetes Mellitus

In the bivariate analysis, FHDM, smoking habit, SBP, DBP, BMI, WC and TC were found to be significantly associated with DM.

The multivariate logistic regression analysis showed that DM was independently associated with FHDM, smoking habit, BMI, SBP and TC. Participants with a positive FHDM were found to be nearly 20 times more likely to have DM than those without FHDM (AOR = 20.24, 95% CI: 4.741, 86.432).

In addition, participants who were overweight and obese were 22 times more likely to have DM than participants with normal weight (AOR = 21.95, 95% CI: 6.731, 71.603). Similarly, participants with smoking habits were about 12.1 times more likely to have DM compared to participants who never smoked (AOR = 12.12, 95% CI: 2.304, 63.737).

Participants with systolic hypertension were 4.6 times more likely to have DM compared to non-hypertensive participants (AOR = 4.61, 95% CI: 1.088, 19.50). Moreover, study participants with hypercholesterolemia were 9 times more likely to have DM than participants who had normal cholesterol levels (AOR = 8.97, 95% CI: 2.053–39.233) (Table 5).

Factors Associated with Prediabetes

The prevalence of prediabetes was significantly associated with age, marital status, education, physical activity, DBP and BMI in the bivariate analysis. The multivariate logistic regression analysis showed that age, marital status, educational status, and BMI were independently associated with prediabetes.

The prevalence of prediabetes has increased significantly with age progression; only age group ≥60 years

Table 3 DM and Prediabetes Prevalence Related to Anthropometric and Biochemical Measurements of Study Participants in Dessie Town, Northeast Ethiopia, 2019 (n=587)

Variable	Category	Total N (%)	DM		Prediabetes	
			No	Yes	No	Yes
Total cholesterol	<200mg/dl ≥200mg/dl	564 (96.1) 23 (3.9)	536 (91.3) 11 (1.9)	28 (4.8) 12 (2.0)	455(83.2) 0(0)	81(14.8) 11(2.0)
Triglyceride	<150 mg/dl ≥150mg/dl	566 (96.4) 21 (3.6)	531 (90.5) 16 (2.7)	35(6.0) 5 (0.9)	455(77.5) 0(0)	76(13.9) 16 (2.9)
BMI	Normal weight Overweight &Obese	479 (81.6) 108 (18.4)	473 (97.6) 74 (12.6)	6(1.0) 34 (5.8)	406(74.2) 49(8.3)	67(12.2) 25(4.6)
WC	Normal High	336 (57.2) 251 (42.8)	320 (54.5) 227(38.7)	16(2.7) 24(4.1)	273(49.9) 182(33.3)	47(8.6) 45(8.2)
SBP	Hypertensive Non-hypertensive	61 (10.4) 526 (89.60	44(7.5) 503(85.7)	17 (2.9) 23(3.9)	32(5.9) 423(72.1)	12(2.2) 80(14.6)
DBP	Hypertensive Non-hypertensive	77 (13.1) 510 (86.9)	59(10.1) 488(83.1)	18(3.1) 22(3.7)	41(7.5) 414 (72.7)	18(3.3) 74(13.5)

Table 4 Prevalence of DM and Prediabetes by Socio-Demographic Characteristics of the Study Participants in Dessie Town, Northeast Ethiopia, 2019 (n=587)

Variable	Category	DM		Prediabetes	
		No n (%)	Yes n (%)	No n (%)	Yes n (%)
Sex	Male	212 (36.1)	21(3.6)	178 (30.3)	34 (5.8)
	Female	335 (57.1)	19 (3.2)	277 (47.2)	58 (9.9)
Age	20–29	76 (12.9)	6 (1.0)	67 (11.4)	9 (1.5)
	30–39	144 (24.5)	7 (1.2)	121 (20.6)	23 (3.9)
	40–59	235 (40.0)	19 (3.2)	212 (36.1)	23 (3.9)
	≥60	92 (15.7)	8 (1.4)	55 (9.4)	37 (6.3)
Marital status	Married	361 (61.5)	27 (4.6)	313 (53.3)	48 (8.2)
	Single	107 (18.2)	4 (0.7)	87 (14.8)	20 (3.4)
	Widowed	48 (8.1)	5 (0.9)	30 (5.1)	18 ((3.1)
	Divorced	31 (5.3)	4 (0.7)	25 (4.3)	6 (1.0)
Religion	Orthodox	252 (42.9)	17 (2.9)	201 (34.2)	51 (8.7)
	Protestant	29 (4.9)	4 (0.7)	27 (4.6)	2 (0.3)
	Muslim	266 (45.3)	19 (3.2)	227 (38.7)	39 (6.6)
Educational status	Cannot read and write	87 (14.8)	3 (0.5)	56 (9.5)	31 (5.3)
	Primary school	17 (2.9)	13 (2.2)	151 (25.7)	25 (4.3)
	Secondary school	56 (9.5)	7 (1.2)	48 (8.2)	8 (1.4)
	Higher education	228 (38.8)	17(2.9)	200 (34.1)	28 (47.7)
FHDM	Yes	8 (1.4)	13 (2.2)	3 (0.5)	5 (0.9)
	No	539 (91.8)	27 (4.6)	452 (77.0)	87 (14.8)

Table 5 Bivariate and Multivariable Analysis of Factors Associated with DM Among Population at Dessie Town, Northeast Ethiopia, 2019 (n=587)

Variables	Category	DM(n)	COR (95% CI)	AOR (95% CI)	P value
FHDM	Yes	13	32.44(12.398–84.87)	20.24(4.74–86.43)	<0.001
	No	27	1	1	
Smoking Habit	Non smoker	32	1	1	
	Smoker	8	19.27(6.58–56.52)	12.12(2.30–63.74) *	0.03
SBP	Hypertensive	17	8.45(4.20–16.99)	4.61(1.09–19.50) *	0.038
	Non-hypertensive	23	1	1	
DBP	Hypertensive	18	6.77(3.43–13.34)	0.75(0.17–3.24)	0.695
	Non-hypertensive	22	1	1	
BMI	Normal weight	6	1	1	
	Overweight& obese	34	36.22(14.70–89.25)	21.95(6.73–71.6) *	<0.001
WC	Normal	16	1		
	High	24	2.12(1.10–4.07)	0.80(0.27–2.35)	0.686
TC	Normal	28	1	1	
	High	12	20.89(8.47–51.47)	8.97(2.05–39.23) *	0.04
Alcohol Drinking habit	Nondrinker	27	1	1	
	Drinker	13	1.75(0.88–3.50)	0.95(0.32–2.78)	0.97

Notes: *p < 0.05, statistically significant association.

Abbreviations: AOR, adjusted odds ratio; CI, confidence interval; COR, crude odds ratio; FHDM, family history of diabetes mellitus; SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; DM, diabetes mellitus; TC, total cholesterol.

proved to have significant associations with the prevalence of prediabetes. Participants with age group 60 years and above were 3.5 times higher risk of prediabetes than younger age groups (AOR=3.55, 95% CI: 1.164, 10.791).

Marital status showed a statistically significant association with the prevalence of prediabetes. Single participants were 3.1 times more likely to have prediabetes than married participants (AOR=3.06, 95% CI: 1.400, 6.674). Moreover, illiterate participants were 2.4 times higher risk of prediabetes than participants with higher educational status (AOR=2.35, 95% CI: 1.037, 5.347). In addition, study participants with overweight showed higher odds of prediabetes than participants who had a normal weight (AOR=2.11, 95% CI: 1.053–4.233) (Table 6).

Discussion

The current prevalence of DM was 6.8% (95% CI: 4.9–8.9), which was in consistent with the study in Mizan-Aman Town, Ethiopia (6.5%).[14] However, our study result was higher than the estimated Ethiopian prevalence of DM (5.2%) by IDFA.[20] This may be due to a higher percentage of the study participants who were physically inactive (54%) and had Khat chewing habit (21.7%), which could be the risk factor for DM.

In addition, this result was higher than those from other studies done in Benin (1.4%)[21] and suburban population of Northwest Nigeria (4.3%),[22] in Southern Ethiopia, Sidama zone (1.9%)[23] and in northwest Ethiopia, Gondar (5.1%).[24] This may be due to differences in the sociodemographic characteristics of study participants, sample sizes, and time frames. Compared to studies done in Sidama and Gondar, Ethiopian, the current study was conducted only among urban residents. So, urbanization can influence the lifestyles of people, and the prevalence of DM among urban residents was usually higher than rural residents.[24]

On the other hand, the prevalence of DM was lower than studies done in North India, Punjab (8.3%),[25] Pakistan

Table 6 Factors Associated with Prediabetes Among Population at Dessie Town, Northeast Ethiopia, 2019 (n=547)

Variable	Category	Prediabetes(n)	COR (95% CI)	AOR (95% CI)	P-Value
Age	20–29	9	1	1	
	30–39	23	1.42(0.62–3.23)	1.77(0.71–4.38)	0.220
	40–59	23	0.81(0.356–1.823)	0.96(0.35–2.61)	0.937
	≥60	37	5.01(2.23–11.27)	3.55(1.16–10.79) *	0.026
Marital Status	Married	48	1	1	
	Single	20	1.49(0.84–2.66)	3.06(1.40–6.67) *	0.05
	Widowed	18	3.91(2.02–7.56)	1.58(0.68–3.64)	0.284
	Divorced	6	1.57(0.61–3.4.01)	1.33(0.47–3.71)	0.589
Educational status	Illiterate	31	3.95(2.19–7.14)	2.35(1.04–5.35)	0.041
	Primary school	25	1.18(0.66–2.10)	1.10(0.52–2.33)	0.799
	Secondary school	8	1.19(0.511–2.78)	1.55(0.609–3.96)	0.357
	Higher education	28	1	1	
Physical activity	Active(Vigorous)	15	1	1	
	Moderate	8	0.60(0.26–1.47)	0.46(0.18–1.17)	0.103
	Inactive	69	2.54(1.39–4.62)	1.89(0.96–3.70)	0.064
DBP	Hypertensive	18	2.46(1.34–4.51)	1.86(0.78–4.48)	0.164
	Non hypertensive	74	1	1	
SBP	Hypertensive	12	1.99(0.98–4.01)	1.06(0.39–2.89)	0.903
	Non hypertensive	80	1	1	
BMI	Normal weight	67	1	1	
	Overweight and Obese	25	3.09(1.79–5.34)	2.11(1.05–4.23) *	0.035
WC	Normal	47	1	1	
	High	45	1.44(0.92–2.25)	0.97(0.0.55–1.68)	0.899

Notes: *p < 0.05, statistically significant associations.
Abbreviations: AOR, adjusted odds ratio; CI, confidence interval; COR, crude odds ratio; Pre-DM, Prediabetes; DBP, diastolic blood pressure; BMI, body mass index; TC, total cholesterol; TG, triglyceride.

(26.3%)[26] and in Bangladeshi (9.7%).[27] This difference might be due to variation in lifestyle, genetic and socio-demographic factors. There was also variation in age group in the study population; we included adults 18 years of age and above, while the Bangladeshi study consisted of an elderly population of 35 years and above,[27] and in North India, Punjab included only 20–69 years of age.[25] However, the higher prevalence of DM in the Pakistan study may be due to the use of OGTT and HbA1c to diagnose DM, but in our study, only FBG was used to diagnose DM, which may underestimate the prevalence of DM and prediabetes.

In our study, more than two-thirds (72.5%) of the diabetes cases were newly diagnosed. The finding was comparable to the IDF estimate in Ethiopia (75.1%).[11] However, the prevalence of the UDM case was higher than the IDF-projected UDM estimates in the world (49.7%)[9] and in the African region (62.3%).[2,11] Moreover, UDM prevalence was also higher than the reports from Pakistan (31%),[26] Bangladeshi (56%),[27] Sidama zone (54%)[23] and in Gondar Town and Dabat residential districts (63%).[24] The high rate of UDM may be due to a lack of DM awareness and poor screening program in the community and primary health care providers.

The findings of multivariate analysis in the current study showed that obese and overweight study participants were significantly associated with DM. These findings were inconsistent with other community-based studies.[14,22,25–29] Obesity may lead to increased production of adipokines/cytokines which contribute to insulin resistance and reduced levels of adiponectin which works as an insulin sensitizer.[30] Obesity is also associated with fat deposition, particularly in the liver which leads to increase insulin resistance.[31] Mitochondrial dysfunction is a significant underlying defect that links obesity to DM. Excessive energy substrates contribute to mitochondrial dysfunction with consequential effects on the lipid and glucose metabolism by both decreasing insulin sensitivity and compromising β-cell function.[32]

A positive FHDM was the main risk factor for the prevalence of DM. This finding was supported by other studies.[26,28,29,33,34] It is well recognized that the lifetime risk of any offspring developing diabetes is about 40% if one parent has diabetes and 70% if both parents have diabetes.[35] How genetic predisposition causes DM solely is not understood, but the contributing factors may be lifestyle and living environments within the families.[36]

Diabetes was significantly associated with systolic hypertension in our study. The risk of diabetes was higher in individuals with systolic hypertension than in those without, this result was in agreement with other studies.[14,23,26–28] The pathophysiological mechanisms that explain the association between hypertension and DM are not clear. However, high blood pressure was shown to induce microvascular and endothelial dysfunction, which may contribute to insulin resistance.[37]

In addition, the smoking habit was the other variables that showed significant associations in the multivariate analysis. This study finding was supported by the previous study.[14] The mechanism of why smoking rises the risk of diabetes and declines glucose homeostasis has not been fully clarified, but the available evidence showed that the smoking habit increases insulin resistance as well as worsens glucose metabolism.[38] Similarly, the level of TC was also significantly associated with DM and this result was in agreement with other studies.[14,26,28] This can be explained TC may enhance the dimerization of the NO synthase enzyme, which down-regulates the glucokinase activity, thereby reducing the intracytoplasmic metabolism of glucose. TC is also significantly associated with individuals with abdominal obesity, which is a risk factor for the development of DM.[39]

The prevalence of prediabetes in this study was 15.7% (95% CI: 12.9–18.6). This finding was comparable to that of a study carried out in Southwest Ethiopia, Mizan-Aman Town (15.9).[14] On the other hand, the finding was lower than a population-based study done in Bangladeshi (22.4%).[27] This disagreement might be due to the age difference in the study population; we included study participants 18 years of age and above, while the Bangladeshi study considered a population of 35 years and above.

The prevalence of prediabetes in our finding was higher than studies done in North India, Punjab (6.3%)[25] and South African country, Benin (1.5%).[21] The difference may be due to variation in socio-demographic characteristics and sample size of the study. They included both rural and urban communities, and a large sample size was used compared to the current study. In addition, the prevalence of prediabetes was higher than those of studies done in Sidama, Ethiopia (2.6%)[23] and Koladiba, Ethiopia (12%).[29] These differences may be due to variation in the residence and sample size of the study population, the current study used only urban populations, but these studies considered both urban and rural residents. In addition, the current study has a large sample size than studies done in Koladuba and Sidama, Ethiopia.

The prevalence of prediabetes was significantly increased with advanced age, and the finding was consistent with reports from studies done in Bangladeshi[27] and Southern Ethiopia, Sidama.[23] This could be because aging is often accompanied by an increased in body fat, which may contribute to the development of insulin resistance. In addition, the aging process is also associated with a decrease of β-cell proliferative capacity and enhances sensitivity to apoptosis.[40]

Overweight and obesity were associated with prediabetes, this was supported by an earlier study in Koladiba, northwest Ethiopia.[29] Obesity causes insulin resistance, and decreases insulin-stimulated glucose disposal, leading to the development of prediabetes and DM.[41]

The prevalence of prediabetes was also associated with the educational status of the study participants. Since educational status is related to access and use of health services, as well as it influences family choices on food, body care, and disease prevention. On the contrary, a study in Bangladeshi[27] presented an opposite finding. Thus, further studies might be required to explore this association.

In addition, being single was associated with prediabetes and this was supported by the previous study in Brazilian population.[28] This may be due to the fact that a single person has been more stressed than a married person because a married person has the advantage of managing his or her economy, controlling unhealthful habits and adopting favorable lifestyles. There are increased levels of certain hormones such as cortisol during stress, which affects the action of insulin and causes insulin resistance.[42]

Conclusion

The prevalence of diabetes and prediabetes was high among individuals aged 18 years and above in Dessie town. In addition, the prevalence of UDM was high, which requires immediate attention. DM was significantly associated with positive FHDM, smoking habit, overweight, obesity, hypercholesterolemia, and systolic hypertension. Furthermore, advanced age, being single, BMI and educational status were showed a significant association with prediabetes. Therefore, targeting the control and prevention strategies to such modifiable risk factors associated with diabetes and prediabetes through health promotion measures may contribute to the reduction of the prevalence and complications of DM.

Limitations of the Study

Only FBG was used to diagnose DM and prediabetes, which may underestimate the prevalence of DM and prediabetes.

List of Abbreviations

AOR, Adjusted Odd Ratio; BMI, Body Mass Index; CI, Confidence Interval; COR, Crude Odd Ratio; DBP, Diastolic Blood Pressure; DM, Diabetes Mellitus; FBG, Fasting Blood Glucose; FHDM, Family History of Diabetes Mellitus; IDFA, International Diabetes Federation Atlas; SBP, Systolic Blood Pressure; T2DM, Type 2 Diabetes Mellitus; UDM, Undiagnosed Diabetes Mellitus; WC, Waist Circumference; WHO, World Health Organization.

Ethical Approval and Consent to Participate

Ethical approval was obtained from the Research and Ethical Review Committee of School of Biomedical and Laboratory Sciences, University of Gondar. The ethics approval was given in accordance with the Declaration of Helsinki. Moreover, a letter of support was secured from the Dessie Town Administration, the Dessie Town Kebele Administration, Dessie Town health office and Dessie Referral Hospital.

Consent to Publish

All participants provided written informed consent to publish this study.

Data Sharing Statement

The main part of the data generated or analyzed during this study was included in this published article.

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Author Contributions

All authors contributed toward data analysis, drafting and revising; gave final approval of the version to be published and agree to be accountable for all aspects of the work.

Disclosure

The authors declare that they have no competing interests.

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