Prevalence of Prediabetes and its Risk Factors among the Employees of Ambo University, Oromia Region, Ethiopia

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Abstract

Background: Prediabetes is a metabolic condition which is characterized by the presence of higher levels of blood glucose. It can be treated by lowering high blood glucose level and maintaining the healthy lifestyle habits, healthy meal plan and regular exercise. The aim of this study was to evaluate the prevalence of prediabetes and to identify the risk factors involved in its progression.

Materials and Methods: A cross-sectional study design was adapted for the present research work. The targeted participants were adults under the age group of 35-59 years. This research included all voluntary individuals who were screened according to the guidelines of the centers for disease control and prevention (CDC). This study protocol included self-administered questionnaires; anthropometric data and blood biochemistry. A total of 380 respondents arrived at the baseline sample in which 16 subjects who had diabetes were excluded and the remaining 364 samples with normal glucose tolerance (NGT), impaired fasting glucose (IFG) and impaired glucose tolerance (IGT) were included as the study subjects. All statistical analysis was carried out by IBM SPSS statistics 20.0 software. The recorded p values are on the basis of two-sided tests with a statistical significance of $p \leq 0.05$.

Results: The present study showed the higher prevalence of prediabetes with normal glucose tolerance, impaired fasting glucose and/or impaired glucose tolerance (IGT) as 79.7%, 8.0%, 6.8% and 5.5% respectively. The total estimated prevalence of prediabetes was 20.3% which includes 12.6% of males and 28.2% of females. As per WHO guidelines 23.0% of pre-obese and 34.4% of obese in the target groups whose BMI $\geq$ 25 with their risk estimate of 2.28 (0.8-6.5) for males and 2.25 (1.03-4.9) for females are in the prediabetic groups. According to the seventh report of joint national committee (JNC) standards around 20.3% of hypertensive individuals with OR: 0.5 (0.21-1.3) for males and OR: 0.12 (0.1-0.30) for females were in prediabetes. Sex, age, occupation, income, alcohol drinking, and elevation in modified risk factors including body mass index (BMI), waist to hip ratio (WHR), blood pressure (BP), high-density lipoprotein cholesterol (HDL) and low-density lipoprotein cholesterol (LDL) were significantly associated with prediabetes.

Conclusion: The present study indicated a higher prevalence of prediabetes and the effect of possible risk factors in the target population. Hence self-care should be prioritized in the community to maintain the normal BP, blood glucose, BMI and regular physical exercise. It is highly recommended to conduct various intervention programs in the form of counseling and health education after the clients are successively screened for prediabetes. This strategy helps in the management of prediabetes and controls a huge number of people from the risk of T2DM.

Keywords: Oral glucose tolerance test; Prevalence; Prediabetes; Risk factors

Introduction

Diabetes mellitus (DM) is the most common endocrine disorder which currently affects more than 100 million people in the world. The number of newly diagnosed DM cases is increasing due to aging, increasing the prevalence of obesity and physical inactivity (1). There are several types of diabetes in which type-2 diabetes mellitus (T2DM) is the most prevalent form which sequentially alters the dysregulation in glucose, blood pressure, body mass index and lipid metabolism (2-4). The development of T2DM begins over a long period of time. Before its progression, a transient stage is developed in which individuals suffer from impaired fasting glucose (IFG), impaired glucose tolerance (IGT) or combined IFG/IGT but not high to be diagnosed with diabetes, a condition which is known as prediabetes. ADA stated this condition as intermediate hyperglycemia formed between normal glucose tolerance and T2DM (5). Around 5-10% of people with prediabetes become diabetic every year because of asymptomatic state and the conversion rate varies by population characteristics and the definition of prediabetes (6, 7). The majority of peoples are unaware of this condition and are often diagnosed after experiencing complications including retinopathy and other cardiovascular diseases (CVD). The latest estimates of the prevalence of DM and prediabetes in Africa are about 3.2% and 7.9% (8). The estimated prevalence of prediabetes will be doubled by the year 2040 (9, 10). In diabetes, risk prediction variables including age, sex, lifestyle information, BMI, and blood glucose measurement provide first line data to reinforce the risk estimation. This system is applicable and supportive for risk estimation of diabetes in the developing countries where resources and skilled manpower are limited and scarce. In case of more precise risk estimation incorporation of 2hrs postprandial glucose (2hPGL) load into a model that already included fasting plasma glucose (FPG) can improve the prediction (11, 12). HbA1c (Glycosylated haemoglobin) is a sensitive indicator and a valid predictor of diabetes including undiagnosed cases, but it should not be used to identify prediabetes (13). It is difficult to identify universal cut-off points for HbA1c in different ethnic groups, with higher levels are observed among people of African origin (14, 15).

The risk of developing T2DM can be delayed or reduced by adopting a healthy lifestyle, reducing obesity, healthy eating habits and increasing physical activity. Several clinical intervention programs have reported reductions in the risk of diabetes development in prediabetic individuals after lifestyle and drug-based interventions (16-18).

So there is an urgent need to evaluate the risk factors and their association in the progression of prediabetes in the adult population. In Ethiopia, the number of diabetic cases estimated by WHO increased to 1.8 million by the year 2030 (19). The prevalence of undiagnosed T2DM in East Shoa was reported as 5% (20). Globalization, rapid adaptation to western lifestyle, unhealthy eating habits like skipping the breakfast (or) eating junk foods because of financial hardships, job stress, lack of awareness, limitation in screening protocols, less propaganda for intervention programs and poor accessibility to health care services are some of the possible determinants of prediabetes in the low and middle income countries (LMICs). So we sought to assess the prevalence and the association of combined risk factors in the progression of prediabetes. This study was performed since the diabetic population is more in the community but there is no static record about prediabetes. So we aimed to evaluate the baseline information on the prevalence of prediabetes in the adult population working in Ambo University, Oromia Region, Ethiopia.

Materials and methods

Participants and study pattern

A cross-sectional study was carried out from 6th February to 25th June 2016 in the adult population working at Ambo University. It is one of the fastest growing Ethiopian Universities, currently expanding with four campuses. The objectives and benefits of the screening process were communicated to all institutes and schools in the form of notice, poster, and advertisement. The sample size was calculated by using the formula represented for finite population (21) with 95% confidence interval and 50% of prevalence for prediabetes. All volunteers who are aged $\geq$ 35 years are recruited by the General Practitioner (GP) team for an opportunistic screening and to identify the risk group for prediabetes. The study was conducted after approval of Ethical clearance received from an institutional review committee of Ambo University (Ref. No: RKTT-CMHS-73 dated on 16/01/2016). We informed the objectives of the study, and a written consent was obtained from every subject before physical examination, questionnaire administration, and blood sample collection. The baseline information including demographic characteristics, lifestyle factors, knowledge, self-care, dietary habits and physical activity (22, 23) were collected using the standard self-reported questionnaire printed in Amharic (National language) and English version.

Anthropometrics and blood pressure

Weight and height were measured to the nearest 0.1 Kg and 0.1 cm using a portable standard weight and

height scale. The subjects were instructed to stand barefoot with their head in an upright position. The body mass index (BMI) was determined by dividing the weight (in kilograms) by the height (in meters) square. The individuals were classified on the basis of their BMI as Underweight (< 18.5), Normal weight (18.5-24.9), Pre-obese (25.0-29.9) and Obese (≥ 30) (24). Waist Circumference (WC) was measured by placing a specially designed spring-loaded tape device (Fazzini tapes, Italy) around the abdomen (ensuring that the tape measure is horizontal). It should be comfortable and not cause compression of the skin. The participants were classified according to the WHO cut-off points for the risk of metabolic complications (Males > 94cm) and (females > 80cm) (25). Hip circumference was measured at the widest part of the hip at the level of the greater trochanter to the nearest half-centimeter. The waist to hip ratio (WHR) was calculated by the ratio of waist circumference (cm) to the hip circumference (cm). The participants were in the risk if the WHR value for males was ≥ 0.90 cm and females were ≥ 0.85 cm. Waist to height ratio (WHtR) was calculated by the ratio of waist circumference (cm) to the height (cm) (26). Each measurement was repeated twice and in case of discrepancy, it was repeated for the third time to ensure the accuracy. The blood pressure was measured using a digital blood pressure machine and a manual mercury sphygmomanometer. At least three readings at 5-minute intervals, as per JNC VII criteria were used for the systolic blood pressure (SBP) and diastolic blood pressure (DBP) (27).

Biochemical measurements
Under strict aseptic precautions, 5 ml of venous blood samples were collected from an antecubital vein of the selected subjects after overnight fasting (8hrs) and stored in appropriate serum separating tubes (SST, BD vacutainer). The samples were centrifuged and the serum was separated for the determination of lipid profile including total cholesterol (TC), triacylglycerol (TAG), high density lipoprotein cholesterol (HDL-C) and low density lipoprotein cholesterol (LDL-C) using automatic standard routine enzymatic method and commercial kits (Linear type Reagent BA-88A, Barcelona, Spain) in clinical chemistry analyzers (Humastar 80, Germany and Echo Autoanalyzer, Italy). According to the national cholesterol education program criteria, the fasting triacylglycerol > 150 mg/dl (1.7 mmol/l), HDL-C cholesterol < 40 mg/dl (1.0 mmol/l) in men and < 50 mg/dl (1.3 mmol/l) in women and LDL-C > 160 are considered as risk (28). In oral glucose tolerance test (OGTT), the blood glucose was measured in a fasting state (at least 8hr) by finger prick using a disposable sterile lancet (100 ct 26 G needle) and the fasting

plasma glucose values were recorded using Prodigy autocode one touch glucometer. The participants whose IFG value ≥ 100 were allowed to drink 75 g of standard glucose for oral glucose tolerance test and the results were recorded after 2hrs post glucose load (29).

Definition for prediabetes
The prevalence of prediabetes was determined as an independent variable when all the study subjects were within the range of IFG from 100 mg/dL (5.6 mmol/L) to 125 mg/dL (6.9 mmol/L) and/or IGT from 140 mg/dL (7.8 mmol/L) to 199 mg/dL (11.0 mmol/L). These two categories are considered as a high-risk state for the progression of diabetes (30, 31).

Exclusion criteria
Exclusion criteria for in the present investigation included pregnant women, known diabetes confirmed by a physician (32), the FPG ≥ 126 mg/dL (7.0 mmol/L) and 2hrs PG ≥ 200 mg/dL (11.1 mmol/L) during the OGTT testing and subjects using any sort of antidiabetic medication. A total of 378 respondents arrived at the baseline sample in which 16 subjects who had diabetes were excluded and the remaining 364 samples with normal glucose tolerance (NGT), impaired fasting glucose (IFG) and impaired glucose tolerance (IGT) were included as the study subjects with the sex ratio of 183 (50.3%) males and 181 (49.7) females.

Statistical methods
The prevalence of prediabetes was expressed in percentage. The sex-wise comparison of all independent variables was done by t-test and the values are expressed as a mean and standard deviation. The odds ratio (OR) of the male and female risk factors was calculated using 95% CI with lower and upper bound values and Pearson chi-square test. To identify the correlates of the dependent variable, all categorical variables were included in a step-wise, logistic regression model to study their independent prognostic significance and its correlation with Pre-DM. All statistical analysis was carried out by IBM SPSS statistics 20.0 software. The recorded p values are on the basis of two-sided tests with a cut-off for statistical significance of p ≤ 0.05.

Results
The present study was conducted to estimate the prevalence of prediabetics in the target population and to identify the significance of associated risk factors in the progression of prediabetes. Table 1 showed the baseline information including education, marital status, occupation, income, knowledge and self-care in the target population and the data are presented in percentage.

Table 1. Baseline characteristics of the adult sample population aged above ≥ 35 years.

Variables	Males N %	Females N %	Total N %
Education			
Technical diploma	3 (0.8)	9 (2.5)	12 (3.3)
Grade 12	31(8.5)	34 (9.3)	65 (17.9)
BSc	76(20.9)	62 (17.0)	138 (37.9)
MSc and above	87(23.9)	62 (17)	149 (40.9)
Marital status			
Unmarried	25 (6.9)	27 (7.4)	52 (14.3)
Married	131 (36.0)	119 (32.7)	250 (68.7)
Separated/Divorced	27 (7.4)	35 (9.6)	62 (17.0)
Occupation status			
Academic instructor	69 (19.0)	24 (6.6)	93 (25.6)
Skilled worker	44 (12.1)	41 (11.3)	85 (23.4)
Office personal	38 (10.4)	44 (12.1)	82 (22.5)
Administration	51 (14.0)	53 (14.6)	104 (28.6)
Income			
Low	93 (25.6)	110 (30.2)	203 (55.8)
Medium	64 (17.6)	49 (13.5)	113 (31.0)
High	26 (7.1)	22 (6.0)	48 (13.2)
Knowledge			
Poor	97 (26.6)	87 (23.9)	184 (50.5)
Fair	62 (17)	70 (19.2)	132 (36.3)
Good	29 (8.0)	19 (5.2)	48 (13.2)
Self-Care			
Disagree	26 (7.2)	19 (5.2)	45 (12.4)
Neutral	38 (10.1)	55 (15.1)	93 (25.5)
Agree	119 (32.7)	107 (29.4)	226 (62.1)

Note: N is the number of respondents.

Background information

The study participants include 50.3% males and 49.7% females with the mean age of 45.9 ± 5.1. The average work experience of the target group is 16.± 11.7 with 69.5% having more than 10 years of experience at Ambo University. Among the participants 25.6 % are academic instructors, 23.4% are skilled workers, 22.5% are office personnel and 28.6% are administrative workers with their educational background as 3.3% with a technical diploma, 17.9% had completed grade twelve, 37.9% are B.Sc. holders and 40.9% have completed M.Sc. and above. In the target population, 14.30% ware unmarried, 68.70% were married and 17% were

separated or divorced. Socioeconomic status of the individuals includes 55.8% in low, 31.0 % in medium and 13.2% are in high-income groups. About the level of knowledge on prediabetes, nearly 50.5% have poor, 36.3% have fair and 13.2 % have good knowledge and the self-care of the respondents are

signified as 12.4% disagreed, 25.5% neutral and 62.1% are in good agreement in the target population. After excluding the known 16 diabetic samples, a total of 364 samples arrived, within which 74 are prediabetic population (19.5 %). The estimated prevalence of the sample population of 364 is 20.3%.

Table 2. Descriptive statistics of each test variable in the study population.

	t-test					
Variables	**Males (N=183) (50.3%)**	**Females (N=181) (49.7%)**	**Mean Difference**	**95%**	**CI**	**P-Value**
Age	46.4 ± 5.4	45.4 ± 4.8	1.05	-0.01,	2.1	0.05
Education	3.1 ± 0.9	3.2 ± 0.9	-0.1	-0.25,	0.1	0.46
Marital status	2.06 ± 0.6	2.10 ± 0.7	-0.05	-0.19,	0.1	0.53
Occupation	2.2 ± 1.2	2.6 ± 1.2	-0.41	-0.66,	0.2	0.002
Income	1.5 ± 0.7	1.6 ± 0.7	-0.13	-0.28,	0.01	0.08
Knowledge	0.6 ± 0.5	0.45 ± 0.5	0.11	0.001,	0.21	0.05
Self-care	0.89 ± 0.3	0.70 ± 0.5	0.19	-0.27,	1.1	0.001
Drinking alcohol	0.56 ± 0.5	0.53 ± 0.5	0.02	-0.1,	0.07	0.60
Unhealthy eating habits	0.40 ±0.5	0.48 ±0.5	-0.08	-0.03,	0.2	0.10
Physical inactivity	0.39 ±0.5	0.45 ±0.5	-0.06	-0.02,	0.1	0.40
BMI	26.2 ± 2.6	26.1 ± 2.9	0.2	-0.4,	0.7	0.60
WC	90.8 ± 6.4	81.8 ± 3.2	8.9	8.0,	10.0	0.001
WHR	0.95 ± 0.1	0.87 ± 0.04	0.1	0.07,	0.1	0.000
WHtR	0.47 ± 0.04	0.49 ± 0.04	-0.01	-0.02,	-0.005	0.002
SBP	129.4 ± 12.4	124.8 ±11.1	4.52	2.1,	6.95	0.001
DBP	84.6 ± 7.1	81.8 ± 5.3	2.8	1.5,	4.04	0.001
Total Cholesterol	201.2 ±14.4	204.4 ±15.2	-3.2	-6.3,	1.5	0.04
TAG's	151.7 ± 6.9	156.1 ± 8.4	-4.4	-5.9,	2.8	0.001
HDL – C	43.6 ± 7.5	52.4 ± 9.8	-8.8	-10.6,	-7.1	0.001
LDL – C	150.3 ±20.9	153.0 ±18.6	-2.7	-6.7,	1.4	0.20
IFG	90.1 ± 9.8	93.9 ± 11.6	-3.8	-5.9,	-1.5	0.001
IGT	126.1 ±18.7	132.4± 19.6	-6.4	-10.3,	2.4	0.002

P- Value refers to the analysis of the difference in mean of each variable in male and female.

The descriptive statistics and mean difference of all variables including age, education, marital status, occupation, income, knowledge, self-care, drinking alcohol, unhealthy eating habits, physical inactivity,

BMI, WC, WHR, WHtR, SBP, DBP, total cholesterol, TAG's, HDL-C, LDL-C, IFG and IGT in male and female respondents are presented in the Table 2.

The prevalence of associated risk factors and the possible risk estimates in the target groups are presented in Table 3.

Prevalence of risk factors
The age group distribution of prediabetes in the selected study population is illustrated in Figure 1. The prevalence of prediabetes comprises 12.6% of males and 28.2% of females with a total prevalence of 20.3%. The estimated total prevalence is 20.3% which comprises 12.6% of males and 28.2% of

females. Increase in age is one of the known risk factors. 8.6% of pre-diabetic prevalence was observed in the age group of 35-39 with OR: 0.39 (0.03-4.7), 20.8% in 40-44 aged participants with OR: 3.4 (1.3-9.2), 22% with OR: 2.9 (1.2-7.4) in the target groups at the age range of 45-49, 21.7% in the respondents of 50-54 age group with OR: 3.1 (0.9-10.5) and 23.5% of prevalence in the age group of 55-59 with OR: 5.5 (0.5-65.2) and the overall significance in all age groups was $p < 0.002$.
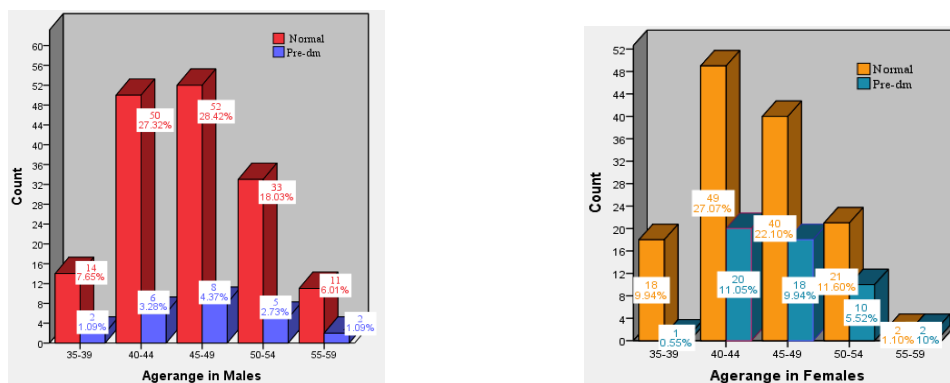
Figure 1. Age group distribution of prediabetes in the study population (N=364).

About the lifestyle factors 25.3% of respondents who drink alcohol with OR: 0.68 (0.4-1.3) for males and 0.34 (0.1-0.9) for females, around 18.2% of the population who had no healthy eating habits with OR: 1.1: (0.5-2.0) for males and OR: 2.79 (1.1-7.2)

for females and 17.8% of respondents who had physical inactivity with OR: 0.87 (0.5-1.7) for males and OR: 3.38 (1.4-8.5) for females are in the prediabetes population.

Table 3. Prevalence of pre-diabetic risk factors and its risk estimate values in the target groups.

Variables (Risk factors)	Risk estimate (95% CI)		Total χ^2 (df = 1)	P-Value
	Males	**Females**		
Drinking alcohol	0.68 (0.4-1.3)	0.34 (0.13-0.9)	4.657	0.01*
Unhealthy eating habits	1.1 (0.5-2.0)	2.79 (1.1-7.2)	1.253	0.05 *
Physical inactivity	0.87 (0.5-1.7)	3.38 (14-8.5)	1.964	0.04 *
Elevated BMI ≥ 25 and above	2.28(0.8-6.5)	2.25 (1.03-4.9)	7.590	0.002**
Elevated WC > 94 cm for men and >80 cm for women	1.2 (0.6-2.8)	2.5 (0.9-6.7)	5.652	0.006**
Elevated WHR, ≥ 90 cm for men) and ≥ 85 cm for women	1.97 (0.8-4.9)	1.96 (0.76-5.1)	9.183	0.001**
At risk WHtR 0.46 - 0.54 for men and 0.45 - 0.53 for women	1.9 (0.78-4.7)	1.4 (0.61-3.2)	6.747	0.003**
Elevated BP ≥ 130 SBP and ≥ 85 DBP	0.5 (0.21-1.3)	0.12 (0.1-0.30)	27.671	0.001**
Elevated Free cholesterol > 200 at border line high risk	1.6 (0.8-3.1)	3.09 (1.0-9.5)	4.455	0.01 *
Elevated TAG's ≥ 150 at risk	1.8 (0.69-4.9)	1.55 (0.75-3.2)	3.472	0.02 *
Elevated LDL – C ≥ 160 at risk	1.6 (0.8-3.2)	3.3 (1.1-10.0)	5.131	0.008 **
Reduced HDL – C < 40 for men and <50 for women at risk	0.3 (0.11-0.71)	1.0 (0.50-1.9)	2.457	0.03*

P - Value refers to the analysis of each risk factor in males and females (**highly significant, *significant).

As per WHO guidelines 23.0% of pre-obese and 34.4% of obese in the target groups whose BMI ≥ 25 with their risk estimate of 2.28 (0.8-6.5) for males and 2.25 (1.03-4.9) for females are in the prediabetic groups, 23.9% of respondents with abdominal obesity (elevated WC) including OR: 1.2 (0.6-2.8) for males and OR: 2.5 (0.9-6.7) for females were in the prevalence of prediabetes. 24.9% of target groups with elevated WHR with OR: 1.97 (0.8-4.9) for males and females OR: 1.96 (0.76-5.1) and 24.6% of population who are at risk for WHtR with OR: 1.9(0.78-4.7) for males and females OR: 1.4 (0.61-3.2) are included in the prevalence of prediabetic groups. According to the seventh report of JNC standards around 20.3% of hypertensive individuals with OR: 0.5 (0.21-1.3) for males and OR: 0.12 (0.1-0.30) for females were in prediabetes. In lipid profile, as per the national cholesterol education program (NCEP) -Adult treatment panel (ATP III) guidelines,

nearly 23.8 % of population is in high cholesterol with risk estimate for males as 1.6 (0.8-3.1) and females as 3.09 (1.0-9.5), 23.2% of target groups in high TAC's and their risk estimate for males as 1.8 (0.69-4.9) and 1.6 (0.75-3.2) for females, 24.1% of the study respondents with high LDL-C and their risk estimate for males as 1.6 (0.8-3.2) and females 3.3 (1.1-10.0) and 51.4 % of low HDL-C respondents whose OR for males 0.3 (0.11-0.71) and females 1.0 (0.50-1.9) were in the prevalence of prediabetes.

A logistic regression model was used to examine the association of all possible variables with prediabetes is presented in Table 4. In the present study, variables including sex, age, occupation, income, drinking alcohol, BMI, WHtR, BP, LDL-C and HDL-C had a positive correlation in prediabetes of the target population.

Table 4. Binary logistic regression model to examine the association of prediabetes with other variables (N = 364).

Variable	Category	Exp (β)	(95%CI)	df	P-Value
Sex	Male	1		1	
	Female	2.2	(1.1 - 4.2)		0.03
Age	35 - 39	1		4	0.05
	40 - 44	3.2	(0.7 - 14.1)		0.11
	45 - 49	5.9	(1.4 - 26.2)		0.02
	50 - 54	8.1	(1.6 - 40.1)		0.01
	55 - 59	3.6	(0.6 - 22.3)		0.12
Occupation	Academic Instructor	1		3	0.02
	Skilled worker	8.2	(2.3 - 29.3)		0.001
	Office Personal	5.8	(1.8 -19.3)		0.004
	Administration worker	8.3	(2.7 - 25.1)		0.001
Income	Low	1		2	0.007
	Medium	0.51	(0.24 - 1.0)		0.05
	High	2.8	(1.12 - 7.5)		0.04
Drinking alcohol	No	1		1	0.05
	Yes	0.59	(0.29 - 1.1)		
BMI	Normal weight (18.5 - 24.9)	1		2	0.001
	Overweight (25.0 - 29.9)	3.2	(1.4 - 7.2)		0.005
	Obese (≥ 30 and above)	9.6	(2.8 - 32.7)		0.001
Waist to Height ratio	No risk	1		1	
	Risk	2.6	(1.2 - 5.2)		0.01
Blood pressure	No	1		1	
	Yes	2.5	(1.3 - 5.2)		0.01
LDL – C	No risk	1		1	
	Risk	2.4	(1.2 - 5.1)		0.02
HDL – C	No risk	1		1	
	Risk	0.97	(0.4 -1.5)		0.05

Discussion

We observed the total prevalence of prediabetes as 20.3% with normal glucose tolerance (NGT), impaired fasting glucose (IFG) and/or impaired glucose tolerance (IGT) as 79.7%, 8.0%, 6.8% and 5.5%, respectively. Our findings are consistent with the prevalence observed in other regional studies as 12% in rural Kolabida town, North West Ethiopia (33), 11.5% in South East Amhara region (34), 29.6% in Gondar (35), 24.4% in HIV-1 adults (36) and 26.7% in TB patients (37) of Addis Ababa. In the global level 6.0% of prevalence in Nigeria (38), 26.5% in rural Uganda (39), 28.52 % in China(40), IFG (7.1%) and IGT (2.9%) in Ireland (41) and 6% of prevalence in Tanzania (42).

The present study showed significance in alcohol consumption (χ^2 = 4.657: p < 0.01), unhealthy eating habits (χ^2 = 1.253: p < 0.05) and physical inactivity (χ^2 = 1.964: p < 0.04) in both male and female respondents. Alcohol consumption increases the concentration of gamma glutamyltransferase (GGT) in the liver (43) which gradually increases the odd's ratio for IFG (44). The odds ratio of unhealthy eating habits and physical inactivity was higher in females compared to males. This might be due to the fact that females are more sedentary in their lifestyle because of cultural feeding practice in the community, improper schedule in food consumption, facing socio-economic problems, frequent pregnancy, resolving family issues and severe stress in a working environment made the females at higher risk for prediabetes than males. The result of our study was supported by other findings stating that unhealthy eating habits and physical inactivity levels are higher in females compared to males (45).

Obesity is a powerful predictor of the development of T2DM which is positively influenced by physical inactivity and excess intake of macronutrient in the diet. Our findings showed a higher prevalence of obesity (BMI: χ^2 =7.590, WC: χ^2 =5.652, WHR: χ^2 = 9.183 and WHtR: 6.747) in male and female respondents. The distribution of body fat is an important determinant of risk because it accurately measures the abdominal obesity which is observed by higher waist circumference (OR: 2.5) in males than in females (OR: 1.2). Our findings are supported by other investigations of higher obesity in females (46) and office workers (47, 48).

A significant association was observed in elevated blood pressure (χ^2 = 27.671) and total lipid profile (TC: χ^2 = 4.455: p < 0.01, TG: χ^2 = 3.472: p < 0.02, HDL-C: χ^2 = 2.457: p < 0.03 and LDL- C: χ^2 = 5.131: p < 0.008) toward prediabetes in the male and female target groups. The results are in accordance with studies suggesting that high BMI, hypertension and elevated triglycerides were significantly associated with increased risk of prediabetes (40).

According to ADA expert panel, 70% of individuals with prediabetes will progress to diabetes (49). A logistic regression model was used to predict the potential effect of risk factors in prediabetes. Variables including sex, age, occupation, income, alcohol, BMI, WHR, BP, LDL-C and HDL-C are strongly associated with prediabetes. The identified risk factors are almost observed in several research works (50).

The present study demonstrated the cluster effect of elevated risk factors and its significance in prediabetes. So it is important to maintain the normal BP, blood glucose, BMI and regular physical exercise to avoid prediabetes. These modifiable risk factors are the core targets in different intervention programs conducted all over the world. They support the change in lifestyle habits by losing excess body weight, regular physical exercise and dietary management could reduce the onset of T2DM. This study may be considered as one of the pre-trial in screening the people to prevent the progression of T2DM and to promote the healthy lifestyle in the near future in Oromia Region.

Conclusion

This study presented a higher prevalence of prediabetes and the effect of associated risk factors in the target population. We observed a higher prevalence compared with earlier research investigations because of urbanization, institutional study and the age of sample population which was ≥ 35 years. In the present scenario, it is highly recommended to conduct a set of intervention programs in the form of counseling to the individual clients after successive screening for prediabetes. The core theme of health education should focus on modifying the risk factors such as reducing obesity, maintaining the routine exercise and proper intake of healthy diet. This strategy can effectively manage the prediabetes and control a huge number of people from the risk of T2DM.

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Author Contributions

RV designed the study, wrote the protocol, performed the interpretation of data and wrote the first draft of

the manuscript. GT and TA managed the acquisition of data and performed the analysis. RV performed a critical revision of the manuscript and managed the literature searches. BA and LK performed the administrative, technical and material support. All the authors provided their input throughout the study and approved the final manuscript.

Competing interest

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