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Prevalence of Undiagnosed Diabetes Mellitus and its Risk Factors in Selected Institutions at Bishoftu Town, East Shoa, Ethiopia

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Abstract

Background: Diabetes mellitus (DM) has significant public health importance and its prevalence is rising. Half of the DM patients are undiagnosed. Undiagnosed DM impose substantial implications because subjects remain untreated and at risk for complications.

Objective: To determine the prevalence of undiagnosed DM and its risk factors in selected institutions at Bishoftu town, East Shoa, Ethiopia.

Materials and methods: Cross-sectional study in selected institutions at Bishoftu town was conducted from December 2012 to February 2013. 422 volunteers proportionally from five institutions were involved. World Health Organization stepwise approach was employed to collect data on demographic, behavioral and physical characteristics. Blood sample after fasting for ≥ 8 hours was collected and serum was assayed for glucose, total cholesterol and triglycerides. Statistical analysis was performed by using STATA (Version 11 USA).

Results: The overall prevalence of undiagnosed DM in the study was 5% [95% CI: 3-7%]. Though not statistically significant undiagnosed DM was higher in males (5.7% vs. 3.7%, P>0.05). Increased occurrence of undiagnosed DM was observed with increasing age but again not statistically significant (P>0.05). Univariate analysis showed undiagnosed DM was significantly associated (P<0.05) with body mass index, waist circumference, alcohol consumption, history of hypertension and high triglyceride level. Predictors for undiagnosed DM in the study were high waist circumference (P=0.001, OR: 7.70 95% CI: 2.31-25.67) and history of hypertension (P=0.009 OR: 3.74 95% CI: 1.39-10.03) after adjusting age, family history of DM, and body mass index.

Conclusion: Higher prevalence of undiagnosed DM than the International Diabetes Federation Atlas projected estimate of DM for Ethiopia was observed in the current study. This calls for the necessity of conducting such studies in wider scale and bring more oblivious patients for medical attention.

Keywords: Prevalence; Undiagnosed diabetes; Risk factors; Institutions; Bishoftu town

Introduction

Diabetes mellitus (DM) is a metabolic disorder resulting from a defect in insulin secretion, insulin action, or both. Insulin deficiency in turn leads to chronic hyperglycemia with disturbances of carbohydrate, fat and protein metabolism [1]. DM as a non-communicable disease has significant public health importance and its prevalence is rapidly rising all over the globe at alarming rate [2]. It has been reported that nearly half of the individuals with DM remain undiagnosed [3]. Undiagnosed DM impose substantial implications because subjects remain untreated and at risk for complications [4].

International Diabetes Federation Atlas (IDFA) in 2011 estimated 366 million people suffer from DM and the number is expected to rise to 552 million by 2030 [5]. Most of this increase will occur as a result of 150% rise in developing countries. It is estimated that developing countries will bear the brunt of DM epidemic to the extent of 77% of the global burden in the 21st century [2] as a result of population growth, ageing, unhealthy diets, obesity and sedentary lifestyles [6]. IDFA estimated that 10.8 million people have DM in sub-Saharan Africa in 2006 and that this would rise to 18.7 million by 2025, an increase of 80%, as such exceeding the predicted worldwide increase of 55% [7]. In Ethiopia, national data on prevalence and incidence of DM are lacking. However, patient attendance rates and medical admissions in hospitals are rising [8]. In addition IDFA reported Ethiopia to be ranked 3rd among the ten top countries in Africa with 1.4 million DM cases and estimated prevalence of 3.32% by year 2012 [9].

Ethiopia is a developing country with a change that influenced the lifestyle of the people towards urbanization, particularly over the recent decades. These rapid changes have lead to the necessity of conducting a study on DM and associated risk factors. Quantifying the prevalence of DM now and in future is important to allow for national planning and allocation of resources. Although numerous studies have documented worldwide increases in DM, there is scarcity of study in Ethiopia. Hence, this study was undertaken to determine the prevalence of undiagnosed DM and its risk factors in institution based adults at Bishoftu town.

Materials and Methods

Study design, area and period

Institutional based cross-sectional study was conducted from

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December 2012 to February 2013 to determine the prevalence of undiagnosed DM and its risk factors in selected institutions at Bishoftu town, East Shoa, Ethiopia. Bishoftu town is located 47 km away from Addis Ababa, capital city of Ethiopia.

Up to 2012 population size of the town was 111,963 whom 47.8% were males and 52.2% females. Majority of people are engaged in trade and other businesses whereas the rest are working in government and non government institutions. These include industries, research centers, schools, health sectors and others which deliver service to public [10].

The institutions such as; National Veterinary Institute, Agricultural Research Center, Zuquala Steel Production Factory, Kalehiwot Kuriftu Center and College of Veterinary Medicine were selected for the study.

Study population, sampling procedure and sample size

The source population consists of subjects working in the institutions. Study subjects were those who consent to participate on the study were included using convenient sampling method. Since there was no prior study in the study site an expected prevalence of 50% and desired precision of 0.05 and 95 % confidence interval (CI) was used for the calculation. The sample size required was calculated using formula for estimating single population proportion giving 384. However as the sample was taken from a relatively small population i.e. the number of individuals working in selected institutions were 1115 (<10000), the required minimum sample obtained from the above estimate adjusted using finite population correction to give a total of 287. Nevertheless by considering the resources, participant's response and to increase precision the size was inflated proportionately to 422. The final sample size was distributed to selected institutions by using proportional allocation as shown in table 1.

Exclusion criteria

- Individuals with diagnosed DM
- Individuals currently taking any drugs with possible impact on glucose metabolism
- Pregnant women (possible impact on anthropometric and laboratory parameters)

Measurement and data collection

Data collection was conducted after having signed informed consent of the participants. World Health Organization (WHO) stepwise approach for non-communicable diseases surveillance was employed to collect the data. The approach had three levels: questionnaire to gather demographic and behavioral information, physical measurements (anthropometric and blood pressure) and biochemical tests [11].

Demographic and behavioral information: Each participant was questioned for age, sex, education status, marital status, occupation type, physical activity, family history of DM, alcohol consumption and smoking habit.

Institutions	No. of staff	Proportional allocation	Final sample size
Agricultural Research Center	270	70	102
National Veterinary Institute	215	55	81
Zuquala Steel Production Factory	200	52	76
Kalehiwot Kuriftu Center	130	33	49
College of Veterinary Medicine	300	77	114
Total	1115	287	422

Table 1: Institutions versus distribution of individuals participated in the study.

Individuals reporting regular aerobic exercise or its equivalent (e.g. walking) for at least 150 minutes per week considered to be physically active [12]. Family history of DM considered as positive if either or both parents or sibling of individuals are diagnosed to have DM. Occupation type reported as sedentary (individuals tending to work much of their time seated or whose work requires little physical activity, moderate (individuals whose work requires moderate physical activity and vigorous (individuals whose work requires higher physical activity

Smoking habit reported as non smoker (individuals who never smoke), smoker (individuals who are currently smoking) and ex-smoker (individuals who don't smoke currently but who smoke in past). Alcohol consumption rated as non drinker (individuals who never drink any kind of alcohol), frequent drinker (individuals who drink any kind of alcohol one or more days per week) social drinker (individuals who drink any kind of alcohol not more than three days per month) and ex-drinker (individuals who don't drink any kind of alcohol currently but drunken in past).

Physical measurements

- **Blood pressure measurement:** History of hypertension considered to be positive when individuals diagnosed to have hypertension. Blood pressure (BP) was measured in sitting position on the right arm using mercury sphygmomanometer. Two readings were taken 5 minutes apart, and the mean was taken as the final BP reading. Hypertension defined as systolic BP of ≥ 140 mmHg or diastolic BP of ≥ 90 mmHg [13].
- **Anthropometric measurements:** Height was measured by using a stadiometer, standing upright on a flat surface. Body weight was measured while wearing light clothes by an adjusted scale. Body mass index (BMI) was calculated by the formula: weight in kilograms divided by height in meters squared. BMI defined <18.5kg/m^2 underweight, 18.5-24.9 kg/m^2 normal, and 25-29.9 kg/m^2 overweight and >30 kg/m^2 obesity [14].

Waist circumference (WC) measured at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest using flexible plastic tape. WC values >94 and >80 cm for men and women respectively was considered high according to world health organization (WHO) [15].

Biochemical measurements: 3ml venous blood using plain vacationer tubes was obtained after an overnight fast (≥ 8hrs) at the institutions. The blood samples were left at room temperature to allow clotting for 15-20 minutes and centrifuged at 3000 rpm for 10 minutes. Then sera were transferred into 2 ml Eppendorf tubes and stored at +4°C for 1-2 hours at sampling sites and transported to biochemistry laboratory of College of Veterinary Medicine (CVM), Addis Ababa University (AAU). The levels of glucose, total cholesterol (TC) and triglycerides (TG) were measured using enzymatic colorimetric assay using Humastar 80 chemistry analyzer (Human diagnostic Germany).

The diagnosis of DM was based on the WHO 2006 with fasting blood glucose of over ≥ 126 mg/dl being diagnostic for DM [16]. The optimal serum level for lipid profiles were considered as <200 mg/dl for TC and <150 mg/dl for TG in both genders as per the third report of the national cholesterol education program expert panel on detection, evaluation, and treatment of high blood cholesterol in adults [17].

Quality assurance

The data collection was conducted by trained nurses. Before starting blood collection, laboratory technicians were refreshed on proper sample collection. After blood collection serum was separated within 30 minutes and prior to analysis samples were placed at -20°C. The instrument Humastar 80 chemistry analyzer was calibrated using calibrator (Autocal) and quality control samples normal (Humatrol N) and pathological (Humatrol P) were run each day before running samples for tests .

Statistical analysis

The data was analyzed using statistical software STATA (Version 11, USA). Univariate logistic regression model was employed to assess the predictive values of the potential risk factors. The strength of the associations was assessed by odds ratios (OR) and 95% confidence intervals (CI) were calculated. Variables that showed collinearity were omitted, the remaining variables P<0.25 in univarate analysis were offered to multivarte logistic regression. Hosmer and Lemeshow goodness of fit test was used as a measure of overall goodness of fit. P<0.05 was considered as significant.

Ethical considerations

Ethical clearance (protocol number DRERC 03/12/MLS) was collected from research and ethics review committee of the department of medical laboratory sciences, school of allied health sciences, college of health sciences, Addis Ababa University. Then the participants after reading the written consent form, and when agree upon, and sign, involved in the study. Confidentiality of the participants was maintained by using unique code. The results of laboratory findings were provided to the study participants and those in need of medical attention were advised to visit health institution.

Result

Characteristics of study participants

Socio-demographic variables: In the study from the total 1115 individuals, 37.9% (n= 422) were involved. Among the study subjects, 62.3% (n=263) were males and 37.7% (n=159) females giving a sex ratio of 1:0.6. The age of the study participants ranged from 20 to 70 years with the mean ± SD of 40.3 ± 10.3. Higher proportion of the study participants reside in the age group 30-49 years old. Education profile of the participants who respond showed 57% (n=232) of the participants had primary or secondary education, the remaining 43% (n=175) had college or university education. Marital status of the subjects indicates that 73.7% (n=311), 20.4% (n=86), 3.6% (n=15) and 2.4% (n=10) were married, single, divorced and widowed respectively. Most subjects had occupation requiring moderate physical activity 48.7% (n=187) followed by vigorous 28.6% (n=110) and sedentary 22.7% (n=87).

Risk factors: Information was collected from study participants about the risk factors and it was indicated that distribution of underweight, normal, overweight, and obese individuals in total 422 studied subjects were 4.3% (n=18), 58.3% (n=246), 29.1% (n= 123) and 8.3% (n=35) respectively; besides high WC was also observed in 40.7% (n=172/422); family history of DM 9% (n= 38/422); history of hypertension had 17.6% (n= 74/420). Moreover, 21.7% (n=94/422) were physically inactive, 4.3% (n= 18/420) were smokers and 48.1% (n=202/420) consumed alcohol during the study period of whom 40% (n=81) were frequent drinkers while 60% (n=121) were social drinkers. About a third of the study participants (n=127/422) had a TC level of below 200 mg/dl while 48.3% (n=204/422) had TG level of below 150 mg/dl.

Prevalence of undiagnosed diabetes mellitus and its relation to socio demographic, modifiable and non modifiable risk factors

In the study out of 422 volunteer subject tested 5% (n=21) [95% CI: 3%-7%] were found to have undiagnosed DM. The remaining 95% (n=401) were non-diabetic. There was an increasing trend prevalence of undiagnosed DM with age. Lowest undiagnosed DM prevalence was detected among those age 30-39 years and highest prevalence rate was noticed in ≥ 60 years. The age specific undiagnosed DM prevalence rate is depicted in Figure 1.

Sex wise undiagnosed DM was found in 5.7% (n=15/263) of males and 3.7% (n=6/159) of females. With regard to marital status there was higher prevalence rate of undiagnosed DM in married subjects 5.79% (n=18/311) while none of the divorced and widowed subjects have undiagnosed DM. Regarding to the educational status, higher prevalence rate 6.03% (n=14/232) was observed in subject's having primary or secondary education. Based on the occupational type higher prevalence rate was observed in those having sedentary work 6.9% (n=6/87) followed by 5.45% (n=6/110) and 4.81% (n=9/187) in moderate and vigorous type of work, respectively (Table 2).

In modifiable risk factors relatively higher prevalence of undiagnosed DM was observed in those overweighed (9.76%), higher WC (9.88%), ex-smokers (11.11%), physically inactive (7.69%), hypertensive (13.51%), frequent alcohol drinker (8.64%), high TC (5.42%) and high TG level (7.8%) as compared to their counterparts. As non modifiable factor subjects having family history of DM had relatively higher prevalence rate (5.26%) than those without family history of DM.

Association of undiagnosed DM with demographic variables:

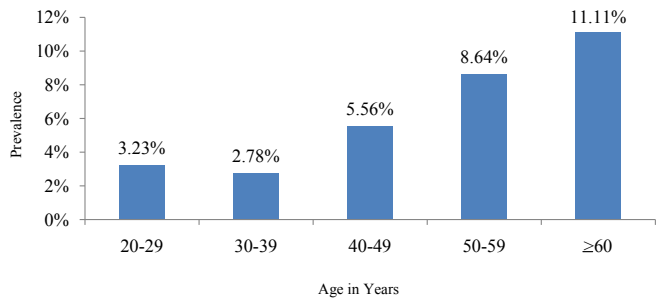

Figure 1: Age specific prevalence of undiagnosed diabetes mellitus among study subjects in selected institutions in Bishoftu town, East Shoa, Ethiopia.

Variable	Category	Undiagnosed DM		OR[95% CI]	P-value
		Frequency	Percent		
Educational status	College or University Primary or secondary	7/175 14/232	4.00 6.03	Ref 1.54 (0.61-3.90)	0.362
Marital status	Single Married	3/86 18/311	3.49 5.79	Ref 1.7 (0.49-5.91)	0.404
Occupation	Vigorous Moderate Sedentary	9/187 6/110 6/87	4.81 5.45 6.90	Ref 1.14 (0.39-3.29) 1.46 (0.50-4.25)	0.870 0.798

Table 2: Univariate logistic regression analysis of demographic variables with undiagnosed DM in selected institutions Bishofu town, East Shoa, Ethiopia.

An attempt was made to correlate undiagnosed DM with socio-demographic variables like, marital status, educational status and occupation type. The univariate logistic regression model showed that there was no statistically significant socio-demographic variable in the study subjects [P>0.05]. The undiagnosed DM in subjects having lower educational status (primary or secondary education) was 1.54 times higher when compared with those having higher educational status (college or university education). There was also higher odds of undiagnosed DM in married subjects [OR=1.7; 95% CI: 0.49-5.91] than single subjects. None of the widowed and divorced subjects were found to have undiagnosed DM. Based on the occupational type individuals having sedentary type of work have higher odds of undiagnosed DM than those in vigorous type of work [OR: 1.46; 95% CI: 0.50-4.25] (Table 2).

Association of modifiable risk factors variables with undiagnosed DM: The univariate logistic analysis of factors showed that WC, BMI, alcohol consumption, high TG level and history of hypertension had statistically significant association with undiagnosed DM [P<0.05]. Overweighed subjects showed 4.32 more common undiagnosed DM than subjects with normal BMI [95% CI: 1.58-11.81]. In addition people having high WC are 6.74 times higher rate of having undiagnosed DM than those having normal WC [95% CI: 2.22-20.41].

Among the respondents who consumed alcohol; frequent drinker compared to non-drinker was 4.5 times more likely to have undiagnosed DM followed by social drinker [OR=4.32; 95% CI: 1.42-14.1]. Subjects with history of hypertension had also shown greater odds of having undiagnosed DM [OR=4.57 95%CI: 1.94-11.67]. Besides the study has shown that high TG level significantly associated with undiagnosed DM [OR=4.22; 95% CI: 1.39-12.78] (Table 3).

Association of non modifiable risk factors variables with undiagnosed DM: The univariate logistic regression model showed that there were no statistically significant non-modifiable risk factors in the study population [P>0.05]. According to the study, an increase in odds of having undiagnosed DM as age increases was observed. The univariable logistic regression model showed that the odds of acquiring undiagnosed DM among those aged ≥ 60 years was more than 3.75 higher when compared with 20-29 years age group [95% CI : 0.3- 46.20]. Comparison of undiagnosed DM by sex revealed that undiagnosed DM was 1.54 more common in men than in men [95% CI: 0.58-4.06] (Table 4). Subjects with family history of DM had also shown 1.06 more common undiagnosed DM than those without history of DM.

Multivariate logistic regression analysis of risk factors: Using multivariate logistic regression, collinearity of independent variables was evaluated before using this model. The non collinear having P<0.25 included in the model were: physical activity, history of hypertension, alcohol consumption, WC, BMI and TG. Additionally age, sex and family history of DM which are biologically associated with DM entered regardless of their P-value. Backward stepwise method was employed to select the best fitting model. Hosmer and Lemeshow goodness of fit test was used as a measure of overall goodness of fit. The final model predicts the data well. The P-value of Hosmer and Leme show goodness

Variable	Category	Undiagnosed DM		OR[95% CI]	P-value
		Frequency	Percent		
BMI	Normal	6/246	2.44	Ref	
	Overweight	12/123	9.76	4.32 (1.58-11.81)	0.004*
	Obese	3/35	8.57	3.75 (0.89-15.73)	0.071
WC	Normal	4/250	1.60	Ref	
	High	17/172	9.88	6.74 (2.22-20.41)	0.001*
Smoking habit	Non smokers	18/384	4.69	Ref	
	Smokers	1/18	5.56	1.19 (0.15-9.49)	0.865
	Ex-smokers	1/18	11.11	2.54 (0.54-11.90)	0.236
Physical activity	Active	14/328	4.27	Ref	
	Inactive	7/91	7.69	1.86 (0.73-4.77)	0.192
History of Hypertension	No	11/346	3.18	Ref	
	Yes	10/74	13.51	4.75 (1.94-11.67)	0.001*
Alcohol consumption	Non drinkers	4/196	2.04	Ref	
	Frequent drinkers	7/81	8.64	4.54 (1.29-15.96)	0.018*
	Social drinkers	10/121	8.26	4.32 (1.32-14.11)	0.015*
TC	<200 mg/dl	5/127	3.94	Ref	
	≥200 mg/dl	16/295	5.42	1.39 (0.50-3.90)	0.521
TG	<150 mg/dl	4/204	1.96	Ref	
	≥150 mg/dl	17/218	7.80	4.22 (1.39-12.78)	0.011*

*= P<0.05

Table 3: Univariate logistic regression analysis of modifiable risk factors with undiagnosed DM in selected institutions Bishoftu town, East Shoa, Ethiopia.

Variable	Category	Undiagnosed DM		OR [95% CI]	P-value
		Frequency	Percent		
Age (in Years)	20-29	2/62	2.23	Ref	
	30-39	4/144	2.78	0.85 (0.15-4.80)	0.861
	40-49	7/126	5.56	1.76 (0.35-8.75)	0.487
	50-59	7/81	8.64	2.83(0.56-14.16)	0.204
	≥ 60	1/9	11.11	3.75 (0.30-46.20)	0.302
Sex	Female	6/159	3.7	Ref	
	Male	15/263	5.7	1.54 (0.58-4.06)	0.380
Family history of DM	No	19/384	4.95	Ref	
	Yes	2/38	5.26	1.06 (0.24-4.76)	0.932

Table 4: Univariate logistic regression analysis of non modifiable risk factors with undiagnosed DM in selected institutions Bishoftu town, East Shoa, Ethiopia.

of fit test P = 0.9770 chi-square = 2.12 and df= 8 indicates that the data fitted the model and is significant.

The multivariable logistic regression analysis showed that history of hypertension (P =0.009) and WC (P=0.001) were independent predictors of undiagnosed DM after adjusting family history of DM, BMI and age (Table 5).

Discussion

The study showed 5% prevalence of undiagnosed DM. The prevalence of undiagnosed DM observed in the study was comparable to Ojewale et al. who reported; 4.7% of undiagnosed DM among civil servants Oyo state secretariat Nigeria [18]. Mohan et al. also reports 4.8% in India [19] and 5.9% Bener et al. (2008) in Qatar were consistent with the findings of the study [4]. Unlike the studies by Ekpenyong et al. Nigeria 0.8% [20], Ahmad et al. in India 2.02% [21] and Muyer et al. Congo 1.5% [22]; the present study recorded a relatively higher level of undiagnosed DM. This could partly be due to differences in the composition of study population. The prevalence (5.0%) found in this study also higher than the estimated national prevalence of Ethiopia; 3.32% reported by the IDF in 2012 [9]. This may be associated with the global increase in the trend of DM and the predicated epidemic in developing countries. However reports in literature indicated that prevalence of undiagnosed DM can be as high as 18.9% (2001) in Nigeria [23] and 18.1% (2009) in South Africa [24]. The direct comparisons of prevalence rates are challenging owing to different methodologies applied and diverse characteristics of the study population.

With regards to distribution of undiagnosed DM by sex, males shown higher rate of undiagnosed DM. The male predominance in occurrence of undiagnosed DM were similar to the result disclosed by On'Kin et al. in Congo [25] Yemane et al., in Ethiopia [26], Nwafor et al. in Nigeria [23] and Al-Habori et al. in Yemen [27]. However women's vulnerability also seen in other reports like and Echouffo-Tcheugui et al. in Cameroon [28] and Majgi et al. in India [29]. It is likely that the gender difference observed in this study was merely due to the lower participation rate among females. In addition, it may be due to co-existing risk factors in males.

Different studies reported that prevalence of DM increases with increased in age. In the current study too, increasing trend in the prevalence of undiagnosed DM with age was observed, even if the association was not statistical significant. Our study findings are in consistent with the finding of Yamane et al. in Ethiopia [26]. In addition Ahmad et al. and Majgi et al. in India [21,29] and Azimi-Nezhad et al. Iran [30] found higher occurrence of undiagnosed DM as age increases. Responsible mechanisms of age-related glucose intolerance include decreased insulin sensitivity and decreased β-cell function [31].

According to our study there was not statically significant association between undiagnosed DM and marital status. The lack of association of marital stus and undiagnosed DM also observed by Azimi-Nezhad et al. in Iran [30] and Muyer et al. in Congo [22]. However some findings suggest that single, divorced and widowed statuses increase the risk of DM [32,33]. The lack of association in this study might be justified by the number of other groups rather than married subjects were less in number.

The study found higher prevalence of undiagnosed DM in subjects having lower educational status; but no statistically significant association. Lack of association also obtained from Majgi et al. [29]. Azimi-Nezhad et al. in Iran [30], Muyer et al. in Congo [22] and Prabhakaran et al. in India [34], Krishnan et al. [35], Signorello et al. in USA [36] and Robbins et al. [37]. The higher prevalence in lower educational status might be related to lack of awareness and opportunity for prevention.

The observation of the study did not reveal a significant association between physical activity with undiagnosed DM, which is similar to findings of Echouffo-Tcheugui et al. in Cameroon [28]. However reports from Nyenwe et al. in Nigeria [38] and Mutebi et al. in Uganda [39] showed significant association between physical activity and DM. The lack of association in this study probably reflects bias to physical activity. The mechanisms of protective effects of physical activity on DM risk explained by body weight control, improvement of biomarker profiles and reduction of metabolic syndrome risk [40].

In the study undiagnosed DM was higher in subjects with family history of DM, although it was not statistically significant. On the contrary significant and positive association between family history of DM and DM occurrence was reported in other studies like Basit et al. in Pakistan [41], On'Kin et al. in Cong [25], Ahmad et al. in India [21], Aksu et al. in Turkey [42], Nyenwe et al. and Oyegbade et al. in Nigeria [38,43]. The lack of association probably results from participants missing DM status of their parents or sibling.

Undiagnosed DM in this study was associated with alcohol consumption. An association between alcohol and DM was also supported by various authors. Echouffo-Tcheugui et al. in Cameroon [28], Muyer et al. in Congo [22], Nyenwe et al. and Oyegbade et al. in Nigeria showed the association of alcohol with DM [38,43]. The hypothesized diabetogenic effects of alcohol include its contribution to inadequate insulin release, reduced insulin binding and inhibition of intracellular signaling with the eventual development of insulin resistance [44].

On the other hand the study showed that smoking was not associated with the undiagnosed DM. Similarly Prabhakaran et al. and Raghupathy et al. in India [34,45] reported lack of association between smoking and undiagnosed DM. Studies from industrialized countries showed positive association of smoking and undiagnosed DM [46-48]. The lack of association in this study could be justified by small participation of smaller proportion of smokers in the study [49].

Variable	Category	OR [95%CI]	P-value
Sex	Male	2.05 (0.53-7.83)	0.296
WC	High	7.70 (2.31-25.67)	0.001*
History of hypertension	Yes	3.74 (1.39-10.03)	0.009*
Alcohol consumption	Social Frequent	2.35 (0.61-9.05) 3.91 (0.81-18.92)	0.212 0.089
Triglyceride	High	2.34 (0.71-7.74)	0.161
Physical activity	Inactive	1.92 (0.66-5.60)	0.232

*= P<0.05

Table 5: Multivariate logistic analyses of risk factors with undiagnosed DM in selected institutions Bishoftu town, East Shoa, Ethiopia.

Consistent with the findings of Zafar et al. in Pakistan [50] Pramono et al. in Indonesia [51] Aksu et al. in Turkey [42] Al-Habori et al. in Yemen [27] Mutebi et al. in Uganda [39], and Prasad et al. our study revealed a significant association of hypertension with undiagnosed DM. This indicates that screening for DM should be targeted to patients with hypertension in Ethiopia.

BMI was associated with undiagnosed DM. In agreement with the current study, Ahmad et al. India [21] On'Kin et al. in Congo [25] and Yemane et al. in Ethiopia [26] reported the association of BMI with undiagnosed DM. In addition, WC also associated with undiagnosed DM. The finding was consistent with previous studies of Azimi-Nezhad et al. in Iran [30] On'Kin et al. in Congo [25] Khambalia et al. in Nauru [52], Pramono et al. in Indonesia [51], Ahmad et al. in India [21] Muyer et al. in Congo [22] Magliano et al. in Australia [47], Prasad et al. in India [53] and Ralph-Campbell et al. in Canada [54]. It has been postulated that expanded abdominal fat stores affect insulin metabolism by releasing free fatty acids (FFA). In addition fat cells secrete signaling factors e.g. Interlukein-6 (IL-6) and tumor necrosis factor-α (TNF- α) which involved in the development of insulin resistance [20].

There was also significant association between high TG level and undiagnosed DM. The finding goes in parallel with Azimi-Nezhad et al. in Iran [30] Bener et al. in Qatari [4] Magliano et al. in Australia [47] Prasad et al. in India [53] Ralph-Campbell et al. in Canada [54] Melidonis et al. in Greek [55] and Tirosh et al. in Israel [56]. It has been suggested that high FFA potentially derived from TG deteriorate insulin sensitivity [57]. The currents study did not show association between TC and undiagnosed DM which is in agreement with Sayeed et al. India [58]. However reports by Khambalia et al. in Nauru [52], Prasad et al. in India [53] indicate the association of TC with DM. The lack of association questioned for further study to explain existence of the association between undiagnosed DM and hypercholesterolemia in our society.

Strength and Limitation of the Study

The strength of the study is its novelty in providing information on undiagnosed DM in particular to Ethiopia; since information regarding DM in general is sparse. However, the study is not without limitations. The study was being institutional based might be affected by selection bias and the conclusions might not apply to the population at large. Owing to logistic reasons we are unable to incorporate testes like oral glucose tolerance test (OGTT) to increase the specificity of the study besides only the blood glucose test was used to diagnose DM, and this did not differentiate DM types.

Conclusion

The study illustrated 5% prevalence undiagnosed DM which was higher than the projected prevalence of DM (3.32%) by IDFA. It should be noted that this result is technically alarming as it has been predicted that much of the global increase in DM is predicted to be in developing countries including Ethiopia. In addition it indicates that there might be a large number of people who have DM, but are not aware of it. It was observed that undiagnosed DM existed in all age groups indicating vulnerability of the population at large. The study also endorses the fact that established risk factors like high BMI, high WC, alcohol consumption, history of hypertension and high TG level were associated with undiagnosed DM. The factors associated with undiagnosed DM were potentially modifiable. Therefore targeting the prevention to such modifiable risk factors might reduce the prevalence of undiagnosed DM and screening of DM in such individuals particularly those having high WC and history of hypertension brings more oblivious patients for medical attention. In addition large scale community based study to formulate guidelines and a policy leading to mitigation of the potentially devastating outcomes of undiagnosed DM is also recommended.

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