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Prevalence of Undiagnosed Diabetes Mellitus and Associated Factors in Adults in Mettu Town, Southwest Ethiopia: Community Based Cross Sectional Study

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Abstract

Background: Despite the availability of simple screening tests to screen people for the possibility of the presence of diabetes, most cases of diabetes mellitus are diagnosed late after the occurrence of multiple irreversible damages on the body. The objective of the current study was to assess the prevalence of undiagnosed diabetes mellitus and the associated risk factors in Mettu town, Southwest Ethiopia.

Methods: A community based cross-sectional study was conducted from March 1st to April 1st, 2018. A total of 696 study participants were randomly selected and included in the study. The data were collected by face to face interview, physical examination and on-site test for random blood sugar. Multivariable logistic regression models were fitted to control the effect of confounders. Adjusted Odds Ratios (AOR) with their 95% Confidence Intervals (95% CI) was computed to measure associations. A p-value of <0.05 was considered as statistically significant.

Results: The prevalence of undiagnosed diabetes mellitus was 12.3%. The independent predictors of undiagnosed diabetes mellitus in this study were: age group 40 to 49 [AOR=3.51; 95% CI: 1.14, 10.77], alcohol consumption [AOR=2.62; 95% CI: 1.34, 5.1], khat consumption [AOR=3.12; 95% CI: 1.76-5.50], sedentariness [AOR=1.73; 95% CI: 1.01, 2.95], raised diastolic blood pressure [AOR=2.56; 95% CI:1.36,4.8] and family history of diabetes mellitus [AOR=1.44; 95% CI: 1.43,4.96].

Conclusion and Recommendations: The prevalence of undiagnosed diabetes mellitus was high. Alcohol consumption, khat consumption, sedentariness, raised diastolic blood pressure and family history of Diabetes Mellitus were independent positive predictors of undiagnosed diabetes mellitus. Focused interventions have to be implemented to reach undiagnosed peoples who are more likely to develop irreversible complications by focusing on identified factors.

Keywords: Undiagnosed diabetes mellitus; Diabetes mellitus; Mettu town

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Abbreviations

ADA: American Diabetes Association; BMI: Body Mass Index; CDC: Center for Disease Control; DM: Diabetes Mellitus; EPHI: Ethiopian Public Health Institute; FBS: Fasting Blood Sugar; GDM: Gestational Diabetes Mellitus; IDF: International Diabetes Federation; LMIC: Low and Middle Income Countries; MET: Metabolic Equivalent per Time; NCD: Non-Communicable Disease; SBP: Systolic Blood Pressure; T1DM: Type 1 Diabetes Mellitus; T2DM: Type 2 Diabetes Mellitus; UDM: Un-diagnosed Diabetes Mellitus

Introduction

Diabetes Mellitus (DM) is a serious chronic metabolic disorder with characteristic hyperglycemia resulting from either failure in the production of insulin or the body's inability to effectively utilize the insulin it produces. Undiagnosed Diabetes Mellitus (UDM) is DM that is identified as part of a health survey, through blood testing, in a person not previously known to have diabetes. Staying for long duration without being diagnosed with diabetes is the main reason leading to severe irreversible complications in Type 2 Diabetes Mellitus (T2DM) [1]. According to the International Diabetes Federation (IDF) statistics publication of 2017, the global prevalence of diabetes is estimated to be 8.8% in adult population aged 20 to 79. The report concludes that there is variation in prevalence with age, economic status, and geographic region. The disease is highly prevalent in high and middle income countries. The middle and low income countries are home for 75% of the patients. The peak

age of the disease is at the age of 65 to 69 and 75 to 79 in males and females respectively. Its standardized prevalence is highest in North America and Caribbean (11.5%) while it is lowest in Africa (3.8%). It is also estimated that the Africa region and the Middle East and North Africa region are expected to experience the surge in the prevalence of the disease [2,3].

It has become clear that Sub-Saharan Africa (SSA) is deemed to face a double burden of disease as represented by increased rates of non-communicable diseases added to endemic, pandemic, and emergent infections such as malaria, tuberculosis, and HIV/AIDS [4]. The prevalence of the disease in Africa as studied by IDF was 4.85% and projected to surge to 5.3% in 2035 [2].

A study in Sudan showed that the prevalence of UDM in men and non-pregnant women was 2.6%. In this study unexplained weight loss was found to be statistically associated with DM. The factors significantly associated with the prevalence of the disease were: Advancing age, lower educational level, high blood pressure, and positive family history of diabetes [5].

The prevalence of DM and raised blood glucose in Ethiopian adult population is 6% [6]. The country wide prevalence of UDM is not clearly known. Few studies done to assess the prevalence of UDM have shown different prevalence levels. A study in Koladiba; Northwest Ethiopia, showed the prevalence of UDM to be 2.3%. Another study in East Gojam found that the prevalence of the condition is 11.5% with slight difference in sex. The same study concluded that the prevalence is higher in urban (13.4%) than rural (10.3%) residents [6-9].

Although they are not satisfactory, some efforts were put forth by the Ethiopian government to tackle the problem of NCDs in the country. The National NCD Prevention and Control Strategy was developed and launched by the FMOH [9].

Despite the availability of simple diagnostic tests to screen people for the possibility of the presence of the disease, most cases of the disease are diagnosed late after the disease has produced multiple irreversible damages on the body. The majority of complications are preventable. All intervention possibilities need clear information about the problem under consideration. Mettu town is a politico-administrative as well as the economic capital of the Ilu Ababor zone. Recently the town is showing some transition being part of the whole demographic change in the nation. Research works and specially those concerning NCDs like the diabetes are rarely conducted in the deep South West regions of the country like Mettu and its surrounding. The prevalence of NCDs in general and the DM in particular was unclear. So this study has clearly identified the status of the UDM in Metu Town and surrounding areas with factors associated to the problem.

Materials and Methods

Study design and study population

A community based cross-sectional study design was used. The data was collected from March 10th to April 10th, 2018 in Mettu Town, the politico-administrative center Ilu-Aba-Bor zone. The source population was all the residents of the Mettu town aged 20 to 79 years except those with previously diagnosed DM. Study population were all individuals 20 to 79 years in the selected households during the study period.

Sample size and Sampling technique

The sample size was determined using single population proportion formula considering 95% confidence interval, prevalence of UDM 11.5% [8], desired precision (marginal error) of 0.03. Systematic random sampling was used to select households from the entire households in the study area. The sampling interval was calculated by dividing the total number of HHs in the town by the sample size (N/n=13143/716=18). The first house was randomly selected from one corner of the town and the next was selected every 18th house. One individual among the eligible residents from the selected household was selected by lottery method. Whenever the selected household did not have eligible resident the immediate neighbor house with eligible individuals was selected.

Variables

The dependent variable of the study was undiagnosed diabetes mellitus status whereas the independent variables include Socio-demographic variables (age, sex, family history of diabetes mellitus), behavioral variables (tobacco smoking, alcohol consumption, sedentariness, khat chewing), Metabolic risk factor variables (weight, height, waist circumference, blood pressure).

Data collection tool and procedures

The data collection tool was adapted from the "Ethiopia STEPS survey questionnaire on risk factors for non-communicable disease and prevalence of selected NCDs, 2015" [6], tool which was adapted from the "WHO STEPS instrument v3.1" [10]. The STEPS approach has three levels and within each level risk factor assessment is divided into core, expanded core, and optional modules. But for the essence of predetermined study objective, this study focused only on core modules with the components related to DM.

Three different data collection techniques were employed. The data for STEP I was collected by face-to-face interview. The data for physical measurement was collected by using the necessary respective equipment. The data on blood sugar also was collected by using i-QARE digital glucometer. There were six data collection teams each Kebele (Amharic term to for sub-district and lowest administrative structure) having two teams. Each team comprises one nurse and one local guide. There were three supervisors each supervising two teams. Data for the socio-demographic variables and physical measurement were collected during the first visit. After once they collect data on STEPS I & II the nurses instruct the participants and obtained consent for random blood sugar. The sample for RBS was taken by finger prick and tested immediately on sight by i-QARE digital glucometer and the individuals were told about their status and when they become positive for diabetes they were advised to visit the nearest health facility for further work-up and follow-up.

Data quality control

All necessary efforts were made to ensure the quality of the data. The data collection tool was adapted from the standardized tool developed by the WHO and used by Ethiopian Public Health Institute (EPHI) during the 2015 STEPS survey. The tool was translated to local language, back translated to English and checked for consistency by language experts. The data collection tool was pre-tested on 5% of the sample size on a population of different geographic location and checked for its ability to measure the intended objectives and necessary correction was made before the actual data collection. The data collectors were trained with practical demonstration. The instruments for weight measurement were calibrated and adjusted

Table 1: Socio-demographic characteristics by the status of UDM, Metu, and South-West Ethiopia March, 2018.

Variables	Response Options	Total (%)	UDM Status		COR	P- Value
			Yes (%)	No (%)	95% CI	
Sex	Male	375 (53.9)	56 (14.9)	319 (85.1)	1.7 (1.06,2.73)	0.027
	Female	321 (46.1)	30 (9.3)	291 (90.7)	1	
Age group	20-29	112 (16.1)	4 (3.6)	108 (96.4)	1	
	30-39	169 (24.3)	11 (6.5)	158 (93.5)	1.88 (0.58,6.05)	0.29
	40-49	211 (30.3)	44 (20.9)	167 (79.1)	7.11 (2.48, 20.36)	0
	50-59	67 (9.6)	12 (17.9	55 (82.1)	5.89 (1.81,19.11)	0.003
	60-69	84 (12.1)	10 (11.9)	74 (88.1)	3.65 (1.1,12.07)	0.034
	70-79	53 (7.6)	5 (9.4)	48 (90.6)	2.81 (0.72, 10.93)	0.136
Level of education	No formal schooling	64 (9.2)	6 (9.6)	58 (90.6)	0.9 (0.34,2.36)	0.828
	Less than primary school	86 (12.3)	14 (16.3)	72 (83.7)	1.69 (0.80,3.55)	0.167
	Primary school completed	127 (18.2)	17 (13.4)	110 (86.6)	1.34 (0.67,2.7)	0.408
	Secondary school completed	235 (33.8)	30 (12.8)	205 (87.2)	1.27 (0.69,2.34)	0.441
	College/University completed	184 (26.4)	19 (10.7)	165 (89.3)	1	
Ethnicity	Oromo	550 (79)	63 (11.5)	487 (88.5)	0.517 (0.24,1.12)	0.096
	Amhara	101 (14.5)	14 (13.9)	87 (86.1)	0.64 (0.26,1.62)	0.35
	Others*	45 (6.5)	9 (20)	36 (80)	1	
Marital status	Currently not married	242 (34.8)	28 (11.6)	214 (88.4)	1	
	Currently married	454 (65.2)	58 (12.8)	396 (87.2)	1.12 (0.69,1.81)	0.65
Occupation	Office workers	147 (21.1)	25 (17)	122 (83)	1.65 (0.64,4,27)	0.298
	Private skilled workers	62 (8.9)	8 (12.9	54 (87.1)	1	
	Traders	215 (30.9)	30 (14)	185 (86)	2.29 (1.10, 4.75)	0.026
	Homemakers	126 (18.1)	11 (8.7)	115 (91.3)	1.81 (0.89,3.67)	0.099
	Unemployed	146 (20.9)	12 (8.3)	134 (91.8)	1.07 (0.45,2.15)	0.88

*Gurage; Silti; Tigraway

every day. The machine for RBS was checked for consistency by standard machine in Mettu Karl Referral Hospital.

Data processing and analysis

Data was checked for completeness and consistency and was entered using Epidata version 3.1 and finally exported to SPSS version 20 computer software for analysis. The univariable analysis was done and the data was described using frequency and outcome measures (prevalence, mean and SD) and differences between groups (age, sex, etc.) was calculated. Further statistical analyses were done by using binary logistic regression models. All factors with a p-value <0.25 in the bivariable analysis were entered into the multivariable model to control for confounding. The model's goodness of fit was tested by Hosmer and Lemeshow test and was found fit. Multi-collinearity was checked and there was no multicollinearity among the variables in the final model. An Adjusted Odd Ratio (AOR) with 95% Confidence Intervals (CI) was calculated to see strength of association. A P-value less than 0.05 as cut of point with 95% CI of AOR was used to declare the observed association was statistically significant.

Ethical consideration

Ethical clearance was obtained from institutional review board of Jimma University and submitted to the town administration. Letter of cooperation was obtained from the Mettu town administration and Mettu town health office. Written consent was obtained from the study subjects during data collection. The data collected were kept confidential and were only used for the intended purpose. The participants found to be positive were informed about their status and linked to the nearest health facilities for further investigation and follow-up.

Results

Socio-demographic characteristics

A total of 696 subjects were included in the study makings the overall response rate to be 97.2%. Among the study participants, 375 (53.9%) were male which makes the male to female ratio 1.17. The mean age of the study participants was 44.62 years with + 14.57 standard deviation. Regarding the educational status, 235 (33.4%) had completed secondary school while 178 (25.6%) had completed primary school. Among the participants 454 (65.2%) are married. Among the Socio-demographic characteristics, sex, age and occupation were candidate variables for multivariable analysis (Table 1).

Prevalence of UDM

The overall prevalence of UDM according to the American Diabetes Association (ADA) classification was 12.3% (95% CI: (11%, 13.6%)). The finding showed that the prevalence was higher in males (14.9%) compared to females (9.3%) (Table 1).

Metabolic risk factors

Prevalence of UDM was higher among participants who had BMI ≥ 25, increased waist circumference, Systolic Blood Pressure (SBP) ≥ 140 mmHg, and Diastolic Blood Pressure (DBP) ≥ 90 mmHg, history of hypertension, family history of hypertension, and family history

Table 2: Metabolic risk factors by status of UDM, Mettu, South-West Ethiopia March, 2018.

Metabolic Condition	Total	UDM Status		COR	P-value
	(%)	Yes n (%)	No n (%)	95% CI	
BMI category					
≤ 24.9	423 (60.8)	36 (8.5)	387 (91.5)	1	
≥ 25	273 (39.2)	50 (18.3)	223 (81.7)	2.41 (1.52,3.81)	0
Waist circumference					
Normal	497 (71.41)	48 (9.66)	449 (90.34)	1	
Increased	199 (28.59)	38 (19.1)	161 (80.9)	2.21 (1.391,3.505	0.001
SBP					
<140 mmHg	613 (88.1)	69 (11.3)	544 (88.7)	1	
≥140 mmHg	83 (11.9)	17 (20.5)	66 (79.5)	2.03 (1.12,3.66)	0.018
DBP					
<90 mmHg	559 (80.3)	51 (9.1)	508 (90.9)	1	
≥ 90 mmHg	137 (19.7)	35 (25.5)	102 (74.5)	3.41 (2.11,5.52)	0
History of HTN					
Yes	214 (30.7)	46 (21.5)	168 (78.5)	3.02 (1.91,4.79)	0
No	482 (69.3)	40 (8.3)	442 (91.7)	1	
Family history of HTN					
Yes	385 (55.3)	67 (17.4)	318 (82.6)	3.23 (1.89,5.52)	0
No	311 (44.7)	19 (6.1)	292 (93.9)	1	
Family history of DM					
Yes	329 (47.3)	67 (20.4)	262 (79.6)	4.68 (2.74,7.99)	0
No	367 (52.7)	19 (5.2)	384 (94.8)	1	

of DM.

The candidate variables for multivariable analysis among the metabolic risk factor variables were: Body Mass Index (BMI), waist circumference, systolic blood pressure, and diastolic blood pressure, history of hypertension, family history of DM, and family history of hypertension (Table 2).

Independent predictors of UDM

In this study, a total of thirteen variables were candidates for multivariable analysis. Sex, age group and occupation were candidates among socio-demographic variables. From the behavioral variables; history of tobacco smoking, ever consumption of alcohol, ever consumption of khat, and sedentariness were candidates. Among the metabolic/biological variables; BMI, systolic blood pressure, diastolic BP, history of HTN, family history of HTN and family history of DM were statistically associated with UDM in bivariate analysis.

In multivariable analysis, it was revealed that age group, alcohol consumption, Khat consumption, sedentariness, diastolic blood pressure, and family history of DM were significantly associated with UDM participants in the age category of 40 to 49 year were nearly 3 times more likely to have UDM as compared to participants in the age category of 20 to 29 years. Alcohol consumers had more than 2 times higher chance of having UDM compared to non-consumers. Khat consumption increased the likely occurrence of UDM by nearly three times compared to non-consumption. Sitting idle for more than four hours per day increased the occurrence of UDM by 1.7 times compared to staying idle for less time. Those with diastolic blood pressure >90 mmHg were more likely to have UDM compared to those with less than 90 mmHg. Those participants having family history of DM were 2.6 times more likely to have UDM compared to those without family history (Table 3).

Discussion

The current study revealed that the prevalence of UDM was 12.3% (95% CI: (11%, 13.6%)). The finding of the study is comparable to a study done in Gojjam, North-west Ethiopia, and Tamil Nadu which concluded that the prevalence of UDM was 13.4% and 11.7% respectively [8,11]. The finding is lower than the findings in urban Libya, Tokelau, Marshall Islands, and Federated States of Micronesia which reported 18%, 20.5%, 18.9%, and 16.1% prevalence respectively [12,13]. But the current finding showed higher prevalence compared to a study in Qatar which reported a prevalence of 5.9% [14]. This difference may be due to sociocultural difference between the two communities such as dietary pattern and work related activities of the community; the low awareness of the community, lack of regular screening at OPDs and lack of attention by primary health care providers about DM. The study findings are in line with global expected pattern of the disease [15].

There is positive association between age group 40 to 49 and UDM. This finding is supported by a study in East Gojjam which showed statistically significant association between UDM and age group 45 to 54 years [8]. This might be due to the progressive effect of different underlying pathologic conditions which would have started in younger age and it might also explain the possibility of diagnosis after this age group once it has already remained hidden for some time. The implication here is that provision of screening services in the third decades of life is very mandatory for early detection of the disease.

Table 3: Multivariable analyses of factors associated with UDM, Metu, South-West Ethiopia March, 2018.

Variables	UDM Status		Bivariate	Multivariable
	Yes	No	COR (95% CI)	AOR (95% CI)
Age group				
20-29	4 (3.6)	108 (96.4)	1	1
30-39	11 (6.5)	158 (93.5)	1.88 (0.58,6.05)	1.6 (0.47,5.46)
40-49	44 (20.9)	167 (79.1)	7.11 (2.48, 20.36)	3.51 (1.14,10.77)*
50-59	12 (17.9	55 (82.1)	5.89 (1.81,19.11)	3.48 (0.95,12.74)
60-69	10 (11.9)	74 (88.1)	3.65 (1.1,12.07)	2.1 (0.57,7.71)
70-79	5 (9.4)	48 (90.6)	2.81 (0.72, 10.93)	0.72 (0.15,3.4)
Alcohol consumption				
Yes	48 (25.5)	140 (74.5)	4.42 (2.66,6.76)	2.62 (1.34,5.1)*
No	38 (7.5)	470 (92.5)	1	1
Khat consumption				
Yes	49 (24.7)	149 (75.3)	4.1 (2.57,6.52)	3.12 (1.76,5.50)*
No	37 (7.4)	461 (92.6)	1	1
Sedentariness				
<240 min/d	36 (9.4)	348 (90.6)	1	1
>=240 min/d	50 (16)	262 (84)	1.88 (1.19,2.97)	1.73 (1.01,2.95)*
DBP				
<90 mmHg	51 (9.1)	508 (90.9)	1	1
>90 mmHg	35 (25.5)	102 (74.5)	3.41 (2.11,5.52)	2.56 (1.36,4.8)*
Family history of DM				
Yes	67 (20.4)	262 (79.6)	4.68 (2.74,7.99)	1.44 (1.43,4.96)*
No	19 (5.2)	384 (94.8)	1	1

The study concluded that alcohol consumption was significantly associated with UDM. The finding of this study was supported by the findings from Ethiopian NCD survey of 2015 and studies in Kenya, South Africa and also a study in Bishoftu town [6,16-18]. The Possible diabetogenic effects of alcohol include, inadequate insulin release, reduced insulin binding inhibition of intracellular signaling with the eventual development of insulin resistance [17].

The other finding from the study was that there was strong statistical association between UDM and khat consumption. This also goes with findings from a study in Yemen [19]. This may be due to the culture of sitting longer time while chewing Khat [19] and poor glycemic control associated with khat consumption [20].

This study revealed that there is statistically significant association between UDM and sedentariness. The finding is supported by other studies in Brazil, and East Gojjam [8,21,22]. The reason behind this might be the fact that sedentariness hinders weight control, decreases energy utilization and make once cells less sensitive to insulin. The mechanism for this is that sedentary behavior reduces the activity of the enzyme Lipoprotein Lipase (LPL), apparently by interfering with the mechanisms of cellular transcription which leads to reduced LPL expression on the cell membrane, resulting in impaired tissue uptake of free fatty acids from blood. As a consequence, there is inhibition of insulin-stimulated glucose oxidation, of glucose uptake and of glucogenesis, important effects for the development of insulin resistance and T2DM [8,21].

The other finding of this study was that there was significant association between high diastolic blood pressure and UDM. There were no studies done so far that concluded increased DBP is separately associated with UDM. This might be due to the well-established fact about the effect of prolonged vasoconstriction on bringing insulin resistance.

The other finding of the study was that there was an association between UDM and family history of DM. This finding was supported by studies in India, Jazan District of Saudi Arabia and Kenya [23]. This might be due to life style, living environments within families, cultural pattern in the family as well as genetic inheritance [8,24].

The study has its own limitations. As the study used some personal information, there might be social desirability bias for some behavioral risk factors such as smoking, alcohol consumption and khat chewing.

Limitations of the Study

The limitations of this study are the fact that it is only conducted in urban center and could be difficult to generalize to rural settings.

Conclusion and Recommendations

The study concluded that the prevalence of UDM was 12%. This was higher than the projected prevalence of DM (3.32%) by IDF. 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 and the

high risk of developing irreversible complication before diagnosis. Most of the factors associated with UDM were potentially modifiable. Therefore, targeting the prevention to such modifiable risk factors might reduce the prevalence of undiagnosed DM. In addition, large scale community based study with more rigorous designs to formulate guidelines and a policy leading to mitigation of the potentially devastating outcomes of undiagnosed DM is also recommended.

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