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Prevalence of undiagnosed diabetes mellitus and associated factors among adult residents of Bahir Dar city, northwest Ethiopia: a community-based cross-sectional study

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ABSTRACT

Objective To assess the prevalence of undiagnosed diabetes mellitus (DM) and associated factors among adult inhabitants of Bahir Dar city, northwest Ethiopia.

Design A community-based cross-sectional study was conducted on adults (n=607) of Bahir Dar city from 10 March to 20 May 2018.

Measurements Data were collected using structured interviewer-administered questionnaire, and anthropometric measurements were taken from each participant. Fasting blood sugar (FBS) level was determined by samples taken early in the morning and readings of FBS≥126 mg/dL were classified as diabetes. The multivariate logistic regression model was fitted to identify the predictors of undiagnosed DM; adjusted OR (AOR) with a 95% CI was computed to assess the strength of associations.

Result The study revealed that the prevalence of undiagnosed DM was 10.2% with 95% CI 7.9 to 12.9. Ever checked blood glucose level (AOR=1.91, 95% CI 1.03 to 3.51), don't know the symptoms of diabetes (AOR=2.06, 95% CI 1.08 to 3.89), family history of DM (AOR=2.5, 95% CI 1.21 to 5.18) and body mass index (BMI) ≥25 kg/m^2 (AOR=1.98, 95% CI 1.09 to 3.60) were factors associated with undiagnosed DM.

Conclusion The magnitude of undiagnosed diabetes was high. Family history of DM, ever checked blood glucose level, don't know about the symptoms of diabetes and overweight BMI were predictors of undiagnosed DM. Hence, screening and treatment are mandatory for high-risk groups. In addition, this study suggests frequent screening for those with family history and awareness creating about the disease for early detection and treatment.

Strengths and limitations of this study

- As this is a community-based work with an adequate sample its finding is highly generalisable for the city and the study might be used as an entry into the screening programme of diabetes among high-risk groups.
- Participants diagnosed with diabetes during the community screening were linked to nearby health facilities for further follow-ups and treatment.
- The study did not show the overall magnitude since it excluded known patients with diabetes.
- Some risk factors with known association with diabetes mellitus, for example, cholesterol level was not assessed and a single fasting blood glucose measurement was used without HbA1c, might have resulted in a misclassification, owing to conditional blood glucose variation.
- In this community-based study conducted through house-to-house visits, women had more chances of being selected than men who usually worked outdoors. Thus, under-reporting of sensitive issues such as smoking and khat chewing (which men are often more likely to indulge in) might have introduced information bias.

INTRODUCTION

Diabetes mellitus (DM) is a metabolic disorder of multiple aetiologies characterised by chronic hyperglycaemia induced from defects of insulin secretion and action or both.[1] Over 425 million people are currently living with diabetes, and the burden is projected to be 529 million by 2030.[2 3] Globally, 1.6 million deaths were attributed to diabetes in 2015.[2] Type 2 diabetes, which is largely preventable through regular physical activity, healthy balanced diet and improved living environments, is the most common.[1] The magnitude and incidence of diabetes has risen rapidly, especially in low and middle-income countries such as sub-Saharan Africa.[4 5] In recent years, non-communicable diseases are becoming the problem in low and middle-income countries due to increased urbanisation and epidemiological transitions.[2 4] Besides, DM has been the leading cause of morbidity and mortality in

association with numerous complications, like blindness, kidney failure, heart attacks, stroke and lower limb amputation.[6–8] Sometimes, diabetes is associated with complications such as foot ulcer, retinopathy and heart attack which are means of the identification of undiagnosed DM.[6 9]

Early diagnosis and treatment are the key interventions to prevent the complications and deaths from diabetes as well as for better treatment outcomes. However, globally one in two peoples living with diabetes remain undiagnosed.[1] Late diagnosis and treatment of DM is associated with the increased occurrence of acute and chronic complications.[10] Complications from undiagnosed diabetes lead to a substantial decrease in patients' quality of life which are usually preventable through early identification of risk factors.[2] According to the 2014 report, about 179.2 million people lived with undiagnosed DM worldwide. The African region has the highest percentage of undiagnosed people compared with other regions. About 62.3% of the people with the diseases do not know their being affected, and about 13.4 million had undiagnosed DM.[4 5 11] In Ethiopia, the magnitude of diabetes is increasing; according to the WHO report, the number of cases was 800 000 in 2000, and is rising to an estimated 1.8 million by 2030.[12–14] Evidence from studies conducted in Gondar, northwest Ethiopia, showed that 2.3% of the individuals lived with undiagnosed DM.[15] Factors such as educational level, body mass index (BMI), family history and the presence of other chronic illnesses have been associated with undiagnosed DM.[10 16–20] In addition, low health-seeking behaviour, like lack of regular health check-ups, also contributed to undiagnosed diabetes. Though a number of studies were conducted in different parts of the country, nothing has been done in the setting we have chosen.

Therefore, this study aimed to determine the prevalence of undiagnosed DM and associated factors among Bahir Dar city residents to try to help policymakers carry out evidence-based interventions and institute community-based screening programmes.

METHODS

Design, setting and period

A community-based cross-sectional study was conducted in Bahir Dar city from 10 March to 20 May 2018. The city is located 565 km from Addis Ababa, the capital of Ethiopia. According to the population and household survey, it had 249 851 inhabitants served by two (one public and one private) hospitals, eight health centres and six private clinics.

Population, sample and sampling method

Adults aged 18 years and above living in the city and its selected subcities were the source and study populations, respectively. Individuals with previous diagnosis of diabetes and follow-ups were excluded. The sample size for this study was determined by using the single population proportion with the assumptions of 50% proportion of undiagnosed DM for lack of previous works in the study setting, 5% margin of error and 1.5 design effect which yielded 607. The multistage sampling technique was employed, and three subcities (Shimbet, Shumabo and Hidar 11) were randomly selected out of the nine in the study area. Samples were proportionally assigned to each of the selected subcities based on the number of households. Thus, 171, 202 and 234 participants were selected from Shimbet, Shumabo and Hidar 11, respectively, using the systematic random sampling technique. In households which had more than one eligible individual the lottery method was used to select one study.

Data collection procedures and measurement of variables

The data collection tool was initially prepared in English and translated to the local language Amharic. Nine laboratory professionals (six data collectors and three supervisors) were recruited and trained by the principal investigator on the objective of the study on how to collect blood samples. The questionnaire contained sociodemographic, behavioural and clinical characteristics developed after a review of literature. Data were collected using a pretested structured interviewer-administered method, and anthropometric measurements such as weight and height were taken from each participant. After data collection participants were instructed to be on overnight fasting (10–16 hours). In the early morning of the next day, data collectors drew 3–5 mL of blood from each participant, and fasting blood glucose level was measured using the glucose oxidase-6 phosphate dehydrogenase method.

Participants who had fasting glucose levels of 126 mg/dL or above were classified as diabetic, while those who had between 100 and 125 mg/dL taken were considered as 'impaired fasting glucose' (IFG) cases.

Data processing and analysis

Data were cleaned, coded and entered using EpiData V.3.1 and exported to SPSS V.20 for further management and analysis. Descriptive statistics, such as means, medians and percentages, presented in tables and texts were used to summarise the characteristics of participants. Bivariate and multivariable logistic regression analyses were employed to identify factors associated with undiagnosed diabetes, which was the response variable, whereas sociodemographic characteristics (age, educational level, religion, ethnicity, marital status and monthly income), behavioural characteristics (smoking status, khat chewing habit, alcohol intake) and clinical characteristics (BMI, history of hypertension, family history of DM) were the independent variables. The bivariable regression model was initially fitted to compute the crude OR, and variables with p values less than 0.2 were entered into multivariable logistic regression model to control potential confounding effects in the model. The strength of associations between independent and outcome variables was assessed using the adjusted OR (AOR) with a 95% CI. Variables with p values less than 0.05 in the multivariable analysis were considered as statistically significant predictors of undiagnosed DM.

Patient and public involvement

Patients were not involved in the study.

RESULT

Sociodemographic and behavioural characteristics

A total of 607 participants furnished data for the final analysis with a response rate of 100%. The mean age of the participants was 35.2 (±13.8) years; about 13.5% of participants had no formal education; the majority (96.7%) were Orthodox Christians, and most (98.2%) were from Amhara. More than half (61%) of the participants were married, and 42.3% had a monthly income of above 2400 Ethiopian birr; 50.2% had history of moderate alcohol intake, 2.7% chewed khat and 1.5% smoked cigarette, the most common self-reported substance use. One hundred and seventy-eight (29.3%) of the participants performed physical exercises, of whom 66.3% performed physical exercises three to six times per week (table 1).

Table 1 Sociodemographic and behavioural characteristics of study participants in Bahir Dar city, northwest Ethiopia (n=607)

		Undiagnosed DM	
Characteristics	Category	Absent n (%)	Present n (%)
Sex	Male	162 (89)	20 (11)
	Female	383 (90.1)	42 (9.9)
Age (years)	18–24	150 (9.5)	7 (4.5)
	25–34	176 (96.2)	7 (3.8)
	35–44	92 (84.4)	17 (15.6)
	45–54	52 (83.9)	10 (16.1)
	55–64	75 (78.1)	21 (21.9)
Educational status	No formal education	68 (82.9)	14 (17.1)
	Primary and secondary education	271 (90)	30 (10)
	Diploma and above	206 (92)	18 (8)
Religion	Orthodox	528 (90)	59 (10)
	Muslim	17 (82.4)	3 (17.6)
	Protestant	3 (100)	0 (0)
Ethnicity	Amhara	538 (90.3)	58 (9.7)
	Oromo	4 (57.1)	3 (42.9)
	Others*	3 (75)	1 (25)
Marital status	Single	192 (95.1)	10 (4.9)
	Married	353 (87.2)	52 (12.8)
Occupation	Unemployed	277 (89.6)	32 (10.4)
	Government employed	91 (86.7)	14 (14.3)
	Private employed	15 (83.3)	3 (16.7)
	Self-employed	162 (92.6)	13 (7.4)
Income per month (ETB)	<1000	172 (94)	11 (6)
	1000–1800	31 (91.2)	3 (8.8)
	1801–2400	115 (86.5)	18 (13.5)
	>2400	227 (88.3)	30 (11.7)
Smoking	Yes	8 (88.9)	1 (11.1)
	No	537 (89.8)	61 (10.2)
Khat chewing	Yes	12 (70.6)	5 (29.4)
	No	533 (90.3)	57 (9.7)
Moderate alcohol intake	Yes	273 (89.5)	32 (10.5)
	No	272 (90.7)	30 (9.9)
Perform physical exercise	Yes	161 (90.4)	17 (9.6)
	No	384 (89.5)	45 (10.5)

*Tigray and Agew.
DM, diabetes mellitus; ETB, Ethiopian birr.

Table 2 Clinical characteristics and laboratory measurements of study participants in Bahir Dar city, northwest Ethiopia (n=607)

Characteristics	Undiagnosed DM		Overall percentage
	Absent n (%)	Present n (%)	
Ever checked your blood sugar level			
Yes	170 (82.5)	36 (17.5)	33.9
No	375 (93.5)	26 (6.5)	66.1
The checked blood sugar level in the last month			
Yes	16 (72.7)	6 (27.3)	3.6
No	529 (90.4)	56 (9.6)	96.4
Family history of DM			
Yes	63 (80.8)	15 (19.2)	12.9
No	482 (91.1)	47 (8.9)	87.1
Diagnosis of hypertension			
Yes	30 (68.2)	14 (31.8)	8.2
No	515 (91.5)	48 (8.5)	92.8
Know symptoms of DM			
Yes	224 (92.2)	19 (7.8)	40
No	321 (88.2)	43 (11.8)	60
Body mass index (BMI), kg/m^2			
≤24.9	376 (93.3)	27 (6.7)	64.5
≥25	169 (82.8)	35 (17.2)	34.5

DM, diabetes mellitus.

Clinical characteristics and undiagnosed DM

More than one-third (35.4%) of the participants had BMI of 25 kg/m^2 and above; 12.9% had a family history of DM, and 8.2% had previous diagnosis of hypertension. About 33.9% of the participants had checked their blood glucose level previously; 3.6% checked last month. Two hundred and forty-three (40%) of the participants knew the symptoms of diabetes, of which polyuria, polydipsia, polyphagia and fatigue formed 19.8%, 29.6%, 35.6% and 16% of the most commonly mentioned symptoms.

The prevalence of undiagnosed DM was found to be 10.2% with 95% CI 7.9 to 12.9, with a fasting blood glucose level ≥126 mg/dL. In addition, the magnitude of IFG was 12.8% with 95% CI 10.3 to 15.7, with a fasting blood glucose level between 100 and 125 mg/dL (table 2).

Factors associated with undiagnosed diabetes

In the univariate logistic regression analysis, age, marital status, level of education, ever checked blood glucose level, family history of DM, had hypertension, BMI≥25 kg/m^2 and those who don't know about the symptoms of DM were factors associated with undiagnosed diabetes at 20% of level of significance. In the multivariable logistic regression analysis, only family history of DM, ever checked blood glucose level, know about symptoms of DM and BMI≥25 kg/m^2 were predictors of undiagnosed DM at p=0.05.

Accordingly, for those participants who do not know the symptoms of DM, the odds of undiagnosed diabetes were 2.06 (AOR=2.06, 95% CI 1.08 to 3.89) times higher compared with those who know. Similarly, those participants who had family history of DM had 2.5 (AOR=2.5, 95% CI 1.21 to 5.18) times higher odds of undiagnosed diabetes compared with those who had no such history. For the participants who had ever checked their blood glucose level previously, the odds of undiagnosed DM were 1.91 (AOR=1.91, 95% CI 1.03 to 3.51) times higher compared with those who had not checked their blood glucose level. Moreover, participants who had BMI≥25 kg/m^2 and above were 1.89 (AOR=1.89, 95% CI 1.04 to 3.43) times more likely to have undiagnosed DM compared with those who had BMI below 24.9 kg/m^2 (table 3).

DISCUSSION

This study revealed that the magnitude of undiagnosed diabetes was 10.2%. Family history of DM, ever checked blood glucose level, 'don't know about symptoms of diabetes' and overweight BMI were the predictors of undiagnosed DM. The magnitude noted was consistent with those of studies conducted in East Gojjam zone, northwest Ethiopia (11.5%),[19] Germany (8.2%),[21] Malaysia (8.9%),[10] USA (11.5%),[7] Quebec, Canada (5.6%),[22] Italia (10%)[8] and from the subgroup analysis of African urban population (8.68%).[23]

However, our finding was higher than that of a study at Koladiba (2.3%),**15** Bishoftu town (5%)[17] and Addis Ababa of Ethiopia (6.6%),[13] pooled estimate of African population (5.37%), Teheran, Iran (5%)[24] and Qatar (5.9%) .[25] However, our result was lower than those of patients with undiagnosed DM and hypertension in Kenya (14%) and India (15%).[26] The possible explanation for these differences in sociodemographic characteristics might be study settings, lifestyles, health-seeking behaviour and practice in relation to routine screening of diabetes and other health problems. Particularly, our finding was markedly higher than that of the previous study in Koladiba, a rural district in northwest Ethiopia.[15] The possible explanation for this difference might be variations in study populations, that, is the other studies included rural residents whose magnitude of DM was lower. Our study was conducted entirely among urban residents whose magnitude of DM was relatively higher and exposed to numerous risk factors. In addition, the measurement tool used to determine fasting blood glucose level by the other studies was HbA1c, which was more reliable, whereas our study was based on a single measurement which might fluctuate due to different factors.

This study also found that the magnitude of IFG was 12.85%, showing that unless appropriate interventions were made, the individuals might develop diabetes. The finding was consistent with population based study in

Table 3 Univariate and multivariable logistic regression analysis to identify factors associated with undiagnosed diabetes among residents of Bahir Dar city, Ethiopia, 2018 (n=607)

Variables	Undiagnosed DM		COR (95% CI)	AOR (95% CI)	P value
	Yes	No			
Marital status					
Single	10	192	0.35 (0.17 to 0.71)	0.69 (0.27 to 1.76)	0.44
Ever married	52	353	1	1	
Age (years)					
18–24	7	150	1	1	
25–34	7	176	0.85 (0.29 to 2.48)	0.53 (0.16 to 1.76)	0.30
35–44	17	92	3.96 (1.58 to 9.91)	1.93 (0.62 to 6.0)	0.25
45–54	10	52	4.12 (1.49 to 11.38)	1.79 (0.51 to 6.30)	0.36
55–64	21	75	6.0 (2.44 to 14.74)	2.08 (0.63 to 6.90)	0.22
Level of education					
No formal education	14	68	1	1	
Primary and secondary	30	271	0.53 (0.27 to 1.06)	0.84 (0.38 to 1.83)	0.66
Diploma and above	18	206	0.42 (0.20 to 0.89)	0.81 (0.33 to 1.97)	0.64
Ever checked blood glucose*					
Yes	36	170	3.05 (1.78 to 5.22)	1.91 (1.03 to 3.51)	0.037
No	26	375	1	1	
Family history of DM*					
Yes	15	63	2.44 (1.29 to 4.62)	2.50 (1.21 to 5.18)	0.013
No	47	482	1	1	
History of hypertension					
Yes	14	30	5.0 (2.48 to 10.08)	2.02 (0.91 to 4.53)	0.085
No	48	515	1	1	
BMI (kg/m^2)*					
≤24.9	27	376	1	1	
≥25	35	169	2.88 (1.69 to 4.91)	1.89 (1.04 to 3.43)	0.035
Know symptoms of DM*					
Yes	19	224	1	1	
No	43	321	1.57 (0.89 to 2.78)	2.06 (1.08 to 3.89)	0.026

*Shows a pvalue less than 0.05.
AOR, adjusted OR; BMI, body mass index; COR, crude OR; DM, diabetes mellitus.

Qatar (12.5%).[25] However, this finding was lower than that of a study conducted in Denmark (27.1%)[27] and Bukittinggi, Indonesia (32%).[28] The possible explanations might be sociodemographic of living habit variations. The study was conducted among dental patients in Denmark whose diabetes was often associated with complications, like periodontitis and gingival ulcer.

Although the causes of diabetes are not fully understood but it has a strong link with overweight, obesity, increasing age as well as family history.[12] This statement is supported by different studies, including the present one. Our study revealed that family history of DM was associated with three times increased odds of getting undiagnosed diabetes compared with participants with no such history. This finding was consistent with those of studies conducted in East Gojjam, Ethiopia and India.[12 19 26] This could be generally attributed to the linkage of diabetes with genetics. Nevertheless, other types of DM may also be associated with family history in relation to behaviour such as living habit and physical inactivity which may predispose to diabetes. Similarly, among those who did not check their blood glucose level, the odds of getting undiagnosed diabetes were two times higher compared with those who checked their blood glucose level. This could be due to the fact that those who practised routine screening for DM might have had greater risk factors for the disease.

Moreover, those who did not know about the symptoms of diabetes were associated with increased occurrence of undiagnosed DM compared with those who knew about

the symptoms. This finding was consistent with those of other studies in Ethiopia.[29] This could be explained by the fact that low knowledge symptoms might affect health-seeking behaviour and regular screening practice might be associated with high rates of hidden/undiagnosed diabetes.

For participants with BMI≥25 kg/m^2, undiagnosed DM was twice higher than those whose BMI was less than ≥25 kg/m^2. This finding was consistent with those of other studies.[4 21 24] Overweight and obesity which ultimately lead to diabetes were associated with insulin resistance.

Strengths and limitations of the study

The strengths of this study were its being community based and involving an adequate sample. The finding might help as an entry into community screening programmes among high-risk groups. However, the study has limitations in that it did not show the actual overall magnitude of diabetes, as known patients with DM were excluded. This study was conducted on adults/a working age group in the city, and the range was 18–64 years which might have introduced selection bias. In addition, this study also has limitations in terms of sex disproportion which was due to the fact that the house-to-house visits involved more females than males who worked outdoors. Some risk factors which have significant associations with undiagnosed DM, like cholesterol level, were not included in this study. In addition, this study was based on a single fasting blood glucose measurement, and HbA1c was not used, perhaps introducing misclassification due to conditional blood glucose variations.

CONCLUSION

The magnitude of undiagnosed diabetes was high. Family history of DM, checking blood glucose level, not knowing about the symptoms of diabetes and overweight BMI were predictors of undiagnosed DM. Hence, screening and treatment are mandatory for high-risk groups. In addition, the study suggests frequent screening for those with family history and creating awareness about the disease for early detection and treatment.

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Contributors GMB, AAW, EBA, MTM, STE, AL, WML and KST conceived the study, approved the proposal with extensive revisions, participated in data analysis and had written the manuscript. The authors read and approved the final manuscript.

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Competing interests None declared.

Patient consent for publication Not required.

Ethics approval Ethical approval was obtained from GAMBY Medical and Business College, Research and Publication Office, with reference number GC-220/2010, and approval letter was obtained from Bahir Dar City Administrative Office. The purpose of the study was explained to the respondents and informed consent was obtained from them. Confidentiality of information was maintained by omitting any personal identifier from the questionnaires. The study participant information sheet was attached on the front page of the questionnaire and before the actual data collection process started, the participants were well informed and the data collection was on a voluntary basis. Those who screened to have DM during data collection were referred and linked to a nearby hospital.

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Data availability statement Data are available upon reasonable request.

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