A community-based cross-sectional study of magnitude of dysglycemia and associated factors in Southwest Ethiopia

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Abstract

Background Diabetes, one of the non-communicable diseases becoming major public health problems in the country, is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction, and failure of different organs, especially the eyes, kidneys, nerves, heart, and blood vessels. This study aimed at assessing the prevalence of dysglycemia (type 2 diabetes and impaired fasting glucose) and associated factors for adults older than 40 years living in Southwest Ethiopia.

Methods A community-based cross-sectional study was conducted using the WHO STEPwise tool for surveillance of non-communicable diseases. Data was collected by face-to-face interview and measurement of anthropometry, blood pressure, and fasting blood sugar using pretested questionnaire, and it was analyzed using SPSS version 20. Logistic regression was used to identify associated factors with the outcome variable.

Results The overall prevalence of dysglycemia was 18.6% among adults older than 40 years. Type 2 diabetes accounts for 5.7%, and impaired fasting glucose accounts for 12.9%. Presence of family history of diabetes [AOR = 2.45, 95% CI (1.08, 5.52)], being overweight [AOR = 3.8, 95% CI (1.84, 7.95)], and being obese [AOR = 7.78, 95% CI (2.90, 20.91)] were significantly and independently associated with dysglycemia.

Conclusion In this study, the prevalence of dysglycemia was high. Having a family history of diabetes mellitus and higher body mass index (overweight or obese) were risk factors for dysglycemia.

Keywords Dysglycemia · Fasting blood sugar · Associated factors · Jimma

Background

Type 2 diabetes which is a group of metabolic diseases is one of the major non-communicable diseases in the world. It is a public health problem due to its high prevalence, and association with cardiovascular diseases is characterized by chronic

hyperglycemia. And also, the chronic hyperglycemia is associated with long-term damage and dysfunction of different organs. In the development of diabetes, several pathogenic processes are involved with consequent insulin deficiency to abnormalities that result in resistance to insulin action [1, 2].

Type 2 diabetes is a non-communicable disease of major importance as the prevalence has increased globally over the last decades [3]. Even though diabetes mellitus was previously considered as a rare condition in sub-Saharan Africa, currently, many studies revealed that the magnitude is rising which indicates that, as compared to developed region, developing countries are losing productive age groups. Type 2 diabetes, previously called non-insulin-dependent diabetes or adult-onset diabetes, accounts approximately 90–95% of those with diabetes, and most patients with this form of diabetes are obese [4, 5]. Majority of the people with diabetes in developing countries are typically older than 40 years while those in developed country areas aged 65 years and above, type 2 DM diagnosis remains undetected for a long time and many patients with newly detected diabetes have complication at the time of diagnosis. This underlines the importance of detecting

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undiagnosed diabetes, and early detection of individuals at risk of diabetes could be extremely beneficial [6, 7]. The difficulty in treating type 2 DM once it has developed and its human and substantial burden makes it an appropriate for early prevention. Further, the existence of a defined state of increased risk allows identification of patients who are most likely to benefit [1, 2].

Undiagnosed type 2 DM and who are at risk of its development are significantly at increased risk for the development of heart diseases, stroke, and peripheral vascular diseases. On the other hand, affected individuals have a greater likelihood of having dyslipidemia, hypertension, and obesity. Therefore, it is important for the clinician to screen for diabetes in a cost-effective manner in subjects who demonstrate major risk factors for diabetes [8].

In Ethiopia, the magnitude of undiagnosed DM is high when compared with many African countries and is responsible for a number of serious health problems and complications. Thus, due attention should be given to it through increasing public awareness on the diseases and even plan mass screening programs. Therefore, the aim of this study was to determine the magnitude of dysglycemia (type 2 diabetes and impaired fasting glucose) and associated factors for adults older than 40 years living in Jimma Town, Southwest Ethiopia.

Methods and materials

A community-based cross-sectional study was conducted from September 2016 to August 30, 2017 in Jimma Town, Southwest Ethiopia. Jimma Town is located 356 km southwest of Addis Ababa, capital city of Ethiopia, and it is divided into 17 administrative units. The town is one of the larger cities located in Oromia regional state with estimated population of 177,900 in 2015 [9]. From this total population, adults older than 40 years constitute 12.5%.

The source population for this study was the adult population living in Jimma Town, and the study population for this study were adults aged 40 years and above. All adults aged 40 years and above and permanent residents of the town were included in the study, but individuals who were known diabetic on treatment or follow-up, individuals who were taking any drugs with possible impact on glucose metabolism (ART drugs, oral contraceptives, steroids) during the study period, pregnant women (by LMP), and individuals who could not give consent due to mental illnesses or other debilitating conditions were excluded from the study.

Sample size and sampling procedure

Sample was calculated using a formula for estimation of single population proportion taking prevalence of hyperglycemia

(DM, IFG) from the previous study [10] to be 20%, margin of error 5%, and using 95% confidence level. Then, after considering non-response rate of 10%, the final sample size became 269. Multi-staged sampling procedures were applied to select study participants. Out of 17 kebeles (smallest administrative units in Ethiopia) in the town, eight kebeles were included in the study. From each kebele, households were selected using systematic sampling techniques with specified sampling interval; every 50th household in the kebele was selected using an estimated 1700 households per kebele, and giving about 34 participants per kebele. Then, eligible individuals from the households were enrolled in the study. In cases where there was more than one eligible individual in the household, a lottery method was used to choose among them, and if there was no eligible individual in a household, the next house was visited.

Data collection, processing, and analysis

As recommended in the WHO STEPwise Approach guidelines on NCD risk factor surveillance [11], the survey consists of the use of interviewer-administered structured questionnaires, to assess the socioeconomic, sociodemographic, and behavioral characteristics of the study subjects. One day prior to the interview, the study participants were told to have overnight fasting till late morning hours (nothing per os except water). Then, the participants were interviewed after verbal consent is obtained. Physical measurements (BP, height, weight, waist circumference) were measured using standard calibrated instruments. A venous blood sample was taken from the interviewed and assessed subjects, and the sample was transported to Jimma University Specialized Hospital Laboratory. Plasma glucose determination was done using glucose oxidase method, and the result was registered.

The questionnaires and checklists were prepared in English by the principal investigator by reviewing different related literature and were translated to local languages (Amharic and Afan Oromo) by a health professional who is fluent in English, Afan Oromo, and Amharic languages and were checked for consistency by a third independent person competent in all the mentioned languages. The questionnaires were precoded and pretested to minimize errors. Then, data were collected by trained clinical nurses and laboratory technician. Instructional manual on the procedures of data collection, handling, operational definitions, roles of data collectors, and ethical issues was prepared. The data collectors and assistant were trained with demonstrations on the questionnaires/checklists by principal investigator for 1 day on the instruction manual of data collection ahead of the data collection schedule. The necessary tools for the data collections were given to the data collectors ahead of time, and data collection was supervised daily. During data collection, the collected data

were checked daily for completeness by the supervisor. The data collection assistant was arranging the equipment needed for the data collection and cross-checked the collected data for completeness and finally by principal investigator before entry in to the computer. The collected data was rechecked for completeness and cleaned by principal investigator. Finally, data was entered and analyzed by using SPSS version 20. Appropriate coding and re-coding were done at each step for the variables as necessary. Descriptive statistics like frequencies, percentages, means, medians, standard deviations, and ranges were used to describe the findings. A binary logistic regression analysis was done to sort variables candidate for multiple logistic regression having a value less than or equal to 0.25. Multivariate logistic regression analysis was conducted to generate factors strongly associated with dysglycemia. Finally, the association was declared with a *p* value less than 0.05 with an adjusted odds ratio (AOR) at 95% confidence level. Additionally, data from sociodemographic factors, behavioral and medical risk factors, and measurable variables were described based on their categories and the identified themes across dysglycemia.

Results

Sociodemographic characteristics

Out of 269 study populations, a total of 264 participated in the study giving a response rate of 98.1%. Of the total respondents, 150 (56.8%) were females and 114 (43.2%) were males. The age of the respondents ranged from 40 to 90 years, with a mean age of 54 (SD = 13) years. The age group 40–64 years, with a total of 194 study subjects (73.5%), constituted the majority of respondents. Majority, 75.8% of the respondents were married, and 37.5% of the respondents were housewives (Table 1).

Medical and behavioral risk factors

Family history of DM was presented in 37 (14%) of participants and gestational DM in 18 (12%) female respondents and personal history of hypertension in 53 (20%). Regarding the level of physical activity, 120 (45.5%) of the respondents reported to have insufficient physical activity, 75 (28.4%) were inactive, and 69 (26.1%) had sufficient physical activity, according to the WHO definitions. History of alcohol consumption was reported by 64 (24.2%) of the study participants, 8 (3%) reported heavy drinking, 16 (6%) moderate drinking, and 40 (15%) reported light drinking. In this study, 18% participants had hypertension. About 15 (30.6%) of participants who had hypertension with our measurement were either told to have hypertension previously or are taking antihypertensive medications. The mean systolic blood pressure of the study

Table 1 Socio-demographic characteristics of the respondents in Jimma Town, Southwest Ethiopia, 2017 (*n* = 264)

Variables	Category	Frequency	Percentage
Age	40–64 years	194	73.5
	65–79 years	57	21.6
	More than 80 years	13	4.9
Sex	Male	114	43.2
	Female	150	56.8
Marital status	Married	200	75.8
	Single	10	3.8
	Divorced	41	15.5
	Widowed	13	4.5
Religion	Orthodox	106	40.1
	Muslim	110	41.7
	Protestant	47	17.8
	Others	1	0.4
Ethnic group	Oromo	118	44.7
	Amhara	57	21.6
	Dawro	28	10.6
	Gurage	22	8.3
	Others*	39	14.8
Educational status	Illiterate	22	8.3
	Read and write	48	18.3
	Grades 1–8	79	29.9
	Grades 9–12	51	19.3
	Higher education	64	24.3
Occupation	Housewives	99	37.5
	Government employees	70	26.5
	Merchants	60	22.7
	Others**	35	13.3
HH monthly income	Low	79	29.9
	Intermediate	154	58.3
	High	31	11.7

*Hadiyya, kaffa

**Students, farmers

population was 118 ± 14 mmHg, while the diastolic mean was 75 ± 10.2 mmHg. There was no statistically significant difference in the mean value of blood pressure either between males and females ($p = 0.44$) or among respondents with normal FBS or dysglycemia ($p = 0.47$).

The BMI of the respondents ranged from 16.65 to 36.40 kg/m², with a mean of 24.16 kg/m². The mean BMI of the female respondents was 24.5 ± 3.4 kg/m² and of the males was 23.6 ± 3.8 kg/m². Females constitute larger frequency of overweight or obese individuals, but there is no statistically significant difference between the two means. The difference between the means of BMI of respondents with normal FBS and dysglycemia is statistically significant ($p = 0.00$).

Table 2 Summary of medical and behavioral risk factors of the study participants in Jimma Town, Southwest Ethiopia, 2017

Variable		Male, <i>N</i> (%)	Female, <i>N</i> (%)	Total, <i>N</i> (%)
Gestational DM		–	18 (12)	18 (12)
Family history of DM		17 (14.9)	20 (13.3)	37 (14)
History of HTN		17 (14.9)	36 (24)	53 (20)
Smoking history		15 (13)	3 (2)	18 (6.8)
Physical activity	Inactive	24 (21)	51 (34)	75 (28.4)
	Insufficiently active	48 (42)	72 (48)	120 (45.5)
Diet (fruit and veg)	Four times or less/day	32 (28)	75 (50)	107 (40.5)
Alcohol consumption		30 (26.3)	34 (22.7)	64 (24.2)
Alcohol amount	Regular daily	6 (5.2)	2 (1.3)	8 (3)
	Moderate	9 (8)	7 (4.7)	16 (6)
	Light	15 (13)	25 (16.7)	40 (15.2)
Hypertension		21 (18.4)	28 (18.7)	49 (18.5)
BMI	Overweight	32 (28)	53 (35.3)	85 (32.2)
	Obese	9 (8)	15 (10)	24 (9.1)
Waist circumference (central obesity)		18 (15.8)	35 (23.3)	53 (20.1)

Waist circumference was (using the European cutoff points) 23.3% for females, and 15.8% of male respondents had central obesity. It ranges from 70 to 105 cm with a mean of 83.2 cm for males and 73 to 104 cm with a mean of 83 cm for females. There was no statistically significant difference between the mean WC of male and female ($p = 0.16$), but there was statistically significant difference between the mean of WC in normal FBS and dysglycemia ($p = 0.00$). The fasting blood sugar in the surveyed population ranges from 70 to 210 mg/dl, and its mean (SD) was 96 ± 17 mg/dl (Tables 2 and 3).

Prevalence of dysglycemia

Of the total 264 subjects who were tested, 15 (5.7%) had diabetes (with a single test for the survey), while 34 (12.9%) had impaired fasting glucose. Overall, dysglycemia was present in 48 (18.6%) of the respondents (10.6% males and 8% females). Highest frequency by age group was seen in greater than 80-year-old age group, although this is not statistically significant ($p = 0.49$). This study revealed that 35% of participants with family history of DM and 22.6% of participants with history of hypertension had dysglycemia.

Factors associated with dysglycemia

Bivariate logistic regression analysis showed that family history of DM, BMI, waist circumference, and Physical inactivity had positive association with dysglycemia. Stepwise multiple logistic regression showed that the likelihood of dysglycemia for study subjects who had family history of DM was about 2.5 times higher than those who had no family

history of DM [AOR = 2.45, 95% CI (1.08, 5.52)]. Similarly, body habitus (overweight or obese) was also associated with increased risk of dysglycemia compared to respondents who had a normal BMI (overweight [AOR = 3.8, 95% CI (1.84, 7.95)], obese [AOR = 7.78, 95% CI (2.90, 20.91)]) (Table 4).

Discussion

In this study, the prevalence of DM was 5.7%, which is comparable with the findings from Northwest Ethiopia, 5.1% [12]; Bishoftu, Central Ethiopia, 5% [13]; and sub-Saharan Africa, 6.5% [14]. Similarly, the prevalence was in line with the finding from Gilgel Gibe research project, Southwest Ethiopia (4.4%) [15], which may be explained by the younger age group it involved (15–64) and inclusion of rural areas as well. However, this finding is in contrast with the estimated magnitude 2% by IDF for Ethiopia overall urban and rural in 2013. Since this estimate is an overall for rural and urban areas, the reason for this difference may be that the prevalence of DM is higher in urban than in rural area.

This study revealed that the prevalence of IFG was 12.9% and that of dysglycemia was 18.6%. When compared with the Gilgel Gibe research project report [15] which used the WHO cutoff point, both IFG (9.7%) and dysglycemia (14.4%) were slightly lower in this study. The study done in Jimma Town, Ethiopia, in 2006 used 100–125 mg/dl to define IFG, and by then, the prevalence was 15.4%. Using this cutoff point and calculating the prevalence to compare and see the trend, the IFG in our study was 26.7%, which may be interpreted as an increase in IFG by about 11% over 10 years (i.e., we used the WHO definition of impaired fasting glucose > 110 mg/dl, and

Table 3 Summary of mean and standard deviation of continuous variables in study subjects in Jimma Town, 2017 ($n = 264$)

Parameter [mean (SD)]	Sex		<i>p</i> value	FBS		<i>p</i> value
	M	F		Normal	Dysglycemia	
Systolic BP	118 (13.76)	119 (14.04)	0.44	119 (13.82)	118.8 (14.4)	0.97
Diastolic BP	75 (10.40)	75 (10.04)	0.70	75 (9.82)	76 (11.7)	0.47
BMI	23.67 (3.83)	25.52 (3.89)	0.07	23.5 (3.55)	26.9 (4.08)	0.00
Waist circ.	83 (8.67)	81.6 (8.98)	0.16	81 (8.26)	86.3 (10.29)	0.00
FBS	96 (16.64)	95 (17.88)	0.58	89.96 (10.35)	122 (17.47)	0.00

they used > 100 mg/dl of American Diabetic Association, which accounts for the difference). Studies in Ethiopia and other African countries showed that, in general, the prevalence of IFG or DM is higher in urban than rural areas. The urban prevalence and rural prevalence of those studies were 5.1% versus 2.1% [12], 8.4% versus 1.1% [16], and 15.9% versus 12.9% [17]. This difference has been ascribed to body habitus, dietary habit, and sedentary lifestyle seen in urban settings.

Among the medical and behavioral risk factors, having a first-degree family history of DM was an independent predictor of dysglycemia. Study participants who had a family history of DM were about 2.5 times more likely to have dysglycemia than those who had no family history of DM. How genetic predisposition alone causes DM is not known, but it is thought to be the result of a combination of genetic and environmental factors [18]. There are only few studies which are specifically designed to assess independent predictors of dysglycemia, as most are focused on type 2 DM rather than prediabetic states. On the other hand, there are many studies which showed that having a family history is an independent predictor of T2DM [19–23]. One study in Ethiopia showed that a family history of DM is an independent predictor of dysglycemia, other determinants being hypertension and age more than 45 years [20]. The other independent predictor of dysglycemia in our study is body mass index. Participants who were overweight were about four times more

likely to have dysglycemia compared to those with normal BMI. Similarly, obese individuals as defined by BMI were about eight times more likely to have dysglycemia compared to those with normal BMI. A study in Addis done to assess the trend of overweight and obesity over one decade (2000–2011) has shown that overweight increased by 24.5% and obesity by 40.2% [14]. In a cross-sectional study done in Gonder, North Ethiopia, to assess the prevalence of hypertension and body habitus, 32.4% of individuals were overweight and 16% were obese [24]. Closely related to overweight and obesity is the presence of sedentary lifestyle especially among the urban population. In this study, about 74% of the participants reported to have either inactive or insufficiently active level of physical activity. This may be because of the less physically demanding nature of occupation in towns compared to rural areas. The largest proportion of dysglycemia, 36.4%, was seen in the physically inactive group. The bivariate analysis revealed that physical inactivity and central obesity were positively associated with dysglycemia in this study, although after adjustment for other variables, their effect was not statistically significant. Studies in African countries, including Ethiopia, showed that physical inactivity and central obesity were independent predictors of DM [13, 19, 25].

This study revealed that hypertension was presented in 18.5% of the study participants in which only 30% of those were told to have elevated BP before or are taking

Table 4 Multiple logistic regression of independent variables with dysglycemia in study subjects of Jimma Town, 2017

Variable		COR (95% CI)	<i>p</i> value	AOR (95% CI)	<i>p</i> value
Family history of DM	No	1	0.007	1	0.031*
	Yes	2.87 (1.34, 6.16)		2.45 (1.08, 5.52)	
Physical inactivity	Inactive	2.5 (1.21, 5.36)	0.054		
	Insufficiently active	1			
	Active	1.7 (0.8, 3.95)	0.047		
Waist circ.	Normal	1	0.002		
	Obese	2.9 (1.5, 5.92)			
Body habitus (BMI)	Normal	1	0.00	1	0.00*
	Overweight	3.96 (1.92, 8.17)		3.8 (1.84, 7.95)	
	Obese	8.5 (3.22, 22.54)		7.78 (2.90, 20.91)	

*Statistically significant at $p < 0.05$

antihypertensive, which means that hypertension remains undiagnosed. This is comparable with the finding from Addis Ababa, 19%, and Gondar, 14.4% [14, 25]. In our study, 22.6% of respondents who reported a history of hypertension had dysglycemia and 24.5% of those with measured high BP had dysglycemia. There is no statistically significant difference between the mean blood pressure between males or females ($p = 0.44$) or between participants with normal FBS or dysglycemia ($p = 0.47$). In both bivariate and multiple logistic regression, there is no significant association between hypertension and dysglycemia in this study. But, literatures show that hypertension remains an important comorbid condition with diabetes or prediabetic conditions [14, 20, 21] and hypertension is considered as a risk factor for insulin resistance and ADA recommends screening for patients with hypertension [8].

Lastly, this study did not show any statistically significant association between the sociodemographic variables (religion, ethnicity, occupation, income category) and dysglycemia. Similarly, even though physical activity was statistically significant in bivariate analyses, it was not statistically significant in multivariable analysis. However, previous meta-analysis [26] showed that there was an association between physical activity and type 2 diabetes. The difference might be due to the fact that different study designs were employed.

This study has its own strength in that it was done using a validated WHO STEPwise Approach and the study used a modified version of the standard WHO risk factor questionnaire that had been pretested for its suitability in the Ethiopian population. However, this study has some limitations: factor like dyslipidemia was not assessed, and OGTT was not done (full picture of prediabetic may not be seen with fasting blood sugar alone).

Conclusions

This study has found a prevalence of dysglycemia higher than previously reported in urban populations, but comparable prevalence of DM. Hypertension was found to be prevalent and remains largely undiagnosed although not associated with dysglycemia in this study. Family history of DM and body habitus (overweight and obesity) were found to be independent predictors for dysglycemia. The proportion of respondents with lower level of physical activity could in part may account for the high prevalence of overweight, obesity, and dysglycemia among the study subjects. Therefore, given the high prevalence of impaired glucose hemostasis in the study area, 40 years and more adults with overweight or obese body habitus, family history of DM, and hypertension need to be screened for dysglycemia. Moreover, further specific studies are needed on the predictor of DM and hypertension, and large-scale studies that also include the rural population, as

the population profile may not be similar to the town population, are needed to develop local protocols for screening.

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Authors' contribution TZ participated in conceptualizing the study, designed the study, coordinated and supervised data collection, and supervised data entry. EH and HM participated in initiating the concept, design of the study, interpretation of the findings, and write-up of the manuscript. DD also participated in the write-up and revision of the manuscript. All authors have read and approved the manuscript.

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Availability of data and materials Data will be available upon request from the corresponding author.

Compliance with ethical standards

Ethics approval and consent to participate Ethical clearance was obtained from the Institutional Review Board (IRB) of the College of Health Science and then from an ethical review committee of JUSH and was taken to the Jimma Town Health Bureau, and letter of permission was written to each kebele administration. Purpose and significance of the study were explained, and informed consent was taken from each study participant. Respondent's confidentiality was ensured during the study period. The interview scripts were numbered and coded and without including personal identifying data. Participants with abnormal blood sugar were advised and informed to go to health institutions to have their blood sugar repeated and have follow-up.

Consent for publication Not applicable.

Competing interests The authors declare that they have no competing interests.

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Abbreviations AOR, Adjusted odds ratio; BMI, Body mass index; BP, Blood pressure; COR, Crude odds ratio; DBP, Diastolic blood pressure; DM, Diabetes mellitus; FBS, Fasting blood sugar; GDM, Gestational diabetes mellitus; IGT, Impaired glucose tolerance; JUSH, Jimma University Specialized Hospital; OGTT, Oral glucose tolerance test; WC, Waist circumference

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