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ORIGINAL RESEARCH

Type 2 diabetes mellitus among government employees in Harar, Eastern Ethiopia: a cross-sectional study

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Background: Lifestyle with less physical activity and higher consumption of sugar and fat has transformed obesity to an epidemic, which poses a risk for the development of type 2 diabetes. This study was aimed to assess type 2 diabetes mellitus and its associated factors among government employees in Harar Eastern Ethiopia.

Materials and methods: A cross-sectional study was conducted on 714 employees working in ten government offices from May 2013 to July 2013. The WHO STEPwise approach to chronic disease risk factor surveillance questionnaire was used. An overnight fasting capillary blood was analyzed for blood glucose concentration using a commercially available electronic glucose monitor (SensoCard Plus). Participants with fasting blood sugar level ≥126 mg/dL were checked with a more specific glucose oxidase method using a compact automated clinical chemistry analyzer. Logistic regression was used to examine the factors associated with type 2 diabetes mellitus, and a *P*-value <0.05 was used to declare statistical significance.

Results: A total of 50 (7%) participants were found to have a fasting blood sugar level of ≥126 mg/dL after an overnight fasting. Of these, 1.5% were known diabetic cases. There was a statistically significant association between hip circumference (crude odds ratio [COR] =2.32; 95% confidence interval [CI] =1.27, 4.22), waist circumference (COR [95% CI] =1.94 [1.05, 3.58]) and type 2 diabetes. Participants who consumed fruits and vegetables for ≥3 days/week were less likely to have type 2 diabetes mellitus (adjusted odds ratio [AOR] =0.49; 95% CI =0.27, 0.91). A ten-point increase of systolic blood pressure increases the likelihood of developing type 2 diabetes mellitus by 6%, AOR (95% CI) =1.057 (1.027, 1.087).

Conclusion: Behavioral change communication on the need for healthy lifestyle, with a special emphasis on fruits and vegetables consumption and regular checkup for blood sugar level is recommended for prevention and early detection of type 2 diabetes mellitus.

Keywords: type 2 diabetes, government employees, fruits and vegetables, systolic blood pressure, waist circumference

Background

Type 2 diabetes mellitus develops due to a complex interaction between genetic predisposition and lifestyle and is characterized by insulin resistance and/or decreased insulin secretion. The actual manifestation of the disease is preceded by a phase of impaired glucose regulation, in which the cardiovascular risk is already increased. Significant lifestyle factors that promote or accelerate the manifestation of type 2 diabetes mellitus are bad nutritional habits, lack of physical activity, and increased obesity.[1]

Concomitant with the development of human societies that caused significant reductions in mortality related to infectious diseases, the adoption of an inadequate lifestyle with less physical activity and higher consumption of sugar and fat

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transformed obesity into an epidemic, which poses a risk for the development of type 2 diabetes.[2–4]

Population growth, aging, and urbanization along with associated lifestyle changes are likely to lead to a 54% increase in the worldwide numbers of patients with diabetes by 2030. A worldwide prevalence, among adults aged 20–79 years, increasing from 285 million in 2010 (6.4%) to 439 million in 2030 (7.7%) has been estimated.[1,5] According to the International Diabetes Federation, the estimated prevalence rate of type 2 diabetes in Africa was approximately 2.8%. Countries such as Malawi and Ethiopia had rates approximately 2%, whereas Ghana, Sudan, and South Africa have prevalence rates greater than 3%.[6] The prevalence of diabetes mellitus is increasing in developing countries due to population growth, aging, unhealthy diets, obesity, and sedentary lifestyles.[7] In sub-Saharan Africa, the estimated number of people with diabetes was 10.8 million in 2006 and this would rise to 18.7 million by 2025, an increase of 80%, as such exceeding the predicted worldwide increase of 54%.[6,8,9]

Studies in different cities and one peri-urban area in South Africa indicated various prevalence rates ranging from 4% to 8%.[8] A study conducted in South Africa among individuals of age >30 reported a prevalence of 8.8%.[10] Another study conducted in Zimbabwe also reported a prevalence of 10% among individuals >25 years of age.[11]

WHO estimates the number of diabetics in Ethiopia to be approximately 800,000 in 2000 and projected that it would increase to approximately 1.8 million by the year 2030.[12] Different studies conducted in Ethiopia reported different prevalence rates. A cross-sectional study conducted in the town of Jimma among adults 40 years and above found a prevalence of 5.3%.[13] A recent study conducted by Megerssa et al in selected institutions in Bishoftu town reported an overall prevalence of diabetes of 5% (95% confidence interval [CI]: 3–7).[14]

Dietary factors are important and are potentially modifiable risk factors for diabetes. There has been a focus on the role of carbohydrates and fiber, but the role of fruit and vegetable intake in the incidence of type 2 diabetes is not fully understood. A meta-analysis concluded that there is an overwhelming support for the benefit of lifestyle interventions to prevent type 2 diabetes. Intervention studies have included the promotion of fruits and vegetables in the diet.[15] Epidemiological studies suggest that higher intakes of fruits and vegetables and low-fat dairy may be protective.[16,17]

Different studies found that obesity, expressed by body mass index or by waist circumference or waist-to-hip ratio (WHR), has been consistently an independent risk factor for diabetes in the African region.[9,18] A cross-sectional study based on record review of 305 diabetic follow-up patients in Jimma, Ethiopia, reported that 189 (62.0%) and 76 (96.1%) patients with type 2 diabetes mellitus had hypertension.[19]

Evidence suggests that the increasing burden of chronic diseases has grave consequences because very few people will seek treatment, leading to high morbidity and mortality rates from potentially preventable diseases.[20] Raising awareness of risk factors among the population, alongside the development of targeted programs to identify those at a high risk of developing type 2 diabetes would go a long way toward reducing the devastating and costly complications of coronary heart disease, renal disease, blindness, stroke, and foot disease.[21,22]

Screening identifies people with impaired fasting glucose or impaired glucose tolerance and facilitates providing them with lifestyle advice, support, and information about healthy eating. Identifying potential modifiable risk factors in the development of type 2 diabetes is increasingly important because of the growing global burden of the disease.[12] Therefore, this study was aimed to assess type 2 diabetes mellitus and its associated factors among government employees in Harar, Eastern Ethiopia.

Materials and methods

Study setting and design

A cross-sectional study was conducted among government employees working in ten different offices in Harar, Eastern Ethiopia, from May 2013 to July 2013. Government offices were selected randomly, and 787 employees were recruited and distributed proportionally. Attendance sheets of the employees were used to select study participants using systematic random sampling. The employee on the next consecutive number was included in case the selected employee was not found on the day of interview. A questionnaire was distributed a day before the fasting blood sugar measurement in order to complete a detailed survey. An in-person interview was also conducted as necessary for the assessment of dietary intake, physical activity, and measurement of anthropometrics and other factors.

Measurements

Data were collected using the WHO STEPwise approach to chronic disease risk factor surveillance questionnaire (STEPS). The questionnaire was translated to the local language and then translated back to the original language to avoid inconsistency. The fasting blood sugar level and anthropometric measurements were conducted by trained

medical laboratory technologists and nurses, respectively. Data on socio-demographic variables and family history were collected. Systolic blood pressure (sBP) and diastolic blood pressure were measured twice and the mean of the two measurements was calculated. Weight, height, and waist and hip circumferences were measured, and the body mass index and the WHR were determined. Body weight was measured with an electronic scale. Waist circumference was measured at a midway between the costal margin and the iliac crest with a tapeline. Hip circumference was measured at its widest part (greater trochanter). Family history of diabetes was considered to be present if any first-degree relative (parents, brother, sister, and child) had diabetes. Participants who already had breakfast were informed to come after an overnight fast next day. Blood sample was collected from an index finger after 10–12 hours overnight fasting, allowing patients to drink only water, and immediately analyzed for blood glucose concentration using a commercially available portable electronic blood glucose monitor (SensoCard Plus; Avecon Healthcare Pvt. Ltd, Kasauli Road, Parwanoo, India). Participants with fasting blood sugar level ≥126 mg/dL were appointed to the specialized university hospital laboratory for a more specific enzymatic test (glucose oxidase method using HumaStar 80 compact automated clinical chemistry analyzer (Wiesbaden, Germany).

The quality of the measuring instruments was validated by weighing or measuring a known weight or length of objects. The measurement was taken constantly by a single reader in order to avoid inter-reader variability. The quality of the laboratory test results was maintained by running the point-of-care tests as per the manufacturers' instructions and daily quality control was monitored before running each sample for the enzymatic test. The laboratory test measures were accepted or rejected based on the quality control result.

Statistical analysis

The collected data were entered and cleaned with EpiData Software version 3.1 and then transferred to SPSS version 16 for analysis. The logistic regression model was used to study the association of risk factors with diabetes. Variables with *P*-value <0.1 in bivariate analysis results obtained using sex as important variable were taken for the multivariate analysis; finally, *P*-value <0.05 was considered statistically significant.

Ethical consideration

The study protocol was approved and ethical clearance was obtained from the College of Health and Medical Sciences Institutional Health Research Ethics Review Committee of Haramaya University. Written informed consent was obtained from the study participants.

Results

Characteristics of study participants

A total of 787 employees were enrolled, and data were collected from 714, resulting in a response rate of 91%. Of the 714 study participants, 472 (66.1%) were males and 242 (33.9%) were females; thus, the sex ratio was 1.9:1. Ethnically, 255 (35.7%) were Oromo, 248 (34.7%) Amhara, 85 (11.9%) Gurage, 37 (5.2%) Harari, 25 (3.5%) Somali, and the remaining 64 (9%) were from Tigray, Southern Nations, and other ethnic groups (Table 1).

Prevalence of type 2 diabetes mellitus

From the total of 714 government employees screened, 57 (8%) had a fasting blood glucose level ≥126 mg/dL. After further checkup using a more specific plasma glucose measurement (glucose oxidase) method, the overall prevalence of type 2 diabetes mellitus (≥126 mg/dL) after an overnight fasting was 50 (7%). From these, 1.5% were known diabetic individuals and 5.5% were individuals with undiagnosed diabetes mellitus.

Factors associated with type 2 diabetes mellitus

In bivariate analysis, the age, hip and waist circumference, frequency of fruit and vegetable consumption, and sBP showed statistically significant association with type 2

Table 1 Socio-demographic characteristics of government employees of Harar, 2013

Socio-demographic variables (n=714)	Number	%
Age		
<35 years	371	51.9
≥35 years	343	48.0
Sex		
Male	472	66.1
Female	242	38.9
Ethnicity		
Oromo	255	35.7
Amhara	248	34.7
Other ethnic groups*	211	29.5
Educational status		
Primary school (grade 1–8)	183	25.6
Secondary school (9–12)	190	26.6
Post-secondary	341	47.7
Marital status		
Married	305	42.7
Unmarried	409	57.2

Note: *Gurage, Harari, Somali, Tigray, Southern Nations, etc.

diabetes mellitus. This study found a statistically significant association between age ≥35 and diabetes mellitus (COR [95% CI] =2.39 [1.34, 4.26]). The prevalence of diabetes mellitus was less among those who consumed fruits and vegetables on ≥3 days/week (COR [95% CI] =0.51 [0.29, 0.91]). There was a statistically significant association between hip circumference (COR [95% CI] =2.32 [1.27, 4.22]), waist circumference (COR [95% CI] =1.94 [1.05, 3.58]), and a ten-point increase of sBP (COR [95% CI] =1.07 [1.04, 1.09]) and type 2 diabetes mellitus (Table 2).

In the final model built, those participants who consumed fruits and vegetables on ≥3 days/week were approximately

Table 2 Type 2 diabetes cases by selected variables among government employees of Harar, Eastern Ethiopia, 2013

Socio-demographic variables (n=714)	Fasting blood glucose		COR (95% CI)	*P*-value
	≥126 mg/dL	<126 mg/dL		
	n (%)	n (%)		
Age				
<35 years	18 (4.85)	353 (95.15)	1	
≥35 years	32 (9.93)	311 (90.67)	2.39 (1.34, 4.26)	0.003
Sex				
Male	37 (7.84)	435 (92.16)	1	
Female	13 (5.37)	229 (94.63)	0.67 (0.35, 1.28)	0.224
Ethnicity				
Oromo	17 (6.67)	238 (93.33)	1	
Amhara	19 (7.66)	229 (92.34)	1.16 (0.58, 2.29)	0.666
Other[#]	14 (6.64)	197 (93.36)	0.99 (0.48, 2.07)	0.989
Educational status				
Primary school (grade 1–8)	9 (4.92)	174 (95.08)	1	
Secondary school (9–12)	12 (6.32)	178 (93.68)	1.30 (0.54, 3.17)	0.559
Above secondary	29 (8.50)	312 (91.50)	1.79 (0.83, 3.88)	0.136
Marital status				
Married	15 (4.92)	290 (95.08)	1	
Unmarried	35 (8.56)	374 (91.44)	1.81 (0.97, 3.38)	0.063
Alcohol in last 12 months				
Yes	11 (8.80)	114 (91.20)	1	
No	39 (6.62)	550 (93.38)	0.73 (0.37, 1.48)	0.388
BMI (kg/m^2)				
<25	31 (6.50)	446 (93.50)	1	
≥25	19 (8.02)	218 (91.98)	1.25 (0.69, 2.27)	0.455
Fruits and vegetables consumption				
≤2 days/week	25 (10.00)	225 (90.00)	1	
≥3 days/week	25 (5.39)	439 (94.61)	0.51 (0.29, 0.91)	0.023
Vigorous work for 10 minutes				
Yes	8 (7.85)	94 (92.15)	1	
No	42 (6.82)	570 (93.28)	0.86 (0.39, 1.90)	0.72
Walking for at least 10 minutes/day				
Yes	25 (8.90)	256 (91.10)	1	
No	25 (5.77)	408 (94.23)	0.62 (0.35, 1.11)	0.113
Vigorous activity that causes high breathing rate				
Yes	6 (7.59)	73 (92.41)	1	
No	44 (6.93)	591 (93.07)	0.64 (0.307, 1.31)	0.221
Waist circumference*				
Normal	11 (4.2)	253 (95.8)	1	
Risk group	39 (8.7)	411 (91.3)	1.94 (1.05, 3.58)	0.034
Hip circumference (mean)				
Low	18 (4.57)	376 (95.43)	1	
High	32 (10.00)	88 (90.00)	2.32 (1.27, 4.22)	0.006
sBP (mmHg)				
Mean ± SD	121.07±12.60	131.00±10.43	1.07 (1.04, 1.09)	0.000

Notes: [#]Gurage, Harari, Somali, Tigray, Southern Nations, etc. *Waist circumference greater than 102 cm for male and 88 cm for female were used as threshold. *P*-value <0.05 indicates statistically significant.

Abbreviations: CI, confidence interval; COR, crude odds ratio; BMI, body mass index; sBP, systolic blood pressure; SD, standard deviation.

50% less likely to be diabetic than those who consumed on <3 days/week, AOR (95% CI) =0.496 (0.271, 0.910). A ten-point increase of sBP increases the likelihood of developing type 2 diabetes mellitus by 6%, AOR (95% CI) =1.057 (1.027, 1.087) (Table 3).

Discussion

This study identified age, hip and waist circumferences, fruits and vegetables consumption, and sBP as significant factors for diabetes mellitus. The prevalence of type 2 diabetes mellitus among the study participants was 7%. Respondents who consumed fruits and vegetables on approximately ≥3 days/week were less likely to experience diabetes mellitus. A ten-point increase in sBP was associated with an increased likelihood of type 2 diabetes mellitus.

The worldwide prevalence of diabetes among adults aged 20–79 years is also estimated to continuously increase from 6.4% in 2010 to 7.7% in 2030.[5] Though there has not been any population-based estimate of the prevalence of type 2 diabetes in Ethiopia, this study found an overall prevalence of 7%. This result was comparable to the cross-sectional study conducted in Jimma and Bishoftu towns in Ethiopia and to other community-based studies in developing countries that reported a prevalence of >5% undiagnosed diabetes mellitus. Different prevalence rates ranging from 4% to 8% were also reported from South African studies undertaken in different cities.[8,13,14] The 7% prevalence reported in this study would likely have been higher if oral glucose tolerance test was used in addition to the fasting glucose test.[23] This result showed a rapid increase in the prevalence of diabetes mellitus at an alarming rate, which may exceed the 2030 estimation soon.

Epidemiologic studies have examined associations between dietary patterns of patients and the risk of type 2 diabetes. It is suggested that higher intakes of fruits and vegetables, whole grains, fish, and low-fat dairy may be protective for diabetes, and higher intakes of processed grains, added sugars, processed and red meat, and fried foods may increase diabetes risk.[16,17] In our study, fruits and vegetables consumption was found to be significantly associated with type 2 diabetes. The prevalence of type 2 diabetes mellitus was less among those who consumed fruits and vegetables ≥3 days/week time (COR [95% CI] =0.51 [0.29, 0.91]). Researchers also reported that the educational status, family origin, and socioeconomic status affect the food purchasing power, food choice, food preparation, and food availability, which in turn affect consumption.[24]

Studies found a significant association between increased blood pressure and diabetes.[17,23] In a similar manner, a ten-point increase of sBP increases the likelihood of diabetes

Table 3 Factors associated with type 2 diabetes among government employees of Harar, Eastern Ethiopia, 2013

Socio-demographic variables (n=714)	Fasting blood glucose		AOR (95% CI)	*P*-value
	≥126 mg/dL	<126 mg/dL		
	Number	Number		
Age				
<35 years	24	457	1	
≥35 years	26	207	1.653 (0.89, 3.07)	0.113
Sex				
Male	37	435	1	
Female	13	229	0.47 (0.22, 1.003)	0.051
Marital status				
Married	15	290		
Unmarried	35	374	1.53 (0.79, 2.942)	0.205
Fruits and vegetables consumption				
1–2 days/week	25	225	1	
≥3 days/week	25	439	0.531 (0.29, 0.98)	0.041
Waist circumference*				
Normal	11	253	1	
Risk group	39	411	1.815 (0.85, 3.90)	0.127
Hip circumference (mean)				
Low	18	376		
High	32	288	1.17 (0.58, 2.36)	0.669
sBP (mmHg)				
Mean ± SD	121.073±12.60	131.00±10.43	1.06 (1.026, 1.084)	0.000

Notes: *Waist circumference greater than 102 cm for male and 88 cm for female were used as threshold. *P*-value <0.05 indicates statistically significant.
Abbreviations: AOR, adjusted odds ratio; CI, confidence interval; sBP, systolic blood pressure; SD, standard deviation.

mellitus by 6%, AOR (95% CI) =1.057 (1.027, 1.087). This result was similar with different studies that found obesity as an independent risk factor for diabetes in the African region.[9,18] A cross-sectional study in Jimma, Ethiopia, also reported hypertension in a high number of type 2 diabetes mellitus patients.[19] This may indicate the importance of screening among hypertensive individuals in Ethiopia.

This study conducted fasting glucose measurement. No additional tests were conducted to differentiate type 1 and type 2 diabetes. Besides, the prevalence of type 2 diabetes would likely have been higher if oral glucose tolerance test had been conducted in addition to the fasting glucose test.

Conclusion

In conclusion, there is a rapid increase in the magnitude of type 2 diabetes in Ethiopia compared to other sub-Saharan African countries. This requires the need for getting regularly screened for blood sugar levels and strengthening behavioral change communication on healthy lifestyles to prevent the occurrence of type 2 diabetes. A large-scale community-based study involving the rural community is recommended to determine the burden of type 2 diabetes mellitus.

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Author contributions

All authors contributed toward data analysis, drafting and critically revising the paper and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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