Determinants of metabolic syndrome among type two diabetic patients following diabetic clinic of Arba Minch General hospital, southern Ethiopia- a case-control study

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Abstract

cardiovascular disease and early death. Globally, 70–80% of diabetic patient develop metabolic syndrome Comprehensive knowledge about risk factors for metabolic syndrome are essential to decrease the risk of cardiovascular diseases and improve the quality of life for diabetic patient. Thus, this study aims to determine predictors of metabolic syndrome among type two diabetic patients. This study aims to identify determinants of metabolic syndrome among type two diabetic patients.

Methods: Institutional based unmatched case-control study was conducted. 204 systematically selected study participants were involved. Data was collected using a pre-tested, interviewer-administered questionnaire. Bivariate and multivariable logistic regression analyses were employed to identify determinants of metabolic syndrome using STAT version 16.

Result: The probability of being female was 3.4 times higher among cases than controls as compared to being male [AOR=3.35, 95% CI (1.28, 8.73)]. The odds of being a rural dweller were 2 times higher among cases than controls as compared to rural dwellers [AOR = 3.10, 95% CI (1.27, 7.624)]. The likelihood being government employment was 4.4 times higher among cases than controls as compared to self-employed [AOR= 4.39, 95% CI ((1.28, 14.97)]. The odds of being obese were 2.7 times higher among cases than controls as compared to normal body mass index [AOR= 2.72, 95% CI ((1.03, 7.17)].

Conclusion: -our study indicated that sex, residence, occupation, and body mass index were found to be determinants of metabolic syndrome. Organizations who work in diabetic mellitus and health professionals should focus on these factors in their efforts to reduce the risk of cardiovascular disease among diabetics.

Introduction

A metabolic syndrome is a group of metabolic abnormalities which includes central obesity, elevated blood pressures, elevated triglycerides, decreased high-density lipoprotein cholesterol, and hyperglycemia (1). It increases the risk of developing cardiovascular disorder and stroke by three to ten times and the risk of diabetic Mellitus by tenfold (2). The new international diabetes federation (IDF) defines metabolic syndrome as central obesity (defined by waist circumference) plus any two of the four risk factors: low high-density lipoprotein (HDL) cholesterol, raised triglyceride, raised blood pressure, and/or raised fasting plasma glucose level (3).

Metabolic syndrome is a complex disorder that leads type 2 diabetes patients and cardiovascular disease (CVD) to be a twin global epidemic problem (3). Globally, 20–25% of the adult population and 70–80% of diabetes mellitus (DM) patients are estimated to have metabolic syndrome (4).

Metabolic syndrome is becoming a worldwide public health concern due to lifestyle changes, urbanization, decreasing levels of physical activity, increased intake of energy, and globalization (3–5). Metabolic syndrome among type 2 DM patients is a common condition in developed and developing

countries. Its magnitude was 24% in Europe, 32% in the UK, 68.6% in Gahanna, 68.7%, and Nigeria (6–8). The pooled prevalence in sub-Saharan Africa was reported at 59.62% where the highest prevalence is observed in Ethiopia (61.1%) (5–10). Similarly, the magnitude varies in different parts of Ethiopia, 51.1% in north Ethiopia, 45.9% in southern Ethiopia Hawassa, 57% in North West Ethiopia Gondar (5, 11, 12).

Among all diabetic type two individuals, 80% also had metabolic syndrome (13). It is thought to be a driver of the modern-day epidemics of diabetes and cardiovascular disorder and has become a major public health challenge around the world (14) (1). In Africa, the prevalence of metabolic syndrome ranges from 17–25% (9). Metabolic syndrome increases the risk of developing non-communicable diseases, and the cost of treatment for non-communicable diseases. It will increase the economic burden of hypertension and other non-communicable diseases by 59–179% by 2020 (15). We can decrease and prevent it by simple lifestyle modifications like weight reduction and using an anti-atherogenic diet (15).

The metabolic syndrome is known to be caused by insulin resistance or insulin resistancelinked obesity, a condition whereby the body's cells are incapable of taking up glucose from the blood. Insulin resistancelinked to obesity is caused by a lack of regular exercise and poor dieting. Increasing age, smoking of cigarettes, alcohol intake, overweight, sedentary lifestyle, and family history of type 2 diabetes are also important risk factors (16).

Dietary changes, physical inactivity, rural to urban migration, industrial development, and genetic susceptibility are playing a substantial role in the spread of metabolic syndrome (Mets). Low HDL-C is the most prominent component of metabolic syndrome and females have an increased risk to develop metabolic syndrome in Ethiopia (12, 14, 17). Studies reported that Being female, consumption of red meat, sedentary leisure time activity, coffee intake, BMI $\geq$ 25 kg/m^2, increased age, self-employment, completion of secondary school and above, having diabetes for over 5 years and poor glycemic control, physical inactivity, inadequate intake of fruits, family history, overweight, and obesity (12, 16, 18–20).

The burden of non-communicable diseases (NCDs) is growing at an alarming rate in developing countries including Ethiopia. Ethiopia has a very weak health system to control the NCDs which also have a high burden of communicable disease. Since its diagnosis and treatment are too expensive, more focus should be given to the upstream risk factors of metabolic syndrome. Even though studies are done to determine the prevalence and factors for metabolic syndrome, most of the studies conducted were a snapshot and subjected to design limitations. So that this case-control study was designed to determine the determinants of metabolic syndrome in southern Ethiopia.

Methods

Study setting and design

A facility-based unmatched case-control study was conducted among type 2 diabetes patients attending Arba Minch General hospital diabetic clinic from May to July 2021. The hospital is located south of Addis

Ababa, the capital city of Ethiopia 434 km far. It provides curative, preventive, and rehabilitative services for its catchment population. It has a diabetic clinic where diabetic patients follow their chronic care. Cases were type 2 DM patients with metabolic syndrome by IDF classification while controls were type 2 DM patients without metabolic syndrome by IDF classification.

Sample size and Sampling procedure

The sample size was calculated using Epi Info™ software by assuming the proportion of type 2 DM patients age 40–49 among controls and cases were 57.89% and 76.27% respectively (18) 95% CI, 80% power, and case to control the ratio of 1:1. The total sample size was 204 (102 cases and 102 controls). To calculate sample size, age was chosen as an independent variable since it gave maximum sample size, and a study conducted in Ethiopia (Dessie Referral Hospital) was used because it was a recently conducted study. Study participants were selected by systematic random sampling using diabetic registration book at follow-up clinic and average weekly patient load and systematic random sampling technique were used to select the first participant.

Data collection procedure

An interview, document review, and physical measurements were carried out by a trained public health officer. Laboratory samples were collected by an experienced nurse working at the diabetic clinic. Laboratory analysis carried out by senior laboratory technician. The lipid profile test is processed inside the university, in coordination with the laboratory department.

Measurements and tools

Weight was measured using Seca weighing scale with participants wearing light clothing (single and thin) and without shoes to the nearest 0.1Kg. Height was measured using a stadiometer to the nearest 0.1 CM. A simple flexible steel metric tape calibrated in meters was used for measuring waist circumference. Waist circumference was measured midway between the iliac crest and the lower rib margin in the horizontal plane while the participant is standing to the nearest 0.5 cm

Blood pressure

Two blood pressure measurements taken 5 min apart were determined for each participant using a Mercury-based sphygmomanometer. Participants were measured after 10 min of rest in sitting position, and arm rest on a table at heart level, back supported, on the same arm and legs rest on the ground. And the average readings of the two measurements were recorded in the questionnaire.

Blood Specimen Collection and Sample Analysis

Lipid profile was done by collecting 5ml blood from Midian cubital vein after 8–10 hours of fasting by trained medical laboratory technologists. Using an automated chemistry analyzer lipid profile measurements were made. Ready-to-use reagent kits was used to control quality according to the

standardized protocols provided by the manufacturers. To ensure the accuracy of the measurements, all tests were run in duplicate. Appropriate standards and quality control sera were also used (21).

Operational definition

Metabolic syndrome: As per the definition of IDF it is defined as having central obesity (defined by waist circumference ≥ 94 cm for males and ≥ 80 cm for females) plus any two of the following four factors: raised triglycerides, reduced HDL cholesterol, raised blood pressure, and/or raised fasting plasma glucose or previously diagnosed type 2 diabetes (3).

Central obesity

waist circumference ≥ 94 cm for males and ≥ 80 cm for females putting to the nearest centimeter (3).

Raised triglycerides

≥150 mg/dl or specific treatment for this lipid abnormality (3).

Reduced HDL cholesterol

< 40 mg/dl in male < 50 mg/dl in female or specific treatment for this lipid abnormality (3).

Raised blood pressure

Is a systolic BP ≥ 130 mm Hg or diastolic BP ≥ 85 mm Hg, or any patient on the treatment of previously diagnosed hypertension (3).

Physical activity

Individuals who did moderate-intensity activity for at least 30 minutes per day on at least five days per week were considered as physically active (18)

Data analysis

The data collected in each day were checked for completeness. After editing and coddling, it was entered into Epi data version 3 then exported to stat 16 statistical software for analysis. Descriptive statistics were conducted. Bivariate analysis was done and all explanatory variables with significant association (p-value < 0.25) were included in multivariate analysis to avoid confounders'. Odds ratio (OR with 95% CI) was used to declare statistically significant association.

Results

Socio-Demographic Characteristics of Participants

A total of 204 type 2 DM patients (102cases and 102 controls) have participated in this study with a mean age of 51.7 years ± 13.7 (SD). The majority 61(59.8%) of cases and 75(73.53%) controls were

urban dwellers and 94(92.16%) of cases and 99(97.0%) controls were married (Table 1).

Table 1
Sociodemographic characteristics of patients in determinants of metabolic syndrome among type two diabetic patients, Arba Minch Hospital, southern Ethiopia

Variables	Cases (N°/%)	Controls (N°/%)	p-value
Sex	70 (68.6%)	41 (40.2%)	0.001
Female	32(31.4%)	61(59.8%)	
Male			
Age in years	46(45.10)	58(56.86)	0.094
< 50	56(54.90)	44(43.14)	
50 and above			
Address	41(40.20%)	27(26.47%)	0.039
Rural	61(59.8%)	75(73.53%)	
Urban			
Marital Status	94(92.16%)	99(97.0%)	0.136
Married	8(7.84%)	3(2.94%)	
Unmarried			
Level of Education	19(18.63)	31(30.39)	0.016
College and above	39(38.24)	25(24.51)	
No formal education	29(28.43)	29(28.43)	
Primary education	15(14.71)	17(16.67)	
Secondary education			
Occupation	28(27.45)	34(33.33)	0.001
Government employed	55(53.92)	32 (31.37)	
Housewife	19(18.63)	36(35.29)	
Self-employed			

Clinical and behavioral characteristics

The mean time of the respondents since diagnosis with DM was 5.5 years ± 4.8 (SD) with a minimum of 1 year and a maximum of 23 years. 45(44.12%) cases and 87(85.29%) controls had central obesity while 42.5% of the study participants were overweight. Hypertension was common comorbidity with

27(26.73%) of cases and 19(18.81%) of the controls. The majority 84(82.35%) of cases and 78(76.47%) controls were poorly controlled their blood glucose level (Table 2).

Table 2
health and behavioral related characteristics of study participants in determinants of metabolic syndrome among type two diabetic patients, Arba Minch Hospital, southern Ethiopia

variables	Cases (No/%)	Controls (No/%)	p-value
Albuminuria	17(18.48)	11(11.34)	0.171
Yes	75(81.52)	86(88.66)	
No			
DM complication	92(90.20)	97(95.10)	0.188
No	10(9.80)	5(4.90)	
Yes			
Musculoskeletal disorders	74(73.27)	82(81.19)	0.181
No	27(26.73)	19(18.81)	
Yes			
Body mass index	38(37.25)	50(49.02)	0.040
normal	45(44.12)	42(41.18)	
overweight	19(18.63)	10(9.80)	
obese			
Waist circumference	57(55.88)	15(14.71)	0.001
Normal	45(44.12)	87(85.29)	
Obese			
Hypertension	76(74.51)	77(75.49)	0.872
No	26(25.49)	25(24.51)	
Yes			
Fasting blood sugar	18(17.65)	24(23.53)	0.300
< 130	84(82.35)	78(76.47)	
131 and above			
Total cholesterol	5(4.90)	78(76.47)	0.001
< 200	97(95.10)	24(23.53)	
200 and above			

variables	Cases (No/%)	Controls (No/%)	p-value
HDL-C	8463(82.35)	96(94.12)	0.013
40 and above	18(17.65)	6(5.88)	
< 40			
Triglycerides	18(17.82)	30(31.58)	0.001
< 150	83(82.18)	65(68.42)	
150 and above			
Chewing chat	100(98.04)	96(94.12)	0.169
No	2(1.96)	6(5.88)	
Yes			
Alcohol consumption	96(94.12)	99(97.06)	0.136
No	6(5.88)	3(2.94)	
Yes			
Physical activity	89(87.25)	87(85.29)	0.684
No	13(12.75)	15(14.71)	
Yes			

Determinants of metabolic syndrome

The probability of being female was 3.4 times higher among cases than controls as compared to being male [AOR = 3.35, 95% CI (1.28, 8.73)]. The odds of being a rural dweller was 3 times higher among cases than controls as compared to rural dwellers [AOR = 3.10, 95% CI (1.27, 7.624)]. The likelihood being government employment was 4.4 times higher among cases than controls as compared to self-employed [AOR = 4.39, 95% CI ((1.28, 14.97)]. The odds of being obese were 2.7 times higher among cases than controls as compared to normal body mass index [AOR = 2.72, 95% CI ((1.03, 7.17)] (Table 3).

Table 3
determinants of metabolic syndrome among type two diabetic patients, Arba Minch Hospital, southern Ethiopia

Variables	Cases (Nº/%)	Controls (Nº/%)	COR.[95% CI]	AOR.[95% CI]
Sex	70(68.6)	41(40.2)	3.255(1.83, 5.78)	3.35 (1.28, 8.73)
Female	32(31.4)	61(59.8)	1	1
Male				
Address	41(40.20)	27(26.47)	1.86(1.02,3.37)	3.10(1.27, 7.624)
Rural	61(59.8)	75(73.53)	1	1
Urban				
Employment	28(27.45)	34(33.33)	1.56(0.73,3.29)	4.39(1.28,14.97)
Government employed	55(53.92)	32 (31.37)	3.25(1.60,6.59)	1.36(0.45, 4.09)
housewife	19(18.63)	36(35.29)	1	1
Self-employed				
Body mass index	38(37.25)	50(49.02)	1	1
Normal	45(44.12)	42(41.18)	1.41(0.77,2.55)	1.69(0.87,3.28)
Overweight	19(18.63)	10(9.80)	2.5 (1.04,5.99)	2.72(1.03,7.17)
Obese				

Discussion

Metabolic syndrome is a cluster of risk factors that is responsible for the risk of coronary heart disease and stroke. The burden of metabolic syndrome and chronic non-communicable diseases is emerging alarmingly in low-income countries. This has led to an increase in the global prevalence of chronic non-communicable diseases, with the majority of the growth occurring in developing countries (22). Increasing urbanization, westernization of lifestyle including unhealthy diet and physical inactivity, over nutrition increasing on top of the already high prevalence of undernutrition leading to a double burden of diseases in sub-Saharan Africa (23, 24). Identifying determinants of metabolic syndrome is crucial to lowering the risk of coronary heart disease and stroke in people with diabetes. This study showed that living in rural areas, female sex, government employment, and obesity are the determinants of metabolic disorders in type two Diabetic Mellitus.

The finding from this study suggests that the odds of metabolic syndrome were 3.35 times higher among females than males. This is consistent with studies conducted in Hawassa Ethiopia, Addis Ababa Ethiopia, Nigeria, and Iran (25–29). This is a result of the observation of sex differences in body fat distribution, sex hormones, and the effect of glucose (19). Women in Ethiopia have a relatively sedentary

lifestyle, are not more exposed to do physical exercise, are supposed to stay home, look after children, and take care of household chores increases their susceptibility to metabolic syndrome. Also, Physiological events such as puberty, pregnancy, and menopause are closely related to alterations in energy homeostasis and gonadal steroid levels during women's lives. An increase usually follows these events in insulin resistance and body fat, important components of metabolic syndrome. Besides, the use of hormonal contraceptives and pathological conditions such as polycystic ovary syndrome and gestational diabetes may also affect.

The likelihood of getting metabolic disorders was 2.72 times higher among obese than normal. This is in line with studies done in Ethiopia, Gahanna, Iran, and Nigeria (26–28, 30). It is a known fact that obesity aggravates insulin resistance which that leads to increased hepatic production of VLDL and later release of high levels of TG in the bloodstream (31). Increased body weight also contributes to central obesity, which leads to the accumulation of fat in the body. Fat forms artery plaque, which narrows arteries and capillaries leading to hypertension (32–35)

The odd of metabolic disorders were 3 times higher among rural dwellers than urban dwellers. This can be explained by low-quality health care, low literacy which affects patients' health-seeking behavior, adherence to lifestyle modifications, and management which are important in controlling non-communicable diseases including components of metabolic syndrome.

Metabolic disorders were about 4 times higher among government-employed than self-employed. This is due to that government employers are involved in office-based work which limits physical activities and increases sedentary lifestyle and works in a stressful, overcrowded environment.

Conclusion

This study showed that sex, occupation, and body mass index were found to be determinants of metabolic syndrome. Thus, concerned organizations and health professionals should focus on these factors in their efforts to reduce the risk of cardiovascular disease among diabetics.

Abbreviations

AOR-adjusted odds ratio

BMI-body mass index

CM-centimeter

CVD-cardiovascular disease

DM-diabetic Mellitus

FBS-fasting blood glucose

Declarations

Ethical clearance

This study adhered to ethical principles and guidelines of the Declaration of Helsinki and was approved and cleared by the Institutional Review Board of the college of medicine and health science, Arba Minch University with the reference number of IRB/1040/20. Letter of cooperation was obtained from respective hospital and informed consent were obtained from each of the study participant. Before obtaining informed consent for participants, they were given a clear description of the study title, procedure, and duration of the study, possible risks and benefits of the study by their language. Their right during the data collection for either not to participate or to withdraw at the middle of data collection was guaranteed. The study ensured individual information kept confidential. A personal unique identifier such as the name of study participants were not asked. There were no any payment for study participants. A study participant who have metabolic disorders were linked to the diabetic's clinic for further management.

Consent for publication

Not applicable

Data availability

All relevant data is included in the manuscript. The data is available upon reasonable request from the corresponding author.

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Competing interests

The authors have no conflicts of interest

Authors' contributions

- Getachew Abebe was involved in the conception, study design, execution, analysis, and writing the draft of the manuscript.

- Teshale Fikadu was involved in study design, critical revision of the manuscript and final approval of the version to be published
- Tadios, Hailu was involved in the acquisition of data, critical revision of the manuscript and final approval of the version to be published
- Rodas Temesgen was involved in the acquisition of data, critical revision of the manuscript and final approval of the version to be published

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