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Modifiable cardiovascular disease risk factors among adults in southern Ethiopia: a community-based cross-sectional study

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ABSTRACT

Objective To assess the prevalence, magnitude and factors associated with the number of major modifiable cardiovascular disease (CVD) risk factors.
Design Community-based cross-sectional study.
Setting General population in urban and rural Wolaita, southern Ethiopia.
Participants A total of 2483 adults aged 25–64 years were selected using the three-stage random sampling.
Outcome measures Prevalence of major modifiable CVD risk factors, co-occurrences and the number of modifiable CVD risk factors.
Results The major modifiable CVD risk factors documented in the Wolaita area were smoking with a weighted prevalence of 0.8%, hypercholesterolaemia 5.0%, hypertriglyceridaemia 15.5%, low high-density lipoprotein cholesterol (HDL-C) 31.3%, high systolic blood pressure 22.2%, high diastolic blood pressure 22.4%, physical inactivity 44.1%, obesity 2.8% and hyperglycaemia 3.7%. The numbers of participants having ≥1, ≥2 and ≥3 major modifiable CVD risk factors in the study area were 2013, 1201 and 576 with a weighted prevalence of 75.8%, 42.3% and 19.4%, respectively. In general, there were 28 different combinations of major modifiable CVD risk factor co-occurrences. The combination of physical inactivity with low HDL-C was found in 19.7% of the study participants, followed by physical inactivity with hypertension of 17.8%. Urban residence, male gender, sugar-sweetened food consumption and older age had a positive association with the number of major modifiable CVD risk factors, while being a farmer had a negative association.
Conclusions The prevalence and magnitude of major modifiable CVD risk factors in the study area were high. The components of the most prevalent combinations of major modifiable CVD risk factors should be targeted. Therefore, public health measures against major modifiable CVD risk factors such as promotion of physical exercise and reduction of sugar-sweetened food consumption have to be taken, targeting the vulnerable groups such as urban residents and older age.

Strengths and limitations of this study

- This is the first community-based study in Ethiopia assessing the prevalence, magnitude and factors associated with the number of major modifiable cardiovascular disease (CVD) risk factors.
- The findings have a policy implication in directing the need to focus on non-communicable disease treatment and control.
- The findings are important for public health practices in preventing CVDs from the study area and similar settings in the country.
- Lack of temporal relations because of the cross-sectional study design.
- Social desirability bias due to the self-reported assessment of behavioural variables.

INTRODUCTION

Globally, cardiovascular diseases (CVDs) continue to be the major public health challenge.[1–5] The magnitude of CVD accountable to modifiable risk factors such as high blood glucose, high systolic blood pressure (SBP), high low-density lipoprotein cholesterol (LDL-C) and obesity is rising.[3] Certain evidence also indicates increased burden and severity of CVD due to the additive and synergistic effect of the presence of multiple modifiable CVD risk factors.[6–8] The burden of CVD cases almost doubled, and the number of deaths, excluding high-income countries consistently increased from 1990 to 2019.[1] About 523 million people suffered, and 18.6 million died from CVD in 2019.[1 3] The magnitude of deaths due to CVD is estimated to be one-third of deaths due to all causes.[3] The burden of CVD in low-income and middle-income countries (LMICs) is on the rise, and these countries carry almost 80% of global CVD deaths.[2 5 9–11] In Africa, CVD becomes an emerging public health problem, mostly due to lifestyle changes, lack of physical activities, increased rural–urban migration and high-calorie intake.[12–14]

According to the American Heart Association, the major modifiable CVD risk factors are smoking, dyslipidaemia, high blood pressure, physical inactivity, obesity and being overweight and diabetes.[15] Modifiable CVD risk factors in an individual may occur either in single or multiple numbers. Some studies reported different levels of modifiable CVD risk factors with a prevalence varying from 17.2% to 73.0%.[16–18] Few studies in Africa reported the presence of multiple modifiable CVD risk factors. A study conducted in semiurban communities in southwestern Nigeria documented the presence of 15.5% of three, and 8.4% of four or more modifiable CVD risk factors.[19] Some of the factors that showed association with having multiple modifiable CVD risk factors are age, sex, residence, altitude, education and socioeconomic status.[16–19]

There is no report on the presence of multiple modifiable CVD risk factors in Ethiopia. However, there are few reports on the prevalence of contracting multiple metabolic syndrome components and CVD risk factors (see online supplemental file 1).[20–22] For instance, a community-based survey on the presence of multiple metabolic syndromes in eastern Ethiopia showed a 9.5% prevalence of having three factors of metabolic syndrome components.[20] On the other hand, a national non-communicable disease (NCD) STEPS survey demonstrated a prevalence of 3.2% diabetes, 5.2% hypercholesterolaemia, 21.0% hypertriglyceridaemia, 14.1% high LDL-C and 68.7% low high-density lipoprotein cholesterol (HDL-C).[21]

We assessed the prevalence, magnitude and factors associated with the number of major modifiable CVD risk factors among the adult population in Wolaita, southern Ethiopia. In Ethiopia, there is no evidence on the prevalence, magnitude and factors associated with the number of major modifiable CVD risk factors. Therefore, this study aimed at assessing the prevalence, magnitude and factors associated with the number of major modifiable CVD risk factors among adults within the context of Wolaita, southern Ethiopia.

MATERIALS AND METHODS

Study setting

Wolaita Zone is a rapidly growing population area with an estimated population of 2 042 593 in 2019. Administratively, Wolaita is divided into 22 districts. The zone has significant educational challenges, especially with the coverage of preparatory high school.[23] As evidence from the literature indicates, the health service coverage in the area was low. The distribution of health posts and health centres in the towns and newly established administrative districts was scarce, and there was no tertiary-level health service delivery in the area.[23] In the study area, there was no detection, treatment and control of NCDs. The health extension programme in Ethiopia was designed to offer technical services on maternal and child health, communicable diseases, and hygiene and sanitation[24] and brought improvements.[25] However, the detection, treatment and control of NCDs were not included within the health extension service package. The health extension workers had no training in the detection, treatment and control of NCDs, and at the primary healthcare level, essential medicines and basic diagnostic equipment for the diagnosis and treatment of NCDs were not available. Most hypertension and diabetes cases were not identified before, and there was no dedicated unit for NCDs.

Study design, participants and sampling procedure

This was a cross-sectional study undertaken in the community among the adult population aged 25–64 years in Wolaita, southern Ethiopia, from May 2018 to February 2019. It involved 1243 people from Wolaita Sodo town and 1240 from rural areas in Ofa district. Wolaita Sodo is the capital and rapidly growing urban area of Wolaita Zone,[26] and Ofa is a rural district with a traditional lifestyle which is located 33 km to the west of Wolaita Sodo town. The study participants were permanent residents in the study sites. We used three-stage random sampling to select the study participants. The study kebeles (villages, the smallest administrative division in Ethiopia), stratified in the urban and rural, were selected using a simple random sampling technique from the list of enumerated kebeles in each stratum. We selected 11 from the 54 urban and ten from the 52 rural kebeles. Then, we applied a simple random sampling technique to select the study households by generating sample household numbers using a random integer generator.[27] The allocation of the kebeles in the urban and rural study sites and households in the study kebeles was based on a sample proportional to size. We used a simple random sampling method to select the study participants from the sampled households. A lottery method was employed using one coloured and the other plain match sticks; the eligible household members would pick from a vessel, and one who picked the coloured match stick was considered the study participant.

Sample size

The sample size was determined using Epi Info V.7 StatCalc. This is a study with a sample size of 2486. Initially, the overall sample size was computed to assess variations in dietary intake and nutrition transition among rural and urban populations in Wolaita using the following assumptions: 95% confidence level, 90% power, one for the ratio of unexposed to exposed groups, 5.3% proportion of smokers in rural areas and 10.7% proportion of smokers in urban areas,[28] 10% non-response rate and design effect of 2. The sample size calculated for this study was based on the number of major modifiable CVD risk factors. Thus, it is adequate for this study using the following assumptions: confidence level=95%, power of the study=85%, unexposed to exposed ratio=1, the occurrence of having two modifiable CVD risk factors in rural=44.0% and urban=53.6%, design effect=2 and the non-response rate=10%.[29] Accordingly, the required sample size becomes 2227.

Table 1 Weighted prevalence and magnitude of major modifiable CVD risk factors across the residential areas in Wolaita, southern Ethiopia

Major modifiable CVD risk factors	Rural (n=1240) n	Rural Weighted prevalence % (95% CI)	Urban (n=1243) n	Urban Weighted prevalence % (95% CI)	Overall (N=2483) n	Overall Weighted prevalence % (95% CI)	P value urban–rural
Smoking							
No	1227	99.0 (97.2 to 99.6)	1238	99.6 (99.0 to 99.8)	2465	99.2 (97.9 to 99.7)	0.058
Yes	13	1.0 (0.4 to 2.8)	5	0.4 (0.2 to 1.0)	18	0.8 (0.3 to 2.1)	
Hypercholesterolaemia							
No	1193	96.2 (94.8 to 97.3)	1148	92.4 (90.5 to 93.9)	2341	95.0 (93.6 to 96.1)	<0.001
Yes	47	3.8 (2.7 to 5.2)	95	7.6 (6.1 to 9.5)	142	5.0 (3.9 to 6.4)	
Hypertriglyceridaemia							
No	1054	85.0 (81.6 to 87.8)	1036	83.3 (79.7 to 86.5)	2090	84.5 (82.0 to 86.7)	0.259
Yes	186	15.0 (12.2 to 18.4)	207	16.7 (13.5 to 20.3)	393	15.5 (13.3 to 18.0)	
Low HDL-C							
No	925	74.6 (56.3 to 87.0)	691	55.6 (49.1 to 61.9)	1616	68.7 (56.0 to 79.1)	<0.001
Yes	315	25.4 (13.0 to 43.7)	552	44.4 (38.1 to 50.9)	867	31.3 (20.9 to 44.0)	
High SBP							
No	993	80.1 (77.2 to 82.7)	901	72.5 (64.1 to 79.6)	1894	77.8 (74.4 to 80.8)	<0.001
Yes	247	19.9 (17.3 to 22.8)	342	27.5 (20.4 to 35.9)	589	22.2 (19.2 to 25.6)	
High DBP							
No	991	79.9 (77.3 to 82.3)	898	72.2 (63.3 to 79.7)	1889	77.6. (74.2 to 80.6)	<0.001
Yes	249	20.1 (17.7 to 22.7)	345	27.8 (20.3 to 36.7)	594	22.4 (19.4 to 25.8)	
Physical inactivity							
No	864	69.7 (64.4 to 74.5)	308	24.8 (17.1 to 34.6)	1172	55.9 (44.7 to 66.4)	<0.001
Yes	376	30.3 (25.5 to 35.6)	935	75.2 (65.4 to 82.9)	1311	44.1 (33.6 to 55.3)	
Obesity							
No	1236	99.7 (99.1 to 99.9)	1138	91.6 (89.2 to 93.5)	2374	97.2 (94.9 to 98.5)	<0.001
Yes	4	0.3 (0.1 to 0.9)	105	8.4 (6.5 to 10.8)	109	2.8 (1.5 to 5.1)	
Hyperglycaemic							
No	1208	97.4 (96.6 to 98.0)	1165	93.7 (92.2 to 95.0)	2373	96.3 (95.2 to 97.1)	<0.001
Yes	32	2.6 (2.0 to 3.4)	78	6.3 (5.0 to 7.8)	110	3.7 (2.9 to 4.8)	

CVD, cardiovascular disease; DBP, diastolic blood pressure; HDL-C, high-density lipoprotein cholesterol; SBP, systolic blood pressure.

Data collection techniques

We used structured questionnaires, laboratory investigations and anthropometric measurements for data collection. A series of questions about the modifiable CVD risk factors and related variables were adapted from the WHO protocol for chronic NCDs (WHO STEPS survey).[30] A team of data collectors consisting of nurses, laboratory technicians, supervisors, coordinators and data clerks was recruited and given a -week training on data collection instruments, interviewing skills, laboratory procedures and analysis, and storage of samples. We conducted a pretest on 5% of the total sample size. Based on the experiences gained during the pretest, retraining was given to the data collection team.

Self-reported daily fruit and vegetable intakes were assessed using food frequency questions adapted from the WHO.[30] Physical activity was assessed based on the self-reported performance of moderate-intensity and vigorous-intensity activities, walking, time spent in minutes to carry out each activity and metabolic equivalents (MET) value of the respective activity. MET-min/week for a particular activity was computed by multiplying the number of days/week taken to perform each activity with the time spent in min/day to perform the activity and the respective MET value of the activity.[30 31] Finally, a combination of MET-min/week of walking and moderate-intensity and vigorous-intensity activities was considered as the total MET-min/week.[30 31]

Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2). Weight was measured to the nearest 0.1 kg using a portable digital weighing scale (Seca electronic scale, 22089 Hamburg, Germany). The study subjects were weighted standing with light clothes on the scale with their shoes off. Height was measured

Table 2 Magnitude and weighted prevalence of major modifiable CVD risk factors by sociodemographic and lifestyle variables among adults in Wolaita, southern Ethiopia

	Magnitude and weighted prevalence of major modifiable CVD risk factors					
Variables (N=2483)	**None n (%)**	**1 n (%)**	**2 n (%)**	**3 n (%)**	**4 n (%)**	**≥5 n (%)**
Age (years)						
25–34	240 (28.8)	399 (35.5)	264 (21.0)	121 (10.3)	45 (3.2)	16 (1.2)
35–44	127 (23.2)	232 (36.4)	181 (24.2)	83 (10.6)	35 (4.0)	16 (1.6)
45–54	65 (19.5)	111 (28.2)	106 (23.1)	77 (15.1)	61 (10.7)	21 (3.4)
55–64	38 (16.3)	70 (27.0)	74 (26.4)	47 (14.4)	32 (9.7)	22 (6.2)
Gender						
Female	228 (26.0)	399 (33.1)	295 (22.2)	142 (11.2)	76 (5.4)	30 (2.1)
Male	242 (22.7)	413 (33.9)	330 (23.5)	186 (12.0)	97 (5.5)	45 (2.4)
Residence						
Rural	405 (32.7)	433 (34.9)	238 (19.2)	114 (9.2)	37 (3.0)	13 (1.0)
Urban	65 (5.2)	379 (30.5)	387 (31.1)	214 (17.2)	136 (11.0)	62 (5.0)
Education						
Primary and below	353 (28.7)	467 (33.7)	320 (21.3)	168 (10.6)	72 (4.1)	30 (1.6)
High school	72 (22.7)	131 (35.3)	103 (22.5)	57 (12.8)	23 (4.4)	11 (2.3)
College+	45 (9.3)	214 (31.5)	202 (29.0)	103 (14.6)	78 (11.1)	34 (4.5)
Occupation						
Employee	44 (8.1)	196 (30.8)	198 (30.4)	99 (15.3)	71 (11.1)	29 (4.3)
Merchant	86 (33.2)	102 (30.6)	76 (19.8)	40 (10.8)	17 (3.4)	11 (2.2)
Farmer	251 (34.8)	255 (35.1)	143 (19.1)	59 (7.3)	22 (2.7)	10 (1.0)
Housewife	62 (16.1)	184 (36.7)	137 (24.8)	77 (14.6)	37 (5.9)	12 (1.9)
Retired	11 (9.7)	30 (23.9)	36 (26.6)	33 (22.7)	13 (9.4)	10 (7.7)
Students	11 (17.8)	32 (41.5)	18 (23.3)	8 (12.6)	5 (4.8)	0 (0.0)
Unemployed	5 (10.4)	13 (26.8)	17 (27.2)	12 (18.5)	8 (12.9)	3 (4.2)
Wealth index						
Poor	141 (22.8)	248 (32.7)	186 (21.8)	126 (14.4)	63 (6.4)	20 (1.9)
Medium	158 (24.7)	259 (34.2)	199 (23.0)	92 (10.3)	55 (4.9)	30 (2.9)
Rich	171 (25.0)	305 (33.7)	240 (23.8)	110 (10.4)	55 (5.1)	25 (2.0)
Marital status						
Single	31 (23.9)	63 (37.7)	35 (19.8)	22 (13.4)	8 (4.4)	2 (0.8)
Ever married	439 (24.2)	749 (33.3)	590 (23.1)	306 (11.6)	165 (5.5)	73 (2.3)
Fruit consumption						
Not daily	7 (14.0)	17 (30.7)	18 (28.5)	14 (20.8)	3 (4.5)	1 (1.5)
Daily	463 (24.4)	795 (33.6)	607 (22.8)	314 (11.5)	170 (5.4)	74 (2.3)
Vegetable consumption						
Not daily	22 (20.1)	35 (25.8)	33 (24.6)	23 (17.2)	14 (9.8)	4 (2.5)
Daily	448 (24.4)	777 (33.9)	592 (22.8)	305 (11.4)	159 (5.3)	71 (2.2)
Sugar-sweetened beverage intake per month						
No	384 (26.3)	579 (34.4)	418 (21.7)	210 (10.9)	106 (4.7)	46 (2.0)
Yes	86 (17.7)	233 (31.0)	207 (26.4)	118 (14.0)	67 (7.7)	29 (3.2)
Sugar-sweetened food intake per month						
No	141 (30.0)	191 (35.9)	124 (20.3)	45 (7.4)	37 (5.2)	7 (1.2)
Yes	329 (22.4)	621 (32.8)	501 (23.7)	283 (13.0)	136 (5.5)	68 (2.6)
Alcohol drinking						

Continued

Table 2 Continued

Variables (N=2483)	Magnitude and weighted prevalence of major modifiable CVD risk factors None n (%)	1 n (%)	2 n (%)	3 n (%)	4 n (%)	≥5 n (%)
No	467 (24.4)	801 (33.7)	601 (22.8)	323 (11.6)	165 (5.3)	70 (2.2)
Yes	3 (10.4)	11 (26.3)	16 (30.2)	5 (13.3)	8 (12.2)	5 (7.6)
Overall	470 (24.2)	812 (33.5)	625 (22.9)	328 (11.7)	173 (5.4)	75 (2.3)

CVD, cardiovascular disease.

using a portable stadiometer (Seca, 22089), which consisted of a simple triangular headboard. For height measurement, the study subjects took off their shoes, stood straight and held their head erect. The external auditory and the lower borders of the eyes were kept in one horizontal plane. The buttocks, shoulder blades and heels touched the scale, while legs with their knees stayed together and arms hung by their sides. Height was measured to the nearest 0.1 cm.

Blood pressure was measured using a digital sphygmomanometer (Riester, Germany). It was measured three times while the study subject was in a sitting position with the right upper arm placed at the level of the heart and after the subject had a 10 min rest. The average of the two measurements was considered to compute SBP and diastolic blood pressure (DBP). There was a 10 min interval between two blood pressure measurements.

We took blood specimens in the morning within the participants' homes after overnight fasting and wiping the skin with 70% alcohol. Vacutainer tubes containing EDTA were used to collect whole venous blood specimens. The test tubes with the blood specimens were stored in the icebox and transferred to the university hospital for analysis. The laboratory analysis was undertaken within 12 hours of the blood specimen collection. Finally, the lipid profiles were analysed with a BS-200 chemistry analyser. The blood glucose level was assessed at the place of data collection with a glucose metre (SensoCard).

Operational definitions

Major modifiable CVD risk factors: according to the AHA, major modifiable CVD risk factors are smoking, elevated TC, high LDL-C, low HDL-C and triglyceride (TG), high blood pressure, physical inactivity, obesity and being overweight, and diabetes.[15] However, based on our data, the major modifiable CVD risk factors included smoking, elevated total cholesterol (TC), low HDL-C, raised TG, high SBP, high DBP, physical inactivity, obesity and hyperglycaemia. The number of major modifiable CVD risk factors was an outcome variable and generated by adding the aforementioned nine variables considered as components of major modifiable CVD risk factors. Hyperglycaemia is characterised by having a blood glucose level of 7.0 mmol/L or more, and/or being under medication for diabetes.[32] An elevated TC level is defined as a TC level of 5.2 mmol/L or more.[33] A low HDL-C is a measure of HDL-C concentration in blood with <1.0 mmol/L in men and <1.3 mmol/L in women.[33] A raised TG is a blood TG concentration of 1.7 mmol/L or more.[33] Hypertension was defined according to the 2018 European Society of Cardiology and the European Society of Hypertension guidelines for the management of arterial hypertension (SBP of 140 mm Hg or more and/or DBP of 90 mm Hg or more) and/ or self-reported for medication.[34] Obesity is a nutritional status with a BMI value of ≥30 kg/m^2.[35] Physical inactivity is the accomplishment of vigorous or moderate physical activity less than 600 MET-min/week or higher otherwise.[30 31] Smoking is defined based on the current use of smoked or smokeless tobacco.

Data analysis

Statistical analysis was performed using Stata V.15 software. The wealth index was constructed using 40 variables for rural and 28 variables for urban areas related to the ownership of household assets using a principal component analysis. During the analysis, in each study setting, 11 components with factor loading of >0.4 were identified and retained (see online supplemental file 2). The wealth index values were calculated by summing up the scores of 11 components in each study setting. Finally, the three socioeconomic categories were generated by splitting the wealth index values into three equal classes. The weighting of the data was done using finite population corrections for kebele/cluster and also household selections. Finally, we generated the weighted prevalences after declaring the data as survey data and incorporating the computed sampling weights.

The outcome variable (number of major modifiable CVD risk factors) was a count variable that comprises values from 0 to 7. The event was analysed using Poisson regression to assess its association with explanatory variables.[36] We have checked the assumptions for the requirements of Poisson regression. Accordingly, the independence of observations was checked using the multicollinearity test, and all observations were found independent of each other. The outcome variable also satisfied the assumption of the equality of the mean and variance. Further, we conducted an interaction analysis of modifiable variables by stratifying in sociodemographic characteristics with the number of major modifiable CVD risk factors. There was no sufficient evidence for the presence of interaction. Therefore, the model without the interaction term is presented. Variables with p values of <0.2 in the bivariate analysis were considered a candidate for the multivariate Poisson regression analysis. The test statistics for the deviance and Pearson goodness-of-fit tests of the simple Poisson regression model were insignificant, indicating our final model was a good fitting model. To identify the best fitting model, we computed the Akaike information criterion (AIC) after carrying out the simple and multilevel (the cluster variable being kebele) analysis with the *estat ic* command. Accordingly, we found a smaller AIC for the multilevel model; therefore, we selected a multilevel model for the final regression analysis. The 95% CI of the adjusted incidence rate ratios (IRRs) (may also be labelled as 'ratios of means', given the cross-sectional nature of the data) that did not include one declared the presence of an association.

PATIENT AND PUBLIC INVOLVEMENT

There was no patient and public involvement in this study.

RESULTS

Profiles of the study participants

We intended to study 2486 adult people, but we studied 2483. The study comprised 1243 (50.1%) urban and 1240 (49.9%) rural residents. Out of the total adults included in the study, 52.9% (1313) were men. The median age of people who participated in the study was 35 (IQR 30–47) years. Generally, 676 (27.2%) people attended college education or higher, while 397 (16%) and 789 (31.8%) attended high school and primary school education. Six hundred thirty-seven (25.6%) of the study population were employees; 332 (13.4%) were merchants; and 740 (29.8%) were farmers by occupation. The socioeconomic status of the study participants was classified into three based on principal component analysis. Accordingly, 906 (36.5%) were rich; 793 (31.9%) were medium level; and 784 (31.6%) were poor. Overall, 1785 (71.9%) adults in the study were married.

Of the total adult people under the study, 1743 (70.2%) had a practice of drinking sugar-sweetened beverages, and 545 (21.9%) had a practice of taking sugar-sweetened food at least once a month. Two thousand four hundred twenty-three (97.6%) people reported having the habit of eating fruits daily, and 2352 (94.7%) people reported having the practice of daily vegetable consumption. Regarding the nutritional status of the adult people in the study, 109 (4.4%) were obese.

Weighted prevalence and magnitude of major modifiable CVD risk factors

The weighted prevalence of physical inactivity of the adult people under the study was 44.1% (95% CI 33.6% to 55.3%). A few adult people used smokeless or smoked tobacco products with a weighted prevalence of 0.8% (95% CI 0.3% to 2.1%). Generally, hyperglycaemia was found in 3.7% (95% CI 2.9% to 4.8%) of the people in the study. We found hypercholesterolaemia in 5.0% (95% CI 3.9% to 6.4%) and hypertriglyceridaemia in 15.5% (95% CI 13.3% to 18.0%) of the study participants (see table 1). The distribution of major modifiable CVD risk factors by sociodemographic characteristics is presented in online supplemental table 1.

Weighted prevalence and co-occurrences of major modifiable CVD risk factors

In general, 470 study participants did not have major modifiable CVD risk factors with a weighted prevalence of 24.2%. Overall, the numbers of participants having ≥1, ≥2 and ≥3 major modifiable CVD risk factors in the study area were 2013, 1201 and 576 with a weighted prevalence of 75.8%, 42.3% and 19.4%, respectively. There was an increasing trend of having major modifiable CVD risk factors with increasing age and living in urban areas (see table 2). Generally, there were 28 different combinations of major modifiable CVD risk factor co-occurrences. The combination of physical inactivity with low HDL-C was found in 488 (19.7%) of the study participants, followed by physical inactivity with hypertension in 443 (17.8%) (see table 3).

Factors associated with the number of major modifiable CVD risk factors

There was a 40% higher number of major modifiable CVD risk factors among urban residents compared with those who resided in a rural area (IRR=1.53, 95% CI 1.29 to 1.81). Furthermore, the number of major modifiable CVD risk factors among men was 10% greater than that of women (IRR=1.13, 95% CI 1.05 to 1.23). Similarly, people who consumed sugar-sweetened food at least once a month had a 10% higher number of major modifiable CVD risk factors than those who did not consume (IRR=1.14, 95% CI 1.05 to 1.24). Moreover, for each year increase in age, the number of major modifiable CVD risk factors increased by 1% (IRR=1.01, 95% CI 1.009 to 1.02). On the other hand, being a farmer was inversely associated with the number of major modifiable CVD risk factors (IRR=0.80, 95% CI 0.70 to 0.92) (see table 4).

DISCUSSION

The numbers of participants having ≥1, ≥2 and ≥3 major modifiable CVD risk factors were 2013, 1201 and 576 with a weighted prevalence of 75.8%, 42.3% and 19.4%, respectively. The combination of physical inactivity with low HDL-C was the largest co-occurrence, followed by physical inactivity with hypertension. The frequency of major modifiable CVD risk factors in the study area was high. Urban residence, male gender, sugar-sweetened food consumption and older age had a positive association with the number of major modifiable CVD risk factors, while being a farmer and walking as physical activity had a negative association.

The association we found between urban residence and the number of major modifiable CVD risk factors is consistent with the findings of other studies.[17 18 37–39] This could be due to the lifestyle of people living in urban environments.

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Table 3 Co-occurrences of major modifiable CVD risk factors among adults in Wolaita, southern Ethiopia

Major modifiable CVD risk factors (N=2483)	Smoking n (%)	Hypercholesterolaemia n (%)	Hypertriglyceridaemia n (%)	Low HDL-C n (%)	Hypertension (high blood pressure) n (%)	Physical inactivity n (%)	Obesity n (%)
Smoking							
Hypercholesterolaemia	2 (0.1)						
Hypertriglyceridaemia	4 (0.2)	68 (2.7)					
Low HDL-C	5 (0.2)	85 (3.4)	175 (7.1)				
Hypertension (high blood pressure)	6 (0.2)	76 (3.1)	165 (6.7)	301 (12.1)			
Physical inactivity	6 (0.2)	86 (3.5)	213 (8.6)	488 (19.7)	443 (17.8)		
Obesity	1 (0.04)	8 (0.3)	18 (0.7)	35 (1.4)	59 (2.4)	85 (3.4)	
Hyperglycaemia	2 (0.1)	22 (0.9)	45 (1.8)	27 (1.1)	57 (2.3)	73 (2.9)	14 (0.6)

CVD, cardiovascular disease; HDL-C, high-density lipoprotein cholesterol.

Therefore, to prevent the growing threat from CVD, public health measures against major modifiable CVD risk factors have to be taken, targeting vulnerable groups. Contrary to our finding, another study from Nepal reported the absence of variation in the number of major modifiable CVD risk factors between urban and rural areas.[40] This might be due to the difference in the socioeconomic and demographic conditions of the populations in the study areas. Similarly, the male gender was positively associated with the number of major modifiable CVD risk factors, which is comparable with the findings from other LMICs.[18 38 41] However, there are also findings from other studies which relate female gender with the number of major modifiable CVD risk factors.[37 42] Therefore, additional investigation in ascertaining the relationship between the number of major modifiable CVD risk factors and gender may be needed. Additionally, the number of major modifiable CVD risk factors was associated with older age. This is in line with the findings reported by other community-based studies.[18 39 43 44] The observed association could be explained by a combination of genetic and lifestyle factors.

Furthermore, having major modifiable CVD risk factors increased with the consumption of sugar-sweetened food, and this was higher in the urban areas. This might be due to positive energy balance leading to developing any related risk factors of CVD.[45] Therefore, reduction of sugar-sweetened food consumption should be promoted in the urban areas while maintaining the practice in the rural areas. On the other hand, being a farmer had a negative association with the number of major modifiable CVD risk factors, which is commonly practised in rural areas. Farmers in Ethiopia are smallholder farmers relying on their physical labour for producing crops and hence more energy expenditure.[46] Therefore, farming-related or similar physical exercises should be promoted in rural areas to prevent major modifiable CVD risk factors.

Experiences from various Asian countries demonstrated that targeting combinations of CVD risk factors for prevention, such as treatment of hypertension, diabetes and hyperlipidaemia, reduces CVDs such as heart attack and stroke among people having these conditions.[47–50] Healthy behaviours such as halting smoking, reducing high cholesterol diets and regular exercising were also reported to reduce the risk of CVDs.[48–50] In our study, physical inactivity, hypertension and hyperlipidaemia were found common and more prevalent in the urban areas. In the study area, there is no detection, treatment and control of NCDs. In addition, there are no essential medicines, and medical equipment in the primary healthcare facilities for the detection, treatment and control of NCD, and the health extension workers are not trained in the diagnosis and treatment of NCD. The health system in Ethiopia was designed to treat and control communicable diseases. It was not intended to detect, treat and control NCD. Recently, in an effort made to realise universal health coverage through primary healthcare, the prevention and control of NCDs were addressed within the health extension programme policy.[51] Therefore, detection, treatment and control of hypertension and hyperglycaemia

Table 4 Multilevel Poisson regression model of major modifiable CVD risk factors among adults in Wolaita, southern Ethiopia

Variables		Number of major modifiable CVD risk factors	
		IRR (95% CI)	P value
Age (years)		1.01 (1.009 to 1.02)	<0.001**
Gender	Female	1.0	
	Male	1.13 (1.05 to 1.22)	0.002*
Residence	Rural	1.0	
	Urban	1.54 (1.31 to 1.82)	<0.001**
Marital status	Single	1.0	
	Ever married	1.06 (0.92 to 1.23)	0.419
Education	Primary nd below	1.0	
	High school	1.01 (0.91 to 1.11)	0.847
	College+	1.08 (0.97 to 1.21)	0.161
Occupation	Employee	1.0	
	Merchant	0.98 (0.86 to 1.12)	0.784
	Farmer	0.80 (0.70 to 0.92)	0.002*
	Housewife	1.12 (0.99 to 1.27)	0.065
	Retired	1.07 (0.94 to 1.23)	0.289
	Students	0.99 (0.80 to 1.23)	0.919
	Unemployed	1.06 (0.87 to 1.29)	0.562
Wealth index	Poor	1.0	
	Medium	0.97 (0.89 to 1.05)	0.411
	Rich	0.92 (0.85 to 1.00)	0.053
Fruit consumption	Not daily	1.0	
	Daily	1.05 (0.86 to 1.28)	0.603
Vegetable consumption	Not daily	1.0	
	Daily	1.09 (0.95 to 1.25)	0.237
Sugar-sweetened beverage intake at least a once a month	No	1.0	
	Yes	1.03 (0.96 to 1.11)	0.358
Sugar-sweetened food intake at least once a month	No	1.0	
	Yes	1.14 (1.05 to 1.24)	0.002*

*P<0.01, **P<0.001.
CVD, cardiovascular disease; IRR, ratio of means; IRR, incidence rate ratio.

might be an important strategy to prevent NCD, targeting the urban population in the study area and similar settings in Ethiopia. In addition, promoting healthy lifestyles such as cessation of smoking, and promotion of regular physical exercise may also reduce the risk of having NCD. The local government may need to provide training for the primary healthcare workers on the detection, treatment and control of NCD; improve the diagnosis and treatment of hypertension and hyperglycaemia; and ensure the availability of essential medicines and medical equipment.

This is the first community-based study in Ethiopia assessing the prevalence, magnitude and factors associated with the number of major modifiable CVD risk factors. We included nine risk factors as a component of major modifiable CVD risk factors based on the American Heart Association definition. However, low LDL-C is missing as we did not have data on it. Other important modifiable risk factors, including fruit and vegetable intakes, were not taken into account as part of our outcome variable. Even though the study participants were instructed to come fasting for blood glucose analysis, we cannot be certain that all persons would have had at least 8 hours of fasting before the analysis. The assessment of behavioural variables was based on the study participants' self-report, which might be subjected to social desirability bias. The study had a weakness in the temporal relation due to the cross-sectional study design. Even though our study design was cross-sectional, the findings have a policy implication in directing the need to focus on NCD treatment and control. They are also important for public health practices in preventing CVDs from the study area and similar settings in the country.

CONCLUSIONS

The prevalence and magnitude of major modifiable CVD risk factors in the study area were high. The combination of physical inactivity with low HDL-C was the largest co-occurrence, followed by physical inactivity with hypertension. Urban residence, male gender, sugar-sweetened food consumption and older age had a positive association with the number of major modifiable CVD risk factors, while being a farmer had a negative association. The most prevalent components of the major modifiable CVD risk factors combinations should be targeted. In general, there is a need to focus on NCD. Therefore, the local government may need to take public health measures against major modifiable CVD risk factors such as promotion of physical exercise and reduction of sugar-sweetened food consumption targeting the vulnerable groups such as urban residents and older age in the study area, and similar settings in the country.

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