

# Low levels of ideal cardiovascular health in a semi-urban population of Western Nepal: a population-based, cross-sectional study

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## ABSTRACT

**Background** The aim of this study was to assess the status of cardiovascular health among a semi-urban population of Nepal, and determine factors associated with ideal cardiovascular health.

**Methods** A population-based, cross-sectional study using a systematic random sample was conducted among 2310 adults aged  $\geq 25$  years in a semi-urban area of the Pokhara Metropolitan City previously named Lekhnath in Nepal. The ideal, intermediate and poor cardiovascular health were defined as the presence of 6–7, 4–5 or 1–3 health metrics, among a list of 7 health behaviours and health factors, namely smoking, body mass index, physical activity, fruits and vegetables intakes, harmful alcohol consumption, blood pressure, and fasting blood glucose. We used univariate and multivariate Poisson regression models adjusting for sex, age groups, ethnicity, educational level and socioeconomic status, and calculated the prevalence ratios with 95% CIs.

**Results** Only 14.3% of the participants had ideal cardiovascular health, whereas 67.0% and 18.7% of the participants had intermediate and poor cardiovascular health, respectively. Age groups 45–54 years (prevalence ratio 0.88, 95% CI: 0.83 to 0.94,  $p < 0.001$ ) and 55–64 years (prevalence ratio 0.84, 95% CI: 0.79 to 0.90,  $p < 0.001$ ) were significantly associated with low prevalence of ideal cardiovascular health compared with the age group 35–44 years. Ethnic groups, including Janajati (prevalence ratio 0.89, 95% CI: 0.85 to 0.93,  $p < 0.001$ ) and Dalit (prevalence ratio 0.9, 95% CI: 0.84 to 0.95,  $p = 0.001$ ), were significantly associated with low prevalence of ideal cardiovascular health.

**Conclusions** Prevalence of ideal cardiovascular health is low in the semi-urban population in Nepal. Concerted efforts are needed to develop a population-based intervention to improve cardiovascular health in Nepal.

## INTRODUCTION

Cardiovascular diseases (CVDs) have been identified as the leading cause of death worldwide.<sup>1</sup> An estimated 17.7 million people died from CVDs in 2015, representing 31% of all global deaths. Of these deaths, an estimated 7.4 million were due to coronary heart disease and 6.7 million were due to stroke. Over three-quarters of CVD deaths have been reported in low-income and middle-income countries.<sup>1</sup> In Nepal, CVDs are the most common cause of death, and ischaemic heart disease is the most common form of CVD.<sup>2</sup> A non-communicable disease (NCD) survey carried out in Nepal helped to determine the prevalence of major CVD risk factors in the country, with hypertension, diabetes,

## Key messages

### What is already known about this subject?

- ▶ Cardiovascular diseases (CVDs) have been identified as the leading cause of death worldwide.
- ▶ Over three-quarters of CVD deaths have been reported in low-income and middle-income countries.
- ▶ The American Heart Association (AHA) in 2010 came up with the concept of cardiovascular health on the basis of seven health metrics: smoking habit, body mass index, nutritional intake, physical activity, blood pressure, blood glucose level and total cholesterol level.
- ▶ The prevalence of ideal cardiovascular health metrics by the AHA definition has not been reported in Nepalese adults.

### What does this study add?

- ▶ The present study shows a low prevalence of ideal cardiovascular health factors among the semi-urban subjects, and that the prevalence of meeting the seven cardiovascular health metrics was extremely low.
- ▶ Most older adults, especially men, and those who belonged to Janajati and Dalit ethnicities had poor ideal cardiovascular health status.

### How might this impact on clinical practice?

- ▶ A low prevalence of ideal cardiovascular health and higher prevalence of intermediate and poor cardiovascular health hint at a growing epidemic of CVD among semiurban population of Nepal.
- ▶ Concerted efforts are needed to develop a population-based intervention to improve cardiovascular health in Nepal.

smoking and overweight as the leading modifiable causes.<sup>3</sup> This survey found that the prevalence of hypertension among a population of Nepalese aged 15–69 years old was 26%, diabetes was 4%, smoking was 19% and overweight was 21%.<sup>3</sup> Another study reported a high diabetes prevalence rate of 8.4% in Nepalese population.<sup>4</sup> These CVD risk factors tend to cluster together, which ultimately increases the risk of developing CVD or premature death due to CVD.<sup>5</sup> Efforts to reduce risk and prevent the prevalence of CVD from growing should be a public health priority.

The American Heart Association (AHA) in 2010 came up with the concept of cardiovascular health on the basis of seven health metrics: smoking habit,



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body mass index (BMI), nutritional intake, physical activity, blood pressure, blood glucose level and total cholesterol level.<sup>6</sup> With the use of these seven metrics, the cardiovascular health status for a whole population has been defined as ideal, intermediate or poor in subsequent studies as attainment of 6–7, 4–5 or 1–3 health metrics, respectively.<sup>6</sup> The distribution of cardiovascular health varies across countries and regions.<sup>7–9</sup> However, the prevalence of ideal cardiovascular health metrics by the AHA definition has not been reported in Nepalese adults. The purpose of this study is to determine the status of cardiovascular health among adults in a semiurban population in Western Nepal and determine the factors associated with ideal cardiovascular health.

## METHODS

### Study population and data collection

This was a cross-sectional study conducted as part of the Community-Based Intervention for Management of Diabetes in Nepal (COBIN-D) trial,<sup>10</sup> which was initiated in a semi-urban area of the Pokhara Metropolitan City previously named Lekhnath. In Nepal, a semi-urban area typically features as the rural–urban transition zone, which carries both rural and urban characteristics such as poverty, poor health literacy and semiurbanisation, as well as some basic facilities to provide, including electricity, road, drinking water and communication.<sup>11</sup> The study is drawn from participants who had participated in the baseline survey of the COBIN-D study from October 2016 to April 2017, the full details of which have been described elsewhere.<sup>12</sup> A systematic random sampling method was used to select a representative sample. Participants aged 25 years and above were included in the study. Those who did not sign the written consent or were unable to complete the questionnaire were excluded from the study.

### Data collection

Data were collected by eight trained research assistants with a health background by visiting door to door. We conducted a week-long training workshop on data collection techniques of the WHO STEPwise approach to Surveillance (STEPS) survey for research assistants. The training focused on teaching the recruitment of participants, systematic sampling of households, conducting household interviews using the STEPS survey questionnaire, and using blood glucose and blood pressure measuring devices, as well as ensuring quality control of all field processes. The STEPS survey questionnaire included assessment of sociodemographics (sex, age groups, ethnicity, socioeconomic status [monthly income of the family was used as a proxy for socioeconomic status<sup>13</sup> and education]), behavioural risk factors (smoking, physical activity, fruit and vegetable intake and harmful alcohol consumption), and anthropometric measurements (height, weight, waist and hip circumference), blood pressure and fasting blood glucose.

### Definition of cardiovascular health metrics

To define cardiovascular health metrics, the following seven cardiovascular health behaviours proposed by the AHA were applied<sup>6</sup> and modified for our analysis: smoking, physical activity, BMI, healthy diet score, harmful alcohol consumption, blood pressure and fasting blood glucose. The ideal, intermediate and poor cardiovascular health were defined as the presence of 6–7, 4–5 or 1–3 health metrics, among a list of 7 health behaviours and health factors. We included harmful alcohol consumption as one of the health metrics as it is evident that

harmful alcohol consumption is prevalent in Nepal and a cause of many NCDs in Nepal<sup>14</sup> and globally.<sup>15 16</sup> Moreover, information about cholesterol level was not available in our study due to logistic limitations. All seven cardiovascular health behaviours were measured at the time of the baseline survey.

Blood pressure was measured using a digital, automated blood pressure monitor after the participants had been sitting for 5 min. Three measurements were taken and the average of the last two was used for analyses. Those who had average systolic blood pressure (SBP)  $\geq 140$  mm Hg and/or average diastolic blood pressure (DBP)  $\geq 90$  mm Hg, or were using regular anti-hypertensive medications, were considered to be suffering from hypertension. An ideal blood pressure was defined as blood pressure lower than 120/80 mm Hg and not under medication for hypertension.<sup>17</sup>

Fasting blood glucose was obtained using a standardised digital glucometer using the capillary finger prick method (fasting being defined as no caloric intake for at least 8 hours). Those who had previously been diagnosed by a physician and/or were on antidiabetic medications and/or had fasting blood glucose  $\geq 7$  mmol/L (126 mg/dL) were considered to be suffering from type 2 diabetes.<sup>18</sup> Fasting was confirmed verbally by the participants immediately before collecting the blood sample. For those who self-reported an earlier diagnosis of diabetes, the information was validated using their medical records.

Smoking was identified by screening participants who self-identified as never, former or current smokers: never smoker or former smoker who had quit  $\geq 12$  months; former smoker who had quit  $< 12$  months; and current smokers ( $> 1$  cigarette/day, or if former but last cigarette was in the past 1 month).

Healthy diet was considered as the consumption of more than five servings of fruits or vegetables per week.<sup>19</sup> One serving of vegetable was considered to be one cup of raw green leafy vegetables or half cup of other vegetables (cooked or chopped raw). One serving of fruit was considered to be one medium-sized piece of apple, banana or orange, half cup of chopped, canned fruit, or half cup of fruit juice (not artificially flavoured).<sup>20</sup> Measurement of the amount of fruit and vegetables was aided by pictorial show cards and measuring cups.

Harmful alcohol consumption was determined by asking the number of standard drinks consumed in the last 30 days. Harmful alcohol use was defined as drinking 8 standard drinks or more in a week among women and drinking 15 or more standard drinks in a week among men.<sup>21</sup> One standard drink (10 g of ethanol) was equivalent to consuming 250 mL of beer, jaand and Tongba, and 45 mL of local Raksi.<sup>22</sup> We used show cards to estimate an average amount of standard drinks per day.

Body weight was measured using weighing scales. Body height was measured using a non-stretchable tape. BMI was defined as weight (kilograms) divided by the square of height (metre).<sup>2</sup> BMI was categorised as less than 23.0 (normal), between 23.0 and 25.0 (overweight), and more or equal to 25.0 (obesity) (the cut-off levels used for South Asians).<sup>23</sup>

Physical activity level was determined by questions on the number of days and time spent on vigorous and/or moderate activities for work, travel or leisure activities. Using the standard formula from the WHO STEPS, the number of metabolic equivalent of task (MET) minutes per week was calculated and categorised as low physical activity ( $< 600$  MET minutes per week), moderate physical activity ( $\geq 600$  but  $< 3000$  MET minutes per week) and high physical activity ( $\geq 3000$  MET minutes per week).<sup>20</sup> Participants were classified as sufficiently active if they exceeded the minimum duration of physical activity per week recommended by the WHO, that is, 2 hours and 30 min

**Box 1** Definition of ideal cardiovascular health metrics

- ▶ Blood pressure: a blood pressure lower than 120/80 mm Hg and not under medication for hypertension.
- ▶ Fasting blood glucose: a fasting blood glucose lower than 7 mmol/L and not under medication for diabetes.
- ▶ Smoking: non-smoking (never smoking or quitting greater than 12 months).
- ▶ Healthy diet score: more than five servings of fruits or vegetables a week.
- ▶ Physical activity: regular participation in physical activity ( $\geq 600$  metabolic equivalent of task minutes per week).
- ▶ Body mass index: a body mass index lower than 23.0 kg/m<sup>2</sup>.
- ▶ Harmful alcohol consumption: no harmful alcohol consumption (drinking 8 or less standard drinks a week among women, and 15 or less standard drinks a week among men).

of moderate-intensity physical activity, or 1 hour and 15 min of vigorous-intensity physical activity, or an equivalent combination of moderate-intensity and vigorous-intensity physical activity achieving at least 600 MET minutes per week with each activity performed in episodes of at least 10 min duration.

We considered the following findings as ideal cardiovascular health metrics (box 1). We assigned 1 point for each of them and 0 point if non-ideal. Based on the sum of these points, a cardiovascular health metrics score was constructed.

**Statistical analysis**

A description of the sociodemographic, behavioural and clinical variables overall and according to sex was performed. Continuous variables were presented as mean with standard deviation (SD) and compared by sex using t-tests. Categorical variables were described by frequencies and compared by sex using  $\chi^2$  tests with 95% confidence intervals (CIs). To better

understand the distribution of health metrics among the study sample, a correlation matrix was computed of all the cardiovascular health metrics. A dendrogram was built using the cluster and tree procedure based on hierarchical cluster analysis of the findings of cardiovascular health metrics. To evaluate the independent association of different variables on ideal cardiovascular health, we used univariate and multivariate Poisson regression models adjusting for sex, age groups, ethnicity, education and socioeconomic status, and calculated the prevalence ratios with 95% CIs. In both models, the total cardiovascular health metric score (0–7) of the aforementioned seven health metrics was entered as a continuous variable. All p values were two-sided and  $p < 0.05$  was considered to be statistically significant. STATA statistical software version 14.1 was used for all analyses.

**RESULTS****Characteristics of study population**

Of the total of 2643 individuals invited to participate, 333 refused to give their consent for participation in the study. Hence, the remaining 2310 subjects took part in this study, with a response rate of 87.4%. Two-thirds (68%) of them were women. Table 1 presents the baseline sociodemographic characteristics by sex. The mean age ( $\pm$ SD) of the study participants was 47.37 ( $\pm$ 9.94) years. Baseline age groups, education and socioeconomic status differed by sex. More women (63.5%) than men (29.45%) had low educational level ( $p < 0.001$ ). More men (38.9%) had low socioeconomic status compared with women (33.7%) ( $p < 0.05$ ).

The dendrogram obtained from the cluster analysis (figure 1) showed two main clusters of disorders. The first cluster encloses clinical conditions such as ideal blood pressure, ideal fasting blood glucose, absence of smoking and healthy diet score. The second cluster encloses habits such as physical activity, ideal BMI and absence of harmful alcohol consumption.

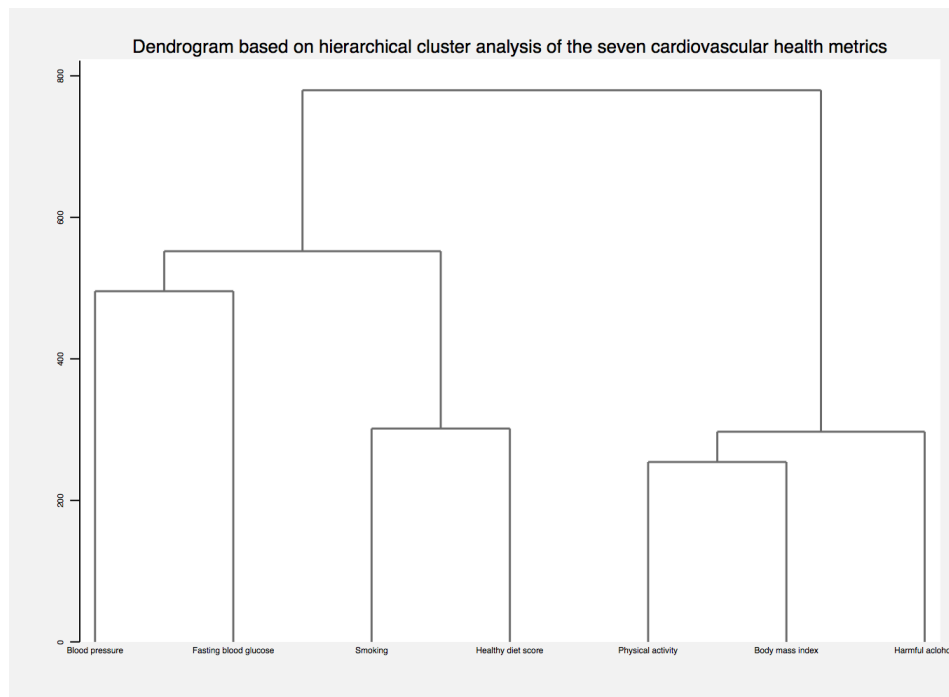
**Table 1** Characteristics of the study population overall and by sex (n=2310)

	n	Total population	Female	Male	P value
		n (%)	n (%)	n (%)	
	2310	2310 (100)	1574 (68)	736 (32)	
Age groups (years)	2310				<0.001
25–34		288 (12.47)	193 (12.26)	95 (12.91)	
35–44		676 (29.26)	523 (33.23)	153 (20.79)	
45–54		727 (31.47)	495 (31.45)	232 (31.52)	
55–64		619 (26.8)	363 (23.06)	256 (34.78)	
Ethnicity*	2310				0.08
Upper caste		1254 (54.29)	836 (53.11)	418 (56.79)	
Janajati		742 (321.12)	508 (32.27)	234 (31.79)	
Dalit		314 (13.59)	230 (14.61)	84 (11.42)	
Education†	2310				<0.001
Low		1215 (52.6)	999 (63.47)	216 (29.35)	
Medium		969 (41.95)	550 (34.94)	419 (56.93)	
High		126 (5.45)	25 (1.59)	101 (13.72)	
Socioeconomic status‡	2310				0.016
Low		817 (35.37)	531 (33.74)	286 (38.86)	
High		1493 (64.63)	1043 (66.26)	450 (61.14)	

\*Ethnicity: The Health Management Information System of the Government of Nepal uses an ethnicity classification system with six categories, namely (1) Dalits, (2) Disadvantaged Janajatis, (3) Disadvantaged Non-Dalit Terai Caste Groups, (4) Religious Minorities, (5) Relatively Advantaged Janajatis and (6) Upper Caste Groups. Based on the data available, we collapsed ethnicity subgroups into three groups: (1) Upper Caste, (2) Janajati and (3) Dalit.

†Education as (1) low: up to primary schooling; (2) medium: up to secondary schooling; and (3) high: college or university education.

‡Socioeconomic status as a monthly household income of (1) low: <20 000 Nepali rupees (NPR) or <US\$200 (1 NPR=US\$0.01, August 2017); and (2) high:  $\geq 20$  000 NPR or  $\geq$ US\$200.



**Figure 1** Dendrogram based on hierarchical cluster analysis of the seven cardiovascular health metrics.

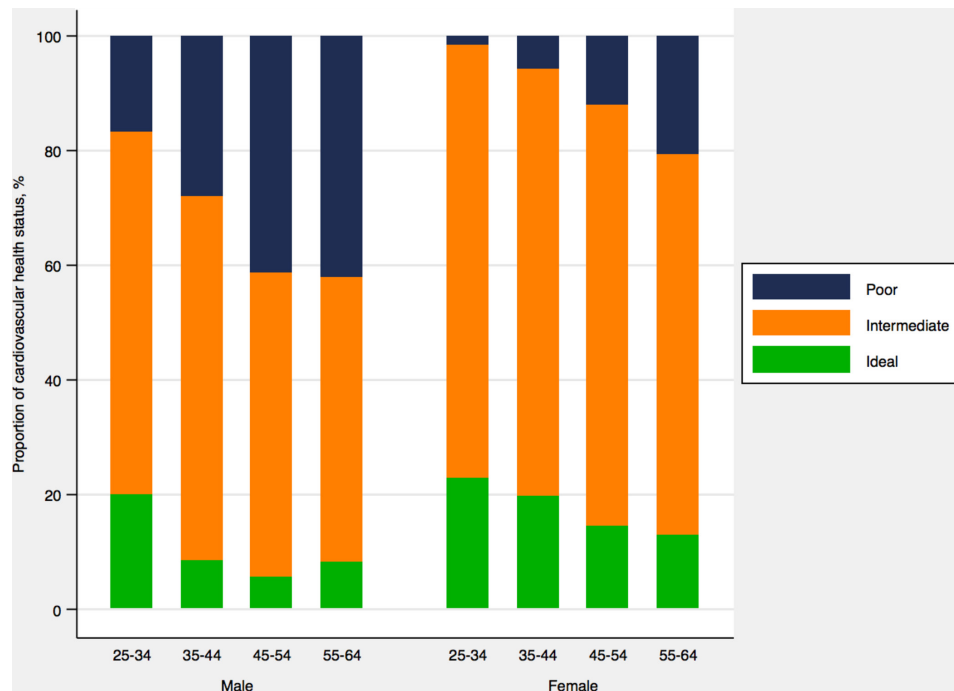
### Distribution of ideal cardiovascular health status

**Table 2** shows the results for the cardiovascular health metrics by sociodemographic variables. Only 14.3% of the participants achieved ideal cardiovascular health (6–7 ideal metrics), and the proportion of men was lower than that for women (8.9% vs 16.8%). The proportion with intermediate cardiovascular health was high (66.9%), and it was lower in men than in women (55.2% vs 72.4%). The remaining 18.7% of the participants had poor cardiovascular health (35.7% in men vs 10.7% in women).

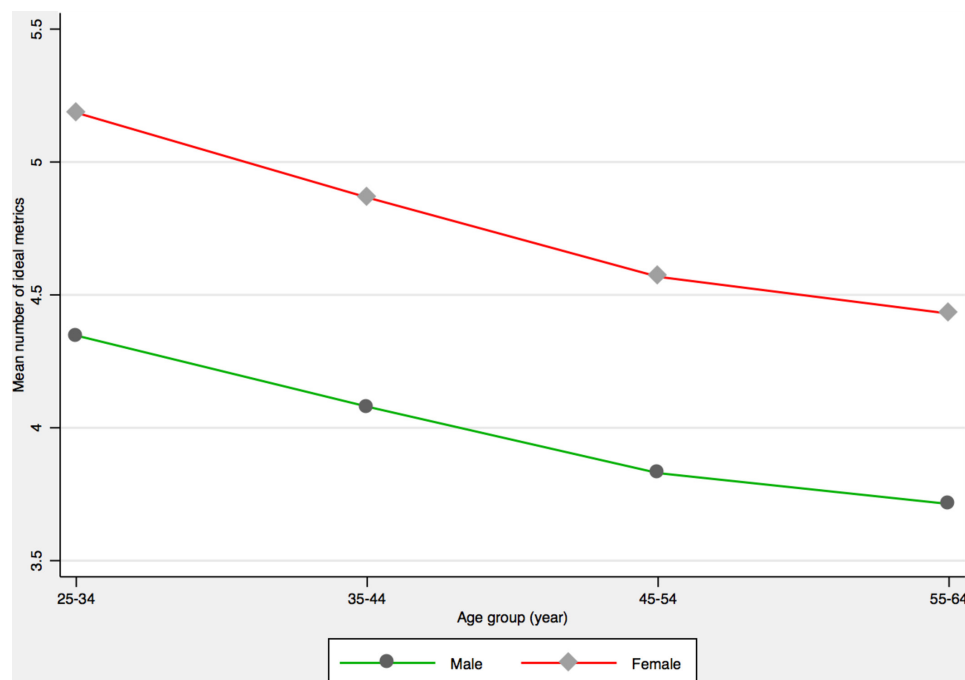
Women exhibited a higher number of ideal metrics than men across all age groups. Upper caste, high educational level and high socioeconomic status had the highest mean lifestyle scores. The proportion of ideal cardiovascular health was 16.4% in low socioeconomic group and 13.1% in high socioeconomic group. Similar differences were seen between low socioeconomic group and high socioeconomic group for poor cardiovascular health (low vs high: 21.2% vs 17.2%), whereas intermediate cardiovascular health was lower in the low socioeconomic group (62.3%

**Table 2** Breakdown of cardiovascular health metrics by sociodemographic variables

	n	Ideal cardiovascular health % (95% CI)	Intermediate cardiovascular health % (95% CI)	Poor cardiovascular health % (95% CI)	Mean cardiovascular health score Mean (95% CI)
Total	2310	14.3 (12.9 to 15.8)	66.9 (65.0 to 68.8)	18.7 (17.1 to 20.3)	4.45 (4.40 to 4.49)
Sex					
Male	736	8.9 (7.1 to 11.2)	55.2 (51.6 to 58.8)	35.7 (32.3 to 39.2)	3.93 (3.84 to 4.01)
Female	1574	16.8 (15.1 to 18.7)	72.4 (70.1 to 74.5)	10.7 (9.2 to 12.3)	4.69 (4.65 to 4.74)
Age groups (years)					
25–34	288	21.8 (17.4 to 27.0)	71.5 (66.0 to 76.4)	6.5 (4.2 to 10.1)	4.87 (4.77 to 4.98)
35–44	676	17.1 (14.4 to 20.1)	71.8 (68.3 to 75.1)	10.9 (8.8 to 13.5)	4.70 (4.63 to 4.77)
45–54	727	11.5 (9.4 to 14.0)	66.9 (63.4 to 70.3)	21.4 (18.6 to 24.5)	4.33 (4.25 to 4.41)
55–64	619	10.9 (8.7 to 13.7)	59.4 (55.5 to 63.2)	29.5 (26.1 to 33.2)	4.12 (4.03 to 4.21)
Ethnicity					
Upper caste	1254	18.1 (16.1 to 20.4)	69.2 (66.6 to 71.7)	12.5 (10.7 to 14.4)	4.66 (4.61 to 4.72)
Janajati	742	9.2 (7.4 to 11.6)	64.4 (60.9 to 67.7)	26.2 (23.2 to 29.5)	4.17 (4.09 to 4.25)
Dalit	314	10.8 (7.8 to 14.7)	63.6 (58.2 to 68.8)	25.4 (20.9 to 30.5)	4.25 (4.13 to 4.37)
Education					
Low	1215	14.4 (12.6 to 16.5)	66.1 (63.3 to 68.7)	19.4 (17.2 to 21.7)	4.41 (4.35 to 4.47)
Medium	969	13.5 (11.5 to 15.8)	68.8 (65.8 to 71.6)	17.6 (15.3 to 20.1)	4.49 (4.42 to 4.45)
High	126	19.0 (13.1 to 26.8)	61.1 (52.2 to 69.2)	19.8 (13.7 to 27.7)	4.50 (4.30 to 4.70)
Socioeconomic status					
Low	817	16.4 (14.0 to 19.1)	62.3 (58.9 to 65.5)	21.2 (18.6 to 24.2)	4.43 (4.35 to 4.51)
High	1493	13.1 (11.5 to 15.0)	69.5 (67.1 to 71.8)	17.2 (15.4 to 19.2)	4.46 (4.40 to 4.51)



**Figure 2** Distribution of cardiovascular health status among the study population by age and sex.



**Figure 3** Mean numbers of ideal cardiovascular health metrics among the study population.

vs 69.5%). Overall, there was negligible differences between low and high socioeconomic group in the mean number of ideal cardiovascular health metrics (4.43% vs 4.46%).

The prevalence of poor cardiovascular health increased with increasing age for both men and women (figure 2). The participants fulfilled, on average, 4.5 cardiovascular health metrics, which decreased across age groups (figure 3). Only 19 (0.8%) participants presented with all 7 ideal metrics (0.1% in men vs 1.1% in women) (figure 4).

#### Distribution of individual cardiovascular health metrics

Of the participants, 34.5% had poor cardiovascular health metrics for blood pressure and 11.7% had poor cardiovascular health metrics for blood sugar. Only 5% of the participants fulfilled >5 servings of fruits and vegetables weekly. However, majority of the participants met the ideal cardiovascular health metrics for smoking, physical activity, BMI and alcohol consumption (71.9%, 98%, 70.1% and 86.7%, respectively).

**Table 3** Association between sociodemographic characteristics and ideal cardiovascular health

	Univariate			Multivariate, adjusted for all other variables		
	PR	(95% CI)	P value	PR	(95% CI)	P value
<b>Sex</b>						
Male	Reference			Reference		
Female	1.19	1.14 to 1.24	<0.001	1.19	1.13 to 1.25	<0.001
<b>Age groups (years)</b>						
25–34	Reference			Reference		
35–44	0.96	0.90 to 1.02	0.256	0.93	0.88 to 0.99	0.05
45–54	0.88	0.83 to 0.94	<0.001	0.88	0.82 to 0.94	<0.001
55–64	0.84	0.79 to 0.90	<0.001	0.85	0.79 to 0.91	<0.001
<b>Ethnicity</b>						
Upper caste	Reference			Reference		
Janajati	0.89	0.86 to 0.93	<0.001	0.89	0.85 to 0.93	<0.001
Dalit	0.89	0.85 to 0.96	0.002	0.9	0.84 to 0.95	0.001
<b>Education</b>						
Low	Reference			Reference		
Medium	1.01	0.97 to 1.05	0.433	1	0.95 to 1.04	0.954
High	1.02	0.93 to 1.11	0.651	1.03	0.93 to 1.14	0.493
<b>Socioeconomic status</b>						
Low	Reference			Reference		
High	1	0.966 to 1.04	0.762	0.99	0.95 to 1.03	0.786

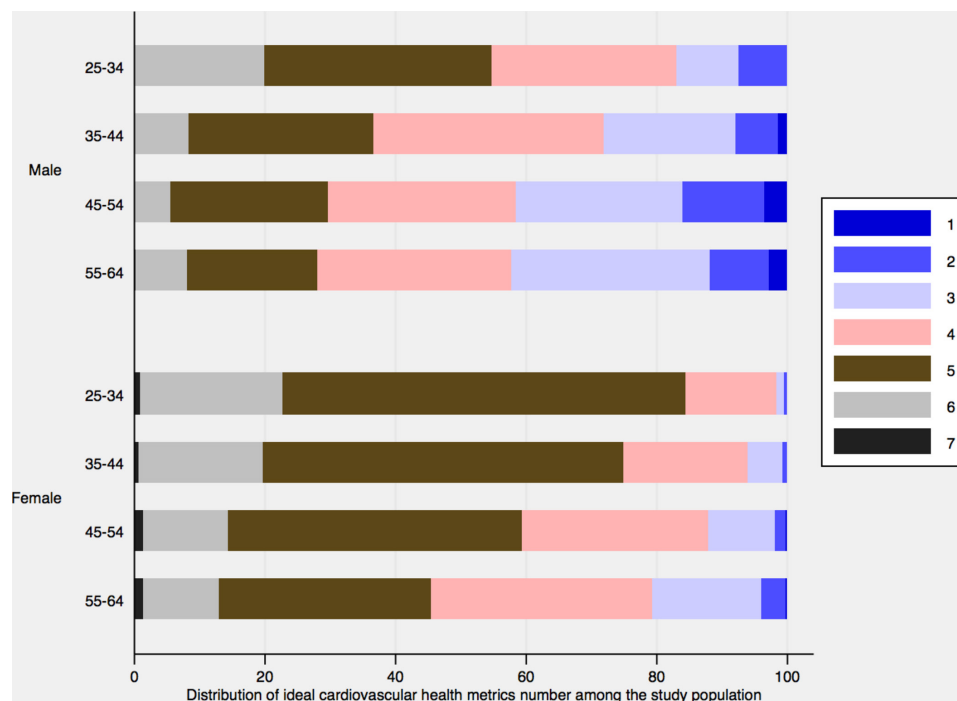
PR, prevalence ratio.

Table 3 shows the association between the sociodemographic variables and ideal cardiovascular health using univariate and multivariate analyses. Age groups 45–54 years (prevalence ratio 0.88, 95% CI 0.83 to 0.94,  $p<0.001$ ) and 55–64 years (prevalence ratio 0.84, 95% CI 0.79 to 0.90,  $p<0.001$ ) were associated with low prevalence of ideal cardiovascular health compared with the age group 35–44 years. Being female (prevalence ratio 1.19, 95% CI 1.14 to 1.24,  $p<0.001$ ) was associated with higher odds of attaining ideal cardiovascular health, and Janajati (prevalence ratio 0.89, 95% CI 0.85 to

0.93,  $p<0.001$ ) and Dalit (prevalence ratio 0.90, 95% CI 0.84 to 0.95,  $p=0.001$ ) ethnicities were associated with low prevalence of ideal cardiovascular health compared with the Upper caste.

## DISCUSSION

Traditionally, efforts to prevent CVD have focused on the management of immediate risk factors such as elevated blood pressure, lipids and blood sugars. Evidence shows a high

**Figure 4** Distribution of ideal cardiovascular health metrics number among the study population.

prevalence of CVD in developed countries and low prevalence in most of the low-income and middle-income countries.<sup>24,25</sup> The prevalence measures inadequately capture the population who have rapidly deteriorating cardiovascular health and have not yet developed the CVDs. Therefore, indices such as ideal cardiometabolic metrics have come out recently that include other determinants such as diets and lifestyle factors,<sup>8</sup> and capture the population with less than an ideal cardiovascular health and urge an immediate intervention at the population level using counselling, lifestyle advice and pharmacotherapy. The present study shows a low prevalence of ideal cardiovascular health factors among the semiurban subjects, and that prevalence of meeting all seven cardiovascular health metrics was extremely low.

We found that only 0.8% of adults have all seven ideal cardiovascular health behaviours. This is comparable with a number of studies from the USA,<sup>26</sup> China<sup>27</sup> and Korea<sup>28</sup> reporting less than 1% of study participants had ideal cardiovascular health. A community-based study of 1933 individuals from USA revealed that only one participant (0.1%) met all ideal cardiovascular health metrics and less than 10% of the participants met five metrics in all subgroups.<sup>29</sup> A Chinese study reported 1.5% of the sample had ideal, 33.9% intermediate and 64.6% poor cardiovascular health metrics.<sup>30</sup> However, definitions of individual ideal cardiovascular health metrics and relevant cut-off for total score were different across these studies. For example, in the US-based study, blood pressure measurements were obtained at a single examination and approximations were used on recommended consumption of fruits and vegetables, as well as the level of physical activity, whereas the Chinese study used descriptive metrics for the dietary assessment. Additionally, the measurements of blood pressure, body weight and height and biochemical tests were not standardised in these studies.

Consistent with previous studies, cardiovascular health was significantly associated with lower age groups<sup>7</sup> and female gender,<sup>7,31</sup> each having higher proportion of ideal cardiovascular metrics in our study. Similarly, we found people with Janajati and Dalit ethnicities had lower ideal cardiovascular health, which also corresponds with a previous study where ethnic minority groups have been reported to have lower cardiovascular health due to adoption of Western diet, heavy drinking habits and sedentary lifestyle.<sup>32</sup> Indeed, ethnic differences have been previously reported among ethnic and indigenous groups showing an overall low prevalence of ideal cardiovascular health metrics.<sup>33</sup> Such differences in our study population need further exploration.

Currently, Nepal is in the midst of a shift towards Western diet and lifestyle, and the overall status of the cardiovascular health is deteriorating more rapidly than expected.<sup>34</sup> Our finding suggests that old age, male, and Janajati and Dalit ethnicities should be the key population groups to target for cardiovascular health promotion. It is urgent to promote cardiovascular health status among these groups for CVD risk reduction. An earlier observation by Vaidya *et al* noted that hypertension burden has nearly tripled in the last three decades in Nepal, which is not typical for low-income countries.<sup>22</sup> The concept of ideal cardiovascular health that captures individual CVD risk factors collectively can build a strong narrative for building policy measures to control the growing cardiovascular risk in Nepal. Notably, poor lifestyle should be improved with intake of recommended fruits and vegetables regularly, based on the seven cardiovascular health metrics. In addition, blood pressure and blood glucose levels should be monitored periodically and timely adjustment of medications is recommended. We further argue that CVD events may continue to rise due to low ideal cardiovascular health in this

population. Therefore, comprehensive interventions targeting smoking cessation, reduction in alcohol consumption, weight control, promotion of healthy diets, promotion of regular physical activity, and screening and control of high levels of blood pressure and blood sugar are urgently needed. The study is the first step in uncovering the dismal status of cardiovascular health in today's urban populace, and also reiterates the need for comprehensive public health policy, initiating from the community level and extending to the provinces and national level.

The study has several strengths. This was a population-based study based on a random sample. Interviews were conducted according to the validated STEPS questionnaire. Some limitations of the current study should be considered. First it was a cross-sectional study, and thus we could not explore the temporal trend in cardiovascular health status. We did not measure cholesterol due to logistic limitations. By not including cholesterol level as a metric, we might have slightly underestimated the total ideal cardiovascular health metrics. A previous nationwide study revealed 23% of the population have raised cholesterol measured as  $\geq 190$  mg/dL or currently taking medication for raised cholesterol, compared with 26% prevalence of raised blood pressure (SBP  $\geq 140$  mm Hg or DBP  $\geq 90$  mm Hg) with a notable clustering ( $\geq 2$  risk factors among 30.9%).<sup>3</sup> However, more people with high cholesterol have overlapping risk factors such as higher BMI, elevated blood pressure and higher blood sugar, and these variables are part of this study. Future studies are needed to confirm these results by including cholesterol, and possibly using a larger population sample across the country. There might also be an issue of bias resulting from non-differential misclassification due to self-reporting of lifestyle behaviours and fruit and vegetable intake, and thus our point estimates are likely to move towards the null as a consequence of this. The development of the AHA cardiovascular health metrics and goals for 2020 represented an important milestone in showing the direction to a healthier future. Ideal cardiovascular health as defined by the AHA should be a part of routine surveillance system and should be built into periodic surveys in low-income and middle-income countries like Nepal. Finally, health being a dynamic state, more studies of longitudinal design that go beyond the seven metrics and capture disease events across the life course are needed in the future.

## CONCLUSIONS

Our results indicate that the prevalence of ideal cardiovascular health was low among the semi-urban population in Nepal, and most older adults, especially men, and those who belonged to Janajati and Dalit ethnicities, had poor ideal cardiovascular health status. A low prevalence of ideal cardiovascular health and higher prevalence of intermediate and poor cardiovascular health hint at the growing epidemic of CVD among the semi-urban population of Nepal. Concerted efforts are needed to develop a population-based intervention to improve cardiovascular health in Nepal.

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