Original Article

Metrics of Ideal Cardiovascular Health are Unequally Distributed between Peruvian Men and Women: Analysis of a National Population-Based Survey in 2017

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Abstract

Background: To determine socioeconomic inequalities in cardiovascular health (CVH) metrics among Peruvian adults as well as differences according to sex. **Methods:** An observational, cross-sectional study was conducted in 26,175 individuals aged 18–65 years using the 2017 Peruvian Demographic and Health Survey. According to the American Heart Association, 5 CVH metrics which comprised three ideal health behaviors (diet, non smoking, ideal body mass index [BMI]), and two ideal health factors (ideal blood pressure and no history of diabetes) were evaluated. The concentration curves (CC) methodology was used to analyze whether CVH metrics vary between socioeconomic status and sex. The concentration index (CI) was used to quantify socioeconomic-related inequality in health variables. **Results:** Overall, the mean age was 36.5 years (SD = 11.9) and 51.2% were women. Only 2.4% had 5 ideal CVH metrics (women 3.7%, men 1.0%) with a CI very close to the equality line (0.0135). (0.0135; higher in women [0.0262], compared to men [0,0002]). A greater prevalence of ideal CHV metrics (3 or more) was found in women ($P < 0.001$). Ideal health factors were more prevalent (52.1%) than ideal health behaviors (13.8%). Regarding inequality measures, CCs for most CVH metrics had a higher concentration in the lowest wealth population, except for ideal diet, which was more frequent among higher levels of wealth. An ideal BMI was the CVH metric with the lowest CI (overall: −0.0817; men: −0.2699). **Conclusions:** Peruvian women presented a higher prevalence of ideal CVH metrics and fewer inequalities. Ideal CVH metrics tend to be concentrated in the wealthiest women. Low- and middle-income countries should consider socioeconomic inequalities in cardiovascular disease prevention programs.

Keywords: *Cardiovascular health, health surveys, inequalities, Latin America, Peru, Sex*

Introduction

Cardiovascular diseases (CVDs) are the number one cause of death globally. In 2016, 17.9 million people died because of CVD, being three-quarters of these deaths reported in lower-middle-income countries (LMIC).[1] It has been stated that CVD mortality could be prevented by addressing behavioral risk and related factors.[2,3] In that sense, the American Heart Association (AHA) established a goal of improving cardiovascular health (CVH) for all Americans by 20% by the year 2020 with CVH metrics.[4] A total of 7 CVH metrics were defined including: four ideal CVH behaviors (nonsmoking, body mass index (BMI) <25 kg/m^2, physical activity at target levels, and a diet consistent with current guideline recommendations) and three ideal CVH factors (untreated total cholesterol <200 mg/dL, untreated blood pressure <120/<80 mmHg, and fasting blood glucose <100 mg/dL).[4]

An increase in ideal CVH metrics could reduce the incidence and disabilities related to CVD.[5-7] Nevertheless, population-based studies from different countries worldwide have described a low prevalence of ideal CVH metrics.[8] A study conducted in a representative sample of three South American countries found that the prevalence of ideal CVH metrics is very low (0.1%), with the prevalence of good lifestyle behaviors being lower than ideal biochemical parameters.[9] The prevalence of ideal CVH metrics was greater in women specifically with regard to smoking status, BMI, blood pressure, and fasting plasma glucose.[9]

In Peru, in recent decades, CVD accounts for an increasing number of deaths, being 23.8% for ischemic heart diseases and

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15.6% for stroke in 2017.[10] In addition, CVD produced 8.2% of disability-adjusted life year (DALYs) (13.8 DALYs per 1000 inhabitants, with 54.8% due to years of life lost), occupying the third place and only being surpassed by mental health disorders and unintentional injuries.[11] Regarding the ideal CVH metrics profile in Peru, a previous study in four urban and rural settings found the prevalence of ideal CVH of only 1.3% for 6 metrics, considering that none of the participants included reached the goal of ideal status in the 7 ideal CVH metrics of the AHA.[12] However, there are no reports about ideal CVH metrics at a representative national level in Peru.

Inequalities among the population in ideal CVH and CVD prevention have been reported showing that the distribution of major risk factors is unequal according to sex, ethnicity, educational level, income, and geographic domains.[13-17] Nevertheless, only a few studies, mostly in developed countries, have examined and measured inequalities in the metrics of ideal CVH.[18-20] Likewise, novel approaches such as inequality assessments regarding these topics are even scarcer. Taking into account that representative national studies in LMIC still represent a huge gap in the literature of CVH and inequalities, we developed the present study with the objective of determining the socioeconomic inequalities in ideal CVH metrics among Peruvian adults and evaluating differences according to sex.

Methods

Study design, data sources, and sample

We performed a cross-sectional study using data from the health and household questionnaires of 2017 Peruvian Demographic and Health Survey (ENDES, 2017, acronym in Spanish). The dataset used is open access and can be obtained at the following website: http://iinei.inei.gob.pe/microdatos.

ENDES 2017 is a recent survey of the demographic and health survey (DHS) series in Peru based on the Monitoring and Evaluation to Assess and Use Results Demographic and Health Surveys (MEASURE-DHS) model.[21] It is carried out annually by the National Institute of Statistics and Informatics (INEI, acronym in Spanish) and its population comprises all home dwellings and their occupants. This survey gathers health information about lifestyle habits, maternal and child health, use of health services, and communicable and chronic diseases, among others. Further details on sampling design, data collection, and data quality can be found in the ENDES report.[22]

A total of 32,514 people over 15 years old were participants of the ENDES 2017. Our analysis only included adults between 18 and 65 years old, who had provided information for all variables of interest, resulting in a final sample of 26,175 people.

Variables and measures

Ideal CVH metrics

Only 5 out of 7 ideal CVH metrics proposed by the AHA were studied.[4] The ENDES survey did not measure physical activity and total cholesterol. For smoking, BMI, and blood pressure we established three categories: poor, intermediate, and ideal. For diet and history of diabetes, only two categories were established: poor and ideal.

Regarding diet, participants were asked about eating habits over the 7 days prior to the survey. An intake of 4.5 or more portions of fruits or vegetables per day was considered as the metric cut-off, similar to that used in a previous study in four Peruvian settings.[12] Hence, ideal diet dichotomized into an ideal (≥4.5 portions/day) or poor (<4.5 portions/day).

For smoking status, participants were asked two questions: whether they had smoked in the previous 30 days and whether they had smoked in the previous 12 months. Categories were defined as ideal if the self-report was of neither having smoked in the last 30 days nor in the past 12 months,[12] intermediate included smoking within the past 1–12 months and poor included having smoked in the previous month.

BMI (kg/m^2) status was calculated directly from the weights and standing heights measured during the survey by an anthropometrist. BMI statuses were classified as ideal (<25 kg/m^2), intermediate (25–29.9 kg/m^2), or poor (30 kg/m^2).[12]

Blood pressure was measured by trained personnel in two consecutive visits with a calibrated electronic and automatic blood pressure monitor. A mean systolic blood pressure (SBP) and diastolic blood pressure (DBP) <120/<80 mmHg was considered as ideal, while a SBP between 120–139 or DBP 80–89 mmHg was categorized as intermediate and ≥140/≥90 mmHg was considered as poor.[12]

The participants were also asked if they had ever been diagnosed with diabetes or "high blood sugar." Since no glycemic assessments were measured during the survey, it was not possible to measure fasting blood glucose metric according to the AHA. Instead, we used diabetes history as a surrogate for this ideal CVH metric; self-reported diabetes was considered as poor status and no reported diagnosis of diabetes mellitus was considered ideal for this metric.[23]

Sociodemographic characteristics

The sociodemographic variables studied were age in years; education level (No education, preschool, primary; secondary; higher); area of residence (urban; rural), and geographic domain (Lima Metropolitana; Rest of Coast; Andean; Amazon). We used the wealth index score, which includes certain consumer durable goods, materials used for household construction, and access to water and sanitation facilities, as a measure of socioeconomic status.[24]

Data analysis

This is a descriptive data analysis. Continuous variables were presented as means with standard deviation (SD) and categorical variables were described by frequencies. Prevalence estimates and 95% confidence intervals were calculated for each of the CVH metrics, and the χ^2 test was used to evaluate differences between women and men. We also calculated percentages with each ideal CVH metrics ranging from 0–1 to 5. Participants who had missing values in the variables of interest were excluded from the analysis (n = 12). All tests were two-tailed, and $P < 0.05$ was considered to be significant.

A concentration curve (CC) and a concentration index (CI) were elaborated for each CVH metric to measure socioeconomic inequalities.[25] The CCs plot the cumulative percentage of a health variable of interest (CVH metrics for this study) against the cumulative percentage of a ranked living standard variable of the sample or population (wealth index for this study). Concerning this study, CCs outline the relationship between the population cumulative wealth index percentage of the survey and the cumulative percentage of the prevalence of ideal CVH metrics. Inequality within the population studied is described by means of the concavity or convexity of the curve regarding the diagonal equality line, that is, the further the curve is from the equality line, the larger the inequality is. When the CC resides below the equality line, it means that the wealthiest population tends to have a greater prevalence of an ideal status of the CVH metric studied compared to the poorest population. The CI is a coefficient that relates to the inequality of a population. Its values lie between −1 and 0 when the variable is concentrated in the poorest population, between 0 and 1 when the variable studied prevails in the wealthiest population.[25] If the CI value is 0, this means that there is no income-related inequality. We calculated the CI according to the Erreygers formula using the command "conindex":

$$CI = \frac{1}{n}\sum_{i=1}^{n}\left[\frac{4c_i}{(c^{max} - c^{min})} * [2R_i - 1]\right]$$

Where *[2Ri − 1]* represents the ordered socioeconomic variable and *c* refers to the categories of the dichotomous variable.

Health inequalities were measured in the total sample of women and men. Sampling weights were applied for all analyses to manage sampling error and for nonresponses. These sampling weights are calculated by the INEI and are included in the ENDES databases. To obtain representative estimates of the population derived from the ENDES survey it is necessary to multiply the data of each sample household by the weight, which is composed of the primary sampling factor equivalent to the inverse of the probability of selection of each dwelling and the adjustment factor for nonresponse. All analyses were performed using the statistical software Stata® version 14.2 (Stata Corporation, College Station, Texas, USA). To perform the analysis, the characteristics of the complex sample design of the survey and the weighting factor (PESO15_AMAS) of the ENDES were taken into account, using the svy command.

Ethics statement

Approval by an ethics committee was not required to conduct this study because it is a secondary analysis of data obtained from a publicly available source, which does not provide identifying variables of the people included in the database.

Results

General characteristics

A total of 26,175 adults were included in our analysis. The mean age was 36.5 ± 11.9 years, and 51.2% were women. The sociodemographic and clinical characteristics of the participants are summarized in Table 1. Only one-third of the population had completed a higher level of education (36.3%), 37.7% were in the poorest and poorer quintile of socioeconomic status, 81.1% lived in urban areas, mainly (62.9%) in Lima Metropolitana, and the remainder in the coastal region. Regarding clinical characteristics, mean SBP was 120.1 mmHg, mean DBP was 71.7 mmHg, and mean BMI was 27.2 kg/m^2. According to sex, there were statistically significant differences in mean age, level of education and clinical characteristics measured (all higher in men).

Prevalence of ideal CVH metrics

Table 2 shows the prevalence of ideal CVH metrics according to categories (poor, intermediate, or ideal) and the overall scores and for each sex. Altogether, only 2.4% of the Peruvian adults had all 5 ideal CVH metrics (3.7% of women and 1.0% of men). About one-third of the population had at least 3 ideal CVH metrics in an ideal status. Ideal CVH status in the three factors studied was found in 52.1% of the general population compared to 13.8% in the two CVH behaviors studied. The prevalence of an increased number of ideal CVH metrics (>3 ideal CVH metrics) was statistically significantly greater in women while achieving only 1 or 2 ideal CVH metrics in an ideal status was more common in men.

On analyzing CVH behaviors, we observed that nonsmoking was the most prevalent, while the ideal diet was the least. Women had a higher prevalence of nonsmoking than men (92.0% and 64.1%, respectively). Overall, more than half of the population was overweight and/or obese. Only 1 out of 3 had a normal BMI, being more likely in women than men (32.3% vs 36.9%, respectively). The ideal diet metric was similarly low in both sexes (15.3% in women vs 12.2% in men). Concerning ideal CVH factors, no history of diabetes was the most prevalent (97.3%). Having

Table 1: Sociodemographic and clinical characteristics of Peruvian adults, ENDES 2017

Characteristics	Overall		Women		Men		*P*†
	(*n*=26,175)	Weighted†	(*n*=14,852)	Weighted†	(*n*=11,323)	Weighted†	
Age, mean (SD)	36.5 (11.9)	37.6	36.0 (11.9)	37.9	37.3 (12.0)	37.4	0.117
Education level, *n* (%)							
No education, preschool, primary	6473 (24.7)	19.6	4238 (28.5)	24.6	2235 (19.7)	14.4	<0.001
Secondary	11417 (43.6)	44.1	6062 (40.8)	41.0	5355 (47.3)	47.3	<0.001
Higher	8285 (31.7)	36.3	4552 (30.7)	34.4	3733 (33.0)	38.3	<0.001
Income, *n* (%)							
Poorest	7062 (27.0)	16.3	3913 (26.4)	16.3	3149 (27.8)	16.3	0.973
Poorer	7028 (26.9)	21.4	4074 (27.4)	21.3	2954 (26.1)	21.4	0.836
Middle	5317 (20.3)	22.1	3043 (20.5)	22.0	2274 (20.1)	22.2	0.845
Richer	4016 (15.3)	20.8	2312 (15.6)	21.2	1704 (15.0)	20.4	0.383
Richest	2752 (10.5)	19.4	1510 (10.2)	19.2	1242 (11.0)	19.7	0.557
Urban, *n* (%)	17946 (68.6)	81.1	10379 (69.9)	81.3	7567 (66.8)	80.8	0.405
Natural region, *n* (%)							
Lima Metropolitana	2931 (11.2)	37.6	1616 (10.9)	37.4	1315 (11.6)	37.8	0.712
Rest of Coast	8005 (30.6)	25.3	4522 (30.5)	25.2	3483 (30.8)	25.4	0.763
Andean	8700 (33.2)	24.5	4973 (33.5)	25.1	3727 (32.9)	23.9	0.084
Amazon	6539 (25.0)	12.6	3741 (25.2)	12.3	2798 (24.7)	12.9	0.189
SBP, mmHg, mean (SD)	118.0 (15.2)	120.1	113.2 (14.5)	115.1	124.2 (13.7)	125.4	<0.001
DBP, mmHg, mean (SD)	70.7 (9.6)	71.7	68.7 (9.1)	69.5	73.4 (9.6)	74.0	<0.001
BMI, kg/m^2, mean (SD)	27.0 (4.6)	27.2	27.4 (4.8)	27.6	26.4 (4.3)	26.8	<0.001

SD: Standard deviation, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, BMI: Body mass index. †The weighting factor and sample specifications of the ENDES 2017 were included

Table 2: Cardiovascular health (CVH) metrics in Peruvian adults, ENDES 2017

CVH metrics	Overall (*n*=26,175)	Women (*n*=14,852)	Men (*n*=11,323)	*P*†
CVH behaviors				
Smoking % (95% confidence interval)				
Ideal (have not smoked in the last 12 months)	78.4 (77.5-79.3)	92.0 (91.2-92.8)	64.1 (62.7-65.4)	<0.001
Intermediate (quit within the past 1-12 months)	9.1 (8.6-9.7)	3.6 (3.1-4.2)	15.0 (14.0-16.0)	<0.001
Poor (>1 cigarette/day or former smoker but smoked past month)	12.5 (11.8-13.2)	4.39 (3.8-5.0)	21.0 (19.8-22.2)	<0.001
BMI (kg/m^2) % (95% confidence interval)				
Ideal (<25)	34.5 (33.5-35.5)	32.3 (31.0-33.6)	36.9 (35.4-38.3)	<0.001
Intermediate (25-29.9)	41.3 (40.3-42.3)	39.9 (38.6-41.2)	42.8 (41.4-44.3)	0.003
Poor (≥30)	24.1 (23.2-25.1)	27.8 (26.6-29.0)	20.3 (19.0-21.6)	<0.001
Consumption of fruits and vegetables (servings per day) % (95% confidence interval)				
Ideal (≥4.5)	13.8 (13.1-14.5)	15.3 (14.3-16.3)	12.2 (11.2-13.3)	<0.001
Non ideal (<4.5)	86.2 (85.5-86.9)	84.7 (83.7-85.7)	87.8 (86.7-88.8)	<0.001
CVH factors				
Hypertension % (95% confidence interval)				
Ideal (SBP <120 and DBP <80 mmHg, untreated)	52.1 (51.0-53.1)	68.1 (66.7-69.5)	35.2 (33.8-36.6)	<0.001
Intermediate (SBP 120-139, DBP 80-89 mmHg)	37.5 (36.5-38.4)	25.0 (23.8-26.2)	50.5 (49.2-51.9)	<0.001
Poor (SBP ≥140 or DBP ≥90 mmHg)	10.5 (9.8-11.2)	6.9 (6.2-7.7)	14.3 (13.1-15.5)	<0.001
History of diabetes % (95% confidence interval)				
Ideal (no)	97.3 (96.9-97.6)	97.2 (96.6-97.6)	97.5 (97.0-97.9)	0.387
Poor (yes)	2.7 (2.4-3.1)	2.8 (2.4-3.4)	2.5 (2.1-3.0)	0.387
Number of ideal CVH metrics % (95% confidence interval)				
0-1	9.2 (8.6-9.9)	2.9 (2.5-3.5)	15.3 (14.6-17.0)	<0.001
2	30.9 (29.9-31.9)	23.7 (22.5-25.0)	38.5 (37.0-40.0)	<0.001
3	36.6 (35.7-37.5)	42.4 (41.4-43.7)	30.4 (29.1-31.8)	<0.001
4	20.9 (20.1-21.7)	27.2 (26.0-28.4)	14.3 (13.3-15.3)	<0.001
5	2.4 (2.1-2.7)	3.7 (3.2-4.2)	1.0 (0.8-1.3)	<0.001

SBP: Systolic blood pressure, DBP: Diastolic blood pressure, BMI: Body mass index. †Between women and men

an ideal blood pressure was more frequent in women than men (68.1% vs 35.2%, respectively). Few participants had all five ideal metrics (2.4%), being more frequent in women than in men (3.7% vs 1.0%, respectively).

Inequalities: Concentration curves (CCs)

The CCs for having ideal CVH metrics are shown in Figure 1. Individually, most of the ideal CVH metrics assessed such as ideal smoking status, ideal BMI, and ideal blood pressure had a higher concentration in the lower wealth quintiles. Likewise, the CC of women was closer to the line of equality than the CC of men for both ideal BMI and ideal blood pressure, which indicates that there is less inequality in these metrics in women compared with men. Conversely, the CC for the ideal diet metric was concentrated in populations with the higher wealth quintiles. The CC of the composite ideal CVH metrics showed an "S"-shaped pattern for the men's curve in which the first half of the curve was above the equality line and the other half lay beneath the equality line. This means that for men, the prevalence of all 5 ideal CVH metrics tended to be higher in the poorest and the wealthiest population.

Inequalities: Concentration index (CI) for the ideal CVH status of each metric

The CI for the presence of the 5 ideal CVH metrics was 0.0135 for the general population. This result, although slightly oriented toward the rich population, is close to the equality line, which would indicate that the presence of the 5 ideal CVH metrics in the general population would not be different according to the wealth index [Table 3]. Ideal BMI status was the ideal CVH metric with the lowest CI for both the general population (−0.1735) and for men (−0.2699), which means that this metric is concentrated in the population with lower income. Furthermore, the CI for ideal smoking status (−0.0817), ideal blood pressure (−0.0821), and no history of diabetes (−0.0184) were concentrated in the poorest population, while the CI for ideal diet (0.1216) was concentrated in the richest group. Other CIs showed that

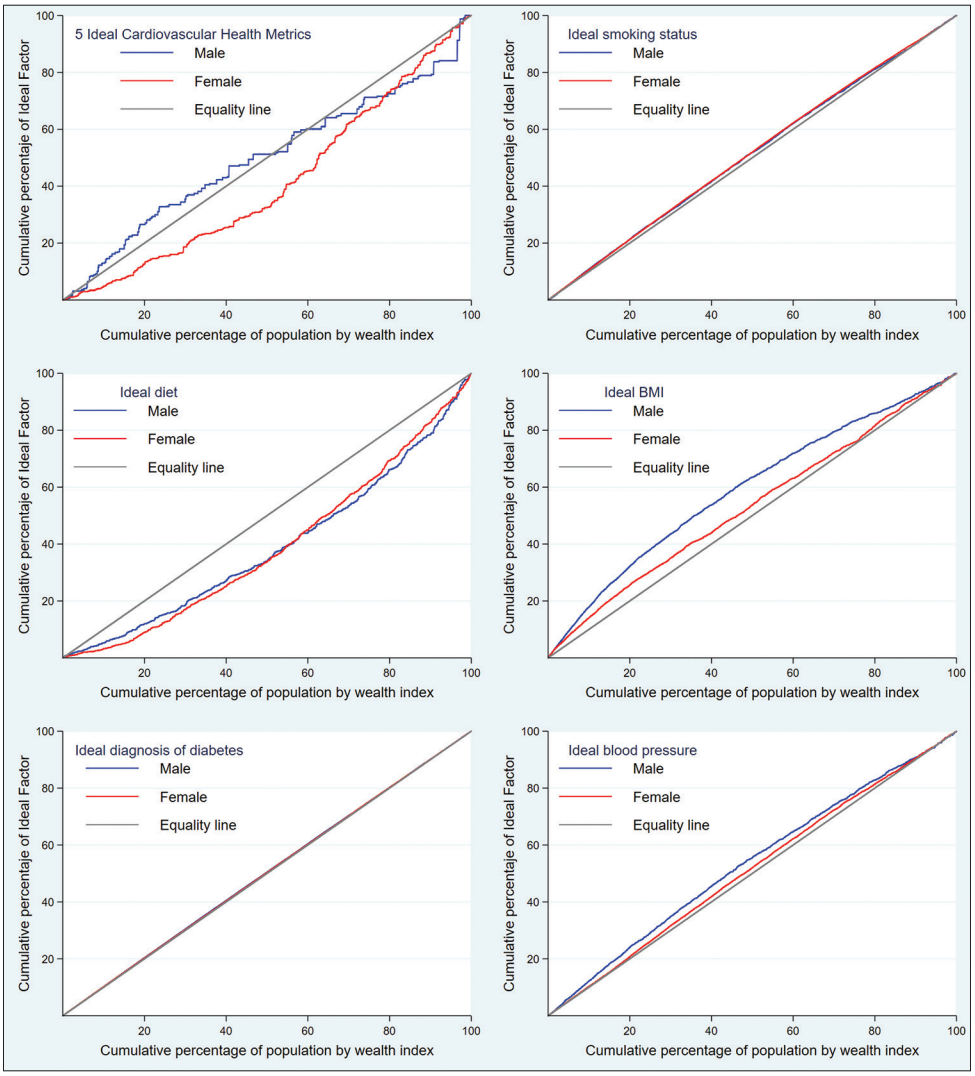

Figure 1: Concentration curves for the ideal cardiovascular health (CVH) metrics of Peruvian adults, ENDES 2017

Table 3: Concentration indices (CI) for the ideal status of ideal CVH metrics in Peruvian adults, ENDES 2017

Population characteristics	Smoking status	Ideal BMI	Diet	HBP	Diabetes	Five ideal CVH Metrics
Adults (Overall)	−0.0817	−0.1735	0.1216	−0.0821	−0.0184	0.0135
Men	−0.0604*	−0.2699*	0.1075	−0.0957	−0.0219	0.0002*
Women	−0.1021*	−0.0812*	0.1351	−0.0693	−0.0151	0.0262*
Area of residence						
Rural	0.0001	−0.2351	0.0403	−0.0135	−0.0099	0.0000
Men	0.0066	−0.2651*	0.0261	−0.0337	−0.0104	0.0002
Women	−0.0152	−0.1981*	0.0551	−0.0021	−0.0091	−0.0003
Urban	−0.0647	−0.0785	0.1040	−0.0768	−0.0122	0.0120
Men	−0.0330*	−0.1437*	0.1050	−0.0662	−0.0145	0.0036
Women	−0.0912*	−0.0167*	0.1035	−0.0828	−0.0102	0.0204
Geographic domain						
Lima Metropolitana	−0.0476	−0.0539	0.1027	−0.0430	−0.0113	0.0680
Men	−0.0240	−0.0701	0.126	−0.0184	−0.0127	0.0075
Women	−0.0731	−0.0374	0.0797	−0.0714	−0.0102	0.0058
Rest of Coast	−0.0722	−0.0807	0.1048	−0.0392	0.0180	0.0194
Men	−0.0777	−0.1793*	0.0876	−0.0607	−0.0253	0.0005*
Women	−0.0736	0.0157*	0.1209	−0.0264	−0.0107	0.0373*
Andean	−0.1008	−0.2089	0.1318	−0.0285	−0.0231	0.0223
Men	−0.1102	−0.3243*	0.1164	−0.0740*	−0.0281	0.0079*
Women	−0.0853	−0.1074*	0.1460	0.0206*	−0.0185	0.0356*
Amazon	0.0116	−0.2609	0.1176	0.0298	−0.0107	0.0099
Men	0.0550*	−0.3531*	0.0878	−0.0328*	−0.0127	−0.0042*
Women	−0.0568*	−0.1593*	0.1481	0.0744*	−0.0075	0.0233*
Education level						
No education, preschool, primary	0.0467	−0.325	0.0668	−0.0774	−0.0646	−0.0033
Men	0.0229	−0.3362	0.0358	−0.0532*	−0.0506	−0.0057
Women	−0.0032	−0.2639	0.0815	−0.1449*	−0.0691	−0.0042
Secondary	−0.0500	−0.2021	0.0611	−0.1245	−0.0269	−0.0019
Men	−0.0423*	−0.2368*	0.064	−0.1289	−0.0319	−0.0021
Women	−0.1031*	−0.1548*	0.0518	−0.1754	−0.0212	−0.0051
Higher	−0.0684	−0.0794	0.1288	−0.0691	−0.0099	0.0099
Men	−0.0518	−0.1136	0.1238	−0.0537	−0.0097	0.0002
Women	−0.0921	−0.0440	0.1328	−0.0948	−0.0103	0.0190

*$P<0.05$. BMI: Body mass index, HBP: High blood pressure

ideal CVH metrics in the urban area were concentrated in the richest population considering the overall population (especially in women), and the same was found for all the geographic domains in which differences according to sex (concentrates in wealthiest women) were identified. In relation to CIs, according to the level of education, they were concentrated in the richest population but only among those with higher education. Differences were found in ideal BMI status according to sex in urban and rural residences and in three geographic domains (Rest of the Coast, Andean, and Amazon). Differences according to sex were found in ideal blood pressure status in people living in the Andean and Amazon regions and in people with a primary or lower level of education.

Discussion

We measured socioeconomic inequalities in metrics of ideal CVH among Peruvian adults and the differences by sex using a representative national database. Among the main findings, a very low proportion of Peruvian adults met an ideal status in the 5 ideal CVH metrics selected (nonsmoking, ideal diet, ideal BMI, ideal blood pressure, and no history of diabetes). The prevalence of the ideal status of ideal CVH factors was higher than ideal CVH behaviors. We found statistically significant differences between sexes, with women presenting a higher prevalence of ideal CVH metrics and fewer inequalities. Ideal CVH metrics status tended to be concentrated in the wealthiest women. These results indicate that the Peruvian population presents low prevalence levels of CVH metrics (factors and behaviors), which increases their risk of developing CVDs, with men presenting more significant inequalities in the CVH metrics status compared to women.

The fact that few adults achieved ideal CVH metrics has previously been described in Peru and other countries. The prevalence of the 7 AHA ideal CVH metrics altogether

varies between 0.3% and 15%.[3,8,26-28] The prevalence we found was lower than that reported in a study conducted in Peru in which 12.7% had at least 5 ideal CVH metrics, but none had the 7 ideal CVH metrics.[12] One possible explanation for this difference could be that the aforementioned study was conducted in only four settings (urban and rural) of Peru, in contrast to our study that comprised a nationally representative sample. Furthermore, our study did not measure 2 ideal CVH metrics: total cholesterol and physical activity. Ideal total cholesterol values have been reported in half of the participants in studies conducted in the Peruvian population[12,29] and overseas.[27] Conversely, ideal levels in physical activity seem to be very low among Peruvians.[12,30,31] Even though the inclusion of these metrics could increase the percentage of people achieving the ideal status in ICH metrics, this prevalence is not expected to increase dramatically. Given that individuals that reach 6 or more ideal ICH metrics have a tenth of the rate of 20-year incident CVD compared with individuals with no ideal ICH metrics,[32] it is imperative to promote strategies to improve the extremely low prevalence of ideal CVH metrics in Peruvians.

When measuring inequalities, we found that most ideal CVH metrics had a higher concentration in lower wealth quintiles, except for ideal diet metrics. Globally, most people affected by CVD live in LMIC.[1] In high-income countries, it is reported that people with low socioeconomic status (evaluated by income level, educational attainment, employment status, and neighborhood socioeconomic factors) have a higher prevalence of CVD.[33,34] However, in LMIC (including Peru), the impact of socioeconomic factors in CVD is variable, being that beyond wealth, lower levels of education and low access to medicines, especially in low-income countries, are associated with worse outcomes in CVD despite presenting a better profile of cardiovascular risk.[19,34,35]

Ideal status in ideal CVH factors was found in more than half of the population while ideal status in ideal CVH behaviors, with the exception of ideal smoking status, was less than 50%. The finding of a difference between ideal CVH behaviors and factors has also been reported by other authors, including the study of Benzinger *et al*. in a Peruvian population.[8,12] Poor knowledge about how much activity or considerations are necessary to have an ideal diet to achieve an ideal CVH profile could explain these differences between ideal CVH behaviors and factors.[36,37] In addition, in relation to ideal CVH behaviors, it has been reported that young adults with healthy behaviors are more likely to have ideal CVH factors in middle age.[38,39] Hence, population-level strategies to promote health behaviors could be complemented by interventions focused on promoting ideal CVH behaviors focused on subgroups of the population at higher risk.

Women presented a higher prevalence of ideal CVH metrics and fewer inequalities compared with men. An ideal CVH metrics status tended to be concentrated in the wealthiest women. These findings are consistent with those of the study by Jankovic *et al.* which found ideal CVH metrics to be more prevalent among women.[40] Although these authors did not provide an explanation for this unequal prevalence, we hypothesize that the strong prevalence of ideal CVH factors such as blood pressure in women could be involved. For instance, the ideal diet metric had the lowest prevalence of all the metrics studied, as in a previous study conducted in the Peruvian population which showed that 90% of the population had a poor status in this metric,[12] and it was concentrated in the wealthiest population without differences according to sex. Conversely, ideal BMI status was concentrated in the poorest wealth quintiles, with differences found between men (36.9%) and women (32.3%). In Peru, the consumption of at least five servings of fruits or vegetable salads in 2017 was 9.2 and 12.4 for men and women, respectively.[22] This consumption profile in the Peruvian population is similar to our results. Worldwide about 11 million deaths (1/5 of total deaths among adults) in 2017 were associated with poor diet, with this factor having a greater contribution to mortality than well-recognized risk factors such as tobacco and hypertension and 255 million DALYs.[41] Hence, achieving an ideal diet is the Ideal CVH metric that needs improvement in the Peruvian population based on its very low prevalence and the impact that this risk factor has on the population.

Men had less optimal status in smoking metrics compared to women, with a ratio of 3:2. In Peru, smoking is more prevalent in men (21.0% compared to 4.7% in women according to the ENDES 2017 report).[22] The optimal status of smoking was more common in people with a lower wealth index. The Peruvian population is concentrated in urban areas with the greatest development, and it has been reported that smoking is more common in people in the greater wealth quintiles, with a higher level of education and for people that live in the urban area and in the coastal region.[22] Bearing this in mind, it was expected that people from rural and the lowest wealth quintiles would present a better status in the smoking metrics. Regarding optimal status for diabetes, no differences were found between men and women, and neither were differences found in the concentrations of this factor within the population. This finding corresponds to what was indicated by the INEI, which states that in 2017, men (2.9%) and women (3.6%) had a similar prevalence for diabetes diagnosis and the rates reported according to urban/rural residence were similar with only slight differences in the coastal region (slightly higher), and being somewhat lower in people with a higher level of education and in the wealthiest quintiles.[11] In relation to blood pressure, having an ideal status was more prevalent in women. This result is in line with that reported by the INEI in 2017, with men having a higher prevalence of hypertension compared to women.[22]

There are some limitations to the interpretation of the results in this study. First, the AHA recommends 7 metrics and our study only assessed 5 because the ENDES survey did not measure physical activity and cholesterol. Furthermore, ideal CVH metrics such as diet and history of diabetes were defined using surrogate definitions instead of those proposed by the AHA. Additionally, since we conducted a secondary analysis of a dataset, we cannot assure the precision of the data analyzed and the cross-sectional nature of these survey data limits our ability to assess causal relationships. The self-reported outcomes analyzed could have been predisposed to recall bias and may have tended to overestimate positive behaviors, and therefore, the expected ideal status in ideal CVH metrics might be lower.[42] Despite these limitations, we used data from the ENDES survey, a database with national representativity, which provides much-needed data on ideal CVH metrics in the Peruvian population. ENDES is based on the DHS Program of the United States Agency for International Development (USAID) that comprises nationally representative household surveys that provide data for monitoring and impact evaluation of different indicators. Hence, the use of a uniform survey instrument allows detailed international and subnational comparisons of health status and health care.

Conclusions:

In this cross-sectional analysis of a nationally representative dataset of Peru, we found important inequalities in ideal CVH metrics. Women presented a higher prevalence of ideal CH metrics and fewer inequalities. CVH metrics status tended to be concentrated in the wealthiest women. Our findings support the need for LMIC to consider health disparities in the development of CVD prevention programs.

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Conflicts of interest

There are no conflicts of interest.

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