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National levels, changes and correlates of ideal cardiovascular health among Beninese adults: evidence from the 2008 to 2015 STEPS surveys

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ABSTRACT

Introduction A higher number of ideal cardiovascular health (CVH) metrics is associated with a lower risk of cardiovascular-related and all-cause mortality. However, the change in CVH metrics has rarely been studied in sub-Saharan Africa. We investigated the level and changes of CVH metrics and their correlates among Beninese adults between 2008 and 2015.

Methods Secondary analysis was performed on data obtained from Benin's 2008 and 2015 WHO Stepwise surveys (STEPS). In total, 3617 and 3768 participants aged 25–64 years were included from both surveys, respectively. CVH metrics were assessed using the American Heart Association definition, which categorised smoking, fruit and vegetable consumption, physical activity, body mass index (BMI), blood pressure (BP), total cholesterol (TC) and glycaemia into 'ideal', 'intermediate' and 'poor' CVH. The prevalence of ideal CVH metrics was standardised using the age and sex structure of the 2013 population census.

Results Few participants met all seven ideal CVH metrics, and ideal CVH significantly declined between 2008 and 2015 (7.1% (95% CI 6.1% to 8.1%) and 1.2% (95% CI 0.8% to 1.5%), respectively). The level of poor smoking (8.0% (95% CI 7.1% to 8.9%) and 5.6% (95% CI 4.8% to 6.3%)) had decreased, whereas that of poor BP (25.9% (95% CI 24.5% to 27.4%) and 32.0% (95% CI 30.0% to 33.5%)), poor total cholesterol (1.5% (95% CI 1.0% to 1.9%) and 5.5% (95% CI 4.8% to 6.2%)) and poor fruit and vegetable consumption (34.2% (95% CI 32.4% to 35.9%) and 51.4% (95% CI 49.8% to 53.0%)) significantly increased. Rural residents and young adults (25–34 years) had better CVH metrics.

Conclusion The proportion of adults with ideal CVH status was low and declined significantly between 2008 and 2015 in Benin, emphasising the need for primordial prevention targeting urban areas and older people to reduce the burden of cardiovascular disease risk factors.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Cardiovascular disease is one of the most common diseases in sub-Saharan African countries, such as Benin.
⇒ The change of cardiovascular health remains poorly understood in such contexts.

WHAT THIS STUDY ADDS

⇒ The prevalence of ideal cardiovascular health was low and decreased between 2008 and 2015 in Benin.
⇒ Older adults and those residing in urban areas were most affected by poor CVH.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study underscores the ongoing need for primordial prevention to reduce the burden of CVD risk factors.
⇒ Policy makers in low-income countries, such as Benin, should pay more attention tochanges of cardiovascular health.

INTRODUCTION

Globally, cardiovascular disease (CVD), especially ischaemic heart disease and stroke, is one of the most common diseases and has been reported to be responsible for approximately 18 million deaths in 2017.[1] Over three-quarters of CVD deaths occur in low-income and middle-income countries, and the absolute number of deaths has increased by more than 50% in sub-Saharan Africa (SSA) over the past three decades, especially in young people.[2 3]

This high CVD burden is mainly due to the predominance of preventable CVD risk factors, at least one of which is present in most adults residing in SSA.[1] Most of these individuals are unaware of their condition, and the region is unprepared for this growing burden because of its limited cardiac care infrastructure and number of healthcare professionals, coupled with under-resourced and fragile healthcare systems, which have failed to meet the demands of these diseases.[3 4]

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To improve the rates of primary prevention, the American Heart Association (AHA) has targeted four behavioural factors (smoking status, body mass index (BMI), physical activity and diet) and three biological factors (total cholesterol, fasting glucose and blood pressure (BP)) associated with cardiovascular health (CVH).[5] Furthermore, three categories (ideal, intermediate and poor) were defined for each metric and overall CVH.

Currently, available data on CVH metrics in SSA populations are insufficient.[6–8] In Ghanaian adults, the proportion of ideal CVH metrics among those residing in Europe (Amsterdam, Berlin and London) as well as in urban and rural Ghana, was extremely low (0.3%) in 2018.[9] Furthermore, a cross-sectional survey of rural South Africans in 2020 showed that less than 1% of rural residents had ideal CVH metrics.[10] Another study in Malawi[11] reported a prevalence of 3.6% for all seven ideal CVH metrics. These studies mainly focused on the prevalence of ideal CVH metrics in different population groups, and to our knowledge, no study in SSA has provided data on the current changes of CVH metrics in the population.

The Republic of Benin, such as most SSA countries, is experiencing an increasing burden of CVD. Thus, using the 2008 and 2015 WHO stepwise surveys in Republic of Benin, we aimed to assess, for the first time in a sub-Saharan context, the levels,changes and correlates of ideal CVH metrics. The findings from this study will help identify priority areas for interventions and act as a baseline for analysing the effectiveness of programmes/policies over time.

METHODS

Study type and setting

We performed a secondary analysis of two cross-sectional surveys conducted in Benin in 2008 and 2015. Republic of Benin is a low-income country in the sub-Saharan region particularly in West Africa. It has a surface area of 114 763 km² and an estimated population of 9 983 884 (2013 census).[12] Its main economic activities include agriculture, handicrafts and informal trade, and the monthly minimum wage is approximately US$47. The average monthly income of Beninese households is approximately US$236 with an increase of the poverty line between 2011 and 2015 of approximately 16.5%.[13] As for diseases, communicable, maternal, perinatal and nutritional diseases are the most common, with an increasing burden of noncommunicable diseases (NCD) in recent years.

Data source

This study aimed to assess cardiovascular health and its evolution in Benin. To achieve this goal, we used two main nationwide and population-based surveys on the common risk factors for NCD in Benin. These were the 2008 and 2015 STEPwise Approach to NCD Risk Factor Surveillance (STEPS) surveys.

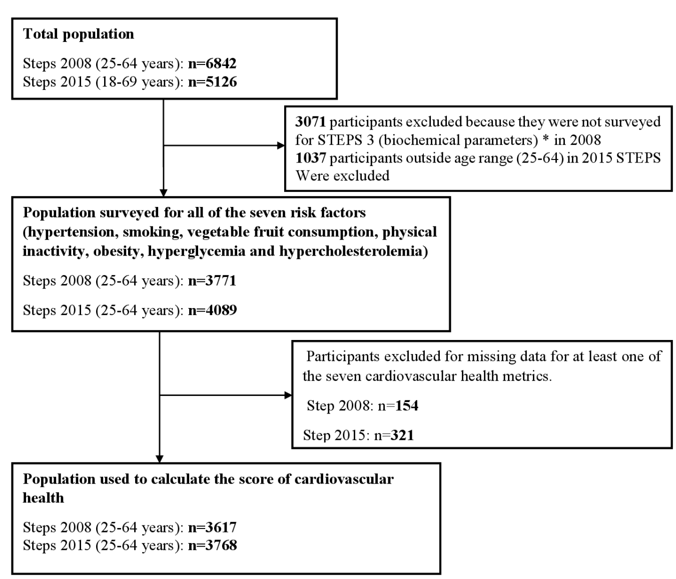
The STEPS approach is a WHO-recommended framework for collecting, analysing and disseminating data on NCDs and their associated risk factors.[14] The framework was applied to conduct nationally representative cross-sectional surveys among the adult population (25–64 years for 2008 and 18–64 years for 2015) in Benin. The surveys covered three different levels of risk factor assessment: home interviews (STEPS 1), physical measurements (STEPS 2) and biochemical measurements (STEPS 3).

Both surveys were conducted using a multistage cluster sampling design to produce data representative of the Beninese adult population. For the 2008 survey, 60 of the 546 Benin districts (clusters) were randomly selected with probability porportional to their population sizes. All neighbourhoods and villages were listed in each district, and half of them were randomly selected. In each cluster, 115 adults aged 25–64 years were selected using the Kish method, as recommended by the WHO.[14]

The sampling frame for the 2015 survey was provided by the National Institute of Statistics and Economic Analysis. Two hundred and sixty enumeration areas (EAs) were randomly selected from the list of EAs provided by the Fourth General Census of Population and Housing in Benin.[15] In total, 20 households were selected in each EA, and 1 individual per household was selected using the Kish method. Overall, 6842 and 5126 participants were surveyed in 2008 and 2015 (15–69 years), respectively. For our analysis, only adults aged 25–64 years were included to make the data comparable. We also only considered participants for whom biochemical data were collected (figure 1).

Data collection and measurements

The data collectors were trained on the sampling technique and collection tool for 2 days. A pretest of the tools



* In steps 2008, only half of participants were taken for the determination of blood sugar and cholesterol levels.

Figure 1 Flowchart of the selected population for the 2008 and 2015 STEPS surveys in Benin.

was subsequently performed in one of the unselected neighbourhoods. At the end of the day, the data collection supervisors discussed with the team leader to harmonise the collected data. They ensured completeness of the data, correct completion of the questionnaire, and completeness of the missing data. Corrections were made to the tool, taking into account the difficulties encountered in the field. Final information was provided to the investigators regarding the procedure to be followed for the conduct of the survey.

Sociodemographic characteristics, such as age, sex, area of residence, level of education and behavioural factors, including tobacco use, fruit and vegetable consumption and physical activity, were collected in step 1 by the reporting interviewers. Physical measurements of weight, height, BP and waist circumference were performed using the recommended standard tools in step 2. In step 3, blood samples were collected to determine fasting blood glucose and total cholesterol levels.

- After at least 10 min of rest, both systolic and diastolic BPs (SBP and DBP, respectively) were measured on the right arm three times with an interval of 5 min in a seated position using an appropriately sized standard cuff sphygmomanometer. The mean values of last two measures were considered as the participants' SBP and DBP.
- Height was measured using a portable constant tape measure in the standing position without shoes, with a precision of 0.1 cm.
- Weight was measured using a digital scale (HANA scale) in light clothing without shoes and was recorded to the nearest 0.1 kg. Body mass index (BMI) was calculated as weight in kilogrammes divided by height in metres squared.
- For biochemical measurements, fasting venous blood samples were drawn–10–12 mL of venous blood sample was drawn from each participant after at least 8 hours of overnight fasting–according to standard protocols. All samples were stored at −20°C and promptly centrifuged (1500 rpm for 10 min at standard room temperature: 21°C).
- Fasting plasma glucose was measured via an enzymatic colorimetric method using oxidised glucose, and total cholesterol levels were assessed via an enzymatic photometric method using cholesterol esterase and cholesterol oxidase.
- The physical activity of each participant was assessed as the duration in minutes of physical exertion at work, during travel,and during leisure time.

CVH definition

CVH metrics were defined in accordance with the AHA classification, which targeted seven cardiovascular risk factors (smoking, diet, physical activity, BMI, BP, fasting blood glucose and total cholesterol). Risk factors were categorised into three groups (ideal, intermediate and poor) (table 1).[5] The dietary and physical activity components were defined according to the recommendations of WHO.

The definitions of biomedical metrics excluded individuals who achieved ideal levels of CVH factors through medication use (ie, lipid-lowering, antihypertensive or hypoglycaemic agents).[5] The thresholds defining the poor and intermediate categories were similar to those for these medications.

To calculate the total CVH metric score, each metric was dichotomised, assigning a score of 1 for 'ideal' vs 0 for 'intermediate' and 'poor'. These newly defined variables were summed to obtain a total CVH metric score (table 1) ranging from 0 to 7, wherein a score of 7 was considered an ideal CVH metric for all seven variables. To identify the correlates of good CVH, the total CVH metric scores were grouped as 'good' if the score was 6–7, 'intermediate' if the score was 3–5 and 'poor' if the CVH metric score was less than 2.[8 11 16 17]

Covariates

The independent variables included in our study were age, sex, education level, employment status and areas of residence.

Data processing and analysis

The distribution of the participants' characteristics was summarised using descriptive statistics. Sampling weights were used in the analyses, and the results are presented as proportions. The prevalence of CVH metrics was standardised according to the age and sex structure of the adult population provided by the 2013 census in Benin. Crude and multivariable modified Poisson regression models were used to identify factors associated with meeting 6–7 CVH metrics. A $p<0.05$ was considered statistically significant. All data were analysed using STATA software V.17.0 (StataCorp).

RESULTS

Overall, biochemical parameters were collected for 3771 and 4089 adults aged 25–64 years from the 2008 and 2015 STEPS surveys, respectively. We were unable to evaluate CVH for those with missing data for at least one of the input variables. Therefore, 3617 and 3768 participants were included in the CVH score analysis from the 2008 and 2015 surveys, respectively (figure 1 and online supplemental table 1).

Sociodemographic characteristics of adult subjects in Benin in 2008 and 2015

More than half of the study population comprised women. The mean age of participants was 43.4±12.2 years in 2008 and 39.3±10.2 years in 2015, and the most-represented age group was 25–34 years in both surveys. Approximately two-thirds (61.8%) of participants in the 2008 survey had no formal education, whereas half (52.7%) of participants in the 2015 survey had no education (table 2).

Trend of CVH metrics between 2008 and 2015

Table 3 shows the distribution of CVH categories (poor, intermediate and ideal) for each of the seven assessment

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Table 1 Operational definitions of variables

Variables	AHA definition	Criteria in the present study
Smoking	**Ideal:** Never smoked or having smoked for more than 12 months **Intermediate:** Stopped smoking for less than 12 months **Poor:** Current smoker–participants who reported consuming all forms of smoking tobacco (cigarette, pipe, snuff, etc.) daily or occasionally within 30 days of the survey.	
Fruit and vegetable consumption	**Ideal:** Four to five fruit and vegetable components/day **Intermediate:** Two to three fruit and vegetable components/day **Poor**: Zero to one fruit and vegetable component/day	**Ideal:** Consume at least 5 servings of fruit and vegetables per day **Intermediate:** Two to four servings of fruit and vegetables per day **Poor**: Zero to one serving of fruits and vegetables per day
Physical activity	**Ideal:** ≥150 min/week moderate intensity or≥75 min/week vigorous intensity exercise or≥150 min/week moderate+vigorous intensity exercise **Intermediate:** A total of 1–149 min/week moderate intensity, 1–74 min/week vigorous intensity or 1–149 min/week moderate+vigorous exercise **Poor:** No physical activity	**Ideal:** ≥1500 metabolic equivalent of task (MET)-min/week **Intermediate:** 600–1500 MET-min/week **Poor:** <600 MET-min/week
Body mass index	**Ideal:** <25 kg/m^2 **Intermediate:** 25–29.9 kg/m^2 **Low:** ≥30 kg/m^2	
Blood pressure	**Ideal:** Systolic BP (SBP)<120 mmHg or diastolic BP (DBP)<80 mmHg **Intermediate:** SBP between 120 and 139 mm Hg and DBP between 80 and 89 mm Hg or subjects on antihypertensive medication **poor:** SBP≥140 mmHg or DBP≥90 mmHg	
Total cholesterol	**Ideal:** < 200 mg/dL **Intermediate:** 200–239 mg/dL or treatment **Poor:** ≥240 mg/dL	
Glycaemia	**Ideal:** <100 mg/dL **Intermediate:** 100–125 mg/dL or treatment **Poor:** ≥126 mg/dL	
Poor	0	0 ideal criteria
Intermediate	1	1 ‘ideal’ criterion
	2	2 ‘ideal’ criteria
	3	3 ‘ideal’ criteria
	4	4 ‘ideal’ criteria
	5	5 ‘ideal’ criteria
	6	6 ‘ideal’ criteria
Ideal	7	All criteria are ‘ideal’

factors as well as the overall score of Beninese adults from 2008 to 2015. The prevalence of poor smoking status decreased from 8.0% in 2008 to 5.6% in 2015. However, there was an increase in the prevalence of poor fruit and vegetable intake (34.2% and 51.4%, respectively) and poor physical activity (4.4% and 19.3%). Poor BMI (9.8% and 10.5%) did not significantly change between 2008 and 2015, whereas poor BP (25.9% and 32.0%), poor total cholesterol level (1.5% and 5.5%) and poor blood glucose level (0.7% and 6.5%) significantly increased. Overall, 7.1% of Beninese adults met all seven ideal CVH metrics in 2008, and this proportion decreased to 1.2% in 2015.

The analysis of CVH metrics stratified according to sex showed disparities between men and women regarding the trend of each CVH metric. Indeed, poor smoking status significantly decreased among men. However, poor fruit and vegetable intake and physical activity have increased between 2008 and 2015. There was no significant difference in BMI between the survey in both men and women. Poor BP increased, particularly among women. Poor blood cholesterol and glucose levels

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Table 2 Sociodemographic characteristics of Beninese adult participants in 2008 and 2015 aged 25 to 64 years (with sampling weights).

Characteristics	STEPS 2008 (n=3617) Frequency	%	STEPS 2015 (n=3768) Frequency	%
Sex				
Male	1758	48.6	1793	47.6
Female	1859	51.4	1975	52.4
Age (years)				
Mean	43.4±12.2		39.3±10.2	
25–34	1049	29.0	1353	35.9
35–44	889	24.6	1177	31.2
45–54	662	18.3	794	21.1
55–64	1017	28.1	444	11.8
Education				
None	2235	61.8	1986	52.7
Primary	927	25.6	1176	31.2
Secondary or more	455	12.6	606	16.1
Employment status				
Unpaid or unemployed	487	13.5	610	16.2
Employed or student	3130	86.5	3158	83.8
Area of residence				
Urban	NA	NA	1836	48.7
Rural	NA	NA	1932	51.3

NA, Not applicable.

increased in both sexes. Overall, ideal CVH decreased in both sexes between 2008 and 2015 (men, 5.6% and 1.1%; women, 8.6% and 1.4%, respectively; table 4).

Factors associated with good (6–7) CVH metrics in 2015

The results of the multivariate regression model are shown in table 5. Good CVH was significantly higher among participants aged between 25 and 34 years than in older individuals. Moreover, participants living in rural areas had a higher prevalence of good CVH than those living in urban areas (adjusted prevalence ratio=1.32 (95% CI 1.09 to 1.74)).

DISCUSSION

This is one of the first studies in West Africa to analyse the national changes in CVH metrics and identify the correlates of good CVH in the adult population. This study found that overall CVH decreased in Beninese adults from 2008 to 2015. This decline was driven by lower ideal levels of fruit and vegetable consumption, blood pressure, total blood cholesterol and blood glucose over time. The same changes were observed in both sexes.

Differences in the composition of cohorts and the periods during which data were collected make comparison difficult with other studies on time trends in CVH. Nevertheless, the negative trend of ideal CVH in this study was in accordance with the findings of several previous studies conducted in different contexts worldwide, even though the decline seems to be lower in high-income countries.[8] Indeed, one study among US adults reported a small but significant decrease in CVH within a 20-year period from 2.0% in 1988–1994 to 1.2% in 2005–2010.[6] Moreover, among Canadian adults, one study showed that the ideal CVH decreased from 8.8% to 8.3% over an 8-year period (2003–2011).[7] Similarly, Rahmani *et al*[8] found a low prevalence (0.5%) of all seven ideal CVH metrics in Iranian adults and noted that good CVH decreased between 2007 and 2016 from 5.5% to 3.4%. In SSA, the reported prevalence of ideal CVH metrics is low (3.6% in Malawi,[11] less than 1% in rural South Africa[10] and between 0.4% and 1% in rural Ghana[9]). The overall decline in CVH is discouraging and potentially reflects the gaps in public health efforts aimed at increasing the awareness of CVD risk in the population. This trend also mirrors the disproportionately low implementation rates of WHO-backed policies to constrain CVD risk factors in the SSA region.[18] More importantly, it emphasises the continuing importance of focusing efforts on primordial prevention through behavioural and policy changes to improve CVH in the general population.

The prevalence of ideal smoking improved in our study population, with a subsequent decline in poor smoking, which might be explained by the effect of the tobacco control programme initiated in Republic of Benin as part of the WHO Framework Convention on Tobacco Control in February 2006. Indeed, the effect of tobacco control policies has been reported in other studies which noted smoking as the 'best CVH metric' among the seven metrics considered by the AHA.[19] This reinforces the importance of such actions, which should be continued consistently to curb the negative effect of tobacco on CVH. The improvement in smoking curve was the steepest in women, possibly due to under-reporting and the social shaming associated with women smoking owing to the cultural practices that preclude African women from smoking.[20 21]

Poor consumption of fruits and vegetables was very prevalent among Beninese adults, and its prevalence further increased during the study period. This trend is similar to the findings of previous studies,[8] which reported poor diet as the lowest CVH metric. This mirrors the current food model characterised by diets rich in saturated fatty acids, cholesterol and carbohydrates but low in polyunsaturated fatty acids and fibre. However, the levels of obesity remained low and unchanged throughout the study period–there was no change in the trend of poor BMI between 2008 and 2015. The effects of diet on the trend of poor BMI could have been delayed in the study population but might have been detected earlier among women due to social prejudices that label overweight/obesity as criteria of beauty in women in SSA.[18]

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Table 3 Age and sex-standardised CVH metrics in 2008 and 2015 in Benin

CVH metrics	2008 (n=3617) Prevalence (95% CI)	2015 (n=3768) Prevalence (95% CI)
Smoking		
Poor	8.0 (7.1 to 8.9)	5.6 (4.8 to 6.3)
Intermediate	0.6 (0.3 to 0.9)	0.0 (0.0 to 0.0)
Ideal	91.4 (90.4 to 92.3)	94.4 (93.7 to 95.1)
Fruit and vegetable intake		
Poor	34.2 (32.4 to 35.9)	51.4 (49.8 to 53.0)
Intermediate	42.0 (40.2 to 43.8)	41.4 (39.8 to 42.9)
Ideal	23.8 (22.3 to 25.4)	7.2 (6.4 to 8.1)
Physical activity		
Poor	4.4 (3.7 to 5.1)	19.3 (18.0 to 20.6)
Intermediate	4.0 (3.3 to 4.7)	8.0 (7.2 to 8.9)
Ideal	91.6 (90.6 to 92.5)	72.7 (71.2 to 74.1)
Body mass Index		
Poor	9.8 (8.8 to 10.9)	10.5 (9.5 to 11.5)
Intermediate	20.8 (19.3 to 22.3)	20.5 (19.2 to 21.8)
Ideal	69.3 (67.7 to 70.9)	69.0 (67.5 to 70.5)
Blood pressure		
Poor	25.9 (24.5 to 27.4)	32.0 (30.0 to 33.5)
Intermediate	37.4 (35.7 to 39.1)	38.7 (37.1 to 40.3)
Ideal	36.7 (34.9 to 38.4)	29.3 (27.8 to 30.8)
Total cholesterol		
Poor	1.5 (1.0 to 1.9)	5.5 (4.8 to 6.2)
Intermediate	3.5 (2.8 to 4.1)	10.8 (9.8 to 11.8)
Ideal	95.1 (94.3 to 95.8)	83.7 (82.5 to 84.9)
Fasting plasma glucose		
Poor	0.7 (0.4 to 0.9)	6.5 (5.7 to 7.3)
Intermediate	3.6 (2.9 to 4.3)	17.8 (16.6 to 19.1)
Ideal	95.7 (95.0 to 96.4)	75.7 (74.3 to 77.0)
Scores		
0–2 CVH metrics	1.0 (0.7 to 1.3)	8.5 (7.6 to 9.4)
3–5 CVH metrics	65.4 (63.7 to 67.2)	76.0 (74.6 to 77.4)
6–7 CVH metrics	33.5 (31.9 to 35.3)	15.5 (14.3 to 16.6)
0	0	0.02 (0.0 to 0.07)
1	0	2.0 (1.6 to 2.4)
2	1.0 (0.6 to 1.3)	6.5 (5.7 to 7.3)
3	5.8 (5.0 to 6.6)	14.4 (13.3 to 15.5)
4	22.5 (21.0 to 23.9)	28.3 (26.8 to 29.7)
5	37.1 (35.4 to 38.9)	33.4 (31.8 to 34.9)
6	26.5 (24.9 to 28.1)	14.3 (13.1 to 15.4)
7	7.1 (6.1 to 8.1)	1.2 (0.8 to 1.5)
Average score	5.0 (4.9 to 5.0)	4.4 (4.2 to 4.7)

Several theories have also justified the high prevalence of poor BMI among women, including those related to the onset of menstruation, which is accompanied by hormonal changes favouring the accumulation of body fat in women.[22]

The prevalence of desirable levels of physical activity and fasting glucose decreased at the end of the study period. These factors have a downstream impact on other cardiovascular factors, including blood pressure and obesity. Thus, if the trend of an

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Table 4 Age-Standardised prevalence of CVH metrics in 2008 and 2015 by sex

	Men		Women	
Health metrics	**2008 (n=1758)**	**2015 (n=1369)**	**2008(n=1859)**	**2015 (n=1491)**
Smoking				
Poor	16.1 (14.2–18.0)	11.2 (9.7–12.7)	0.8 (0.4–1.2)	0.5 (0.2–0.8)
Intermediate	1.2 (0.6–1.7)	0.0 (0.0–0.0)	0.1 (0.0–0.2)	0.00
Ideal	82.7 (80.7–84.7)	88.8 (87.3–90.3)	99.1 (98.6–99.5)	99.5 (99.2–99.8)
Fruit and vegetable intake				
Poor	35.6 (33.1–38.1)	52.7 (50.3–55.2)	32.7 (30.2–35.2)	50.3 (48.1–52.6)
Intermediate	39.9 (37.3–42.4)	40.5 (38.2–42.9)	44.0 (41.4–46.6)	41.9 (39.7–44.1)
Ideal	24.5 (22.3–26.8)	6.7 (5.5–7.9)	23.3 (21.1–25.6)	7.7 (6.5–8.9)
Physical activity				
Poor	3.3 (2.4–4.2)	17.3 (15.4–19.1)	5.0 (3.9–6.1)	20.7 (18.9–22.5)
Intermediate	3.1 (2.2–4.0)	5.9 (4.8–7.1)	4.7 (3.6–5.7)	9.6 (8.3–10.9)
Ideal	93.6 (92.3–94.8)	76.8 (74.7–78.8)	90.3 (88.8–91.8)	69.6 (67.6–71.6)
Body mass index				
Poor	4.4 (3.4–5.5)	5.8 (4.7–6.9)	14.7 (12.9–16.5)	14.6 (13.0–16.1)
Intermediate	17.5 (15.5–19.4)	17.9 (16.1–19.8)	23.7 (21.5–25.9)	22.7 (20.8–24.6)
Ideal	78.1 (75.9–80.2)	76.3 (74.2–78.3)	61.6 (59.1–64.1)	62.7 (60.6–64.9)
Blood pressure				
Poor	26.6 (24.4–28.8)	30.9 (28.7–33.1)	24.1 (22.1–26.1)	31.7 (29.7–33.7)
Intermediate	47.0 (44.4–49.6)	43.2 (40.8–45.7)	29.7 (27.3–32.1)	35.1 (33.0–37.2)
Ideal	26.4 (24.1–28.7)	25.8 (23.7–28.0)	46.2 (43.6–48.7)	33.2 (31.1–35.3)
Total cholesterol				
Poor	1.4 (0.8–2.1)	3.7 (2.8–4.6)	1.4 (0.8–2.0)	6.8 (5.7–7.9)
Intermediate	2.4 (1.7–3.1)	8.5 (7.0–9.7)	4.2 (3.2–5.3)	12.9 (11.4–14.4)
Ideal	96.1 (95.2–97.1)	87.9 (86.4–89.5)	94.3 (93.1–95.5)	80.2 (78.4–82.0)
Fasting plasma glucose				
Poor	0.8 (0.4–1.2)	6.1 (4.9–7.2)	0.4 (0.1–0.8)	6.8 (5.8–8.0)
Intermediate	4.2 (3.2–5.3)	18.0 (16.2–19.9)	3.1 (2.2–3.9)	17.4 (15.7–19.1)
Ideal	94.9 (93.8–96.0)	75.9 (73.8–78.0)	96.45 (95.5–97.4)	75.7 (73.8–77.6)
Scores				
0–2 CVH metrics	0.7 (0.3–1.2)	6.8 (5.6–7.9)	1.2 (0.7–1.7)	9.7 (8.5–11.0)
3–5 CVH metrics	69.7 (67.3–72.1)	79.4 (77.4–81.4)	61.5 (59.0–64.0)	72.9 (70.9–74.9)
6–7 CVH metrics	29.6 (27.2–32.0)	13.8 (12.1–15.5)	37.4 (34.8–39.9)	17.4 (15.6–19.1)
0	0	0	0	0.03 (0.00–0.09)
1	0	1.3 (0.7–1.8)	0	2.5 (1.8–3.2)
2	0.7 (0.3–1.2)	5.5 (4.4–6.6)	1.2 (0.7–1.7)	7.2 (6.1–8.3)
3	6.3 (5.0–7.5)	12.8 (11.2–14.4)	5.2 (4.1–6.2)	15.6 (14.0–17.2)
4	24.1 (21.9–26.3)	29.6 (27.4–31.8)	20.8 (18.8–22.9)	26.9 (24.9–28.9)
5	39.73 (36.8–41.8)	37.0 (34.7–39.4)	35.5 (33.0–38.0)	30.4 (28.3–32.4)
6	23.9 (21.7–26.2)	12.8 (11.1–14.4)	28.8 (26.4–31.2)	15.9 (14.3–17.6)
7	5.6 (4.4–6.9)	1.1 (0.5–1.6)	8.6 (7.1–10.1)	1.4 (0.8–1.9)
Average score	5.0 (4.9–5.1)	4.4 (4.2–4.5)	5.0 (4.9–5.0)	4.5 (4.1–4.9)

increasing prevalence of physical inactivity, obesity and diabetes continues, the prevalence of CVH could be exacerbated.

Our results show an increasing trend in poor BP between 2008 and 2015. Hypertension is well known to be associated with higher CVD morbidity and mortality.[23 24] The increase in poor total cholesterol levels in our study was the result of an overly westernised diet and a slight decrease in physical activity from 2008 to 2015.

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Table 5 Factors associated with meeting 6–7 ideal CVH metrics in Beninese adults from the 2015 steps survey

Variables	n=3768	Good CVH	Crude PR (95% CI)	Adjusted PR (95% CI)
Sexes		%	**p=0.008**	p=0.083
Male	1793	12.8	1 (Reference)	1 (Reference)
Female	1975	16.2	1.25 (1.06 to 1.47)	1.16 (0.98 to 1.38)
Age (years)			p<0.001	p<0.001
25–34	1353	20.7	1 (Reference)	1 (Reference)
35–44	1177	13.0	0.65 (0.55 to 0.78)	0.65 (0.59 to 0.77)
45–54	794	11.5	0.55 (0.44 to 0.68)	0.55 (0.50 to 0.69)
55–64	444	5.6	0.30 (0.21 to 0.42)	0.29 (0.20 to 0.41)
Education			p=0.14	p=0.19
None	1986	16.2	1 (Reference)	1 (Reference)
Primary	1176	12.6	0.88 (0.72 to 1.05)	0.84 (0.69 to 1.01)
secondary or more	606	13.2	0.94 (0.76 to 1.17)	0.90 (0.72 to 1.13)
Employment status			p=0.16	p=0.78
Unpaid or unemployed	610	15.4	1 (Reference)	1 (Reference)
Employed or student	3158	14.4	0.88 (0.73 to 1.05)	0.98 (0.80 to 1.18)
Residence			p=0.004	p=0.006
Urban	1836	12.2	1 (Reference)	1 (Reference)
Rural	1932	16.8	1.40 (1.11 to 1.78)	1.32 (1.09 to 1.74)

PR, prevalence ratio.

Our study showed a higher prevalence of good CVH (six to seven CVH metrics) among younger individuals and rural residents. This corroborates the findings of previous studies with similar trends among younger individuals and women.[9 10] With the exception of smoking, the prevalence of other ideal CVH factors (behavioural and biological) decreased with age.[5 25] Taken together, these data suggest that efforts to improve CVH are more beneficial to younger adults than to older adults and rural residents. These improvements among rural residents may point to increased physical activity and traditional diet compared with urban residents. Therefore, strategies to improve CVH should focus on urban residents and the older adult population.

Strengths and limitations of the study

Therefore, the findings of this study should be interpreted with caution. First, CVH metrics (blood glucose and lipids) were assessed using the AHA threshold, which differs in the African population. Second, self-reporting of physical activity, smoking status and fruit and vegetable consumption in the surveys could have led to information bias.

Regardless of these limitations, our study provides useful information on the change of ideal CVH metrics in the Beninese population in the context of the ongoing epidemiological transition. These findings will help identify which CVH metrics to prioritise in limited-resource settings.

CONCLUSION

In conclusion, there was a decreasing trend in ideal CVH between 2008 and 2015 among Beninese adults. The prevalence of poor CVH was higher in urban areas and in older adults. High BP, high blood glucose, high total cholesterol and low daily intake of fruits and vegetables were cardiovascular risk factors associated with the highest negative change among Beninese adults. This alarming decrease in overall CVH rates between 2008 and 2015 highlights the need for primordial prevention to reduce the burden of CVD risk factors. This could be achieved via sustained commitment by the authorities to respond to the challenges in prevention and care targeting urban areas and older people.

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