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ORIGINAL ARTICLE

Status of cardiovascular health in a transition European country: findings from a population-based cross-sectional study

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Abstract
Objectives Our aim was to assess the prevalence of ideal cardiovascular health (CVH) in the adult population of Republic of Srpska (RS), Bosnia and Herzegovina, and its relationship with socio-demographic characteristics of participants.
Methods We included 4,170 adults (mean age 50.2 years; 54 % women) from the National Health Survey performed from September to November 2010 in RS. Population prevalence of CVH health metrics (smoking, body mass index, physical activity, diet, cholesterol, blood pressure, and glucose) were estimated according to the American Heart Association criteria for "ideal", "intermediate", and "poor" levels.
Results Only 0.02 % participants had ideal (all 7 health metrics at ideal levels), 7.6 % intermediate, and 92.4 % poor (at least one metric at poor level) CVH. The fasting glucose was the most prevalent (75.9 %), whereas the healthy diet was the least prevalent (4.4 %) ideal CVH metric.
Conclusions Our study indicates extremely low prevalence of ideal and high prevalence of poor CVH in the adult RS population. Such alarming results require urgent action. Comprehensive public health strategies and interventions must be developed to assist individuals and population in improving their CVH.

Keywords Cardiovascular health · Cardiovascular disease · Epidemiology · Health behaviors · Health factors

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Introduction

Cardiovascular diseases (CVD), mainly coronary heart disease and stroke, are the leading causes of deaths worldwide (WHO 2011). Over 80 % of CVD deaths occur in low- and middle-income countries (WHO 2011), such as Republic of Srpska (RS), one of two autonomous entities that constitute Bosnia and Herzegovina, a country in Southeastern Europe, located in the western part of the Balkan Peninsula. For decades CVD in RS have ranked first as a cause of death, with cardiovascular mortality rates increasing over time. In 2010, CVD were responsible for 53 % of all causes of death (60 % in women and 47 % in men) (Marinkovic and Majic 2012). In 2010, the American Heart Association (AHA) for the first time created the definition of ideal cardiovascular health (CVH) as a part of its efforts to improve the CVH of all Americans while reducing deaths from CVD and stroke (Lloyd-Jones et al. 2010). This is a relatively new concept of health focusing on health behaviors and health factors, which include

smoking, physical activity, obesity, dietary intake, total cholesterol, blood pressure, and blood sugar.

Until now, research in different populations has demonstrated that adherence to a higher number of ideal CVH metrics (as defined by AHA) has been associated with lower rates of CVD events (Folsom et al. 2011; Ford et al. 2012; Dong et al. 2012; Laitinen et al. 2012). This finding calls attention to the currently largely untapped opportunities for improving both health factors and preventing CVD events by targeting health behaviors. Therefore, knowledge of CVH status of a given population is essential to reduce its burden of CVD.

The aim of this study was to estimate the prevalence of ideal and poor CVH across sex and age groups in the adult RS population according to AHA criteria, as a starting point from which the effectiveness of recommended programs for CVH promotion and CVD prevention could be monitored and compared. Our second aim was to assess the relationship between ideal CVH and socio-demographic characteristics of participants. This is the first study to report population-based data on CVH in a Southeastern Europe.

Methods

Study design and sample

This cross-sectional study utilized the data collected in the 2010 National Health Survey (NHS) in RS, Bosnia and Herzegovina. To assure that the sample of the civilian adult population is nationally representative a two-stage stratified sampling was used. The first stage units were enumeration districts stratified by type of settlement (urban and rural) and five geographical regions. The second stage units were the households. Out of 1,866 households randomly selected for the sample, 1,779 were interviewed with a response rate of 95.3 %. 4,673 adults have been identified in the responding households, out of which 4,170 were interviewed yielding a response rate of 89.2 %. To take part in the survey, subjects had to be aged $\geq$18 years, and needed to reside in RS for at least 1 year. Persons living in collective households and in institutions (homes for older people, hospitals, and prisons) were excluded. All study procedures were in accordance with ethical standards outlined in the Helsinki Declaration of 1975, revised in 1983. Informed written consent was obtained for all participants. Ethical approval was received from The Research Ethics Committee of the Public Health Institute of RS.

All participants were interviewed using a standardized questionnaire and underwent physical examinations (anthropometric and blood pressure measurements, and blood tests) at home by trained staff (physicians and laboratory technicians) as described elsewhere (Matovic Miljanovic et al. 2011).

Study variables

Demographic and socio-economic characteristics (age, sex, marital status, education, employment status and type of settlement), as well as data about smoking status, physical activity, diet and individual history of CVD (ischemic heart disease or stroke) were obtained during a door to door NHS performed from September to November, 2010 in RS.

Participants were stratified by age into three groups: younger age (18–39), middle age (40–64), and older age (65 years and more). Their marital status was categorized in two groups: married or living with partner and unmarried, divorced or widowed. Educational attainment was categorized as low (no schooling, incomplete primary education, and primary education), middle (3 or 4 years of secondary education), and high (college and university education). Employment status was defined by one of three groups: employed, unemployed and inactive (retired, people attending some form of education, homemakers, persons who are inactive due to family reasons, and people who are ill, unable to work or elderly). Type of settlement was identified at survey level as urban or rural.

Smoking status of the participants was classified as "never", "former", or "current" according to self-reported information. Physical activity in this study was measured with a question: "In your leisure time, how often do you do physical exercise for at least 30 min which makes you at least mildly short of breath or perspire?" The response alternatives were (1) daily, (2) 4–6 times a week, (3) 2–3 times a week, (4) once a week, (5) 2–3 times a month, (6) a few times a year or less, (7) I cannot exercise because of illness/of disability. Those who participated in physical activity four times or more per week (response alternatives 1 and 2) were categorized as active, those who exercised less than four times a week but at least 2–3 times a month (response alternatives 3–5) were categorized as moderately active and those who exercised several times a year or did not exercise at all were categorized as inactive (response alternatives 6 and 7).

For assessment of dietary intake we used a validated 25-item self-administered food frequency questionnaire (FFQ). Each of the three items regarding fruit and vegetable consumption had a choice of six frequency categories ranging from "never" to "two or more times per day". For all other food groups, each of the 22 items had a choice of four frequency categories ranging from "never" to "six or seven times per week". Because FFQ assessed only usual frequency of intake of food and beverages over the previous week, but did not include information on portion sizes, each eating occasion was assumed to represent consumption of

one serving of the food. We also used a validated food habits questionnaire (FHQ) consisting of ten questions. For the purpose of this study, a healthy diet score (HDS) was developed. It consists of 11 indicators identified for each dietary guideline with the development of cut-offs and food groupings guided by the dietary guidelines for RS adults (Stojisavljevic et al. 2005). Each of the 11 indicators had a defined minimum and maximum score. Both, vegetables and fruits group had a score range of 0–4 each. Protein group (meat, fish, eggs, nuts, legumes) and cereals and their products groups each had a range of 0–6. Low fat milk group and related products had a score of 0–3, while fats and alcohol group had scores of 0–2 each. Consumption of high saturated fat, low nutrient density foods, so-called "junk food" had a score of 0–4 as well as the consumption of sweets and sugary drinks. Use of salt and regular meals ranged from 0 to 1 and 0 to 2 respectively. The total HDS was the sum of 11 items, therefore it had a possible range of 0–38, with a higher score reflecting increased compliance with the dietary guidelines.

Height and weight were measured with participants wearing light clothing and no shoes, by trained health professionals. A portable electronic medical scale (Seca, 877) was used to measure body weight to the nearest half-kilogram. Standing body height (cm) was measured to the nearest 0.1 cm with a portable wall-mounted stadiometer (Seca, 206). The body mass index (BMI) was calculated as weight divided by height squared (kg/m^2).

Systolic blood pressure (SBP, mmHg) and diastolic blood pressure (DBP, mmHg) have been measured using mercury sphygmomanometer—diplomat-presameter (Riester, CE 0124, Germany) with appropriately sized cuffs, after the participants have been resting in a sitting position for at least 10 min. Sitting blood pressure was measured three times after a 5-min rest. The mean of the last two measurements was used for the analysis.

As recommended for developing countries to measure fasting blood glucose (FBG, mg/dL), and total cholesterol (TC, mg/dL) early-morning capillary blood samples were obtained and analysed (Rapi et al. 2009; Priya et al. 2011; Ploubidis et al. 2013) using a calibrated Accutrend® Plus GCTL analyser (Roche Diagnostics, Mannheim, Germany). Participants were asked to fast for 12 h before assessments were performed.

To properly categorize blood pressure, FBG and TC, interviewees were specifically inquired on the use of antihypertensive, hypoglycemic, and hypocholesterolemic drugs, respectively.

Evaluation of CVH

In accordance with AHA (Lloyd-Jones et al. 2010), "ideal" CVH was defined as the simultaneous presence of 7 ideal CVH metrics: 4 ideal health behaviors (nonsmoking, ideal body mass index, physical activity at goal, and diet consistent with current recommendations) and 3 ideal health factors including nonsmoking (untreated TC <200 mg/dL, untreated BP <120/80 mmHg, untreated FBG <100 mg/dL, and nonsmoking) in the absence of clinical CVD. Given the importance of abstinence from smoking and smoking cessation to health promotion, smoking appears in both lists of health behaviors and health factors (Lloyd-Jones et al. 2010).

Each health behavior and health factor was categorized as "ideal", "intermediate", or "poor". Ideal, intermediate, and poor CVH metrics for smoking were, respectively, "never smoker or quitting >12 months before", "former smoker (quitting ≤12 months before)" and "current smoker". BMI was classified as ideal (<25 kg/m^2), intermediate (25–29.9 kg/m^2), or poor (≥30 kg/m^2). The corresponding metrics for physical activity were active, moderately active, and inactive (without physical activity). Ideal healthy diet was defined if HDS was ≥26, intermediate if HDS was in the range of 21–25 and poor if HDS was less than 21 points. The ideal health behaviors index corresponds to the number of ideal behaviors that were present at the time of study visit (score 0–4). Subjects with a score of 4 were classified as having "ideal health behaviors". Health factors included assessment of TC status which was classified as ideal (<200 mg/dL, untreated), intermediate (200–239 mg/dL or drug treated to goal), or poor (≥240 mg/dL). For blood pressure status the corresponding categories were: SBP <120 mmHg and diastolic BP <80 mmHg, untreated; systolic BP 120–139 mmHg or DBP 80–89 mmHg, or treated to goal; and SBP ≥140 mmHg or DBP ≥90 mmHg. Corresponding categories for FBG were: ideal FBG <100 mg/dL untreated; intermediate FBG 100–125 mg/dL or treated to goal; and poor FBG ≥126 mg/dL. The ideal health factors index corresponds to the number of health factors present at the study visit plus "not smoking" (score 0–4). A score of 4 classified a subject as having "ideal health factors".

For "intermediate" CVH (at least 1 of 7 health metrics at intermediate level and no poor health metrics) and "poor" CVH (at least 1 of 7 health metrics at poor level) we used definition by Folsom et al. (2011).

Statistical analysis

Statistical analyses were carried out on 4,170 participants except when indices of ideal CVH were in question. These analyses were done on 4,020 participants. We excluded 150 subjects who lacked data on any of the CVH metrics. Continuous variables were described with means and standard deviations while categorical variables were described with frequencies and percentages. Prevalence

rates were estimated for core study outcomes, namely: indices of ideal CVH, health behaviors, and health factors for all participants, and separately for male and female, as well as for younger, middle-aged and older participants. All reported estimates and 95 % confidence intervals (CI) were weighted using probability-sampling weights calculated to reflect an underlying population of inhabitants in RS in 2010. Variance estimates and CI reported account for the impact on precision of stratification and sampling weights, using Taylor-series linearization techniques for complex samples. The Chi-square, Student *t* test and one-way ANOVA with post hoc Bonferroni test were used where appropriate. Associations between indices of ideal CVH and socio-demographic variables were analyzed with multivariable logistic regression analysis. The dependent variables formed four different models: ≥90 percentile vs. <90 percentiles of ideal CVH metrics, health behaviors, and health factors; and ideal and intermediate CVH vs. poor CVH. Independent variables were: sex, age, type of settlement, marital status, educational level, and employment status. They were reported with odds ratios and their 95 % CI. All statistical analyses were performed using SPSS version 20.0 software (SPSS Inc., Chicago, IL, USA) and STATA version 11.1 (StataCorp LP College Station, TX, USA) with the complex sampling design taken into account. Statistical significance was set at 2-sided $P < 0.05$.

Results

The study included 4,170 adults (1,920 men and 2,250 women), representing the non-institutionalized adult population of the RS (~1.16 million). The baseline characteristics of the study participants according to sex and age groups are presented in Table 1. Overall, 54 % of

Table 1 Characteristics of survey participants across sex and age groups, Republic of Srpska, Bosnia and Herzegovina, 2010

Characteristics	All ($n = 4,170$)	Women ($n = 2,250$)	Men ($n = 1,920$)	P*	Age 18–39 ($n = 1,252$)	Age 40–64 ($n = 1,930$)	Age ≥65 ($n = 988$)	P*
Age, mean (SD)	50.2 (17.6)	51.0 (18.0)	49.3 (17.1)	0.022	28.9 (6.4)	52.0 (7.0)	73.6 (5.6)	–
Settlement, *n* (%)								
Urban	1,729 (41.5)	946 (42.0)	783 (40.8)	0.409	565 (45.1)	817 (42.3)	347 (35.1)	<0.001
Rural	2,441 (58.5)	1,304 (58.0)	1,137 (59.2)		687 (54.9)	1,113 (57.7)	641 (64.9)	
Education, *n* (%)								
Low	1,694 (40.7)	1,136 (50.5)	558 (29.1)	<0.001	216 (17.3)	713 (37.0)	765 (77.5)	<0.001
Middle	2,076 (49.8)	942 (41.9)	1,134 (59.2)		887 (71.0)	1,024 (53.1)	165 (16.7)	
High	395 (9.5)	170 (7.6)	225 (11.7)		146 (11.7)	192 (10.0)	57 (5.8)	
Marital status, *n* (%)								
Married/living with partner	2,739 (65.9)	1,410 (62.9)	1,329 (69.4)	<0.001	665 (53.2)	1,538 (80.0)	536 (54.4)	<0.001
Living without partner[a]	1,419 (34.1)	833 (37.1)	586 (30.6)		585 (46.8)	384 (20.0)	450 (45.6)	
Employment status, *n* (%)								
Employed	1,234 (29.6)	484 (21.5)	750 (39.1)	<0.001	522 (41.7)	695 (36.0)	17 (1.7)	<0.001
Inactive	1,938 (46.5)	1,299 (57.8)	639 (33.3)		268 (21.4)	765 (39.7)	905 (91.7)	
Unemployed	994 (23.9)	464 (20.6)	530 (27.6)		461 (36.9)	468 (24.3)	65 (6.6)	
BMI, kg/m^2, mean (SD)	26.6 (5.0)	26.5 (5.4)	26.8 (4.4)	0.066	24.6 (4.4)	27.6 (4.8)	27.2 (5.3)	<0.001
SBP, mmHg, mean (SD)	135.6 (21.4)	134.9 (22.8)	136.3 (19.5)	0.026	121.4 (14.0)	137.4 (19.7)	149.8 (21.2)	<0.001
DBP, mmHg, mean (SD)	84.1 (11.4)	83.2 (11.9)	85.1 (10.7)	<0.001	77.7 (9.4)	86.1 (10.8)	88.1 (11.6)	<0.001
TC, mg/dL, mean (SD)	5.1 (1.4)	5.2 (1.4)	5.0 (1.4)	<0.001	4.5 (1.3)	5.4 (1.3)	5.3 (1.4)	<0.001
FBG, mg/dL, mean (SD)	5.0 (1.7)	5.0 (1.7)	5.0 (1.6)	0.675	4.4 (1.0)	5.1 (1.7)	5.4 (2.1)	<0.001

BMI body mass index, *SBP* systolic blood pressure, *DBP* diastolic blood pressure, *TC* total cholesterol, *FBG* fasting blood glucose

* According to Chi-square test/*t* test/one-way ANOVA where appropriate

[a] Unmarried, divorced or widowed

the participants were women and 46 % were men. The mean age was 50.2 years, ranging from 18 to 95 years. More than half of the participants (58.5 %) lived in a rural area, and almost two-thirds were married or living with a partner. Approximately half of the participants (49.8 %) had secondary education and only 9.5 % attained high education. Almost a quarter of all participants (23.9 %) were unemployed.

Men compared to women were younger, had higher education, were more frequently married or living with partner and were more frequently employed. SBP and DBP levels were significantly higher in men, while TC level was higher in women.

Education levels were inversely correlated with age. The group aged 18–39 showed the highest percentage of high education. SBP, DBP, TC, and FBG levels increased with age. BMI level increased from the youngest to the middle-aged, but decreased in the elderly.

Prevalence estimates for all CVH metrics according to CVH status (poor, intermediate and ideal) stratified by sex and age groups are presented in Table 2.

Ideal FBG level was the most prevalent ideal CVH metric among the participants (75.9 %). More than half of the participants had ideal smoking status (54.0 %). The prevalence of other ideal CVH metrics ranged from 4.4 % for healthy diet to 46.2 % for the TC level. More than 95 % of the participants were classified as having intermediate (34.6 %) or poor (61.0 %) healthy diet (Table 2).

A higher prevalence of ideal CVH was seen in women for smoking status, BMI, HDS, and BP, and in men for TC. Less than one half of women (45.2 %) and no more than a third of men (36.5 %) exhibited ideal BMI. Women had higher prevalence of obesity (22.5 %), while men had higher prevalence of overweight (43.7 %). Men compared to women more frequently reported ideal physical activity level (Table 2).

In comparison to middle-aged and older participants, younger participants had a higher prevalence for all ideal CVH metrics except for healthy diet. The prevalence of ideal smoking status was the highest in older participants. More than a quarter of middle-aged adults were obese (27.2 %). Younger and middle-aged adults compared to older participants more frequently reported ideal physical activity level. Unlike other health behaviors, the prevalence of an ideal HDS increased with age (Table 2).

The distribution of participants according to the number of ideal CVH metrics attained is shown in Table 3. Only 0.02 of participants met ideal levels of all 7 CVH metrics, and 1.8 and 8.2 % for at least 6 and 5 metrics, respectively. The mean value of ideal CVH metrics was 2.8. The percentage of participants who achieved the all 4 metrics of ideal behaviors was lower (0.3 %) than the percentage of those with 4 ideal health factor metrics (5.5 %).

The mean values of ideal CVH metrics, ideal behaviors, and ideal health factors were significantly higher for women (2.9, 1.5 and 2.0 respectively) than those for men (2.6, 1.3 and 1.8 respectively) There were no statistically significant differences in the mean number of intermediate and poor CVH metrics between women and men (Table 3).

The proportion of participants who had 4, 5, and 6 ideal health metrics significantly decreased with age. The mean values of ideal CVH metrics, ideal behaviors and ideal health factors were significantly higher in younger participants in comparison to middle-aged and older participants (3.6, 1.7 and 2.5 respectively). The same pattern was observed for the mean number of intermediate CVH metrics, while the case is opposite for the mean number of poor CVH metrics (Table 3).

According to our results, the prevalence of having ideal CVH (0.02 %) was low. Furthermore, the prevalence of having intermediate CVH (at least 1 intermediate metric and no poor metrics) was also low (7.6 %). In contrast, 92.4 % of participants had poor CVH (at least 1 poor health metric) (Table 3). Out of those with poor CVH more than the third of participants (36.9 %) had $\geq$3 poor health metrics (data not shown). Younger participants compared to middle-aged and older participants had significantly lower mean value of number of poor CVH metrics (1.8 vs. 2.4 and 2.5), while there was no statistically significant difference between women and men (2.2 vs. 2.3) (data not shown).

We observed better results considering the number of ideal CVH metrics and CVH status (ideal and intermediate vs. poor) in women, younger and middle aged participants, and those with higher levels of education (Table 4). The most prominent associations were found for ideal health factor metrics. Rural settlement was associated with greater number of ideal behaviors while urban settlement with better CVH status. Living without partner was associated with greater number of both ideal CVH metrics and ideal health factor metrics. Greater numbers of ideal health factor metrics were also seen in those participants who were inactive or unemployed. However, there were no statistically significant differences between them and employed participants in regard to the numbers of ideal CVH metrics, behaviors and CVH status.

Discussion

To our knowledge, this is the first study to report information on the prevalence and distribution of CVH from a Southeastern European country. Our findings indicate an extremely low prevalence of ideal CVH among the population of RS. Only a few adults (0.02 %) achieved ideal levels of all 7 CVH metrics; 1.8 and 8.2 % for at least 6

Table 2 Prevalence (95 % CI) of poor, intermediate and ideal levels of cardiovascular health (CVH) metrics across sex and age groups, Republic of Srpska, Bosnia and Herzegovina, 2010

CVH metrics	All	Women	Men	*P**	Age 18–39	Age 40–64	Age ≥65	*P**
Smoking status, *n*	4,170	2,250	1,920		1,252	1,930	988	
Poor	30.3 (28.8–31.6)	24.9 (23.1–26.7)	36.9 (34.7–39.0)	<0.001	33.4 (30.6–35.9)	34.9 (32.7–37.1)	17.4 (15.2–19.8)	<0.001
Intermediate	15.7 (14.6–16.9)	10.8 (9.5–12.1)	21.6 (19.8–23.5)		9.3 (7.7–11.0)	18.3 (16.5–20.1)	18.8 (16.3–21.4)	
Ideal	54.0 (52.4–55.5)	64.3 (62.4–66.3)	41.5 (39.2–43.7)		57.3 (54.7–60.2)	46.7 (44.4–49.0)	63.8 (60.8–66.8)	
Body mass index, *n*	4,044	2,201	1,843		1,209	1,878	957	
Poor	21.3 (20.0–22.6)	22.5 (20.7–24.1)	19.8 (18.0–21.7)	<0.001	10.5 (8.6–12.2)	27.2 (25.1–29.5)	23.2 (20.5–25.9)	<0.001
Intermediate	37.5 (35.9–38.9)	32.3 (30.4–34.4)	43.7 (41.4–45.9)		28.9 (26.3–31.6)	41.0 (38.6–43.4)	41.4 (38.5–44.5)	
Ideal	41.2 (39.7–42.7)	45.2 (43.1–47.2)	36.5 (34.2–38.7)		60.6 (57.7–63.3)	31.8 (29.7–34.0)	35.4 (32.4–38.4)	
Physical activity level, *n*	4,170	2,250	1,920		1,252	1,930	988	
Poor	38.7 (37.3–40.4)	44.7 (42.6–46.7)	31.3 (29.1–33.5)	<0.001	23.9 (21.3–26.2)	35.0 (33.0–37.1)	64.1 (61.1–67.1)	<0.001
Intermediate	20.0 (18.8–21.2)	20.3 (18.7–22.0)	19.8 (18.0–21.6)		29.2 (26.8–32.0)	18.2 (16.4–20.0)	12.2 (10.1–14.3)	
Ideal	41.2 (39.7–42.7)	35.0 (33.0–37.0)	49.0 (46.6–51.2)		46.9 (44.1–49.8)	46.7 (44.6–48.9)	23.7 (21.0–26.5)	
Healthy diet score, *n*	4,170	2,250	1,920		1,252	1,930	988	
Poor	61.0 (59.6–62.5)	54.2 (52.1–56.3)	69.0 (66.8–71.0)	<0.001	75.4 (72.9–77.9)	58.3 (56.0–60.5)	47.7 (44.3–50.8)	<0.001
Intermediate	34.6 (33.2–36.0)	40.5 (38.4–42.6)	28.0 (26.0–30.2)		23.2 (20.7–25.5)	37.2 (35.0–39.5)	44.8 (41.8–48.1)	
Ideal	4.4 (3.8–5.1)	5.3 (4.4–6.3)	3.1 (2.3–3.9)		1.4 (0.8–2.1)	4.5 (3.6–5.5)	7.5 (5.9–9.2)	
Blood pressure, *n*	4,170	2,250	1,920		1,252	1,930	988	
Poor	28.3 (26.9–29.7)	27.9 (26.0–29.7)	30.3 (28.5–32.6)	<0.001	8.0 (6.4–9.5)	32.2 (30.0–34.5)	49.3 (46.2–52.4)	<0.001
Intermediate	56.9 (55.4–58.4)	52.2 (50.1–54.3)	60.5 (58.3–62.3)		58.6 (56.1–61.3)	58.3 (56.1–60.6)	48.2 (45.0–51.3)	
Ideal	14.7 (13.7–15.8)	19.9 (18.2–21.4)	9.1 (7.8–10.5)		33.4 (30.8–36.0)	9.5 (8.2–10.8)	2.5 (1.5–3.5)	
Total cholesterol, *n*	4,064	2,216	1,848		1,214	1,875	975	
Poor	20.8 (19.6–22.0)	23.7 (22.0–25.7)	17.5 (15.8–19.3)	<0.001	7.3 (5.8–8.7)	27.5 (25.3–29.5)	25.3 (22.6–28.4)	<0.001
Intermediate	33.0 (31.4–34.5)	33.5 (31.6–35.6)	32.5 (30.4–34.9)		21.5 (19.2–23.9)	37.7 (35.4–40.2)	38.7 (35.7–41.6)	
Ideal	46.2 (44.7–50.0)	42.7 (40.6–44.7)	50.0 (47.6–52.3)		71.2 (68.7–73.7)	34.9 (32.6–37.1)	36.1 (33.1–39.3)	
Fasting blood glucose, *n*	4,063	2,216	1,847	0.273	1,213	1,875	975	
Poor	6.3 (5.7–7.1)	6.0 (5.1–7.1)	6.7 (5.6–7.9)		0.5 (0.2–0.9)	7.3 (6.1–8.5)	11.7 (9.8–13.9)	<0.001
Intermediate	17.7 (16.5–18.9)	17.0 (15.4–18.4)	18.4 (16.7–20.3)		9.9 (8.2–11.6)	19.3 (17.4–20.9)	24.1 (21.3–26.9)	
Ideal	75.9 (74.7–77.3)	77.0 (75.4–78.8)	74.9 (72.7–76.9)		89.6 (87.9–91.3)	73.4 (71.4–75.4)	64.1 (61.1–67.2)	

* According to Chi-square test

Table 3 Distribution of cardiovascular health (CVH) metrics across sex and age groups, Republic of Srpska, Bosnia and Herzegovina, 2010

	Total sample (n = 4,020)	Women (n = 2,194)	Men (n = 1,826)	P*	Age 18–39 (n = 1,202)	Age 40–64 (n = 1,864)	Age ≥65 (n = 954)	P*
No. of ideal CVH metrics, % (95 % CI)								
0	2.8 (2.7–2.8)	2.0 (1.4–2.6)	3.5 (2.7–4.4)	<0.001	1.1 (0.5–1.7)	3.4 (2.7–4.3)	3.2 (2.1–4.5)	<0.001
1	14.4 (13.2–15.4)	12.8 (11.4–14.2)	16.3 (14.5–18.0)		4.3 (3.2–5.5)	17.9 (16.1–19.6)	20.2 (17.4–22.9)	
2	26.2 (24.8–27.6)	26.5 (24.7–28.5)	25.8 (23.8–27.8)		13.8 (11.9–15.8)	30.7 (28.6–32.9)	32.8 (29.9–35.9)	
3	27.9 (26.4–29.2)	26.2 (24.4–28.1)	29.8 (27.8–32.1)		25.7 (23.3–28.2)	28.5 (26.4–30.8)	29.3 (26.4–32.4)	
4	18.8 (17.6–20.0)	19.8 (18.2–21.5)	17.6 (15.9–19.2)		29.3 (26.8–31.8)	15.2 (13.6–16.9)	12.6 (10.3–14.8)	
5	8.2 (7.4–9.1)	10.3 (9.0–11.5)	5.7 (4.8–6.8)		20.5 (18.2–22.8)	3.7 (2.9–4.5)	1.7 (0.9–2.6)	
6	1.8 (1.4–2.3)	2.4 (1.7–3.0)	1.2 (0.7–1.7)		5.3 (4.2–6.6)	0.5 (0.2–0.8)	0.1 (0.0–0.3)	
7	0.02 (0.00–0.07)	0.00	0.05 (0.00–0.17)		0.00	0.05 (0.00–0.16)	0.00	
1–7, mean (95 % CI)	2.8 (2.7–2.8)	2.9 (2.8–2.9)	2.6 (2.6–2.7)	<0.001	3.6 (3.5–3.7)	2.5 (2.4–2.5)	2.3 (2.3–2.4)	<0.001
No. of ideal behaviors, % (95 % CI)								
0	14.5 (13.5–15.5)	10.8 (9.6–12.1)	18.9 (17.2–20.7)	<0.001	10.0 (8.2–11.6)	17.1 (15.5–19.0)	15.1 (12.9–17.2)	<0.001
1	40.6 (39.1–42.2)	40.4 (38.4–42.5)	40.9 (38.6–43.1)		30.5 (28.1–33.1)	44.5 (42.0–46.9)	45.8 (42.7–49.1)	
2	34.7 (33.2–36.2)	37.3 (35.3–39.3)	31.6 (29.6–33.8)		43.3 (40.4–45.7)	30.1 (28.1–32.4)	32.9 (29.8–36.0)	
3	9.8 (8.9–10.7)	11.3 (9.9–12.6)	8.1 (6.9–9.4)		15.7 (13.7–17.8)	8.0 (6.8–9.3)	5.9 (4.5–7.5)	
4	0.3 (0.2–0.5)	0.3 (0.1–0.5)	0.4 (0.1–0.7)		0.5 (0.2–0.9)	0.2 (0.0–0.4)	0.3 (0.0–0.7)	
1–4, mean (95 % CI)	1.4 (1.38–1.43)	1.5 (1.46–1.53)	1.3 (1.26–1.34)	0.001	1.7 (1.6–1.7)	1.3 (1.2–1.3)	1.3 (1.2–1.3)	<0.001
No. of ideal health factors, % (95 % CI)								
0	6.9 (6.1–7.7)	5.0 (4.0–5.9)	9.2 (7.9–10.6)	<0.001	2.4 (1.6–3.4)	9.6 (8.3–10.9)	7.2 (5.7–8.9)	<0.001
1	27.5 (26.1–28.9)	25.0 (23.2–26.8)	30. 6 (28.4–32.7)		12.7 (10.9–14.6)	33.9 (31.9–36.1)	33.7 (30.8–36.7)	
2	38.7 (37.3–40.2)	38.9 (37.0–41.0)	38.5 (36.4–40.9)		31.5 (29.0–34.3)	40.4 (38.1–42.6)	44.5 (41.3–47.7)	
3	21.3 (20.0–22.7)	23.3 (21.5–25.0)	19.0 (17.1–20.8)		37.5 (34.7–40.3)	14.6 (13.0–16.3)	14.1 (11.8–16.4)	
4	5.5 (4.8–6.2)	7.8 (6.6–8.9)	2.7 (2.0–3.4)		15.8 (13.9–17.9)	1.5 (1.0–2.1)	0.3 (0.0–0.7)	
1–4, mean (95 % CI)	1.9 (1.9–1.9)	2.0 (2.0–2.1)	1.8 (1.7–1.8)	<0.001	2.5 (2.5–2.6)	1.6 (1.6–1.7)	1.7 (1.6–1.7)	<0.001
Intermediate CVH metrics								
1–7, mean (95 % CI)	3.83 (3.69–3.96)	3.93 (3.75–4.09)	3.68 (3.47–3.88)	0.075	4.19 (4.00–4.39)	3.61 (3.41–3.81)	3.38 (3.07–3.69)	<0.001
Poor CVH metrics								
1–7, mean (95 % CI)	2.24 (2.21–2.28)	2.23 (2.18–2.28)	2.26 (2.07–2.31)	0.368	1.78 (1.73–1.83)	2.39 (2.34–2.44)	2.50 (2.43–2.58)	<0.001
CVH status, % (95 % CI)								
Ideal health[a]	0.02 (0.00–0.07)	0.0	0.05 (0.00–0.17)		0.0	0.05 (0.00–0.17)	0.0	<0.001
Intermediate health[b]	7.6 (6.7–8.4)	8.5 (7.3–9.7)	6.5 (5.3–7.6)		10.9 (9.1–12.6)	7.0 (5.8–8.2)	4.6 (3.3–5.9)	
Poor health[c]	92.4 (91.5–93.3)	91.5 (90.2–92.7)	93.5 (92.3–94.7)	0.511	89.1 (87.3–90.8)	93.0 (91.7–94.1)	95.4 (94.1–96.7)	<0.001

* According to Chi-square test or t test or one-way ANOVA where appropriate

[a] Ideal health is all 7 health metrics at ideal levels

[b] Intermediate health is at least 1 health metric at intermediate level, but no poor health metrics

[c] Poor health is at least 1 of 7 health metrics at poor level

Table 4 Association between cardiovascular health (CVH) metrics and main demographic and socio-economic variables—multivariable logistic regression analyses, Republic of Srpska, Bosnia and Herzegovina, 2010

Variables	Ideal CVH metrics (5–7 vs. 0–4)		Ideal CVH behaviors (3–4 vs. 0–2)		Ideal CVH factor metrics (4 vs. 0–3)		Ideal[a] and intermediate CVH[b] vs. poor CVH[c]	
	OR (95 % CI)	*P*	OR (95 % CI)	*P*	OR (95 % CI)	*P*	OR (95 % CI)	*P*
Women	2.4 (1.9–3.1)	<0.001	1.5 (1.2–1.9)	<0.001	3.7 (2.6–5.3)	<0.001	1.4 (1.1–1.8)	0.010
Men	1[d]		1		1		1	
Age 18–39	17.4 (10.0–30.2)	<0.001	2.6 (1.8–3.7)	<0.001	56.0 (17.2–185.2)	<0.001	2.4 (1.5–3.6)	<0.001
Age 40–64	2.7 (1.5–4.7)	<0.001	1.4 (1.0–1.9)	0.088	5.1 (1.5–19.5)	0.004	1.5 (1.0–2.14)	0.065
Age ≥65	1		1		1		1	
Urban	1		1		1		1	
Rural	1.3 (1.0–1.6)	0.057	1.33 (1.0–1.6)	0.023	1.33 (1.0–1.8)	0.074	0.7 (0.5–0.9)	<0.001
Low education	1		1		1		1	
Middle education	1.5 (1.1–2.0)	0.011	1.5 (1.1–1.9)	0.006	2.0 (1.3–3.0)	0.003	1.3 (0.9–1.8)	0.102
High education	2.3 (1.5–3.5)	<0.001	1.3 (0.9–2.0)	0.200	3.6 (2.1–6.5)	<0.001	1.9 (1.3–3.0)	0.002
Married/living with partner	1		1		1		1	
Living without partner[e]	1.8 (1.4–2.3)	<0.001	1.2 (1.0–1.5)	0.060	2.1 (1.5–2.9)	<0.001	0.9 (0.7–1.1)	0.337
Employed	1		1		1		1	
Inactive	1.1 (0.8–1.5)	0.502	1.1 (0.8–1.4)	0.606	1.8 (1.2–2.6)	0.007	1.1 (0.8–1.3)	0.386
Unemployed	1.1 (0.8–1.5)	0.462	1.0 (1.8–1.3)	0.935	1.5 (1.1–2.2)	0.025	0.9 (0.6–1.2)	0.451

[a] Ideal CVH health = all 7 health metrics at ideal levels

[b] Intermediate health is at least 1 health metric at intermediate level, but no poor health metrics

[c] Poor health is at least 1 of 7 health metrics at a poor level

[d] 1 = Reference value

[e] Unmarried, divorced or widowed

and 5 health metrics, respectively. These prevalence estimates were lower in comparison with previous reports mainly from the US (Bambs et al. 2011; Folsom et al. 2011; Shay et al. 2012) and China (Zeng et al. 2013; Wu et al. 2013). According to Graciani and colleagues (2013) who were the first in Europe to apply AHA criteria to assess the prevalence of CVH in the Spanish general population only, 0.2 % of subjects attained ideal values for all 7 health metrics, while 3.4 and 15.3 % attained ideal values for at least 6 and 5 metrics, respectively. Recently Vetrano et al. (2013) reported that less than 2 % of the examined Italian population met all 7 ideal CVH metrics.

We observed better CVH status in women and young and middle-aged adults in RS, which is consistent with recently published studies on CVH status in the general population of US (Shay et al. 2012; Fang et al. 2012), China (Zeng et al. 2013; Wu et al. 2013), and Spain (Graciani et al. 2013). Like in previous studies (Shay et al. 2012; Wu et al. 2013; Graciani et al. 2013; Fang et al. 2012), we found statistically significant association between CVH and education level—participants with higher education had better CVH profile in comparison with low educated. Olsen et al. (2013) using data from six cross-sectional studies conducted in Denmark from 1978 to 2006 reported an increasing trend in ideal CVH with a more unfavorable risk profile among women with low educational level, while educational difference was less pronounced for men. However, Danish authors did not use AHA definition for ideal CVH.

We found better CVH in urban dwellers, despite better health behaviors in a rural setting. Recently Del Brutto et al. (2013) reported that the CVH status of a rural population of a developing country in Latin America is better than that of an urban US population and concluded that these differences are likely related to a healthier lifestyle in a rural setting.

In our study, living alone was associated with greater number of ideal CVH metrics and ideal health factors, but was not associated with ideal cardiovascular behaviors. In the literature living alone has been inconsistently linked with cardiovascular risk, although there is substantial epidemiological evidence that social isolation may alter neurohormonal-mediated emotional stress, influence health behavior (Luksiene et al. 2011), and effect access to health care, resulting in association with cardiovascular risk (Udell et al. 2012).

The greater number of ideal health factor metrics found in our study in participants who were inactive or unemployed could be explained by a considerable percentage of young and middle-aged adults in both groups.

Similarly to other published studies (Shay et al. 2012; Graciani et al. 2013) the percentage of subjects in RS who achieved all 4 ideal health behaviors was lower than that for the all 4 ideal health factors (0.3 vs. 5.5 %). Even 96 % of RS adults reported poor or intermediate healthy diet, more than a half exhibited poor or intermediate BMI, almost half had poor and intermediate smoking status, and less than a half reported physical activity at goal levels. Because of the strong relationship between health behaviors and CVH factors, such adverse lifestyles resulted in unfavorable state of CVH factors of RS adults. In opposite direction the improvements in health behaviors can result in improvements in CVH factors and this should be considered to determine strategic interventions for the CVH improvements of RS adults.

Folsom et al. (2011) demonstrated a graded relationship between an individual's number of ideal health metrics and their risk of future CVD events. Individuals having 0 metrics of ideal CVH had a nearly tenfold higher risk than individuals having 6 metrics, while those having all 7 metrics of ideal CVH did not experience CVD events through almost 20 years of follow-up. These data suggest that the majority of CVD events are preventable, or can be delayed until much later stage in life.

Our findings point out that only a minority of RS population meets relatively moderate definitions of optimal healthy diet, physical activity, adiposity and smoking status, provide enormous room for improvement. Even modest changes in the distribution of these health behaviors will result in substantial cardiovascular benefits. To improve CVH prevention efforts should be strengthened at both individual and population levels.

The main strength of our study is the large sample representative of the RS population aged $\geq$18 years. However our findings should be interpreted in light of several limitations. Firstly, our data are cross-sectional and do not represent changes in single individuals over time. Secondly, information regarding several health metrics and educational level was self-reported, which may be subject to recall bias, but is widely used in epidemiological research. Thirdly, we excluded institutionalized subjects and consequently the levels of ideal CVH could be overestimated.

In conclusion, our study indicates extremely low prevalence of ideal CVH (0.02 %) and intermediate CVH (7.6 %), and extremely high prevalence of poor CVH (92.4 %) in the RS adult population. Such alarming results require urgent action. Comprehensive strategies and interventions at both individual and population-based levels must be developed to assist individuals and population in improving their CVH by reducing the prevalence of poor levels (through treatment and lifestyle) while increasing the prevalence of ideal levels (with lifestyle change) of CVH behaviors and health factors.

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References

Bambs C, Kip KE, Dinga A, Mulukutla SR, Aiyer AN, Reis SE (2011) Low prevalence of "ideal cardiovascular health" in a community-based population: the Heart Strategies Concentrating on Risk Evaluation (Heart SCORE) study. Circulation 123:850–857

Del Brutto OH, Dong C, Rundek T, Elkind MS, Del Brutto VJ, Sacco RL (2013) Cardiovascular health status among Caribbean Hispanics living in Northern Manhattan and Ecuadorian natives/mestizos in rural coastal Ecuador: a comparative study. J Community Health 38:634–641

Dong C, Rundek T, Wright CB, Anwar Z, Elkind MS, Sacco RL (2012) Ideal cardiovascular health predicts lower risks of myocardial infarction, stroke, and vascular death across whites, blacks, and hispanics: the northern Manhattan study. Circulation 125:2975–2984

Fang J, Yang Q, Hong Y, Loustalot F (2012) Status of cardiovascular health among adult Americans in the 50 States and the District of Columbia, 2009. J Am Heart Assoc 1:e005371. doi:10.1161/JAHA.112.005371

Folsom AR, Yatsuya H, Nettleton JA, Lutsey PL, Cushman M, Rosamond WD, ARIC Study Investigators (2011) Community prevalence of ideal cardiovascular health, by the American Heart Association definition, and relationship with cardiovascular disease incidence. J Am Coll Cardiol 57(16):1690–1696

Ford ES, Greenlund KJ, Hong Y (2012) Ideal cardiovascular health and mortality from all causes and diseases of the circulatory system among adults in the United States. Circulation 125:987–995

Graciani A, León-Muñoz LM, Guallar-Castillón P, Rodríguez-Artalejo F, Banegas JR (2013) Cardiovascular health in a southern Mediterranean European country: a nationwide population-based study. Circ Cardiovasc Qual Outcomes 6:90–98

Laitinen TT, Pahkala K, Magnussen CG et al (2012) Ideal cardiovascular health in childhood and cardiometabolic outcomes in adulthood: the Cardiovascular Risk in Young Finns Study. Circulation 125:1971–1978

Lloyd-Jones DM, Hong Y, Labarthe D et al (2010) American Heart Association Strategic Planning Task Force and Statistics Committee. Defining and setting national goals for cardiovascular health promotion and disease reduction: the American Heart Association's strategic Impact Goal through 2020 and beyond. Circulation 121:586–613

Luksiene DI, Baceviciene M, Tamosiunas A, Daugeliene E, Kranciukaite D (2011) Health, Alcohol and Psychosocial factors in Eastern Europe study: dietary patterns and their association with socio-demographic factors in the Lithuanian urban population of Kaunas city. Int J Public Health 56:209–216

Marinkovic D, Majic A (2012) Changes in mortality of the Republic of Srpska population in the period 1996 to 2010—causes and consequences (in Serbian). Demography 9:27–44

Matovic Miljanovic S, Gozdanov J, Bozanic V et al (2011) Population health survey in Republic of Srpska. Report on results. Public Health Institute of Republic of Srpska, Banja Luka

Olsen GS, Holm AS, Jørgensen T, Borglykke A (2013) Distribution of ideal cardiovascular health by educational levels from 1978 to 2006: a time trend study from the capital region of Denmark. Eur J Prev Cardiol. doi:10.1177/2047487313485513

Ploubidis GB, Mathenge W, De Stavola B, Grundy E, Foster A, Kuper H (2013) Socioeconomic position and later life prevalence of hypertension, diabetes and visual impairment in Nakuru, Kenya. Int J Public Health 58:133–141

Priya M, Mohan Anjana R, Pradeepa R et al (2011) Comparison of capillary whole blood versus venous plasma glucose estimations in screening for diabetes mellitus in epidemiological studies in developing countries. Diabetes Technol Ther 13:586–591

Rapi S, Bazzini C, Tozzetti C, Sbolci V, Modesti AP (2009) Point-of-care testing of cholesterol and triglycerides for epidemiologic studies: evaluation of the multicare-in system. Transl Res 153:71–76

Shay CM, Ning H, Allen NB et al (2012) Status of cardiovascular health in US adults: prevalence estimates from the National Health and Nutrition Examination Surveys (NHANES) 2003–2008. Circulation 125:45–56

Stojisavljevic D, Danojevic D, Bojanic J, Jandric Lj (2005) Nutrition guidebook for health professionals (in Serbian). Public Health Institute of Republic of Srpska, Banja Luka

Udell JA, Steg PG, Scirica BM et al (2012) Living alone and cardiovascular risk in outpatients at risk of or with atherothrombosis. Arch Intern Med 172:1086–1095

Vetrano DL, Martone AM, Mastropaolo S et al (2013) Prevalence of the seven cardiovascular health metrics in a Mediterranean country: results from a cross-sectional study. Eur J Public Health 23:858–862

World Health Organization (2011) Global status report on noncommunicable diseases 2010. World Health Organization, Geneva. http://www.who.int/nmh/publications/ncd_report_full_en.pdf. Accessed 3 May 2014

Wu HY, Sun ZH, Cao DP, Wu LX, Zeng Q (2013) Cardiovascular health status in Chinese adults in urban areas: analysis of the Chinese Health Examination Database 2010. Int J Cardiol 168:760–764

Zeng Q, Dong SY, Song ZY, Zheng YS, Wu HY, Mao LN (2013) Ideal cardiovascular health in Chinese urban population. Int J Cardiol 167:2311–2317