8 Rasmussen JN, Rasmussen S, Gislason GH, et al. Persistent socio-economic differences in revascularization after acute myocardial infarction despite a universal health care system-a Danish study. *Cardiovasc Drugs Ther* 2007;21:449–57.

9 Bavry AA, Kumbhani DJ, Rassi AN, et al. Benefit of early invasive therapy in acute coronary syndromes: a meta-analysis of contemporary randomized clinical trials. *J Am Coll Cardiol* 2006;48:1319–25.

10 Fox KA, Poole-Wilson PA, Henderson RA, et al. Interventional versus conservative treatment for patients with unstable angina or non-ST-elevation myocardial infarction: the British Heart Foundation RITA 3 randomised trial. Randomized Intervention Trial of unstable Angina. *Lancet* 2002;360:743–51.

11 Katritsis DG, Siontis GC, Kastrati A, et al. Optimal timing of coronary angiography and potential intervention in non-ST-elevation acute coronary syndromes. *Eur Heart J* 2011;32:32–40.

12 Mehta SR, Granger CB, Boden WE, et al. Early versus delayed invasive intervention in acute coronary syndromes. *N Engl J Med* 2009;360:2165–75.

13 Andersen HR, Nielsen TT, Rasmussen K, et al. A comparison of coronary angioplasty with fibrinolytic therapy in acute myocardial infarction. *N Engl J Med* 2003;349:733–42.

14 Maeng M, Nielsen PH, Busk M, et al. Time to treatment and three-year mortality after primary percutaneous coronary intervention for ST-segment elevation myocardial infarction-a DANish Trial in Acute Myocardial Infarction-2 (DANAMI-2) substudy. *Am J Cardiol* 2010;105:1528–34.

15 Danish National Board of Health. Treatment protocols for unstable angina and acute myocardial infarction without ST-segment elevation. Available at: http://www.sst.dk/Udgivelser/2009/Pakkeforloeb%20for%20ustabil%20angina%20pectoris%20UAP%20og%20akut%20myokardieinfakt%20uden%20st-elevation%20NSTEMI.aspx. 2009. (November 2014, date last accessed).

16 Danish Society of Cardiology. The national cardiology treatment guideline for Acute Coronary Heart Syndrome. 2011.

17 Peterson ED, Shah BR, Parsons L, et al. Trends in quality of care for patients with acute myocardial infarction in the National Registry of Myocardial Infarction from 1990 to 2006. *Am Heart J* 2008;156:1045–55.

18 Hetemaa T, Keskimaki I, Manderbacka K, et al. How did the recent increase in the supply of coronary operations in Finland affect socioeconomic and gender equity in their use? *J Epidemiol Community Health* 2003;57:178–85.

19 Lammintausta A, Immonen-Raiha P, Airaksinen JK, et al. Socioeconomic inequalities in the morbidity and mortality of acute coronary events in Finland: 1988 to 2002. *Ann Epidemiol* 2012;22:87–93.

20 Bajekal M, Scholes S, O'Flaherty M, et al. Unequal trends in coronary heart disease mortality by socioeconomic circumstances, England 1982–2006: an analytical study. *PLoS One* 2013;8:e59608.

21 Hjerteforeningen. Elsk hjertet—Resultater 2012. 2012

22 Ernstsen L, Strand BH, Nilsen SM, et al. Trends in absolute and relative educational inequalities in four modifiable ischaemic heart disease risk factors: repeated cross-sectional surveys from the Nord-Trondelag Health Study (HUNT) 1984–2008. *BMC Public Health* 2012;12:266.

23 Alter DA, Chong A, Austin PC, et al. Socioeconomic status and mortality after acute myocardial infarction. *Ann Intern Med* 2006;144:82–93.

24 Bernheim SM, Spertus JA, Reid KJ, et al. Socioeconomic disparities in outcomes after acute myocardial infarction. *Am Heart J* 2007;153:313–9.

25 Rasmussen JN, Gislason GH, Rasmussen S, et al. Use of statins and beta-blockers after acute myocardial infarction according to income and education. *J Epidemiol Community Health* 2007;61:1091–7.

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Sex inequalities in cardiovascular health: a cross-sectional study

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Background: The aim of this study was to determine sex differences in the prevalence of cardiovascular health (CVH) metrics according to the CVH status. **Methods:** The cross-sectional, population-based study involved 2250 women and 1920 men aged $\geq$18 years that participated in the 2010 National Health Survey in the Republic of Srpska, Bosnia and Herzegovina. Prevalence of CVH behaviours (smoking, body mass index, physical activity, diet), CVH factors (cholesterol, fasting blood glucose and blood pressure, plus smoking) and ideal CVH were estimated according to the American Heart Association criteria for ideal, intermediate and poor levels. Association between sex and ideal CVH categories was analyzed with multivariable logistic regression analysis across three age stratums. **Results:** A higher prevalence of ideal CVH metrics was seen in women for smoking status, body mass index, healthy diet score and blood pressure, and in men for physical activity and total cholesterol. Women from all age groups had better CVH behaviours (odds ratio [OR] = 1.40 for the youngest; OR = 2.05 for middle-aged; and OR = 2.03 for older-aged women), while only women from the youngest age group had better CVH factors (OR = 5.09). In line with this, ideal overall CVH prevailed in younger and middle-aged women in comparison to men of the same ages (OR = 3.01 and OR = 2.25, respectively), while disappeared in older ones. **Conclusions:** Significant differences in the prevalence of CVH metrics between men and women in the Republic of Srpska should be considered in cardiovascular disease prevention.

Introduction

It is well known that cardiovascular disease (CVD) is the biggest killer globally not only among men but also among women.[1] Women in low- and middle-income countries fare worse than men, experiencing a higher proportion of CVD deaths than men.[2] In the Republic of Srpska (RS), Bosnia and Herzegovina the absolute numbers of women living with and dying of CVD exceed those of men. In 2013, CVD were responsible for 53.8% of all causes of death in women and 42.3% in men.[3] Despite the magnitude of this problem, information about preventive strategies, diagnostic testing, responses to medical and surgical therapies and other aspects of CVD in women is still insufficient.

From the beginning of this century, considerable efforts have been made to improve understanding of the sex/gender differences in CVD and to heighten awareness of heart disease in women. Evident sex differences in morbidity and mortality from CVD have been attributed to differences in major cardiovascular risk factors[4,5] (such as cigarette smoking, unhealthy diet and obesity, physical inactivity, high blood pressure (BP), diabetes and raised lipids), hormonal differences,[6] differences in vessels anatomy[7] and differences in socioeconomic status.[8]

In 2010, the American Heart Association (AHA) introduced the concept of ideal, intermediate and poor cardiovascular health (CVH) based on the levels of seven CVH risk factors and behaviours: smoking, body mass index (BMI), healthy diet, physical activity, BP, fasting blood glucose (FBG) and total cholesterol (TC).[9] Achieving a greater number of ideal health metrics is associated with a lower risk of CVD events.[10]

The aim of this study was to examine age-specific sex differences in major cardiovascular risk factors using the AHA concept of ideal, intermediate and poor CVH metrics.

Methods

Study population

This cross-sectional population-based study used data collected in National Health Survey (NHS) performed in RS, Bosnia and Herzegovina in 2010. Out of 1866 households randomly selected for the sample, 1779 were interviewed. In the interviewed households, 4673 adults were identified, of which 4170 (2250 women and 1920 men) were interviewed (a response rate was 89.2%). To be enrolled, subjects had to be aged ≥ 18 years and had to be living in RS for at least 1 year. Details of the NHS have been published previously.[11]

The study was approved by the Ethics Committee of the Public Health Institute of RS, and written informed consent was obtained from all the participants.

Measurements

Demographic and socioeconomic characteristics were self-reported by the participants. Educational attainment was categorized as low (no schooling, incomplete primary school and primary school), middle (3 or 4 years of secondary education) and high (college and university education). Marital status was categorized in two groups: married or living with partner and not married, divorced or widowed. Employment status was defined by one of three groups: employed, unemployed and inactive. Type of settlement was identified as urban or rural.

Using the AHA definitions,[9] individual CVH metrics were classified as ideal, intermediate or poor (table 1).

Participants self-reported their smoking status by questionnaire. Never, former and current smokers were categorized into ideal, intermediate and poor health categories, respectively.

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?' Those who participated in physical activity four times or more a week were categorized as active, those who exercised <4 times a week but at least 2–3 times a month were categorized as moderately active and those who exercised several times a year or did not exercise at all were categorized as inactive. Categories of active, moderately active and inactive were used to define ideal, intermediate and poor health, respectively.

Table 1 Definition of poor, intermediate and ideal CVH metrics

Health metric	Category	Definition[a]
Smoking	Poor	Current
	Intermediate	Former, quit ≤ 12 months
	Ideal	Never or quit >12 months
BMI	Poor	≥30 kg/m^2
	Intermediate	25–29.9 kg/m^2
	Ideal	<25 kg/m^2
Physical activity	Poor	Inactive
	Intermediate	Moderately active
	Ideal	Active
HDS	Poor	<21
	Intermediate	21–25
	Ideal	≥26
TC	Poor	≥240 mg/dl
	Intermediate	200–239 mg/dl or treated to goal
	Ideal	<200 mg/dl, untreated
FBG	Poor	≥126 mg/dl
	Intermediate	100–125 mg/dl or treated to goal
	Ideal	<100 mg/dl untreated
BP	Poor	SBP ≥ 140 or DBP ≥ 90 mmHg
	Intermediate	SBP 120–139 or DBP 80–89 mmHg or treated to goal
	Ideal	SBP/DBP < 120/80 mmHg, untreated

a: According to the AHA, except for HDS, and physical activity.
SBP, systolic blood pressure; DBP, diastolic blood pressure.

As described elsewhere[12] for assessment of dietary intake an 11-item healthy diet score (HDS) was created. We used data from self-administered food frequency questionnaire and food habits questionnaire. The total HDS was the sum of 11 indicators identified for each dietary guideline with the development of cut-offs and food groupings guided by the dietary guidelines for adults in the RS.[13] The HDS had a possible range from 0 to 38 points, with a higher score reflecting increased compliance with the dietary guidelines.

Height and weight were measured with participants wearing light clothing and no shoes. BMI was calculated as weight divided by height squared (kg/m^2).

Systolic blood pressure (SBP, mmHg) and diastolic blood pressure (DBP, mmHg) were measured using mercury sphygmomanometer with appropriately sized cuffs, after the participants have been resting in a sitting position for at least 10 min. Sitting BP was measured three times after a 5-min rest. The mean of the last two measurements was used for analysis. A combination of BP level and self-reported treatment status from the questionnaire was used to define hypertension category (table 1).

To measure FBG (mg/dl) and TC (mg/dl), early-morning capillary blood samples were obtained and analyzed using a calibrated Accutrend Plus GCTL analyzer (Roche Diagnostics, Mannheim, Germany). To define FBG and TC categories, we used self-report of doctor-diagnosed diabetes and current use of cholesterol-lowering medication, respectively (table 1).

Participants were also classified into overall CVH health categories based on the combination of individual health metrics. Ideal CVH is defined as all seven health metrics at ideal levels (score 0–7). The ideal health behaviours index (score 0–4) and the ideal health factors index (score 0–4) correspond to the number of all 4 ideal behaviours (smoking, BMI, physical activity and diet) and all 4 ideal health factors (TC, FBG, BP and plus smoking as recommended by the AHA), respectively.[9]

Statistical analyses

Sociodemographic characteristics and prevalence estimates for all CVH metrics according to CVH status (poor, intermediate and ideal) stratified by sex and age group were reported with 95% confidence intervals (CI). All reported estimates and 95% CI were weighted using probability-sampling weights calculated to reflect an underlying population of inhabitants in RS in 2010. Association between sex and ideal CVH was analyzed with multivariable logistic regression analysis used as a discriminatory tool. The dependent variable was sex stratified by three age groups (young: 18–39; middle-aged: 40–64 and elderly: 65 years and more) while the independent variables were CVH categories (≥90 percentile vs. <90 percentiles of ideal CVH metrics, health behaviours and health factors), adjusted on educational level, type of settlement, marital status and employment status.

In all the analyses, a *P*-value of <0.05 was considered statistically significant. Data analysis was carried out with the 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.

Results

Overall, 54% of the participants were women (mean age, 51.0 ± 18.1) and 46% were men (mean age, 49.3 ± 17.1). Women compared with men were less educated, less frequently married or employed. Middle and high education levels were inversely correlated with age in both sexes except the high education in the young males. Young and middle-aged adults (both sexes) tended to be more frequently unemployed, whereas inactive status was most frequently reported for older adults. Most participants of both sexes used to live in rural areas. Males and females from the middle-age group in comparison to other two groups were more frequently married or have been living with a partner (data not shown).

A higher prevalence of ideal CVH was seen in women for smoking status, BMI, HDS and BP, and in men for physical activity and TC. No statistically significant gender difference regarding ideal FBG level was noted (table 2).

In comparison to middle-aged and older adults, younger participants had a higher prevalence for all ideal CVH metrics except for HDS (both sexes), and smoking and physical activity (women). Ideal BP and FBG levels (both sexes) and BMI and TC (women) decreased with age, while ideal BMI and TC levels in men decreased from the youngest to the middle-aged, but significantly increased in the oldest. Unlike other health behaviours, the prevalence of an ideal HDS increased with age in both sexes (table 2).

Prevalence estimates for the number of ideal CVH metrics (0–7) by sex and age groups are presented in figure 1. Young women most frequently met ideal criteria for 4 ideal CVH metrics, while young men most frequently had three ideal CVH metrics. The middle-aged and the oldest persons of both sexes most commonly exhibited 2–3 ideal CVH metrics (figure 1 A and B).

According to multivariable logistic regression analysis, females from the youngest age group had better ideal CVH, CVH behaviours and CVH risk factors. The middle-aged women had better ideal CVH and CVH behaviours while there was no statistically significant difference in CVH risk factors between women and men in this group. The older-aged women compared with men had only better CVH behaviours (table 3).

Discussion

In this study, we observed important differences according to sex in the number and prevalence of ideal CVH metrics. Compared with men, women had greater number of ideal CVH metrics, higher prevalence of ideal smoking status, BMI, HDS and BP and lower prevalence of ideal levels for physical activity and TC. On the contrary, poor and intermediate CVH metrics observed together (i.e. cardiovascular risk factors) were more frequently seen in women for physical activity level and TC, while men had more frequently poor CVH metrics for smoking, BMI, HDS and BP. Women from all age groups had better CVH behaviour index than men, while only those from the youngest age group had also better CVH risk factor index in comparison to the youngest men. In line with this younger and middle-aged women had better ideal CVH than men, while regarding the older participants no significant difference existed.

It is well known that the most important preventable risk factors for developing CVD are smoking, unhealthy diet and physical inactivity. Related to these risk factors is the presence of comorbidity including dyslipidaemia, hypertension, diabetes and obesity.[14]

'Cigarette smoking' is well known as a major risk factor for CVD.[15,16] Men smoke more frequently than women, but smoking rates are increasing for women, amongst whom cardiovascular awareness is relatively poor.[17] In this study smoking was more frequently seen in men.

However, epidemiological evidence suggests that smoking is a stronger cardiovascular risk factor in women than it is in men.[17,18] To estimate the effect of smoking on coronary heart disease (CHD) in women compared with men Huxley and Woodward[19] undertook the largest systematic review and meta-analysis to date. They concluded that independent of other cardiovascular risk factors women had a significant 25% increased risk for CHD conferred by cigarette smoking compared with men. Although it is still unclear whether mechanisms underlying this difference in risk of CHD are biological or related to differences in smoking behaviour between two sexes, this finding and increasing trend in female smoking suggest that tobacco control policies should include items specifically targeted at women.

'Poor diet and lack of physical activity' can worsen CVH, yet most inhabitants of RS neither meet diet (94.5% of women and 96.9% of men) nor physical activity (65.1% of women and 51.3% of men) recommendations. Lin et al.[20] in a systematic review of trials on effect of dietary or physical activity counselling in CVD prevention found that counselling to improve diet or increase physical activity changed health behaviours and was associated with small improvements in adiposity, BP and lipid levels.

Reduction and modification of dietary fats (replacing some saturated, animal fats with plant oils and unsaturated spreads) have differing effects on cardiovascular risk factors (such as cholesterol) and may reduce risk of CVD but there are no clear health benefits.[21] The beneficial effects of the Mediterranean diet, which has a high proportion of fruit and vegetables, on mortality and morbidity for CVD are well known.[22] Although literature data suggest adverse effects of 'obesity' in women as well as in men, especially on CVH,[23–25] we face the emergence of obesity as a worldwide problem.[26] More than a half of the adult population in RS (63.5% of males and 54% of females) are either overweight or obese. In the past much evidence has focused on the distribution of fat with a more android, apple-shape representing a higher risk of CHD compared with more gynaecoid, pear-shape.[27] Regional distribution of adipose tissue was hypothesized to be more important in determining cardiovascular risk than total body weight,[28] especially in postmenopausal women with a higher presence of other cardiovascular risk factors compared with ageing men.[29] However, Gelber et al.[30] who analyzed data from two large clinical trials (the Physician's Health Study and the Women's Health Study), concluded that BMI was clinically equivalent to waist circumference in predicting major CVD events or death and that measures of general obesity (BMI) and abdominal adiposity (waist circumference or waist-to-hip ratio) correlated with each other and with incident CVD. Higher levels of adiposity, however measured, confer increased risk of CHD or stroke. The results are similar for both men and women.[23]

Table 2 Prevalence (95% CI) of CVH metrics in women and men by age group

Health metric	Women				Men			
	18–39 years	40–64 years	≥65 years	Total[a]	18–39 years	40–64 years	≥65 years	Total[a]
Smoking status, n	665	1003	582	2250	587	927	406	1920
Poor	28.6 (25.1–32.0)	29.3 (26.5–32.1)	11.9 (9.3–14.5)[b]	24.9 (23.1–26.7)[c]	37.8 (33.9–41.7)	41.7 (38.5–44.9)	24.9 (20.7–29.1)[b]	36.9 (34.7–39.0)
Intermediate	9.3 (7.1–11.5)	12.6 (10.6–14.6)	8.9 (6.6–11.2)	10.8 (9.5–12.1)	9.2 (6.9–11.5)	24.6 (21.8–27.4)	32.8 (28.2–37.4)	21.6 (19.8–23.5)
Ideal	62.1 (58.4–65.8)	58.1 (55.0–61.1)	79.2 (76.0–82.5)	64.3 (62.4–66.3)	53.0 (49.0–57.0)	33.7 (30.7–36.7)	42.4 (37.6–47.2)	41.5 (39.2–43.7)
BMI, n	647	990	564	2201	562	888	393	1843
Poor	6.8 (4.9–8.7)	29.3 (26.5–32.1)	28.9 (25.2–32.6)[b]	22.5 (20.7–24.1)[c]	14.6 (11.7–17.5)	25.1 (22.5–27.1)	14.8 (11.3–18.3)[b]	19.8 (18.0–21.7)
Intermediate	19.2 (16.2–22.2)	37.7 (34.7–40.7)	37.8 (33.8–41.8)	32.3 (30.4–34.4)	40.2 (36.1–44.2)	44.7 (41.4–48.0)	46.6 (41.7–51.5)	43.7 (41.4–45.9)
Ideal	74.0 (70.6–77.4)	33.0 (30.1–35.9)	33.3 (29.4–37.2)	45.2 (43.1–47.2)	45.2 (41.1–49.3)	30.2 (27.2–33.2)	38.7 (33.9–43.5)	36.5 (34.2–38. 7)
Physical activity, n	665	1003	582	2250	587	927	406	1920
Poor	32.6 (29.1–36.2)	38.8 (35.8–41.8)	69.6 (65.8–73.3)[b]	44.7 (42.6–46.7)[c]	14.5 (11.6–17.3)	30.6 (27.7–33.6)	57.9 (53.1–62.7)[b]	31.3 (29.1–33.5)
Intermediate	30.4 (26.8–33.9)	18.4 (16.0–20.8)	11.5 (8.9–14.1)	20.3 (18.7–22.0)	27.1 (23.5–30.7)	18.4 (15.9–20.9)	12.6 (9.3–15.8)	19.8 (18.0–21.6)
Ideal	37.0 (33.6–40.7)	42.8 (39.7–45.8)	18.9 (15.7–22.1)	35.0 (33.0–37.0)	58.4 (54.4–62.4)	50.9 (47.7–54.1)	29.6 (25.1–34.0)	49.0 (46.6–51.2)
HDS, n	665	1003	582	2250	587	927	406	1920
Poor	69.9 (66.4–73.4)	50.0 (47.0–53.1)	42.4 (38.4–46.4)[b]	54.2 (52.1–56.3)[c]	81.8 (78.7–84.9)	68.1 (65.1–71.1)	54.4 (49.6–59.2)[b]	69.0 (66.8–71.0)
Intermediate	28.4 (25.0–31.8)	43.9 (40.8–47.0)	49.0 (44.9–53.1)	40.5 (38.4–42.6)	16.9 (13.9–19.9)	29.1 (26.2–32.0)	39.2 (34.4–43.9)	28.0 (26.0–30.2)
Ideal	1.7 (0.7–2.7)	6.2 (4.7–7.7)	8.6 (6.3–10.9)	5.3 (4.4–6.3)	1.4 (0.4–2.3)	2.8 (1.7–3.9)	6.4 (4.0–8.8)	3.1 (2.3–3.9)
TC, n	649	990	577	2216	565	885	398	1848
Poor	7.1 (5.1–9.1)	30.9 (28.0–33.8)	30.0 (26.2–33.7)[b]	23.7 (22.0–25.7)[c]	7.6 (5.4–9.8)	23.3 (20.5–26.1)	18.1 (14.3–21.9)[b]	17.5 (15.8–19.3)
Intermediate	19.0 (15.9–21.9)	38.6 (35.5–41.6)	41.1 (37.0–45.1)	33.5 (31.6–35.6)	24.4 (20.8–27.9)	36.7 (33.3–39.7)	34.2 (29.5–38.8)	32.5 (30.4–34.9)
Ideal	74.0 (70.5–77.4)	30.5 (27.6–33.4)	28.9 (25.1–32.5)	42.7 (40.6–44.7)	68.0 (64.1–71.8)	40.0 (36.7–43.2)	47.7 (42.8–52.7)	50.0 (47.6–52.3)
Fasting glucose, n	649	990	577	2216	563	885	398	1846
Poor	0.5 (0.0–1.0)	5.9 (4.4–7.3)	12.8 (10.0–15.6)[b]	6.0 (5.1–7.1)	0.5 (0.0–1.1)	8.9 (7.0–10.8)	10.3 (7.3–13.3)[b]	6.7 (5.6–7.9)
Intermediate	7.9 (5.8–9.9)	18.3 (15.9–20.7)	25.0 (21.4–28.5)	17.0 (15.4–18.4)	12.2 (9.5–14.9)	20.5 (17.8–23.1)	23.4 (19.2–27.5)	18.4 (16.7–20.3)
Ideal	91.7 (89.7–94.0)	75.9 (73.2–78.5)	62.2 (58.2–66.2)	77.0 (75.4–78.8)	87.2 (84.4–90.0)	70.6 (67.6–73.6)	66.3 (61.7–70.9)	74.9 (72.7–76.9)
BP, n	665	1003	582	2250	587	927	406	1920
Poor	3.8 (2.3–5.2)	29.7 (26.8–32.5)	51.4 (47.3–55.4)[b]	27.9 (26.0–29.7)[c]	12.3 (9.6–14.9)	33.1 (30.1–36.1)	44.3 (39.4–49.2)[d]	30.3 (28.5–32.6)
Intermediate	49.0 (45.2–52.8)	58.9 (55.8–61.9)	46.7 (42.6–50.8)	52.2 (50.1–54.3)	72.1 (68.4–75.7)	59.7 (56.5–62.8)	51.5 (46.6–56.4)	60.5 (58.3–62.3)
Ideal	47.2 (43.4–51.0)	11.4 (9.4–13.3)	1.9 (0.7–3.0)	19.9 (18.2–21.4)	15.7 (12.7–18.6)	7.2 (5.6–8.9)	4.2 (2.2–6.1)	9.1 (7.8–10.5)

CI, confidence intervals.
a: Adjusted on age.
b: $P < 0.001$ between age categories.
c: $P < 0.001$ between women and men.
d: $P < 0.01$ between age categories.

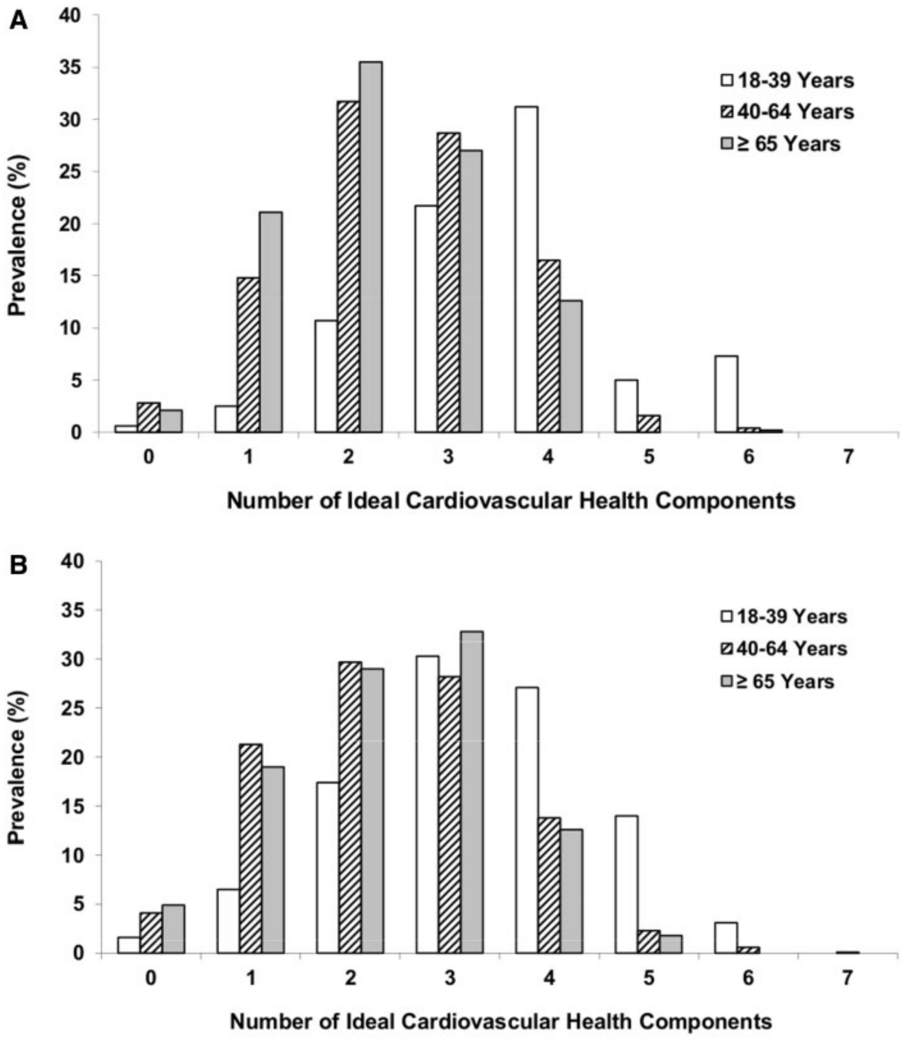

Figure 1 Prevalence of number of ideal CVH metrics in adult population of RS by age and sex group. (A) Women. (B) Men

Table 3 Association between sex and ideal CVH adjusted for sociodemographic variables in three age groups—multivariate logistic regression analyses

Age group/variable	OR[a]	95% CI	*P*
18–39 years			
Ideal CVH metrics (5–7 vs. 0–4)	3.01	2.25–4.03	<0.001
Ideal CVH behaviours (3–4 vs. 0–2)	1.40	1.01–1.93	0.038
Ideal CVH factors (4 vs. 0–3)	5.09	3.44–7.53	<0.001
40–64 years			
Ideal CVH metrics (5–7 vs. 0–4)	2.25	1.37–3.68	0.001
Ideal CVH behaviours (3–4 vs. 0–2)	2.05	1.44–2.94	<0.001
Ideal CVH factors (4 vs. 0–3)	1.79	0.81–3.93	0.146
≥65 years			
Ideal CVH metrics (5–7 vs. 0–4)	1.14	0.35–3.74	0.825
Ideal CVH behaviours (3–4 vs. 0–2)	2.03	1.05–3.96	0.036
Ideal CVH factors (4 vs. 0–3)	0.25	0.03–1.80	0.171

a: For female sex adjusted on educational level, type of settlement, marital and employment status.
OR, odds ratio; CI, confidence intervals.

In all WHO regions, men have slightly higher prevalence of 'raised BP' than women but this difference was only statistically significant in the Americas and Europe.[31] Our results are in accordance with this finding. Conflicting results have been reported on whether the strength of the association between increments in SBP and future risk for CVD differs between men and women.[15] Meta-analysis of 61 prospective observational studies of BP and mortality has shown that an increase of 20-mmHg SBP or 10-mmHg DBP doubles mortality from CHD and from other vascular causes in both men and women aged 40–69 years old.[32] According to Peters et al.[33] who performed a systematic review with meta-analysis of 124 cohort studies, including 1.2 million individuals, there was no evidence to suggest a sex difference in the relationship between SBP and either the risk of stroke or CHD. Individuals with an elevated BP more commonly have other risk factors for CVD such as diabetes, insulin resistance or dyslipidaemia. Because risk factors may interact, the overall risk of hypertensive patients is increased although the BP elevation is only mild or moderate.[28]

Epidemiological evidence indicates that 'diabetes' is a more potent risk factor for CHD and stroke in women than in men.[34,35] A meta-analysis including data from 37 prospective cohort studies showed that relative risk for fatal CHD associated with diabetes is 50% higher in women than it is in men.[34] Another large meta-analysis of data from 64 cohort studies[35] representing over 775 000 individuals demonstrated that the relative effect of diabetes on stroke risk was 27% grater in women with diabetes compared with men. A greater excess risk for CHD and stroke in women than in affected men may be explained by more adverse cardiovascular risk profiles among women with diabetes, combined with possible disparities in treatment that favour men.[15,34] We failed to find any statistically significant difference in FBG levels between males and females.

Genetic and epidemiological studies have established the crucial role of dyslipidaemia, especially 'hypercholesterolaemia', in the development of CVD. Increased TC and LDL cholesterol and low HDL cholesterol are among the main risk factors for CVD.[28]

It is well known that elevated TC is lower in younger women compared with men, while it rises after menopausal transition,[4,15] i.e. in accordance with our results. The increased risk of CVD in postmenopausal period can be explained by elevated levels of lipid profile together with increased SBP regardless of the effects of advanced age or anthropometric parameters.[36]

However, until now there has been no systematic evaluation of the sex-specific effects of cholesterol on cardiovascular risk.[15]

Furthermore, there is accumulating evidence that 'female-specific risk factors' (hypertensive disorders of pregnancy and gestational diabetes, as well as endocrine disorders in women of reproductive age) are of influence on the impact of major risk factors on the onset of CVD.[15]

The strengths of this study are the large sample representative of the adult population of RS and the use of validated standardized methods for the measurement of the CVH metrics.

However, the information on several CVH metrics (smoking, physical activity and diet) had been self-reported and may have been subject to recall bias. Further, the cross-sectional design does not allow inferences to be drawn, with respect to the causal relationships among variables. In addition, we were unable to study associations between ideal or intermediate and poor CVH metrics and CVD outcomes.

Over the past decade remarkable progress has been made concerning the knowledge of cardiovascular risk factors related to gender. Although men and women share the same classical cardiovascular risk factors findings from a number of studies suggest that they may not apply to women as they do in men.[4,15] Consequently the strategies for prevention of CVD, as already suggested,[37,38] should be different in the two sexes.

We consider that CVH metrics concept defined by the AHA, which we employ in this study, could be used in future as a risk-communication tool, as people may find it easier to understand than traditional risk-prediction tools. Future studies are required to examine whether such approach would improve understanding of cardiovascular risk in both men and women.

In conclusion, our finding that there are age-specific sex differences in the prevalence and number of ideal CVH metrics (overall as well as behaviours and health factors) should be used for the development of appropriate CVD prevention policies tailored to fit specific needs of both sexes.

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Conflicts of interest: None declared.

Key points

- There are age-specific sex differences in the prevalence and number of ideal CVH metrics in the adult population of the Republic of Srpska.
- Poor CVH metrics for physical activity and total cholesterol were more frequently seen in women, and for smoking, BMI, healthy diet score and blood pressure in men.
- Our findings should be used for the development of appropriate CVD prevention strategy.

References

1 World Health Organization. Global status report on noncommunicable diseases 2010. Geneva: WHO, 2011, p. 9. (20 August 2014, date last accessed).

2 World Heart Federation. Cardiovascular disease in women. Available at: http://www.world-heart-federation.org/press/fact-sheets/cardiovascular-disease-in-women/ (30 January 2015, date last accessed).

3 Institute of Statistics of Republic of Srpska. Statistical Yearbook of Republika Srpska. Population, 2014, 81. Available at: http://www.rzs.rs.ba/front/article/1331/ (30 January 2015, date last accessed).

4 Maas AH, Appelman YE. Gender differences in coronary heart disease. *Neth Heart J* 2010;18:598–602.

5 Vitale C, Miceli M, Rosano GM. Gender-specific characteristics of atherosclerosis in menopausal women: risk factors, clinical course and strategies for prevention. *Climacteric* 2007;10 Suppl 2:16–20.

6 Maturana MA, Irigoyen MC, Spritzer PM. Menopause, estrogens, and endothelial dysfunction: current concepts. *Clinics* 2007;62:77–86.

7 Phan TG, Beare RJ, Jolley D, et al. Carotid artery anatomy and geometry as risk factors for carotid atherosclerotic disease. *Stroke* 2012;43:1596–601.

8 Vogels EA, Lagro-Janssen AL, van Weel C. Sex differences in cardiovascular disease: are women with low socioeconomic status at high risk? *Br J Gen Pract* 1999;49:963–6.

9 Lloyd-Jones DM, Hong Y, Labarthe D, et al. 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* 2012;121:586–613.

10 Folsom AR, Yatsuya H, Nettleton JA, et al. ARIC study investigators. Community prevalence of ideal cardiovascular health, by the American Heart Association definition, and relationship with cardiovascular disease incidence. *J Am Coll Cardiol* 2011;57:1690–6.

11 Janković S, Stojisavljević D, Janković J, et al. Status of cardiovascular health in a transition European country: findings from a population-based cross-sectional study. *Int J Public Health* 2014;59:769–78.

12 Janković S, Stojisavljević D, Janković J, et al. Association of socioeconomic status measured by education, and cardiovascular health: a population-based cross-sectional study. *BMJ Open* 2014;4:e005222.

13 Stojisavljevic D, Danojevic D, Bojanic J, et al. Vodič za pravilnu ishranu za zdravstvene profesionalce (Nutrition guidebook for health professionals). *Public Health Institute of Republic of Srpska, Banja Luka*, 2005.

14 Schenck-Gustafssn K. Coronary heart disease. In: Schenck-Gustafsson K, DeCola PR, Donald Pfaff DW, Pisetsky DS, editors. *Handbook of Clinical Gender Medicine*. Basel: Karger, 2012:190–205.

15 Appelman Y, van Rijn BB, Ten Haaf ME, et al. Sex differences in cardiovascular risk factors and disease prevention. *Atherosclerosis* 2015;241:211–8.

16 Tunstall-Pedoe H. *MONICA Monograph and Multimedia Sourcebook.* Geneva: WHO, 2003.

17 Asia Pacific Cohort Studies Collaboration. Smoking, quitting, and the risk of cardiovascular disease among women and men in the Asia-Pacific region. *Int J Epidemiol* 2005;34:1036–45.

18 Prescott E, Hippe M, Schnohr P, et al. Smoking and risk of myocardial infarction in women and men: longitudinal population study. *BMJ* 1998;316:1043–7.

19 Huxley RR, Woodward M. Cigarette smoking as a risk factor for coronary heart disease in women compared with men: a systematic review and meta-analysis of prospective cohort studies. *Lancet* 2011;378:1297–305.

20 Lin JS, O'Connor E, Whitlock EP, et al. Behavioral counseling to promote physical activity and a healthful diet to prevent cardiovascular disease in adults: a systematic review for the U.S. preventive services task force. *Ann Intern Med* 2010;153:736–50.

21 Hooper L, Summerbell CD, Thompson R, et al. Reduced or modified dietary fat for preventing cardiovascular disease. *Cochrane Database Syst Rev* 2012;5:CD002137.

22 Kris-Etherton P, Eckel RH, Howard BV, et al. AHA science advisory: Lyon diet heart study. Benefits of a Mediterranean-style, national cholesterol education program/american heart association step I dietary pattern on cardiovascular disease. *Circulation* 2001;103:1823–5.

23 Whitlock G, Lewington S, Sherliker P, et al. Prospective studies collaboration. Body-mass index and cause-specific mortality in 900 000 adults: collaborative analyses of 57 prospective studies. *Lancet* 2009;373:1083–96.

24 Willett WC, Manson JE, Stampfer MJ, et al. Weight, weight change, and coronary heart disease in women. Risk within the 'normal' weight range. *JAMA* 1995;273:461–5.

25 Kaplan RC, Avilés-Santa ML, Parrinello CM, et al. Body mass index, sex, and cardiovascular disease risk factors among hispanic/latino adults: hispanic community health study/study of latinos. *J Am Heart Assoc* 2014;3. pii: e000923.

26 World Health Organization. Obesity and overweight. Fact sheet no. 311. Available at: http://www.who.int/mediacentre/factsheets/fs311/en/ (30 January 2015, date last accessed).

27 Yarnell JW, Patterson CC, Thomas HF, et al. Central obesity: predictive value of skinfold measurements for subsequent ischaemic heart disease at 14 years follow-up in the Caerphilly Study. *Int J Obes Relat Metab Disord* 2001;25:1546–9.

28 Perk J, De Backer G, Gohlke H, et al. European guidelines on cardiovascular disease prevention in clinical practice (version 2012). The fifth joint task force of the European society of cardiology and other societies on cardiovascular disease prevention in clinical practice (constituted by representatives of nine societies and by invited experts). *Eur Heart J* 2012;33:1635–701.

29 Kip KE, Marroquin OC, Kelley DE, et al. Clinical importance of obesity versus the metabolic syndrome in cardiovascular risk in women. *Circulation* 2004; 109:706–13.

30 Gelber RP, Gaziano JM, Orav EJ, et al. Measures of obesity and cardiovascular risk among men and women. *J Am Coll Cardiol* 2008;52:605–15.

31 World Health Organization. Global health observatory. Mean systolic blood pressure (SBP). Available at: http://www.who.int/gho/ncd/risk_factors/ blood_pressure_mean_text/en/ (30 January 2015, date last accessed).

32 Lewington S, Clarke R, Qizilbash N, et al. Prospective studies collaboration. Age-specific relevance of usual blood pressure to vascular mortality: a meta-analysis of individual data for one million adults in 61 prospective studies. *Lancet* 2002;360:1903–13.

33 Peters SA, Huxley RR, Woodward M. Comparison of the sex-specific associations between systolic blood pressure and the risk of cardiovascular disease: a systematic review and meta-analysis of 124 cohort studies, including 1.2 million individuals. *Stroke* 2013;44:2394–401.

34 Huxley R, Barzi F, Woodward M. Excess risk of fatal coronary heart disease associated with diabetes in men and women: meta-analysis of 37 prospective cohort studies. *BMJ* 2006;332:73–8.

35 Peters SA, Huxley RR, Woodward M. Diabetes as a risk factor for stroke in women compared with men: a systematic review and meta-analysis of 64 cohorts, including 775,385 individuals and 12,539 strokes. *Lancet* 2014;383:1973–80.

36 Yousefzadeh G, Mahdavi-Jafari F, Shokoohi M, et al. Modulation of coronary artery disease risk factors by menopausal status: a population based study among Iranian women (KERCADRStudy). *ARYA Atheroscler* 2013;9:332–6.

37 Mosca L, Benjamin EJ, Berra K, et al. Effectiveness-based guidelines for the prevention of cardiovascular disease in women-2011 update: a guideline from the American Heart Association. *Circulation* 2011;123:1243–62.

38 Mosca L, Barrett-Connor E, Wenger NK. Sex/gender differences in cardiovascular disease prevention: what a difference a decade makes. *Circulation* 2011;124:2145–54.

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Colorectal cancer screening participation: a systematic review

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Background: Colorectal cancer (CRC) is one of the most common cancers in men and women. CRC screening programmes have been implemented in various countries. However, the participation rate remains disappointingly low. For a screening method to be beneficial, high participation rates are essential. Therefore, understanding the factors that are associated with CRC screening and follow-up adherence is necessary. In this systematic review, factors studied in literature were identified that are associated with CRC screening adherence. **Methods**: A systematic search in PUBMED, EMBASE and COCHRANE was performed to identify barriers and facilitators for CRC screening adherence. Study characteristics were summarized and analysed. **Results:** Seventy-seven papers met the inclusion criteria to be applicable for review. Female gender, younger participants, low level of education, lower income, ethnic minorities and not having a spouse were the most frequently reported barriers. Health provider characteristics, such as health insurance and a usual source of care were also frequently reported barriers in CRC screening adherence. Disparities were found in weight, employment status and self-perceived health status. **Conclusion**: Barriers and facilitators of CRC screening participation are frequently reported. Understanding these factors is the first step to possibly modify specific factors to increase CRC screening participation rate.

Introduction

Colorectal cancer (CRC) is the fourth leading death cause worldwide, leading to approximately 694 000 deaths annually.[1] In the Netherlands, it is the second most prevalent cancer with an estimated 4100 deaths annually.[2,3] Therefore, there is a need for preventive measures against this disease. Regular screening with faecal occult blood test (FOBT) or endoscopy has shown to be effective in the reduction of CRC mortality. Through early detection and possible curative interventions, death rates decrease by 15–33%.[4,5]

In 2014 the screening for CRC was launched in the Netherlands which is based on a national outreach-screening programme.[6] Similarly as in the Netherlands, the UK, Finland, France and