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# Association of Behavioral Cardiovascular Risk Factors with Mortality in Croatian Adult Population: the CroHort Study

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## ABSTRACT

*This study examined individual and combined influence of smoking, physical inactivity, alcohol drinking, and unhealthy diet on total mortality. Relationship between individual and combined poor health behaviours and total mortality were examined using Cox proportional hazards regression. Out of 7490 individuals included in the study, during 5 years follow up 808 died. Adjusted hazard ratios (HRs), and 95% confidence intervals (95% CIs) for men with health behaviour scores 1, 2, 3, and 4 compared with those with score 0 were 1.67 (1.24–2.24), 2.28 (1.64–3.18), 2.24 (1.32–3.84), and 2.86 (0.77–11.70), respectively ( $p$  value for trend  $< 0.001$ ). Adjusted HRs (95% CIs) for women with health behaviour scores 1, 2, and 3 compared with those with score 0 were 1.17 (0.97–1.42), 1.37 (1.02–1.86), and 1.20 (0.37–3.61), respectively ( $p$  value for trend = 0.04). A unit of the health behaviour score increased mortality risk equivalent to being 5.9 and 2.9 years older; for man and woman respectively.*

**Key words:** life style, health behaviour, mortality, cause of death, proportional hazard model, CroHort study

## Introduction

Various studies have shown that smoking<sup>1–3</sup>, physical inactivity<sup>4–6</sup>, alcohol drinking<sup>7–9</sup>, and unhealthy diet<sup>10</sup> are associated with increased risk of total and/or cause-specific mortality. Since these specific health behaviours frequently coexist, it is also important to examine their combined effect on mortality<sup>11</sup>. Few studies have examined combined effect of smoking and alcohol drinking on total<sup>12,13</sup>, and cause-specific mortality<sup>14–16</sup>. Additionally, few studies have examined association of combined effect of smoking, physical inactivity, alcohol drinking, and diet habits with risk of mortality<sup>17–20</sup>. Combined effect of poor health behaviours is also associated with increased risk of coronary heart diseases, stroke, and major chronic diseases<sup>20–25</sup>. In all these studies, poor health behaviours were associated with increased morbidity or mortality. Risk of all cause and cause-specific mortality increase as number of poor health behaviours increase<sup>11,12,14</sup>.

The aim of this article was to examine possible association between life style and mortality in population aged 18 and older in Croatia.

## Materials and Methods

This study was part of the Croatian Health Survey (CroHec). The base of the study was the sample examined in the 2003 Croatia Adult Health Survey (CAHS). Details of the study were described previously<sup>26</sup>. Sample was re-examined in the 2008 Croatian Health Survey. Details were explained elsewhere<sup>27</sup>. Out of initial sample in 2008 we could not contact 1580 participants, so they were excluded from this analysis. Final sample was 7490 participants (female 67.75%).

Data on health behaviours, and other characteristics analysed in this study were those collected in the 2003 CAHS. Each examined health behaviour: smoking, physical activity, alcohol drinking, and unhealthy diet, were described with numerous questions<sup>26</sup>. Criteria for categorising health behaviours as poor were: current regular smoking, and/or regular smoking for at least 5 years in the previous 10 years; practice of at least 3 of the following 6 behaviours: not working, working at home, traveling to work by public transport or working within a 15-min walking or cycling distance, easy or very easy job

(sedentary or walking), physical activity for at least 30 min less than twice a week during leisure time, advice received from a health care professional within the past year to increase physical activity; drinking 6 or more shooters, glasses or bottles of alcohol at one occasion at least once a month, and/or drinking spirits, wine or beer every day combined with received advice to drink less from health care professional or member of the family; practice at least 2 of the following 5 behaviours: consuming animal fat, consuming milk and milk products with more than 3.2% fat, not eating fruits every day, consuming cured meat every day or almost every day, adding salt prior to meal tasting. Based on the number of poor health behaviours we created a health behaviour score. It was calculated adding 1 point for each of 4 poor health behaviours. The health behaviour score ranged from 0 (no poor behaviours) to 4 (4 poor behaviours).

Relationship between individual and combined poor health behaviours and total mortality were examined using Cox proportional hazards regression, after checking that proportional hazard assumption had not been violated. Analyses of association of individual poor health behaviour with mortality were adjusted for age, and other potentially confounding variables. As potentially confounding variables were considered: level of education measured in years (from »1« less than 8 years, to »5« university degree), self-perceived economic status measured on 5-point scale (»1« – much worse than average, »3« – average, »5« – much better than average), prior history of high blood pressure, high blood fats, heart attack, »weak« heart, cancer, angina, stroke, diabetes mellitus, and other 3 poor health behaviours. Analyses of influence of the combined poor health behaviours on mortality were adjusted for age, level of education, self-perceived economic status, and prior history of high blood pres-

sure, high blood fats, heart attack, »weak« heart, cancer, angina, stroke, and diabetes mellitus. In order to examine possibility that illness at study beginning influenced health behaviours and mortality, we repeated all analyses after excluding 992 men, and 2185 women with prior history of high blood pressure, diabetes mellitus, heart conditions, and cancer. In analyses of influence of combined poor health behaviours on mortality for men, health behaviour score ranged from 0 to 4. In same analyses for women, health behaviour score ranged from 0 to 3. We could not examine combined effect of 4 poor health behaviours and mortality in women because in the study was only 1 woman that practiced 4 poor health behaviours. Additionally, after exclusion of women with prior history of selected health conditions in sample for analyses remained only 1 woman that practiced 3 poor health behaviours. In these analyses health behaviour score for women ranged from 0 to 2. We estimated how a unit increases in number of poor health behaviour correspond to an increase in years of age. In full adjusted analysis, a regression coefficient for the number of poor health behaviours entered as a continuous variable into Cox regression model was divided by a regression coefficient for age entered as a continuous variable<sup>12</sup>. p values for tests of linear trends were estimated using the health behaviour score as continuous variable.

## Results

We analysed data for 7490 participants with 35906 person-years of exposure. In five years follow up 808 participants died. Classified in three age groups: 18–34, 35–64, and 65 years and over, there were 13 (4.4%), 90 (30.2%), and 195 (65.4%) men, and 19 (3.7%), 145 (28.4%), and 346 (67.9%) women.

**TABLE 1**  
DISTRIBUTION OF BEHAVIOURAL CARDIOVASCULAR RISK FACTORS AT BASELINE IN 2003 AND MORTALITY OF MEN AND WOMEN IN THE STUDY

Age, $\bar{X}$ (SD)	54.78 (16.25)	54.27 (17.33)	54.43 (16.99)	No of participants /No of deaths		
Poor health behaviour	Men %	Women %	Total %	Men 2415/298	Women 5075/510	Total 7490/808
Smoking						
No	71.9	83.8	80	1737/207	4253/462	5990/669
Yes	28.1	16.2	20	678/91	822/48	1500/139
Physical activity						
No	64.6	63.2	63.6	1559/134	3206/237	4765/371
Yes	35.4	36.8	36.4	856/164	1869/273	2725/437
Alcohol drinking						
No	88.3	99.3	95.8	2133/256	5041/505	7174/761
Yes	11.7	0.7	4.2	282/42	34/5	316/47
Unhealthy diet						
No	80.8	89	86.4	1951/245	4519/451	6470/696
Yes	19.2	11	13.6	464/53	556/59	1020/112

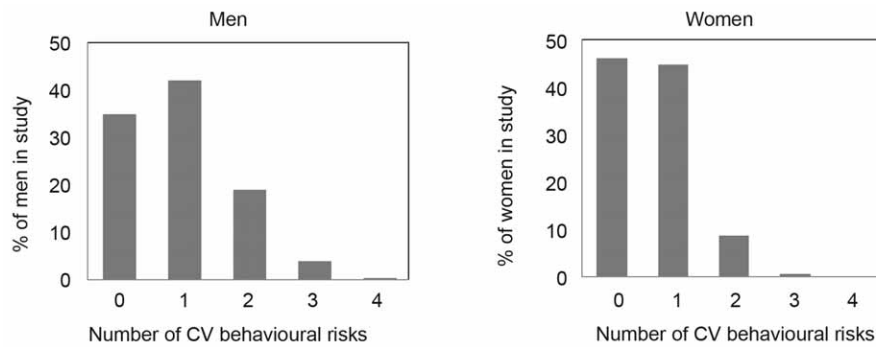


Fig. 1. Distribution of the number of poor health behaviours in men and women at baseline in 2003.

Table 1 presents distribution of age, health behaviours and mortality for men and women in the study. The most common poor health behaviour was physical inactivity, followed by smoking, unhealthy diet, and alcohol drinking. Health behaviours differ between men and women, particularly for alcohol drinking. With exception of physical activity, men were more likely to practice poor health behaviours.

Figure 1 presents distribution of the number of poor health behaviours for men and women. Both distributions were skewed, with mode of 1 point for men and 0 point for women.

Details on the distribution of poor health behaviours for men and women are available in Table 2.

Table 3 shows hazard ratios (HRs) and 95% confidence intervals (95% CIs) for mortality associated with individual poor health behaviours. In age-adjusted analyses, poor health behaviours were associated with increased risk of mortality, although statistical significance was apparent only for physical inactivity in both genders, and smoking in men. Full-adjustment basically unchanged these effects. After exclusion of participants with prior history of selected health conditions, full-adjustment led to an increase of relationship between alcohol drinking in men and mortality, and some decrease in relationship between physical inactivity in both genders and mortality.

Table 4 presents HRs (95% CIs) for mortality related to the health behaviour score. In age-adjusted analysis

TABLE 2  
BEHAVIOURAL CARDIOVASCULAR MULTIRISKS IN MEN AND WOMEN IN STUDY AT BASELINE IN 2003

Poor health behaviours	Men		Women	
	Participants N (%)	Deaths N (%)	Participants N (%)	Deaths N (%)
None	822 (34.0)	67 (22.5)	2295 (45.2)	184 (36.1)
S	283 (11.7)	30 (10.1)	514 (10.1)	25 (4.9)
P	488 (20.2)	85 (28.5)	1453 (28.6)	222 (43.5)
A	85 (3.5)	6 (2.0)	11 (0.2)	2 (0.4)
D	167 (6.9)	12 (4.0)	327 (6.4)	21 (4.1)
SP	162 (6.7)	32 (10.7)	230 (4.5)	16 (3.1)
SA	43 (1.8)	4 (1.3)	3 (0.1)	0
SD	94 (3.9)	8 (2.7)	52 (1.0)	4 (0.8)
PA	44 (1.8)	12 (4.0)	11 (0.2)	2 (0.4)
PD	83 (3.4)	18 (6.0)	151 (3.0)	30 (5.9)
AD	38 (1.6)	5 (1.7)	3 (0.1)	1 (0.2)
SPA	24 (1.0)	9 (3.0)	2 (0.1)	0
SPD	34 (1.4)	4 (1.3)	19 (0.4)	3 (0.6)
SAD	27 (1.1)	2 (0.7)	1 (0.02)	0
PAD	10 (0.4)	2 (0.7)	2 (0.04)	0
SPAD	11 (0.5)	2 (0.7)	1 (0.02)	0
Total	2415 (100)	298 (100)	5075 (100)	510 (100)

S – Smoking, P – Physical inactivity, A – Alcohol drinking, D – Unhealthy diet

**TABLE 3**  
INDIVIDUAL CARDIOVASCULAR BEHAVIOURAL RISKS IN  
RELATION TO TOTAL MORTALITY IN MEN AND WOMEN AT  
BASELINE IN 2003

Poor health behaviour	Men	Women
Smoking		
No	1 (Reference)	1 (Reference)
Yes		
HR <sup>a</sup> (95% CI)	1.62 (1.26–2.08)	0.95 (0.70–1.29)
HR <sup>b</sup> (95% CI)	1.36 (1.25–2.11)	0.96 (0.70–1.31)
HR <sup>c</sup> (95% CI)	1.60 (1.10–2.35)	1.09 (0.73–1.63)
Physical activity		
No	1 (Reference)	1 (Reference)
Yes		
HR <sup>a</sup> (95% CI)	1.74 (1.38–2.19)	1.29 (1.08–1.55)
HR <sup>b</sup> (95% CI)	1.67 (1.32–2.11)	1.29 (1.07–1.55)
HR <sup>c</sup> (95% CI)	1.43 (0.98–2.08)	1.20 (0.88–1.62)
Alcohol drinking		
No	1 (Reference)	1 (Reference)
Yes		
HR <sup>a</sup> (95% CI)	1.36 (0.98–1.88)	1.14 (0.48–2.76)
HR <sup>b</sup> (95% CI)	1.31 (0.94–1.83)	1.08 (0.44–2.64)
HR <sup>c</sup> (95% CI)	1.67 (1.02–2.74)	0.48 (0.07–3.49)
Unhealthy diet		
No	1 (Reference)	1 (Reference)
Yes		
HR <sup>a</sup> (95% CI)	0.96 (0.71–1.29)	1.09 (0.83–1.43)
HR <sup>b</sup> (95% CI)	0.84 (0.62–1.16)	1.05 (0.80–1.39)
HR <sup>c</sup> (95% CI)	0.72 (0.44–1.16)	0.70 (0.42–1.18)

<sup>a</sup> Adjusted for age

<sup>b</sup> Adjusted for age, education level, material status of household, high blood pressure, high blood fats, heart attack, »weak« heart cancer, angina, stroke, diabetes mellitus, and 3 other health behaviours

<sup>c</sup> Adjusted for age, education level, material status of household, high blood fats, and 3 other health behaviours after exclusion of participants with prior history of high blood pressure, diabetes mellitus, heart conditions, and cancer

for men, men that practiced poor health behaviours had increased mortality risk compared with those with no poor health behaviour. These results remained basically unchanged in full-adjusted analysis, and in full-adjusted analysis after exclusion of men with prior history of high blood pressure, diabetes mellitus, heart conditions, and cancer (*p* values for trends <0.001 in all analyses). When men with 3, and 4 poor health behaviours were combined into one group, HRs (95% CIs) for this group compared with men with no poor health behaviour were 2.30 (1.38–3.84) in full-adjusted analysis, and 2.14 (1.22–3.75) in full-adjusted analysis after exclusion of men with prior history of selected health conditions. Tests for trends in both analyses remain statistically significant, *p*<0.001.

In age-adjusted model for women, women that practiced poor health behaviours had increased mortality risk compared with women with no poor health behaviour (test for trend, *p*=0.03). Relationship between the health behaviour score and mortality in women decreased in full-adjusted analysis, but statistical significance remain (test for trend, *p*=0.04). When women with 2 and 3 poor health behaviours were combined into one group, in full-adjusted analysis HR (95% CI) for this group, compared with women with no poor health behaviour was 1.34 (1.06–1.92), (test for trend *p*=0.04). After exclusion of women with prior history of selected health conditions, in analysis remained only women with 0 to 2 poor health behaviours.

A unit of the health behaviour score increased mortality risk equivalent to being 5.9 years older for men. A unit of the health behaviour score increased mortality risk equivalent to being 2.9 years older for women.

## Discussion

We examined influence of life style on total mortality in Croatia. Study members, men and women aged at least 18 years at baseline in 2003, were followed up for 5 years. Combined effect of 4 poor health behaviours was associated with increased mortality risk. Compared with men with no poor health behaviour, mortality risk of those with 3–4 poor health behaviours was 2.3. A unit of the health behaviour score increased mortality risk equivalent to being 5.9 years older for men. Mortality risk of women with 2–3 poor health behaviours compared with women with no poor health behaviour was 1.4. A unit of the health behaviour score increased mortality risk equivalent to being 2.9 years older for women.

In some previous studies distributions of the number of poor health behaviours approximated normal distribution<sup>11,12</sup>. In this study distributions were skewed, with mode of 1 for men, and 0 for women. Combined poor health behaviours practiced only 23.6% of men, and 9.3% of women. Alcohol drinking was most likely to be combined with other poor health behaviours, 70% of men and 68% of women at risk practiced at least 1 of 3 other poor health behaviours. Concerning unhealthy diet, 64% of men, and 42% of women at risk practiced at least 1 of 3 other poor health behaviours. Regarding smoking, these proportions were 58% of men, and 38% of women. Physical inactivity was less likely to be combined with other poor health behaviours, 43% of men and 23% of women practiced other poor health behaviours. This is important because there could be different synergy between different poor health behaviours. Specific distribution of the number of poor health behaviours, and short follow up period in this study (5 years in comparison to 10–20 years in other studies)<sup>11,12,17–18</sup> could explain absence of strong trend of an increase in mortality related to the increase of the number of poor behaviours which has been shown in some previous studies<sup>11,12,17–18</sup>. Additionally, relationship between individual health behaviours and mortality in our study were not always statistically sig-

**TABLE 4**  
BEHAVIOURAL CARDIOVASCULAR MULTIRISKS IN RELATION TO TOTAL MORTALITY IN MEN AND WOMEN AT BASELINE IN 2003

Health behaviour score	HR <sup>a</sup> (95% CI)	HR <sup>b</sup> (95% CI)	HR <sup>c</sup> (95% CI)
<b>Men</b>			
0	1 (Reference)	1 (Reference)	1 (Reference)
1	1.72 (1.28–2.30)	1.67 (1.24–2.24)	1.59 (1.13–2.23)
2	2.31 (1.67–2.31)	2.28 (1.64–3.18)	2.07 (1.42–3.01)
3	2.27 (1.33–3.86)	2.24 (1.32–3.84)	2.10 (1.16–3.79)
4	2.83 (0.70–11.57)	2.86 (0.70–11.70)	2.46 (0.60–10.12)
	p<0.001	p<0.001	p<0.001
<b>Women</b>			
0	1 (Reference)	1 (Reference)	1 (Reference)
1	1.21 (1.00–1.46)	1.17 (0.97–1.42)	1.16 (0.96–1.41)
2	1.44 (1.06–1.96)	1.39 (1.02–1.89)	1.34 (1.00–1.80)
3	1.20 (0.40–3.75)	1.15 (0.37–3.61)	
	p=0.03	p=0.04	p=0.04

<sup>a</sup> Adjusted for age

<sup>b</sup> Adjusted for age, education level, material status of household, high blood pressure, high blood fats, heart attack, »weak« heart cancer, angina, stroke, and diabetes mellitus

<sup>c</sup> Adjusted for age, education level, material status of household, high blood fats, after exclusion of participants with prior history of high blood pressure, diabetes mellitus, heart conditions, and cancer

nificant. HRs for individual health behaviours is some other studies seem to be higher than these in this study<sup>11,17,19</sup>. One of the possible bias is underreporting especially among women for alcohol consumption.

Association of poor health behaviours and mortality risk in this study is not strong as it has been shown in previous studies, but findings in this study are consistent with those from some previous studies. Study on combined impact of not smoking, not being physically inactive, having a moderate alcohol intake, and having a high fruit and vegetable intake on men and women aged 45 to 79, followed up for 11 years showed trend of decreasing mortality with increasing number of positive health behaviours<sup>17</sup>. Multicentre European study among men and women aged 70 to 90 years, followed up for 10 years showed that Mediterranean diet, physical activity, moderate alcohol use and not smoking were associated with lower rate of all-cause and cause-specific mortality<sup>18</sup>. Study on men and women aged 18 years and more, followed up for 20 years showed that combined effect of four poor health behaviours were associated with significantly higher mortality from all-cause, CVD, cancer, and from all other causes<sup>11</sup>.

In order to exclude influence of prior history of illness on mortality we repeated all analyses after exclusion of participants with selected health conditions, previously shown to be associated with an increased mortality<sup>17–19</sup>. In previous studies authors also made exclusion of par-

ticipants who died within first 3<sup>12</sup> or 4<sup>11</sup> years of follow up. We could not make this kind of exclusion because of short period of follow up.

Studies use various criteria to categorise health behaviours as unhealthy or high-risk. In high-risk category for smoking were included current and former smokers<sup>17</sup>, only current smokers<sup>11</sup>, or both depend on years since quitting<sup>12</sup>. Physical inactivity was explained as leisure time exercise<sup>11</sup>, or considering all types of activity<sup>17</sup>. High alcohol consumption was defined as amount of alcohol consumed per week<sup>11,14</sup>, or per day<sup>12</sup>, and these amounts differ for men and women. Diet was analysed as amount of fruit or vegetable intake<sup>11</sup>, or practice of Mediterranean diet<sup>18</sup>. However, all studies observed an increase of mortality associated with poor health behaviours.

Observed health behaviours were associated, both independently and combined, with increased mortality risk. These results could serve as support in quantitative risk assessment of poor health behaviour, and help policy makers in identifying point for health intervention.

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## UTJECAJ PONAŠAJNIH KARDIOVASKULARNIH RIZIKA NA MORTALITET U HRVATSKOJ: CroHort STUDIJA

### SAŽETAK

Cilj ispitivanja je bio istražiti učinak rizičnih zdravstvenih ponašanja na opći mortalitet. Coxovim regresijskim modelom analiziralo se povezanost izabranih zdravstvenih ponašanja i općeg mortaliteta. Mortalitetni rizik povezan s rizičnim zdravstvenim ponašanjem usporedilo se s onim povezanom sa starenjem. U istraživanje je uključeno 7490 osoba od 18 i više godina. Tijekom 5-ogodišnjeg perioda praćenja umrlo je 808. Mortalitetni rizici i 95% intervali pouzdanosti muškaraca s 1, 2, 3 i 4 rizična zdravstvena ponašanja u usporedbi s onima koji nemaju nijedno rizično zdravstveno ponašanje su 1,67 (1,24–2,24), 2,28 (1,64–3,18), 2,24 (1,32–3,84) i 2,86 (0,77–11,70). Svako rizično zdravstveno ponašanje kod muškaraca povisi mortalitetni rizik jednako kao 5,9 godina života. Za žene s 1, 2 i 3 rizična zdravstvena ponašanja u usporedbi s onima koje nemaju nijedno rizično zdravstveno ponašanje rezultati su 1,17 (0,97–1,42), 1,37 (1,02–1,86) i 1,20 (0,37–3,61). Svako rizično zdravstveno ponašanje kod žena povisi mortalitetni rizik jednako kao 2,9 godina života.