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Health factors and longevity in men and women: a 26-year follow-up study

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Abstract Health factors have the power to prevent and postpone diseases and death; however, studies using the same methodology in both men and women are sparse. We aimed to study the ability of health factors to prevent mortality in a population-based, 26-year follow-up of Swedish men and women. During 1969–70, a health-screening programme was offered to a stratified sample of 3064 individuals aged 18–64 years to estimate health-care needs. Missing data (largely according to protocol) for physical fitness, BMI, and smoking habits left 935 subjects, 463 men and 472 women. Alcohol consumption in grams per week and BMI was calculated. Tobacco smoking was recorded as yes/no. Multivariate analysis was performed by Cox regression with age adjusted hazard ratios (HR) and 95% confidence interval (CI).

Moderate alcohol consumption did not lead to any decrease in mortality. Having two health factors halved the mortality risk in men and women (hazard ratio (HR) 0.52, confidence interval (CI) 0.39–0.70). A further risk reduction was seen in men with three health factors (HR 0.17, CI 0.074–0.41). Men had about 70 per cent higher risk of mortality compared with
women after adjustments for all health factors (HR 1.67, CI 1.26–2.23). Men compared to women had greater benefit of all three health factors. This in combination with the overall higher mortality risk in men makes a healthy lifestyle more important for them. The benefit of moderate alcohol consumption could not be detected in this study, and may be explained by an unhealthy drinking pattern in Sweden.

**Keywords** Body mass index · alcohol consumption · tobacco smoking · physical fitness · health factors · mortality

**Abbreviations**

HR hazard ratio

CI confidence interval

BMI body mass index
Introduction

Health factors have the power to prevent and postpone the development of cardiovascular diseases, cancer and type II diabetes [1-3]. Several factors have been studied, usually: being physically active or being physically fit, having a healthy dietary pattern, non-smoking, low waist/hip ratio or normal BMI, and moderate alcohol consumption. As an example, in a study of over 24,000 postmenopausal women, a healthy lifestyle was shown to have the potential to prevent 77% of all myocardial infarctions [4]. Studies of healthcare workers in the US have shown impressive preventive results regarding hypertension prevention in women and heart failure prevention in men [5, 6]. In a study of a British civil service based cohort, cardio-protective effects were seen with a health score comprising of similar factors, but moderate alcohol consumption was only shown to be beneficial in individuals with an otherwise unhealthy lifestyle [7]. In contrast, a study of health factors in men and the risk of myocardial infarction showed benefits of moderate alcohol intake among individuals with many health factors as well as in those with many unhealthy factors [8]. These conflicting results regarding the potential benefits of moderate alcohol consumption in individuals with a healthy lifestyle call for additional studies in other cohorts. In addition, none of these previous studies have data on both men and women. Possible interactions with gender have therefore not been analysed.

In the early 1970s, a cohort was initiated to estimate the healthcare need in the population of Stockholm, Sweden. Both men and women were included. The cohort has been linked to the National Cause of Death Register in Sweden, and several long-term follow-up studies have been published recently [9-11]. We identified four health factors in the baseline investigation: moderate alcohol consumption, non-smoking, body mass index (BMI) and physical fitness based on an exercise test.

The aim of this study was to calculate the beneficial effects of health factors and to calculate their combined effects in a 26-year follow-up of total mortality. A secondary aim
was to study the health effect of moderate alcohol consumption additional to the other three health factors and to study interactions between the various health factors. All variables will be analysed in men and women separately.

Methods

Study population

The baseline examination was performed during the period 1969–70. From the total population aged 18–64 years in Stockholm County (a total of 445,000 inhabitants), a sample of 32,185 individuals was drawn. The individuals in the sample received a postal questionnaire including 30 questions concerning physical and social difficulties in daily life and healthcare needs. The total response rate was 87%. The sample was stratified into three age groups, 18–24 years, 25–44 years and 45–64 years. A random sample was drawn from each of the age strata, in a ratio of 3 to 2 to 1, resulting in more individuals in the younger age groups. The subjects were classified into four different groups according to their estimated healthcare needs. This estimation was made based on the postal questionnaire answers and on data obtained from registers containing information regarding hospitalisation and sick leave. Thereafter, a further randomisation procedure was performed in which a higher proportion of individuals with high needs were selected, as they were expected to be rather few, especially in the younger age groups. In this way, a group of 3064 individuals was obtained. These subjects were invited to the health-screening programme, on average one year after the questionnaire survey, with an attendance rate of 84% (n=2578). According to the original protocol of the healthcare need investigation, an exercise test was performed in 1066 individuals. Missing data for physical fitness, BMI, and smoking habits left 935 subjects that could be included in this sub-study, 463 men and 472 women.

The study was approved by the ethics committee at the Karolinska Institutet and all participants gave their consent.
Health factors

Alcohol habits were self-reported in the questionnaire, and these questions have been validated [12]. Healthy moderate alcohol consumption was defined as a weekly consumption of 70–210g for men and 70–140g for women, which corresponds to an average daily consumption of 1-3 drinks/day for men and 1-2 drinks/day for women [8, 13, 14]. This was compared with abstinence, low alcohol consumption and heavy drinking. Smoking habits were classified as non-smokers and smokers. Non-smoking was classified as healthy. BMI was calculated from weight and height measurements and expressed in kg/m². Based on a mortality follow-up in this cohort, a BMI of 20–29.9 was associated with lower mortality [10], and in this study we defined individuals with a BMI lower than 30 as having a healthy BMI. Physical fitness was defined as above median VO2 max, i.e. above 30mL/kg/min in both men and women [15]. Age was adjusted for in 5-year intervals. This adjustment also compensates for the age-stratification in the baseline investigation.

Health score

The health factors above were combined into a score to predict the associated risk of mortality with in individuals with different levels of health. Only factors that were significant in the final sex-adjusted model containing all individuals were included.

Follow-up

All participants were followed up in the National Cause of Death Register for 26 years. This register contains records of all deaths among the people of Sweden and is more than 99% complete, with the exception of certain emigrants.

Statistical analysis
Hazard ratios for total mortality were calculated using Cox regression with the PHREG procedure in the SAS data package. 95% confidence intervals were used and considered significant in the adjusted full models. Interactions were studied between the health factors and sex. Adjustments for healthcare need could not be made as this variable is largely based on the health variables studied. The 1% that was lost to follow-up was censored in the Cox regression models. All calculations were performed during 2009.

Results

In total, 80 out of the 472 women and 121 out of the 463 men died during the 26-year follow-up. The study participants’ health factors and the health score are presented in relation to mortality in table 1. Few individuals had no health factors, and to get an “unhealthy” reference group we decided to define “unhealthy” as a health score of 0−1.

Table 2 shows the health factors and their relation to total mortality as hazard ratios. Moderate alcohol consumption was not associated with mortality and could not be included in the full models. The other health factors were significant in the crude models among men. Non-smoking was significant in all models in men and women. The full model with both men and women showed significant hazard ratios for all included health factors. Sex adjustments revealed an approximately 70% higher mortality risk in men.

Hazard ratios for mortality of the combined health score variable are shown in table 3. Having no or one factor was used as reference. Having two out of three health factors halved the mortality risk. The men with all three health factors decreased their hazard ratio to 0.17, whereas women with three factors did not seem to decrease their risk dramatically more than women with two factors.
No significant interaction between either sex or any of the health factors or the combined health score variable was found (data not shown). Adjustments for healthcare need could not be done due to co-linearity with the health factors (data not shown).

**Discussion**

Non-smoking, being physically fit and having a healthy BMI were mortality risk reducers and worked well as a composite health score in this long-term follow-up of Swedish men and women. In contrast to some previous studies, moderate alcohol consumption did not lead to any decrease in mortality and was not included in the health score. Having two health factors halved the mortality risk in men and women. A further dramatic risk reduction was seen in men with all three health factors. Men had about 70 per cent higher risk of age-adjusted mortality compared with women after adjustments for the health scores. These findings expand the knowledge on gender aspects of health factors, as we used the same methodology in both men and women.

Previous studies have shown beneficial effects of health factors in either men or women [4-6]. The findings in our study revealed that although beneficial effects were present with more health factors in both men and women, men had more additional benefit of having all three studied health factors. This is an important finding considering the overall higher age-adjusted morbidity and mortality seen in men seen in this and other studies [9, 16], indicating that this excess mortality risk may partly be possible to battle with lifestyle interventions.

The finding that moderate alcohol consumption did not decrease mortality is interesting considering the body of evidence supporting the health benefits of such consumption [3, 4, 8, 17-19]. This may be explained by the drinking pattern in Sweden in the 1960s and 1970s, with most of the alcohol consumed during the weekends as seen in “vodka belt” countries.
a pattern known as binge drinking. Thus, while drinking moderately daily prevents cardiovascular disease, drinking the whole week’s consumption on one or two occasions does not seem to reduce the mortality risk. As mentioned in the introduction, the health benefits of moderate alcohol consumption have shown conflicting results in individuals with an otherwise healthy lifestyle [7, 8]. These conflicting results can perhaps be explained by drinking pattern. For example, high blood pressure is a prevalent cardiovascular risk factor [9, 21], and alcohol in general and especially high consumption has been associated with increases in blood pressure [22, 23]. In contrast, drinking alcohol with meals was not associated with increased blood pressure in a study of New Yorkers free from cardiovascular disease [24]. This is in agreement with a meta-analysis showing slightly increased risk of coronary heart disease in occasional heavy drinkers or binge drinkers, whereas regular heavy drinkers had a risk reduction [25].

Interactions between the health factors and between men and women could possibly reveal that certain combinations are extra beneficial. Despite thorough analysis, we were not able to detect any statistically significant interactions. Considering this, there is a need to explore interactions between gender and health factors in larger populations. Furthermore, the important risk factors for cardiovascular diseases may be influenced by health factors to different degrees, and this interplay needs to be explored in order to identify the patients that have the greatest health gain from lifestyle interventions.

There are some limitations in this study. The physical examination was performed on only one occasion, which could weaken the associations, as changes in the different factors were not registered. Despite this, the healthy lifestyle factors were found to be predictive for longevity. Besides, a recent paper from the Whitehall study showed that although many variables changed over time, the baseline data were predictive for mortality [26]. We have no data on dietary factors or physical activity. However, the baseline investigation included an
exercise test. The sample was drawn with larger proportions of individuals with healthcare needs so the results are valid for a population of patients rather than the general population [27].

The strengths of the study include the high quality of population registers in Sweden, allowing us to reach the whole population and link each individual to The National Cause of Death Register. We had data on men and women which allowed a unique comparison of the healthy lifestyle factors. The baseline investigation had a high attendance rate and a long follow-up time, 26 years. The follow-up was almost complete (99%) except for some emigrants. Finally, most of the participants of this study were young, whereas many other studies have analysed lifestyle factors in older individuals. We analysed men and women in the same study and also possible interactions between health factors and gender.

**Conclusion**

A high health score is associated with longevity in both men and women. Men compared to women had greater benefit of all three health factors. This in combination with the overall higher mortality risk in men makes a healthy lifestyle more important for them. The benefit of moderate alcohol consumption could not be detected in this study, and may be explained by an unhealthy drinking pattern.

**Funding** The study was supported by the Stockholm County Council.

**References**


Table 1 Basic characteristics are shown in men and women in relation to all-cause mortality

<table>
<thead>
<tr>
<th>Variable</th>
<th>Alive men</th>
<th>Dead men (%)</th>
<th>Alive Women</th>
<th>Dead women (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate alcohol consumption</td>
<td>286</td>
<td>76 (21%)</td>
<td>432</td>
<td>72 (16%)</td>
</tr>
<tr>
<td>Non-moderate alcohol consumption</td>
<td>190</td>
<td>45 (19%)</td>
<td>65</td>
<td>8 (11%)</td>
</tr>
<tr>
<td>Being a non-smoker</td>
<td>197</td>
<td>41 (17%)</td>
<td>264</td>
<td>47 (15%)</td>
</tr>
<tr>
<td>Smoker</td>
<td>279</td>
<td>80 (22%)</td>
<td>233</td>
<td>33 (12%)</td>
</tr>
<tr>
<td>Being physically fit</td>
<td>252</td>
<td>34 (12%)</td>
<td>210</td>
<td>16 (7%)</td>
</tr>
<tr>
<td>Being unfit</td>
<td>224</td>
<td>87 (28%)</td>
<td>287</td>
<td>64 (18%)</td>
</tr>
<tr>
<td>Having a healthy BMI</td>
<td>441</td>
<td>102 (19%)</td>
<td>473</td>
<td>70 (13%)</td>
</tr>
<tr>
<td>BMI ≥0</td>
<td>35</td>
<td>19 (35%)</td>
<td>24</td>
<td>10 (29%)</td>
</tr>
<tr>
<td>0 Healthy lifestyle factors</td>
<td>10</td>
<td>7 (41%)</td>
<td>5</td>
<td>1 (17%)</td>
</tr>
<tr>
<td>1 Healthy lifestyle factors</td>
<td>136</td>
<td>57 (30%)</td>
<td>128</td>
<td>32 (20%)</td>
</tr>
<tr>
<td>2 Healthy lifestyle factors</td>
<td>236</td>
<td>51 (18%)</td>
<td>273</td>
<td>40 (13%)</td>
</tr>
<tr>
<td>3 Healthy lifestyle factors</td>
<td>94</td>
<td>6 (6%)</td>
<td>91</td>
<td>7 (7%)</td>
</tr>
</tbody>
</table>

Moderate alcohol consumption defined as a weekly consumption of 70–210g for men and 70–140g for women and non-moderate alcohol consumption below or above these values, being physically fit was defined as having above median VO2 max, i.e. above 30mL/kg/min.
and a healthy BMI was defined as having a BMI below 30. The score of healthy lifestyle factors included: being a non-smoker, being physically fit and having a healthy BMI.
Table 2 Hazard ratios (HR 95% CI) for total mortality risk of individual and combined health factors in men and women. Age-adjusted model and fully adjusted models of the important variables based on findings from the age-adjusted model.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Age-adjusted Men</th>
<th>Full Model Men</th>
<th>Age-adjusted Women</th>
<th>Full Model Women</th>
<th>Age- &amp; sex-adjusted All</th>
<th>Full Model All</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HR (95% CI)</td>
<td>HR (95% CI)</td>
<td>HR (95% CI)</td>
<td>HR (95% CI)</td>
<td>HR (95% CI)</td>
<td>HR (95% CI)</td>
</tr>
<tr>
<td>Moderate alcohol consumption</td>
<td>1.01 (0.70–1.47)</td>
<td>excluded</td>
<td>1.57 (0.75–3.26)</td>
<td>excluded</td>
<td>1.12 (0.81–1.55)</td>
<td>excluded</td>
</tr>
<tr>
<td>Being a non-smoker</td>
<td>0.48 (0.33–0.71)</td>
<td>0.45 (0.31–0.67)</td>
<td>0.59 (0.37–0.94)</td>
<td>0.53 (0.33–0.85)</td>
<td>0.53 (0.40–0.71)</td>
<td>0.50 (0.38–0.68)</td>
</tr>
<tr>
<td>Being physically fit</td>
<td>0.61 (0.39–0.94)</td>
<td>0.68 (0.43–1.06)</td>
<td>0.69 (0.38–1.24)</td>
<td>0.61 (0.33–1.12)</td>
<td>0.67 (0.47–0.95)</td>
<td>0.69 (0.49–0.98)</td>
</tr>
<tr>
<td>Having a healthy BMI</td>
<td>0.38 (0.23–0.65)</td>
<td>0.35 (0.21–0.59)</td>
<td>0.71 (0.36–1.39)</td>
<td>0.72 (0.36–1.42)</td>
<td>0.49 (0.33–0.73)</td>
<td>0.47 (0.31–0.71)</td>
</tr>
<tr>
<td>Male sex</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>1.77 (1.33–2.35)</td>
<td>1.63 (1.22–2.17)</td>
</tr>
</tbody>
</table>

Moderate alcohol consumption defined as a weekly consumption of 70–210g for men and 70–140g for women and non-moderate alcohol consumption below or above these values was used as reference, being physically fit was defined as having above median VO2 max, i.e. above 30mL/kg/min and a healthy BMI was defined as having a BMI below 30 and BMI≥30 was used as reference. Alcohol consumption was excluded from the full models as it was non significant and did not change results.
**Table 3** Hazard ratios (HR 95% CI) for total mortality risk of a combined health factor score in men and women. The hazard ratios are adjusted for age in 5-year intervals

<table>
<thead>
<tr>
<th>Health score</th>
<th>Full Model Men</th>
<th>Full Model Women</th>
<th>Full Model All</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HR (95% CI)</td>
<td>HR (95% CI)</td>
<td>HR (95% CI)</td>
</tr>
<tr>
<td>0–1 Factors</td>
<td>reference</td>
<td>reference</td>
<td>reference</td>
</tr>
<tr>
<td>2 Factors</td>
<td>0.55 (0.37–0.80)</td>
<td>0.46 (0.29–0.74)</td>
<td>0.52 (0.39–0.70)</td>
</tr>
<tr>
<td>3 Factors</td>
<td>0.17 (0.074–0.41)</td>
<td>0.41 (0.18–0.95)</td>
<td>0.27 (0.15–0.48)</td>
</tr>
<tr>
<td>Male sex</td>
<td>–</td>
<td>–</td>
<td>1.67 (1.26–2.23)</td>
</tr>
</tbody>
</table>

The score of health factors included: being a non-smoker, being physically fit and having a healthy BMI.