International Journal of Cardiology 168 (2013) 946–952

Contents lists available at ScienceDirect

International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard

Seven modifiable lifestyle factors predict reduced risk for ischemic cardiovascular disease and all-cause mortality regardless of body mass index: A cohort study

Axel C. Carlsson [a,b,*], Per E. Wändell [b], Bruna Gigante [a], Karin Leander [a], Mai-Lis Hellenius [c], Ulf de Faire [a]

[a] Division of Cardiovascular Epidemiology, Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden
[b] Centre for Family Medicine, Department of Neurobiology, Care Sciences and Society, Karolinska Institutet, Huddinge, Sweden
[c] Department of Medicine, Karolinska Institutet and Karolinska University Hospital Solna, Stockholm, Sweden

ARTICLE INFO

Article history:
Received 7 June 2012
Received in revised form 27 August 2012
Accepted 28 October 2012
Available online 22 November 2012

Keywords:
Alcohol consumption
Tobacco smoking
Physical activity
Fruit and vegetable consumption
Fish intake
Processed meat

ABSTRACT

Objectives: A healthy lifestyle has an impact on cardiovascular health. Yet, the importance of body mass index (BMI) and gender remains less clear. The aim of this study was to investigate whether healthy lifestyle factors can predict incident cardiovascular disease (CVD) and all-cause mortality.
Methods: Representative population-based prospective cohort study of 60-year-old women (n = 2193) and men (n = 2039). The following factors related to a healthy lifestyle were assessed using a questionnaire: non-smoking, alcohol intake of 0.6–30 g/day, moderate physical activity at least once a week, low intake of processed meats, weekly intake of fish, daily intake of fruit, and daily intake of vegetables. These factors were combined to produce a total score of healthy lifestyle factors (0–7) and classified into four groups: unhealthy (0–2 lifestyle factors), intermediate (3), healthy (4–5), and very healthy (6–7). National registers enabled identification of incident CVD (n = 375) and all-cause mortality (n = 427) over a follow-up of 11 years.
Results: Very healthy women and men exhibited a decreased risk for incident CVD compared with unhealthy individuals, with hazard ratios (HRs) and 95% confidence intervals (CIs) adjusted for educational level and BMI of 0.44 (0.26–0.75) and 0.39 (0.25–0.61), respectively. The corresponding HRs (95% CIs) for all-cause mortality for very healthy women and men were 0.25 (0.15–0.44) and 0.35 (0.23–0.54), respectively.
Conclusion: With seven healthy lifestyle factors, it was possible to identify men and women with substantially lower relative risks of incident CVD and death, regardless of BMI and educational level.

1. Introduction

A healthy lifestyle has repeatedly been shown to have an impact on health and longevity in women and men, and several factors have been combined to produce health scores in different studies [1–5]. These factors generally include: being physically active or physically fit, having a healthy diet, being a non-smoker, having a low waist/hip ratio or normal body mass index (BMI), and moderate alcohol consumption. US studies have shown impressive associations between self-reported adherence to healthy lifestyle factors and risk for developing hypertension as well as risk for sudden cardiac death in women [5,6], and risk for heart failure in men [4]. In addition, a healthy lifestyle was shown to be associated with a 77% lower relative risk for myocardial infarction (MI) in postmenopausal women [1], and similar results have been reported in men [2,7].

Because the associations between lifestyle factors and CVD in men and women have been published separately, few studies have investigated gender differences. The HALE project showed positive effects of a healthy lifestyle in both men and women [8], but the main findings were reported in sex-adjusted models only. The studies mentioned above have all included an anthropometric measure as a lifestyle component in their health score. Quantitative genetic studies of BMI in twins show that there is an environmental component of BMI that may be affected by lifestyle [9]. This means that BMI is only partly a lifestyle factor which is influenced by, for example, diet, exercise, sleep patterns, and non-exercise activity thermogenesis [10].

Thus, the aim of the present study was to evaluate a score of easy to assess healthy lifestyle factors as predictors of incident cardiovascular disease (CVD) and all-cause mortality. We also aimed to determine whether the results were valid regardless of BMI, and adjusted for anthropometric measures.

2. Methods

2.1. Study population

All men and women living in Stockholm County who were born between 1 July 1937 and 30 June 1938 were identified from a register of the population of Sweden. From August 1997 to March 1999, every third individual (male or female) was invited

* Corresponding author at: Division of Cardiovascular Epidemiology, Karolinska Institutet, Institute of Environmental Medicine, Sweden. Tel.: +46 761 745174; fax: +46 8 52488706.
E-mail address: axelcefam@hotmail.com (A.C. Carlsson).

0167-5273/$ – see front matter © 2012 Elsevier Ireland Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.ijcard.2012.10.045

by mail to participate in a cardiovascular and metabolic health-screening study. Of 5460 individuals invited to participate, 4232 (78%) agreed to do so. About 20% of the study subjects were immigrants, mostly from European countries. The study was approved by the ethics committee at the Karolinska Institutet. The authors of this manuscript have certified that they comply with the Principles of Ethical Publishing in the International Journal of Cardiology.

2.2. Baseline investigation

BMI was calculated from weight and height measurements [11]. Blood pressure was measured twice after 5 min of rest and the mean of the two measurements was calculated. Blood samples were drawn in the morning after overnight fasting. Serum levels of glucose and lipids were analyzed using enzymatic methods, as previously reported [12].

The presence of CVD was determined using the questionnaire. Diabetes was defined as self-reported diabetes, use of antidiabetic medication, or a fasting serum glucose ≥7.0 mmol/l [12]. All participants were classified as current smokers or non-smokers. Alcohol intake was calculated and converted to average absolute alcohol consumed in g/day. Leisure time physical activity during the past year was categorized as: inactive, light activity for at least 2 h/week, moderate activity once or twice per week, and intense activity three or more times each week. Dietary questions concerned the frequency of intake of fruit, vegetables, and fish. In addition, the frequency of eating processed meat (defined as sausages and bacon) as a main course was evaluated. Educational level was classified as compulsory school education (≤9 years), secondary/12-year school (9–12 years), and university or college (>12 years).

2.3. Lifestyle score

We created a healthy lifestyle score similar to that of previous studies, but without a separate diet score as one of the components [1,2,4,5]. To increase the possible clinical utility of our findings, all lifestyle components in our score were easily assessed with single questions requiring yes/no answers. We did not include any anthropometric measures; instead we adjusted for BMI. Based on previously reported preliminary analyses or cross-sectional findings from the baseline investigation of this study of associations between lifestyle factors and newly diagnosed diabetes [13], newly diagnosed high blood pressure [14], hypertension control [15], blood lipids [12], and the metabolic syndrome,[16] the following healthy lifestyle factors were included: non-smoking, alcohol intake of 0.6–30 g/day, leisure time physical activity at least once a week, weekly intake of fish, eating processed meats as a main meal less than once a week, eating fruit daily, and eating vegetables daily. As shown in Table 1, these seven factors can be assessed easily with questions, and the number of "yes" answers formed the healthy lifestyle score. The score from a maximum of seven possible healthy lifestyle factors was divided into four lifestyle groups: unhealthy (none, one, or two healthy lifestyle factors; 0–2), intermediate (three healthy lifestyle factors; 3), healthy (four or five healthy lifestyle factors; 4–5), and very healthy (six or seven healthy lifestyle factors; 6–7).

2.3.1. Outcomes

A composite endpoint of first-time ischemic CVD events, using data from the In Hospital Care Register and the Cause of Death Register in Sweden, and all-cause mortality. The mean follow-up duration was 11 years. The ischemic CVD outcome included all fatal and non-fatal MI, fatal and non-fatal ischemic stroke, and hospitalizations due to angina pectoris as the primary cause (International Classification of Diseases 10th revision codes: I20, I21, I25, I46, I63, I64, I65, and I66).

2.4. Statistical analysis

No age adjustments were necessary in the analyses as all men and women in the Stockholm cohort were 60 years of age. For medical and anthropometric baseline characteristics as well as healthy lifestyle factors, we calculated frequencies or mean values and standard deviations in men and women, subdivided into the healthy lifestyle groups. Significant differences were calculated by ANOVA (mean values) or the chi-square test (frequencies). A power calculation for Cox regression was performed post hoc (80% power and one-sided alpha to detect a 50% reduced risk).

Table 1
Seven questions to assess a healthy lifestyle.

1. Are you a non-smoker?
2. Do you drink between one alcoholic drink/month and three alcoholic drinks/day?
3. Do you participate in moderate or intense physical activity once a week or more?
4. Do you eat processed meats as a main meal more seldom than once a week?
5. Do you eat fish at least once every week?
6. Do you eat fruit every day?
7. Do you eat vegetables every day?

The sum of the score of "yes" answers to these seven questions can be used to estimate the risk of CVD and all-cause mortality.

Kaplan–Meier curves were estimated. Participants with known CVD at baseline were excluded from calculations of the relative risk of incident CVD. Cox regression was used to calculate hazard ratios (HRs) with 95% confidence intervals (CIs) for incident CVD and all-cause mortality. Unadjusted models are shown in men and women separately. Adjustments were made for educational level (categorical variable) in Model A, and for educational level (categorical variable) and BMI (continuous variable) in Model B. The significance levels (two-sided tests) are indicated as follows: * $p<0.05$, ** $p<0.01$, and *** $p<0.001$. Stata 11.2 (Stata Corporation, College Station, TX, USA) was used for all calculations.

3. Results

Follow-up evaluation of data from the cause of death register resulted in 427 (269 men and 158 women) deaths due to all causes. Participants with missing data on diseases in the baseline questionnaire (n = 122), and those with CVD at baseline (n = 369) were not included in the analyses of incident CVD outcome, thus 1990 women and 1751 men were included. During the follow-up period (mean 10.85 years, range 0.15–12.93), incident CVD was recorded in 240 men and 135 women.

We had power to detect 50% relative risk reductions in men and in all calculations in women except in the comparisons between unhealthy and intermediately healthy.

Tables 2a and 2b show the mean values for clinical and anthropometric baseline data in women and men, respectively, in the different healthy lifestyle groups. The cardiometabolic risk pattern differed between men and women. Women with many healthy lifestyle factors had significantly higher HDL and lower triglyceride and glucose levels. The frequency of diabetes was also lower in women with many healthy lifestyle factors. BMI, systolic blood pressure, and low-density lipoprotein did not differ significantly with regard to healthy lifestyle factors in women. However, significantly lower BMI, systolic blood pressure, and triglyceride levels were seen in men with more healthy lifestyle factors.

Fig. 1 shows Kaplan–Meier curves for all-cause mortality in women (A) and men (B). In general, a higher mortality rate was noted in men. There was also a tendency toward similar survival with 0–2 or 3 healthy lifestyle factors in women; there were obvious differences between all other groups in both women and men. A clear pattern of higher survival in individuals with many healthy lifestyle factors was observed. Similar slopes were seen throughout the study period in the different healthy lifestyle groups in women and men.

Tables 3a and 3b show Cox regression models with incident ischemic CVD or all-cause mortality as outcome and number of healthy lifestyle factors as the explanatory variable in women and men, respectively. The healthy lifestyle factor score predicted survival in both women and men for both outcomes; however, wider confidence intervals were seen in women due to fewer cases of incident CVD and deaths compared with men. Men in the intermediate group (3 healthy lifestyle factors) had a significantly reduced risk of CVD; the point estimate was similar in women in this group but was not significant. Having 4–5 and 6–7 healthy lifestyle factors was similarly significantly associated with decreased incident CVD in women: HR 0.43 (95% CI 0.27–0.71) and 0.39 (95% CI 0.23–0.65), respectively. However, in men, the HR for incident ischemic CVD decreased from 0.61 (95% CI 0.44–0.84) for 4–5 healthy lifestyle factors to 0.37 (95% CI 0.24–0.57) for 6–7 factors.

For all-cause mortality, there were significant risk reductions in both men and women using 0–2 factors as the reference. The HR was 0.48 (95% CI 0.32–0.72) in women and 0.42 (95% CI 0.31–0.56) in men with 4–5 healthy lifestyle factors. Further reduction in HR to 0.27 (95% CI 0.16–0.43) in women and 0.29 (95% CI 0.19–0.45) in men was seen in participants with 6–7 healthy lifestyle factors.

Although some associations were marginally weakened, all the above findings remained significant after adjustments for educational level and BMI. After adjustment for lifestyle, each unit increment in