Association between changes in lifestyle and all-cause mortality: The Health and Lifestyle Study

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What is already known on this subject

It is well established that an unhealthy lifestyle comprising of smoking, excess alcohol intake, physical inactivity and low fruit and vegetable consumption is associated with an increased risk of premature mortality.

Little is known about the combined influence of changes in these behaviors on mortality risk.

What this study adds

In this cohort study of UK adults, 7.3% of participants with none and 43.1% of those with all four unhealthy lifestyle factors, comprising smoking, excess alcohol intake, physical inactivity and low fruit and vegetable consumption in the two surveys, died during follow-up. Unhealthy changes in lifestylewere associated with an increased risk of mortality. Healthy changes in lifestyle were not associated with reduced mortality.

Abstract

Background: To examine the combined influence of changes in physical activity, diet, smoking, and alcohol consumption on all-cause mortality.

Methods: Health behaviors were assessed in 1984/5 and 1991/2 in 8,123 adults from the United Kingdom (4,666 women, median age, 41.0 years). An unhealthy lifestyle score was calculated, allocating one point for smoking, fruits and vegetables < 3 times a day, physical activity < 2 hours a week, and > 14 units (women) or >21 units of alcohol (men) per week.

Results: There were 2,003 deaths over a median follow-up of 6.6 years (interquartile range, 5.9, 7.2) following the resurvey. The modal change in the unhealthy lifestyle score was zero, 41.8% had the same score, 35.5% decreased, and 22.7% increased score between surveys. A one unit decrease in the unhealthy lifestyle score was not associated with a beneficial effect on mortality (hazard ratio (HR) = 0.93; 95% confidence interval (CI) = 0.83, 1.04). A one unit increase in the unhealthy lifestyle score increased the risk of mortality (adjusted HR = 1.09; 95% CI = 1.01, 1.18).

Conclusions: In this general population sample, the adoption of an unhealthy lifestyle was associated with an increased risk of mortality.

Introduction

Health behaviors, including smoking,[1] physical inactivity,[2] excess alcohol intake,[3] and diets low in fruits and vegetables,[4] are well-documented risk factors for premature mortality. Reductions in mortality risk have been associated with smoking cessation,[5] increases in physical activity,[6, 7] and fruit consumption,[7, 8] but very few studies have examined changes in these behaviors combined. Of the two studies, one cohort study,[9] and an analysis based on the control arm of a randomized colorectal screening trial,[10] found unhealthy changes in lifestyle (BMI<30 kg/m^2; non-smoking, physically active and a healthy diet) were associated with increases in mortality risk. For healthy changes, one study found the risk of mortality improved[10] whereas the other did not. [9] However, these studies characterized obesity, which is an established risk factor for mortality,[11] as part of a healthy lifestyle and did not investigate the contribution of each component of lifestyle to the association with mortality. Accordingly, we carried out analysis into the association between changes in lifestyle (smoking, physical inactivity, excess alcohol intake, poor diet) and the risk of all-cause mortality in a well described general population-wide sample of adults.

Methods

This manuscript adheres to the STROBE guidelines on the reporting of observational studies.[12] We used data from the Health and Lifestyle Survey I (1984/5) and II (1991-1992), a prospective cohort of people resident in England, Wales, and Scotland in 1984. In survey I, 12,254 households were randomly selected from electoral registers and visited. One person aged ≥18 years was selected from each household and 9,003 were interviewed. In survey II, participants were traced and interviewed at home. Local research ethics committees approved the studies and participants gave written informed consent. [13]

In study I and II, an interviewer assessed participants' current smoking status (current smokers versus former/never smokers), alcohol consumption (≥ 14 for women/ ≥21 units for men per week; abstainers were classified in the < 14/21 units group), the frequency and time spent in 17 leisure time physical activities (≥2 hours a week), and the frequency of consuming eight types of fruit and vegetables (≥ 3 times a day over the past year). We calculated an unhealthy lifestyle score (range 0 to 4) by summing the number of behaviors present in both surveys, as calculated previously. [14] We then computed a score representing the change in the number of unhealthy behaviors at study II minus the number in study I (range = -4 to +4).

Data on the current or most recent occupation were used to derive occupational social class. [15] Lifetime diagnoses of a physical health condition by a physician were reported during the interview in participants homes and included heart conditions (heart disease, angina, previous heart attack); respiratory diseases (asthma, bronchitis, emphysema, tuberculosis, other disease of the respiratory system); gastrointestinal diseases (stomach ulcer, other diseases of gastrointestinal system), diabetes and arthritis. Height, weight, blood pressure, force expiratory volume in 1 second (FEV^1 in ml) and cognitive function (prospective memory, reasoning, simple and choice reaction time) were measured during a visit by a research nurse using standard protocols.

The outcome all-cause mortality was ascertained for consenting study members (8,671; 96.3% of eligible participants) by linking to the UK National Health Service mortality register up to June 2009.

Statistical Analysis

We imputed missing data using multiple imputation by chained equations to generate 10 imputed data-sets. We compared the characteristics of participants at survey I who did and did not provide data in survey II using chi-square test and t-tests. We then used Cox proportional hazards models to estimate the association between changes in the unhealthy lifestyle score and all-cause mortality. We found no interactions by age, sex or ethnicity so pooled data across these groups. We estimated hazard ratios for a one-unit increase in the unhealthy lifestyle score between study one and two. This assessment assumes a linear effect for both healthy and unhealthy changes. To test this assumption, we conducted separate analyses comparing people with no change as the reference group, to those whose had increased or decreased by 1, 2, and 3-4 unhealthy behaviors combining 3-4 behaviors as only 0.08% participants score had increased or decreased by +/- 4 behaviors. We then calculated the sum of the unhealthy behaviors in both surveys, plotted Kaplan–Meier failure curves for each score and compared them with the log-rank test. The proportional hazards assumption was checked using Schoenfeld residuals.

Sensitivity analyses were conducted after excluding participants with any missing data, participants with poor physical health, deaths occurring in the first five years after survey II (to explore reverse causality whereby imminent death/terminal illness prompts a change in health behaviors), after removing each behavior from the lifestyle score to examine whether any single behavior accounted for associations, and after adjusting for only age, sex and ethnicity. All analyses were conducted using Stata version 13.

Results

Of the 9,003 baseline participants (73.5% of target population recruited in survey I), 5,352 (59.4%) took part in survey II. We excluded those study members who had died between surveys (n= 880). Participants with data at both surveys were more likely in survey I to be younger, male, white, have a managerial occupation, married, be physically active, a lower systolic blood pressure, FEV^1, memory and reasoning score, but less likely to have arthritis, diabetes, a respiratory disease, a heart condition or smoke, than those who did not. The resulting analytical sample had 8,123 participants (4,666 women, median age, 41.0 years (interquartile range, 30.0, 56.0)).

There were 2,003 deaths over a median follow-up of 6.6 years (interquartile range, 5.9, 7.2) following the resurvey. The modal change in the unhealthy lifestyle score was zero with 41.8% of participants having the same score, 35.5% decreasing, and 22.7% increasing score between surveys. Only 0.06% did not have one unhealthy behavior in both surveys. In general, relative to those without any unhealthy behaviors, people with more unhealthy behaviors were older, and were more likely to have an unskilled occupation, and be in worse physical health (online supplementary table 1).

The adjusted hazard ratio for a one-unit change in unhealthy lifestyle score was 1.09 (95% CI: 1.01, 1.18). There was a difference in the association between changes in unhealthy lifestyle and mortality: decreases had less impact on mortality risk (HR per one unit decrease, 0.93, 95% CI: 0.83, 1.04) than increases (HR per one unit increase, 1.15, 95% CI: 1.03, 1.29, Figure 1). The unadjusted Kaplan–Meier curve shows mortality risk increasing with the sum of the unhealthy lifestyle scores from both surveys (log rank = 142.42; $p<0.0001$; Figure 2).

We re-ran the analysis in the 3,163 participants without any missing data, after excluding 1,370 participants with any health condition, the 773 deaths that occurred in the first five years of follow-up, each behavior from the unhealthy lifestyle score, as well as after adjusting for only age, sex and ethnicity and found essentially the same results (online supplementary tables 2 to 6).

Discussion

In this population-wide cohort study, changing to an unhealthier lifestyle was associated with an increased risk of mortality. Adopting a healthier lifestyle was not associated with a beneficial effect on mortality.

A meta-analysis of 18 cohort studies with a single baseline assessment of health behaviors found one fewer of smoking, physically inactivity, excess alcohol intake, obesity or poor fruit and vegetable intake reduced the risk of mortality by between 21-31%.[16] In the NORCCAP colorectal screening trial a one unhealthy behavior decrease was associated with a larger effect on mortality (hazard ratio = 0.62) than those found in the current study (hazard ratio = 0.93) and exclusion of people reporting chronic disease or severe pain did not attenuate this estimate.[10] The attenuation we observed after excluding a more comprehensive range of diagnoses suggests poor physical health may prompt both the adoption of an unhealthy lifestyle and increase the risk of mortality. We also replicated the finding from Doetinchem cohort study, which found no beneficial effect of improving lifestyle on mortality. [9] While it would be premature to change guidance on lifestyle change, if this association is causal, one implication is that more emphasis is needed on the benefits of preventing unhealthy changes in lifestyle than is currently provided.

A major strength of this study is its generalizability. The use of electoral registers to select men and women from a wide age range of aged 18 to 93 is unlikely to have resulted in selection bias as most adult have a residence. This hypothesis is supported by previous analyses, which found no differences in the association between risk factors at study one and cardiovascular mortality in participants who did and did not participate in study two.[17] We also extend literature by including excess alcohol consumption in the assessment of an unhealthy lifestyle. The main limitation of this study is loss to follow-up. However, sensitivity analysis comparing complete case with imputed datasets provided no evidence that missing data introduced bias.

In conclusion, in this population-wide cohort, changing to an unhealthier lifestyle was associated with an increased risk of mortality.

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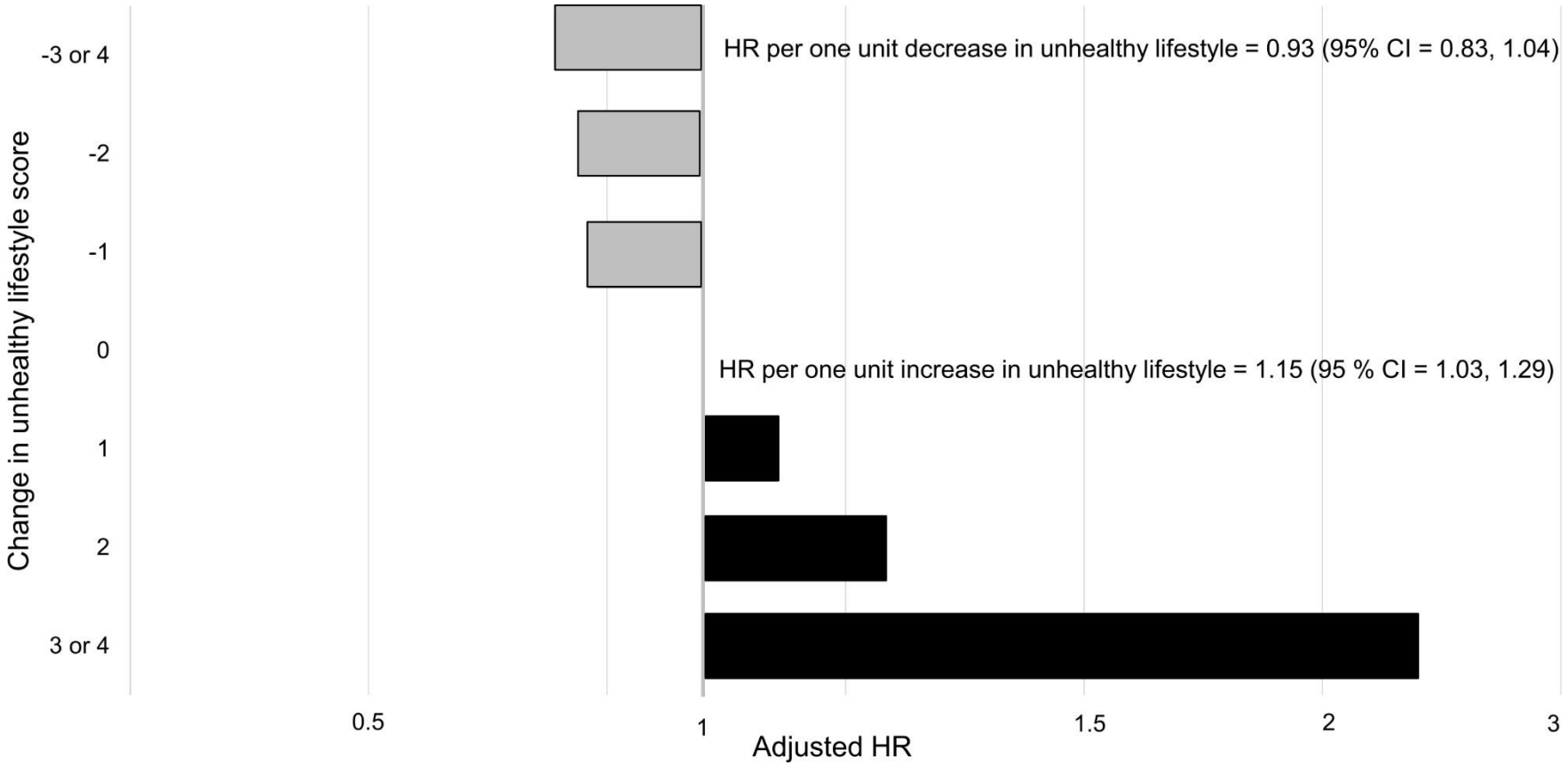

Figure 1. Change in the unhealthy lifestyle score between 1984/5 and 1991/2 and the risk of mortality

Grey bars show adjusted hazard ratios (HRs) for decreases in the number of unhealthy behaviors. No change number of unhealthy behaviors (zero) was the reference group. Black bars show adjusted HRs for increases in the number of unhealthy behaviors. HRs were adjusted for the baseline number of unhealthy behaviors, age, sex, ethnicity, occupational social class, marital status, body mass index, systolic blood pressure, diastolic blood pressure, FEV^1, simple reaction time, choice reaction time, memory index score, visual spatial reasoning score, diagnoses of a heart condition/ stroke, respiratory disease, diabetes, gastrointestinal disease, and arthritis. BMI = Body Mass Index; FEV^1 = Forced expiratory volume in one second.

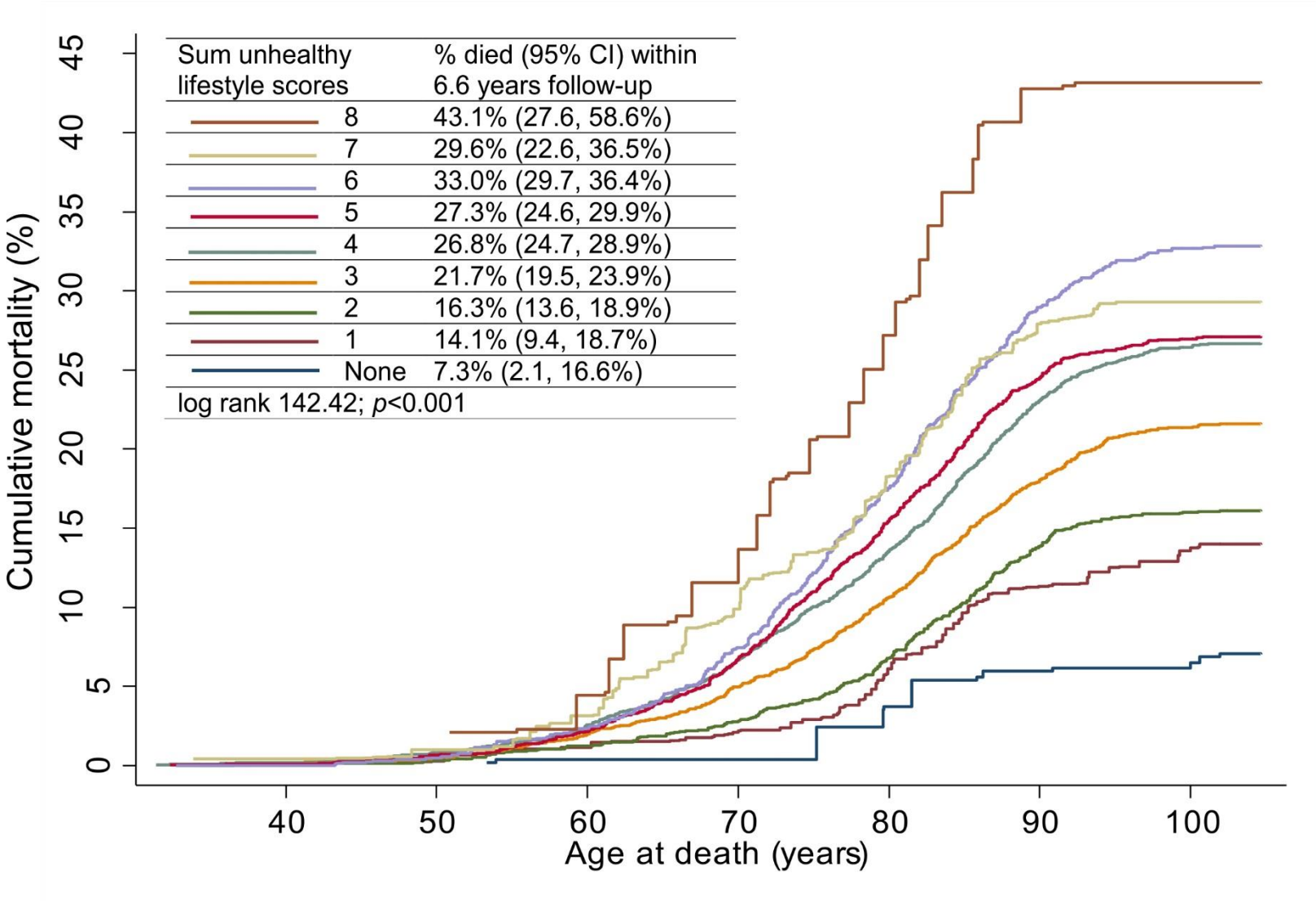

Figure 2. Kaplan-Meier failure curve for all-cause mortality according to the sum of the unhealthy lifestyle score in 1984/5 plus 1991/2