Clinical Nutrition xxx (2016) 1–5

Contents lists available at ScienceDirect

Clinical Nutrition

journal homepage: http://www.elsevier.com/locate/clnu

Original article

Adherence to healthy lifestyle factors and risk of death in men with diabetes mellitus: The Physicians' Health Study

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ARTICLE INFO

Article history:
Received 23 February 2016
Accepted 4 November 2016

Keywords:
Lifestyle
Epidemiology
Mortality
Diabetes mellitus

SUMMARY

Background & aims: The relationship between healthy lifestyle factors and mortality in people with type 2 diabetes is unclear. The purpose of this study was to examine whether healthy lifestyle factors are associated with mortality in people with type 2 diabetes.

Methods: We prospectively studied 1163 men with type 2 diabetes from the Physicians' Health Study. Lifestyle factors consisted of currently not smoking, moderate drinking (1–2 drinks/day), vigorous exercise (1+/week), BMI < 25 kg/m^2, and being in the top 2 quintiles of the alternate healthy eating index-2010 (AHEI-2010). Multivariate Cox regression models were used to estimate hazard ratios (95% confidence intervals) of mortality.

Results: At baseline, average age was 69 years and mean follow up was 9 years. About 22% of study participants had ≤1 healthy lifestyle factor, 37% had two, 29% had three, and 12% had four or more healthy lifestyle factors. An inverse relationship was found between the number of lifestyle factors and total mortality. Compared with participants who had ≤1 healthy lifestyle factor, the risk of death was 42% (95% CI; 19%–58%) lower for those with two healthy lifestyle factors, 41% (95% CI; 18%–58%) lower for those with three, and 44% (95% CI; 12%–64%) lower for those with 4 or more healthy lifestyle factors.

Conclusion: Adherence to modifiable healthy lifestyle factors is associated with a lower risk of death among adult men with type 2 diabetes. Our study emphasizes the importance of educating individuals with diabetes to adhere to healthy lifestyle factors.

1. Introduction

Type 2 Diabetes (DM) is a growing health problem in United Stated and throughout the world [1]. In 2012, 29.1 million Americans had DM, which comprises 9.3% of the US population, with 1.7 million new cases diagnosed in year 2012 [1]. The total cost of DM care in the United States was $245 billion in year 2012 [2] and an estimated 1.5 million deaths worldwide were directly related by DM [3].

Lifestyle risk modification has been a cornerstone of DM prevention as shown in Diabetes Prevention Study [4,5]. This has also been demonstrated in prospective cohort study of Physicians' Health Study, Cardiovascular Health Study, and the Nurses' Health Study, where modifiable lifestyle factors including regular exercise, healthy diet, moderate drinking, normal body weight, and not smoking were jointly associated with a lower residual lifetime risk of DM [6–8]. In patients with impaired glucose tolerance, lifestyle interventions have been shown to reduce all-cause mortality in Da Qing Diabetes Prevention Study [9]. These healthy lifestyle factors have also been associated with lower risk of all-cause mortality in healthy subjects [10,11].

However, data on the relation of individual and combined lifestyle factors on mortality in people with DM are scarce [12,13]. The answer to this question is particularly important, as the impact of lifestyle factors on outcomes might differ between people with DM and the general population free of DM. We sought to test the hypothesis that healthy lifestyle factors are inversely associated with incidence of death in subjects with DM.

2. Materials and methods

2.1. Study design

Data from the Physicians' Health Study (PHS) were used in these analyses. A detailed description of the PHS has been published

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http://dx.doi.org/10.1016/j.clnu.2016.11.003

previously [14–16]. In brief, PHS was a randomized controlled trial that used a 2 × 2 factorial design of low-dose aspirin and β-carotene in the primary prevention of cardiovascular disease and cancer. Each participant gave a written informed consent, and the Institutional Review Board at the Brigham and Women's Hospital approved the study protocol. From the 22,071 participants recruited into the PHS, we had 1163 men with prevalent diabetes at the time of PHS II enrollment (1997). Validation of self-reported diagnosis of DM in this population has been reported [8].

2.2. Ascertainment of lifestyle factors

We focused on modifiable lifestyle factors that have been shown to influence the risk of mortality in DM. These included physical activity, smoking, alcohol consumption, body mass index, and dietary habits. At baseline, each subject provided information on smoking (never, former, and current smoker); alcohol intake (servings per month, week, and day), and exercise (how often do you exercise vigorously enough to work up sweat? Possible answers included rarely/never, 1–3/month, 1/week, 2–4/week, 5–6/week, and daily). Self-reported baseline weight and height were used to calculate body mass index (weight in kilograms divided by height in meter squared). We used a 128-item food frequency questionnaire (whose validity has been published [17]) to assess diet in PHS. For each individual food item, participants were asked to report their average consumption during the past year. Possible answers were never or less than once per month; 1–3/month; 1/week; 2–4/week; 5–6/week; 1/day; 2–3/day; 4–5/day; and 6+/day. We used the alternate healthy eating index (AHEI) AHEI-2010 to assess dietary habits [18]. The components of AHEI-2010 diet score include vegetables, fruits, nuts/soy, white to red meat ratio, cereal fiber, trans fat, polyunsaturated to saturated fat ratio, multivitamin use, and alcohol intake.

2.3. Definition of lifestyle groups

To investigate the association between healthy lifestyle factors and risk of mortality in DM, each lifestyle factor was dichotomized as follows: normal weight (BMI < 25 kg/m^2) vs. overweight/obese (BMI ≥ 25 kg/m^2); non-current smoking vs. current smoking; vigorous exercise (≥1 day per week) vs. infrequent/no exercise (<1 day per week). A score of 1 is each assigned to subjects who have BMI < 25 kg/m^2, are non-current smoking, and are exercising ≥1 days per week. AHEI-2010 diet score was divided into quintiles; subjects in the upper 2 quintiles of AHEI-2010 score were considered as adhering to healthy dietary pattern and were given a score of 1. For moderate drinking, a score of 1 was assigned to self-report of up to 1–2 drinks per day as defined by US dietary guidelines and 0 otherwise. Each subject could have a minimum of 0 and a maximum of 5 healthy lifestyle factors. Since only 17 men were in categories with 5 healthy lifestyle factors, we collapsed the upper 2 categories to obtain stable estimates (referred to as 4+ groups). Thus, study participants were categorized according to the number of desirable lifestyle factors (0–1, 2, 3, and 4+).

2.4. Ascertainment of deaths

A questionnaire was mailed to participants every 6 months during the first year and annually thereafter to collect data on intervention compliance and new medical diagnoses, including death. Participants who did not return the questionnaires within 5–6 weeks were sent a follow-up questionnaire. Up to 4 questionnaires were sent to non-respondents. Last, subjects were called if they were still nonrespondents. A letter with a return postcard was also mailed to participants at the 6 month time point between annual mailings, which was to be completed if any major medical problems (e.g., death) occurred. An endpoints committee confirmed death after review of the medical records. The deaths were categorized by type as due to cardiovascular disease, coronary artery disease, stroke, or cancer and based on review of autopsy reports, death certificates, medical records, or family/next of kin report [14,16,19,20]. Details on endpoint validation in the PHS have been published [16,19,20].

2.5. Statistical analyses

Means and percentages of baseline characteristics of the study participants are presented according to the number of healthy lifestyle factors met by participants. We used Cox proportional hazard models to estimate hazard ratios (HRs) and 95% confidence intervals (CIs). We fitted crude, age-adjusted, and a multivariable models that controlled for age, history of cancer, coronary heart disease, hypertension, and congestive heart failure. P for linear trend was obtained by treating the number of healthy lifestyle factors met as ordinal variable in the Cox regression models. In secondary analyses, we examined the association of meeting each healthy factor while adjusting for others in the same regression model. Since adherence to healthy diet showed a strong inverse relation with mortality, we examined the relation of AHEI (quintiles) with total mortality by fitting Cox regression as described above. Assumptions of Cox proportional hazard models were checked using product terms of exposure and log (person-time) and were met (all P > 0.05).

All analyses were performed using SAS version 9.3 (SAS Institute Inc, Cary, North Carolina), and the alpha level was set at 0.05. All P values were 2-sided.

3. Results

During a median follow up of 9 years, 248 men died. Table 1 shows baseline characteristics of the participants according to the number of lifestyle factors met. Twenty-two percent of study participants met ≤1 lifestyle factor, thirty-seven percent met two lifestyle factors, twenty-nine percent met three lifestyle factors, and about twelve percent met four or more lifestyle factors.

In this study, there was an inverse relation between number of healthy lifestyle factors and mortality (Table 2). Compared with participants with <1 healthy lifestyle factor, male diabetic physicians with two, three, and four or more healthy lifestyle factors had a 42% (95% CI 19%, 58%), 41% (95% CI 18%, 58%), and 44% (95% CI 12%, 64%) lower risk for mortality, respectively (P = 0.005 for linear trend, Table 2), adjusting for age, history of cancer, coronary heart disease, hypertension, and congestive heart failure.

AHEI-2010 was the only statistically significant predictor of mortality among the five healthy lifestyle factors examined (adjusted HR = 0.59; 95% CI 0.44, 0.79, Table 3, comparing subjects in the top 2 quintiles to those in the bottom 3 quintiles of the AHEI-2010; adjusting for age, history of cancer, coronary heart disease, hypertension, and congestive heart failure).

In a secondary analysis, there was an inverse relation of AHEI with mortality (P for trend 0.0003, Table 4), adjusting for age, history of cancer, coronary heart disease, hypertension, and congestive heart failure.

4. Discussion

In this prospective cohort of male physicians with DM, we found an inverse relation between number of healthy lifestyle factors met and all-cause mortality.

Please cite this article in press as: Patel YR, et al., Adherence to healthy lifestyle factors and risk of death in men with diabetes mellitus: The Physicians' Health Study, Clinical Nutrition (2016), http://dx.doi.org/10.1016/j.clnu.2016.11.003