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Nut Consumption and Risk of Heart Failure in the Physicians' Health Study I

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Abstract

Background—Heart failure is highly prevalent among older adults and is associated with high cost and societal burden. While previous studies have reported beneficial effects of dietary factors on heart failure predictors, no previous study has examined whether frequent consumption of nuts is associated with a lower risk of heart failure in a large prospective cohort.

Objective—To examine the association between nut consumption and incident heart failure and determine whether such relation is modified by overweight/obesity.

Design—Prospective cohort study of 20,976 participants from the Physicians' Health Study I. Nut consumption was assessed using a simple abbreviated food questionnaire and self-reported heart failure was ascertained by follow-up questionnaires. We used Cox regression to estimate relative risks of heart failure.

Results—After an average follow-up of 19.6 years, 1,093 new cases of heart failure occurred. Nut consumption was not associated with the risk of developing heart failure in this cohort: multivariable adjusted hazard ratios (95% CI) were 1.0 (reference), 0.98 (0.83–1.15), 1.06 (0.89–1.27), and 1.014–1.22) for nut consumption of <1, 1, and 2+ servings per week, respectively (p for linear trend 0.64). The lack of a meaningful relation between nut intake and incident heart failure was seen in both lean and overweight/obese people (p for interaction 0.96).

Conclusion—Our data do not provide evidence for an association between nut consumption and incident heart failure in US male physicians. However, our data cannot rule out possible benefits of nut consumption on subtypes of heart failure not prevalent in this cohort.

Keywords

Diet; epidemiology; heart failure; nut consumption

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Author contribution
Study concept and design: Djoussé
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Introduction

Heart failure is a condition that could result from heterogeneous factors including myocardial damage, heart valve pathology, dysregulation in volume homeostasis, hormonal changes, etc. It is the leading cause of hospitalization among elderly and is associated with higher costs. At age 40 y, it is estimated that 1 in every 5 adults will develop heart failure during the remaining life time(1). Despite advances in medical and surgical management of heart failure, mortality after onset of heart failure remains high. Thus, underscoring the importance of primary prevention of this disease. Several predictors of heart failure can be influenced by modifiable lifestyle factors. For example, healthy diet, exercise, not smoking, and maintaining healthy weight have been shown to favorably influence heart failure risk factors including coronary artery disease(2–6), diabetes(7–9;9–11), and hypertension(12;13). Among dietary factors, nuts are low in sodium and also contain a variety of nutrients including mono- and polyunsaturated fatty acids, minerals such as magnesium and potassium, fiber, antioxidants, and vitamins with beneficial influence on blood pressure. Nut consumption has been previously associated with improved blood pressure(14–18), lower risk of diabetes(19), weight loss(20), and lower risk of sudden death/coronary heart disease death(21). However, it is not known whether consumption of nuts is associated with a lower risk of heart failure. The current project sought to prospectively assess whether nut consumption was associated with a lower risk of heart failure among US male physicians.

Methods

Study population

We used data from the Physicians' Health Study (PHS) I which was a randomized, double-blind, placebo-controlled trial designed to study low-dose aspirin and beta-carotene for the primary prevention of cardiovascular disease and cancer. Detailed description of the PHS I has been published(22). Of the total 22,071 participants, we excluded 615 subjects because of missing data on nut consumption; 27 subjects with prevalent heart failure at the time of exposure assessment; and 453 people who died before collection of data on nut consumption or with missing covariates. Thus, a final sample of 20,976 participants was used for current analyses. Each participant signed an informed consent and the Institutional review Board at Brigham and Women's Hospital approved the study protocol.

Nut consumption

We used an abbreviated food frequency questionnaire to obtain self-reported information on nut consumption at 12 months post-randomization (1983–1985). Participants were asked to report how often, on average, they have consumed nuts (small packet or 1 oz) during the past year (possible responses were "rarely/never", "1–3/month", "1/week", "2–4/week", "5–6/week", "daily", and "2+/day"). Due to limited number of subjects in the higher frequency categories, we combined the last 4 categories to obtain stable estimates as previously published (21). While the food frequency questionnaire was not validated in this cohort, it has been validated in several cohorts(23–26).

Ascertainment of heart failure in the PHS

Ascertainment of endpoints including heart failure in the PHS has been achieved using self-reported information on follow-up questionnaires. A questionnaire was mailed to each participant every 6 months during the first year and has been mailed annually thereafter to obtain information on compliance with the intervention and the occurrence of new outcomes including heart failure. Detailed description of heart failure validation in the PHS using the Framingham criteria(27)has been published elsewhere(28).

Other variables

Information on atrial fibrillation, coronary artery disease, valvular heart disease, hypertension, and diabetes mellitus has been collected through self-reported annual follow-up questionnaires. Data on demographics, anthropometric, history of hypercholesterolemia, and selected foods such as fruits and vegetables; breakfast cereals; physical activity; and smoking; alcohol consumption were obtained at baseline (1982 –1983).

Statistical analyses

We classified each subject into one of the following categories of nut consumption: none, < 1 per week, 1 per week, and = 2 servings per week. We computed person-time of follow up from exposure assessment (12 months post-randomization) until the first occurrence of a) heart failure, b) death, or c) date of receipt of last follow-up questionnaire. We used Cox proportional hazard models to compute multivariable adjusted hazard ratios with corresponding 95% confidence intervals using subjects in the lowest category of nut consumption as the reference group. We assessed confounding by established risk factors for heart failure. The initial model only adjusted for age (5-year categories) and a final model also controlled for body mass index (BMI), smoking (never, former, and current smokers of 1–19 and 20+ cigarettes per day), exercise (none, up to 1, 2–4, and 5+ times per week), alcohol consumption (none, <1, 1–4, 5–7, and 8+ drinks/week), multivitamin use (never, past, and current), aspirin assignment, hypercholesterolemia, fruit and vegetable intake (<5, 5–6, 7–13, and 14+ servings pr week), and prevalent diabetes. Assumptions for proportional hazard models were tested (by including main effects and product terms of covariates and logarithmic transformed time factor) and were met (all p values >0.05). In a secondary analysis, we examined whether adiposity modified the association between nut intake and heart failure by using BMI of 25 kg/m^2 as cut point to separate lean from overweight/obese subjects. We then conducted stratified analyses by adiposity status (BMI < 25 or = 25 kg/m^2) and tested statistical interaction using a product term of nut consumption and adiposity variable in a hierarchical model. All analyses were completed using SAS, version 9.1 (SAS Institute, NC). Significance level was set at 0.05.

Results

The baseline characteristics of 20,976 US male physicians according to nut consumption are presented in Table 1. The mean age of study participants was 54.6±9.4 years (range 40.7 to 87.1 y) at the time of nut consumption assessment. Of the total population, 36%, 24%, and 20% reported nut consumption with a frequency of <1 serving/week, 1 serving/week, and = 2 servings/week, respectively. Nut consumption was associated with a higher proportion of current drinkers; physical activity; breakfast cereal consumption; and with a lower proportion of current smokers and hypertension. During an average follow-up of 19.6 years, 1,093 new cases of heart failure were documented. From the lowest to the highest category of nut consumption, crude incidence rates for heart failure were 27.9, 25.3, 28.0, and 26.1 cases/10,000 person-years, respectively. There was no evidence for a statistically significant association between nut consumption and incident heart failure. Multivariable adjusted hazard ratios (95% CI) for heart failure were 1.0 (reference), 0.98 (0.83–1.15), 1.06 (0.89–1.27), and 1.01 (0.84–1.22) for nut consumption of <1 serving/week, 1 serving/week, and = 2 servings per week, respectively (p for linear trend 0.64, Table 2). In secondary analysis, nut consumption was not associated with incident heart failure in lean subjects (BMI < 25 kg/m^2) [multivariable adjusted hazard ratios (95% CI) of 1.0 (reference), 0.96 (0.75–1.24), 1.11 (0.85–1.46), and 1.00 (0.75–1.32) from the lowest to the highest category of nut consumption, respectively, p for trend 0.70] or overweight and obese subjects [corresponding multivariable adjusted hazard ratios (95% CI) of 1.0 (reference), 0.98 (0.79–1.23), 1.03 (0.81–1.30), and 1.01 (0.78–1.31), respectively, p for trend 0.80]. P value for interaction between nut consumption and obesity status was 0.96.

Discussion

In this prospective study, we demonstrated that nut consumption was not associated with incident heart failure in apparently healthy US male physicians. In addition, such relation was not modified by overweight/obesity status. To the best of our knowledge, this is the first large epidemiological study to evaluate whether nut consumption is associated with the risk of heart failure. The lack of an association between nut consumption and heart failure risk is contrary to our a priori hypothesis of a lower risk of heart failure with frequent nut consumption and merits some comments.

Our inability to further differentiate the type of heart failure (with and without preserved left ventricular function) or conditions leading to heart failure development in this study prevent us from examining the relationship between nut consumption and heart failure subtypes. In addition, we did not have detailed information on types of nuts consumed (i.e. cashews, almonds, hazelnuts, walnuts, almonds, etc) to assess the amounts of saturated, polyunsaturated, monounsaturated fatty acids, and other nutrients provided by nuts. For example, walnuts would have more omega-3 fatty acids than macadamias nuts, which would contain more monounsaturated fatty acids. In addition, we did not have data on the preparation of nuts such as salted, spiced, roasted, or raw nuts to examine the influence of the preparation method on the risk of heart failure. Since study participants were physicians, it is less likely that consumption of salted nuts was important in this population given the positive association between sodium intake and hypertension. It is possible that overall, nut consumption does not have a meaningful influence on the risk of heart failure. Alternatively, because of their medical knowledge, participants at risk of heart failure (those with diabetes, hypertension, coronary heart disease, or left ventricular dysfunction) may have been more likely to consume nuts given previous reports on beneficial effects of nut consumption on diabetes(19), weight control (20), coronary artery disease(21), or blood pressure(17;18). Such scenario would bias the association towards the null and be consistent with our data. With a single measurement of nut consumption at baseline, it is difficult to disentangle such hypothesis.

Additional limitations of our study include the inability to generalize of our findings to the general population since our participants consisted solely of male physicians who may have different lifestyle habits than the general population; the inability to account for changes in frequency of nut consumption over time; possible over- or underreporting of nut consumption; and the lack of data on other foods and energy intake in this population to account for confounding by other dietary factors. However, our study has major strengths including the large sample size, a 20-year follow up, and a standardized and comprehensive ascertainment of outcomes in this cohort.

In conclusion, our data do not provide evidence for an association between nut consumption and the risk of incident heart failure among US male physicians. However, given the heterogeneity of heart failure syndrome, the current study cannot rule out possible beneficial effects of nut consumption certain subtypes of heart failure (i.e. heart failure due to diabetic causes).

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Table 1

Baseline characteristics of 20,976 US male physicians according to nut consumption*

	0 (N=4,229)	< 1/week (N=7,625)	1/week (N=4,961)	2+/week (N=4,161)	P for trend
Age (y)	55.4±9.8	54.3±9.4	54.3 ±9.3	54.7±9.4	**0.005**
Body mass index (kg/m^2)	24.8±2.9	24.8±2.8	24.9±2.8	24.6±2.6	**0.015**
Fruits & vegetables (serving/d)	1.1±0.7	1.1±0.7	1.2±0.7	1.2±0.7	**<0.0001**
Current smoking (%)	12.4	10.6	10.4	10.4	**0.008**
Current drinking (%)	70.0	74.6	76.0	74.9	**<0.0001**
Randomized to aspirin (%)	50.4	49.9	49.1	50.8	**0.94**
Exercise (%)	81.9	86.7	88.5	88.7	**<0.0001**
Coronary heart disease (%)	2.9	2.4	2.0	2.4	**0.09**
Atrial fibrillation (%)	1.5	1.6	1.9	1.8	**0.16**
Hypertension (%)	26.6	24.4	23.3	21.6	**<0.0001**
Valvular heart disease (%)	0.3	0.3	0.4	0.3	**0.72**
Diabetes mellitus (%)	3.5	2.8	2.8	3.6	**0.66**
Breakfast cereal intake (%)	59.1	66.7	72.2	71.5	**<0.0001**
Current use of multivitamins (%)	20.1	19.0	19.5	21.6	**0.05**

* Data are presented as mean ± standard deviation or percentages. P for linear trend using linear regression for continuous variables and logistic regression for categorical variables.

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Table 2

Hazard ratios (95%CI) for heart failure according to nut consumption

Nut intake	Cases	Hazard ratios (95% CI)	
		Age-adjusted	Multivariable Model*
None	225	1.0	1.0
<1/week	380	0.97 (0.82–1.14)	0.98 (0.83–1.15)
1/week	274	1.06 (0.89–1.26)	1.06 (0.89–1.27)
2+/week	214	0.96 (0.79–1.15)	1.01 (0.84–1.22)
P for trend		0.98	0.64

*Adjusted for age (<45, 45–49, 50–54, 55–59, 60–64, 65–69, and 70+), body mass index (continuous), smoking (never, former, and current smokers of 1–19 and 20+ cigarettes/d), valvular heart disease, atrial fibrillation, history of diabetes, hypertension, coronary heart disease, aspirin arm, multivitamin (never, past, current), history of hypercholesterolemia, alcohol consumption (<1, 1–4, 5–7, and 8+ drinks/week), fruit and vegetable consumption (<5, 5–6, 7–13, and 14+ servings pr week), and exercise (none, = 1, 2–4, and 5+ per week).