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Nut consumption, weight gain and obesity: Epidemiological evidence

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Abstract *Background and aims:* Short-term trials support that adding tree nuts or peanuts to usual diets does not induce weight gain. We reviewed the available epidemiological evidence on long-term nut consumption and body weight changes. We also report new results from the SUN ("Seguimiento Universidad de Navarra") cohort.
Methods and results: Published epidemiologic studies with ≥1-yr follow-up were located. Two published reports from large cohorts (SUN and Nurses Health Study-2) showed inverse associations between frequency of nut consumption and long-term weight changes. A beneficial effect of a Mediterranean diet supplemented with tree nuts on waist circumference was reported after 1-yr follow-up in the first 1224 high-risk participants in the PREDIMED ("PREvencion DIeta MEDiterranea") trial. After assessing 11,895 participants of the SUN cohort, a borderline significant (p value for trend = 0.09) inverse association between baseline nut consumption and average yearly weight gain (multivariate-adjusted means = 0.32 kg/yr (95% confidence interval: 0.22—0.42) and 0.24 (0.11—0.37) kg/yr for participants with no consumption and >4 servings/week, respectively) was found after a 6-yr follow-up.
Conclusions: Consumption of nuts was not associated with a higher risk of weight gain in long-term epidemiologic studies and clinical trials.

Introduction

Overweight, obesity and age-related weight gain are major health problems in developed countries and are strongly related to dietary habits [1]. Rapidly increasing rates of overweight and obesity in most countries highlight that the primary determinant of obesity development comes from behavioral and dietary changes rather than from genetic factors [2,3]. Increasing trends of overweight/obesity with potentially devastating long-term consequences underline the importance of understanding the role of key food items in the prevention of age-related weight gain. Tree nuts or

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peanuts (which actually are legumes) can be a good candidate to prevent obesity and obesity-related metabolic and cardiovascular diseases. Several epidemiological studies have reported that frequent nut consumption is inversely associated with fatal and nonfatal coronary heart disease [4–7]. A recently published pooled analysis of 25 feeding studies with different nuts supported also a consistent cholesterol-lowering effect of nut consumption [8]. Epidemiological studies suggest that nut consumption protects against the development of diabetes in women [9] and against hypertension in men [10]. In a cross-sectional assessment of 847 participants in one of the centers of the PREDIMED study, nut consumption was inversely associated with adiposity measures (BMI and waist circumference) independently of other factors. The adjusted models predicted that BMI and waist circumference decreased by 0.78 kg/m^2 and 2.1 cm, respectively, for each daily serving of 30 g of nuts [11].

Despite these findings, since nuts are energy-dense foods with a high-fat content, there is still a fear that their consumption may lead to unwanted increases in body weight and to a higher long-term risk of developing overweight or obesity. However, available metabolic studies and short-term controlled feeding trials support that adding nuts to usual diets does not induce weight gain, despite an expected increase in total caloric intake. Some small trials have also suggested that isocaloric replacement of other food items by nuts may reduce body weight and fat mass [12]. However, these studies only assessed the short-term effects of nuts in small groups of volunteers and did not assess the association of nut consumption with long-term ($\geq$1 yr) weight changes or with the risk of developing overweight/obesity in the subsequent years.

Therefore, the aim of our study was to prospectively evaluate the long-term association between nut consumption and weight gain or incidence of overweight/obesity in epidemiologic studies. We did a literature search and also analysed new data of a Mediterranean cohort, the SUN (Seguimiento Universidad de Navarra) project.

Methods

Literature search

We initially conducted a Medline search using the following search strategy: (nut OR nuts OR walnuts OR almonds OR hazelnuts OR *nuts) & (weight OR overweight OR obesity OR adiposity OR waist) & (follow-up OR cohort). This search retrieved 49 articles. Our selection criteria were a sample size larger than 500 participants and that, after a minimum follow-up period of 1 year, there was an assessment of the relationship between the consumption of nuts and at least one of the following outcomes (a) weight change, (b) change in waist circumference, (c) incidence of overweight, or (d) incidence of obesity. Only 2 of the initially selected studies met one of these criteria [13,14]. Additional contact with experts provided another study [15].

The SUN cohort

The SUN project is a prospective cohort study with a dynamic design (enrollment is continually open). It was designed in collaboration with the Harvard School of Public Health, following a similar methodology to that of large American cohorts such as the Nurses' Health Study or the Health Professionals Follow-up Study. Details on the objectives, design and methods of this cohort have been published elsewhere [16,17].

Briefly, beginning on December 1999, all Spanish alumni of the University of Navarra and several other professional collectives with a university degree received a letter of invitation to participate in the study, a questionnaire to respond and a postage-prepaid envelope to return the questionnaire. This baseline questionnaire gathered information about sociodemographic variables, lifestyle factors, as well as information on health and diet through a validated 136-item semiquantitative food frequency questionnaire (FFQ) [18–20]. All participants who completed a baseline assessment (Q_0) up to October 2006 (n = 16,593) were assessed. Among them we excluded 1653 who reported total energy intake out of predefined values ($<$800 kcal/d for men, $<$500 kcal/d for women or $>$4000 kcal/d for men, $>$3500 kcal/d for women), 753 who reported chronic disease at baseline (cancer or cardiovascular disease), 54 deceased participants, 1727 subjects with no follow-up data (retention rate = 88%), and 556 participants with missing data in some variable of interest, leaving a total of 11,895 participants available for the analyses.

The study was approved by the Institutional Review Board at the University of Navarra. Informed consent was implied by the voluntary completion of the baseline questionnaire.

The FFQ was collected only at baseline and was based on typical portion sizes and had nine options for the average frequency of intake in the previous year of each food item (ranging from never/almost never to at least six times per day). Questions on nut consumption included walnuts, almonds, hazelnuts, and peanuts. These four types represent $>$95% of total nut consumption in the Spanish general population [13]. Information on body weight of each participant was recorded at baseline and at follow-up questionnaires, which were completed every two years. The reliability and validity of self-reported weight was assessed in a subsample of the cohort. The mean relative error in self-reported weight was 1.45%, and the correlation coefficient between measured and self-reported weight was 0.99 (95% CI: 0.98–0.99) [21].

The outcomes were (1) the change in body weight during follow-up, defined as average change in body weight per year of follow-up [the last weight reported minus the baseline weight divided by the years of follow-up]. (2) Weight gain $\geq$ 3 kg/yr during follow-up.

Physical activity during leisure time was assessed with a previously validated questionnaire [22]. The Spearman correlation coefficient between energy expenditure assessed with this questionnaire and with a triaxial accelerometer was 0.51, 95% confidence interval (CI) 0.23, 0.71. An activity metabolic equivalent (MET) index was computed by assigning a multiple of resting metabolic rate (MET score) to each activity (17 activities). Time spend in each of the activities was multiplied by the MET score specific to each activity, and then summed over all activities obtaining a value of overall weekly MET-hours [23].

Generalized linear models were used to assess the association between total nut consumption, based on the frequency of servings (50 g) categorized as never/almost