Long-term associations of nut consumption with body weight and obesity[1–4]

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ABSTRACT

There is some concern that the high-fat, energy-dense content of nuts may promote weight gain. Nuts, however, are rich in protein and dietary fiber, which are associated with increased satiety. They also contain high amounts of vitamins, minerals, antioxidants, and phytoesterols that may confer health benefits for cardiovascular disease and type 2 diabetes delay and prevention. Therefore, it is important to determine the association between nut consumption and long-term weight change and disease risk to reach scientific consensus and to make evidence-based public health recommendations. Several cross-sectional analyses have shown an inverse association between higher nut consumption and lower body weight. In addition, several independent prospective studies found that increasing nut consumption was associated with lower weight gain over relatively long periods of time. Moreover, high consumption of nuts (especially walnuts) has been associated with lower diabetes risk. Therefore, regular consumption (approximately one handful daily) of nuts over the long term, as a replacement to less healthful foods, can be incorporated as a component of a healthy diet for the prevention of obesity and type 2 diabetes. *Am J Clin Nutr* 2014;100(suppl):408S–11S.

INTRODUCTION

Rapid increases in the prevalence of overweight and obesity worldwide represent a major public health problem. Weight gain is a gradual process; on average, an adult gains ~1 pound (or 0.45 kg) per year, which adds up to, for example, 20 pounds over 20 y (1). Age-related gradual weight gain poses a challenge for identifying specific causes or preventive measures. Nonetheless, the difficulty in losing and maintaining weight once it is gained and the long-term consequences of being overweight or obese underscore the importance of weight-gain prevention.

Diet and lifestyle are important means for achieving and maintaining a healthy body weight to ward off or prevent chronic diseases, and an understanding of the role of specific food items in the prevention of age-related weight gain may be particularly useful. As good sources of vegetable proteins, dietary fiber, antioxidants, plant sterols, and unsaturated fatty acids, nuts are nutritious and may be beneficial for preventing a host of chronic diseases (2, 3). The healthfulness of nut consumption, however, has been questioned because they are naturally energy dense and rich in fat (albeit mostly unsaturated), which has caused concern about its potential to contribute to weight gain.

In weight-loss or cholesterol-lowering randomized controlled trials (RCTs)[5] that incorporated nuts, higher nut consumption was associated with no weight gain or with maintaining a stable weight (4–10). These short-term findings may, however, have little relevance to determinants of long-term, gradual weight gain in nonobese populations whose weight is typically gained gradually over a long period of time. To make public health recommendations with regard to the healthfulness of nut consumption, it is important to determine and reach consensus with regard to its association with long-term weight change and obesity risk.

EPIDEMIOLOGIC EVIDENCE

Weight gain, overweight, and obesity

A number of cross-sectional studies have shown an inverse association between nut consumption and BMI (11–13). Briefly, Lairon et al (12) found that dietary fiber that included nuts was associated with a lower BMI, waist-to-hip ratio, as well as fasting concentrations of apolipoprotein B and glucose; and Schröder et al (13) concluded that the Mediterranean diet pattern, which includes high intakes of nuts, was associated with a lower obesity prevalence in men and women. A review investigating nuts, body weight, and insulin resistance that included a number of cross-sectional studies concluded that adding nuts to a calorie-restricted diet was not associated with weight gain but with greater weight loss and improved insulin sensitivity. Nonetheless, the temporality of nuts and BMI cannot be determined in cross-sectional analyses. Also, potential confounding factors (eg, other dietary factors) were not adjusted in the analyses of these cross-sectional studies. To date, there have been 3 studies (consisting of 4 independent prospective cohort studies) that directly sought to determine the relation between nut consumption and long-term weight change (14–16), and all concluded that increasing nut consumption was associated with less weight gain.

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[5] Abbreviations used: NHS, Nurses' Health Study; RCT, randomized controlled trial; T2D, type 2 diabetes; WMD, weighted mean difference.

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Bes-Rastrollo et al (15) examined the long-term association between nut consumption and weight change over 8 y in a free-living population of women from the Nurses' Health Study (NHS) II, which is a prospective cohort study in US female nurses. Beginning in 1989, this study prospectively evaluated dietary intake of nuts and subsequent weight changes from 1991 to 1999 among 51,188 women aged 20–45 y. Models were adjusted for age, BMI, alcohol consumption, physical activity, smoking, postmenopausal hormone use, oral contraceptive use, and dietary factors (eg, glycemic load, total fiber, *trans* fat, fruit, vegetables, red and processed meat, refined grains, whole grains, snacks, sugar-sweetened and diet beverages, low- and high-fat dairy products) all at baseline. Changes in covariates previously shown to be associated with weight gain over the study period were also adjusted in the models, and additional models adjusted for changes in Western and "prudent" dietary patterns.

Based on an average consumption of peanut butter [1 tablespoon = 1 ounce of peanuts (28.35 g)], peanuts [1 ounce (28.35 g) of peanuts], and tree nuts [1 ounce (28.35 g) of nuts] during the previous year, this study found that women who reported eating nuts ≥2 times/wk experienced a slightly lower mean (±SE) weight gain (5.04 ± 0.12 kg) than did women who rarely ate nuts (5.55 ± 0.04 kg) (*P*-trend <0.001). The findings were similar when nut consumption was subdivided into peanuts and tree nuts as well as for normal-weight, overweight, and obese participants.

Another recent study used NHS II data in addition to 2 other separate prospective cohorts that included 120,877 US women and men with follow-ups ranging from 1986 to 2006 (16). Within each 4-y period, participants gained an average of 1.52 kg (5th–95th percentile: −1.86 to 5.64 kg). Based on increased daily servings of individual dietary components, 4-y weight change was inversely associated with a 1-serving increment in the intake of nuts (−0.26 kg), fruit (−0.22 pounds), vegetables (−0.10 kg), whole grains (−0.17 kg), and yogurt (−0.37 kg), whereas weight gain was strongly associated with intake of potato chips (0.77 kg), potatoes or fries (0.58 kg), sugar-sweetened beverages (0.45 kg), unprocessed red meats (0.43 kg), and processed meats (0.42 kg) ($P \leq 0.005$ for each comparison) (*see* **Figure 1**). These data suggest that specific dietary factors (ie, types of foods) and overall diet quality contribute to long-term weight gain, which has important implications for obesity prevention strategies.

A Spanish cohort study investigated nut consumption and its association with either risk of weight gain of ≥5 kg or the risk of becoming overweight or obese in a Mediterranean population (14). The cohort consisted of 8865 adult men and women who completed a follow-up questionnaire with validated semiquantitative food-frequency questionnaires after a median of 28 mo. Nut consumption was not significantly associated with incident overweight/obesity in the cohort, but it was significantly associated with a reduced risk of weight gain of ≥5 kg. After adjustment for age, sex, smoking status, physical activity, and other established obesity risk factors, participants who ate nuts ≥2 times/wk had a significantly lower risk of weight gain (OR: 0.69; 95% CI: 0.53, 0.90; *P*-trend = 0.006) compared with those who never or almost never ate nuts. The results of the aforementioned prospective studies should reduce fears of possible weight gain with nuts and therefore support a recommendation that nut consumption be considered an important component of a healthy, calorie-appropriate diet.

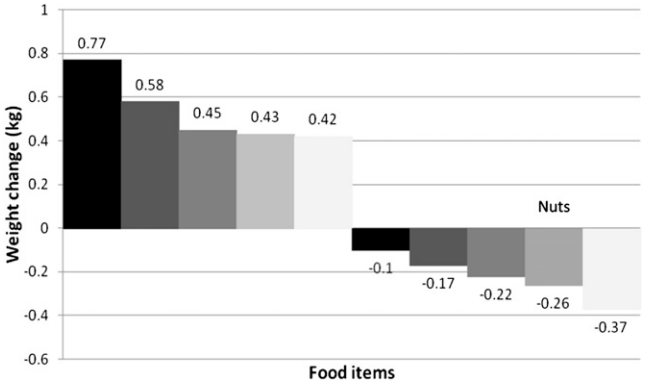

FIGURE 1. Average weight change associated with a 1-serving increase for each food or beverage over 4 y. Data are from Nurses' Health Study (NHS): 50,422 women followed for 20 y (1986–2006); NHS II: 47,898 women followed for 12 y (1991–2003); and Health Professionals Follow-Up Study: 22,557 men followed for 20 y (1986–2006). All weight changes were adjusted simultaneously for age, baseline BMI, sleep duration, and changes in smoking status, physical activity, television watching, alcohol use, the dietary factors shown as well as butter, sweets/desserts, refined grains, cheese, fruit juice, low-fat skim milk, and diet (zero-calorie) soda. Decreased intake of a specific food item would be associated with the inverse weight changes. $P < 0.001$ for all dietary factors shown in this figure. Multivariable linear regression with robust variance accounting for within-individual repeated measures was used for statistical analyses. Adapted from reference 16. Left side of panel: black column, potato chips; dark-gray column, potatoes or fries; medium-gray column, sugar-sweetened beverages; light-gray column, unprocessed red meats; white column, processed meats. Right side of panel: black column, vegetables; dark-gray column, whole grains; medium-gray column, fruit; light-gray column, nuts; white column, yogurt.

Type 2 diabetes

Emerging evidence suggests that nut consumption may be protective against type 2 diabetes (T2D). In 2002, Jiang et al (17) prospectively examined the relation between consumption of nuts and T2D risk over a 16-y time period by using NHS I data. The authors found potential benefits of higher nut and peanut butter consumption in lowering diabetes risk in women after adjustment for age, BMI (the strongest confounder), family history of diabetes, physical activity, smoking status, alcohol consumption, and important dietary factors (eg, dietary fats, cereal fiber). Specifically, women who ate nuts ≥5 times/wk in comparison to those who never or almost never ate nuts had an RR of 0.74 (95% CI: 0.61, 0.89). With regard to peanut butter consumption, women who ate peanut butter ≥5 times/wk had an RR of 0.79 (95% CI: 0.68–0.91) for diabetes in comparison to women who never or almost never ate peanut butter.

With the use of data from NHS II and extended follow-up data from NHS I, Pan et al (18) found that nut consumption was associated with a lower risk of T2D in women. Consumption of walnuts, in particular, was associated with an even lower risk of T2D in comparison to other tree nuts. After adjustment for BMI, which was updated across the study period, the association between walnuts and diabetes was attenuated but remained significantly associated with a lower risk of diabetes. Specifically, each 2-serving/wk increment of walnut consumption was associated with a 21% (95% CI: 13%, 29%) and 15% (95% CI: 6%,

23%) lower risk of incident diabetes before and after adjustment for updated BMI, respectively. Other tree nuts had statistically significant inverse associations with diabetes, but these were attenuated and became insignificant after adjusting for BMI. Furthermore, the impact of substituting nuts for red meat as well as processed meat on diabetes risk reduction was estimated (18), and one daily serving of nuts was associated with a 21% (95% CI: 14%, 26%) lower risk of T2D compared with 1 serving of total red meat/d. Nut consumption, substituted for processed meats, was associated with a 32% (95% CI: 26%, 37%) lower risk of diabetes, whereas unprocessed meat was associated with a 20% (95% CI: 13%, 26%) lower risk.

A recent systematic review and meta-analysis of 30 generally short-term (<24 wk) RCTs designed to determine the effect of recommended amounts of nut consumption on various adiposity measures concluded that diets including nuts did not increase body weight [weighted mean difference (WMD): –0.47 kg; 95% CI: –1.17, 0.22 kg], BMI (in kg/m^2) (WMD: –0.40; 95% CI: –0.97, 0.17) nor waist circumference (WMD: –1.25 cm; 95% CI: –2.82, 0.31 cm). With regard to RCTs, incorporating nuts into cholesterol-lowering diets over a relatively long time period also did not lead to weight gain (4). Although weight was not a primary outcome in other ≥24-wk trials, one RCT with 24 wk of follow-up data that was designed to test the effects of nuts on weight in 65 overweight and obese free-living adults found that the incorporation of either almonds or complex carbohydrates into a formula-based low-calorie diet was effective in decreasing body weight beyond weight loss during the long-term pharmacologic interventions (4). The group randomly assigned to receive almonds, however, experienced a greater weight reduction over the study duration. Compared with the "complex carbohydrate plus low-calorie diet" intervention, almonds also coupled with a low-calorie diet were associated a 62% greater reduction in weight/BMI, a 50% greater reduction in waist circumference, and a 56% greater reduction in fat mass.

Another long-term RCT with 4 y of follow-up data in 418 participants without (but at high risk of) diabetes investigated the effects of a Mediterranean diet supplemented with nuts (50% walnuts and 50% almonds and hazelnuts) and found that the group who consumed the Mediterranean diet with nuts experienced a lower diabetes incidence than the control group, even without significant changes in body weight and physical activity (19).

CONCLUSIONS

Based on the available evidence from prospective studies (also supported by RCTs and cross-sectional studies), long-term nut consumption is associated with lower weight gain and overweight/obesity. Higher consumption of total nuts and walnuts, in particular, is associated with a significantly lower risk of T2D in women, and much of the inverse association with T2D appears to be mediated through body weight.

As described by Bes-Rastrollo et al (15), several mechanisms linking nut consumption to lower body weight and weight gain have been proposed (*see* **Figure 2**). For instance, nuts are rich in *1*) proteins and *2*) dietary fiber, which are associated with increased satiety, and in *3*) unsaturated fats, which may increase oxidation that potentially decreases body fat accumulation. The protein, fiber, and unsaturated fat content in nuts may also increase thermogenesis and resting energy expenditure (20). The high amount of dietary fiber (especially viscous fiber) in nuts may additionally delay gastric emptying and subsequent absorption that potentially suppresses hunger (21). Nuts also contain a variety of vitamins, minerals, phytoesterols, and antioxidants (eg, folic acid, vitamins E and B-6, calcium, magnesium, copper, zinc, selenium, phosphorus, arginine, potassium, and niacin) that may all have additional benefits for chronic disease prevention (3). In addition, incomplete mastication of nuts may lead to increased energy loss via feces because less chewing could limit the amount of lipids liberated from the nut, thereby decreasing the amount of energy available to the body and contributing to a lower energy intake (8, 22). Furthermore, individuals who consume nuts regularly tend to consume less red meat and refined carbohydrates (18, 23). Such replacement is likely to be beneficial for the prevention of weight gain because both red meat and refined carbohydrates have been associated with increased weight gain (18).

Prevailing dietary recommendations on weight loss (eg, reducing energy density and fat contents) may not be very helpful to the general public, and public health messages should expand

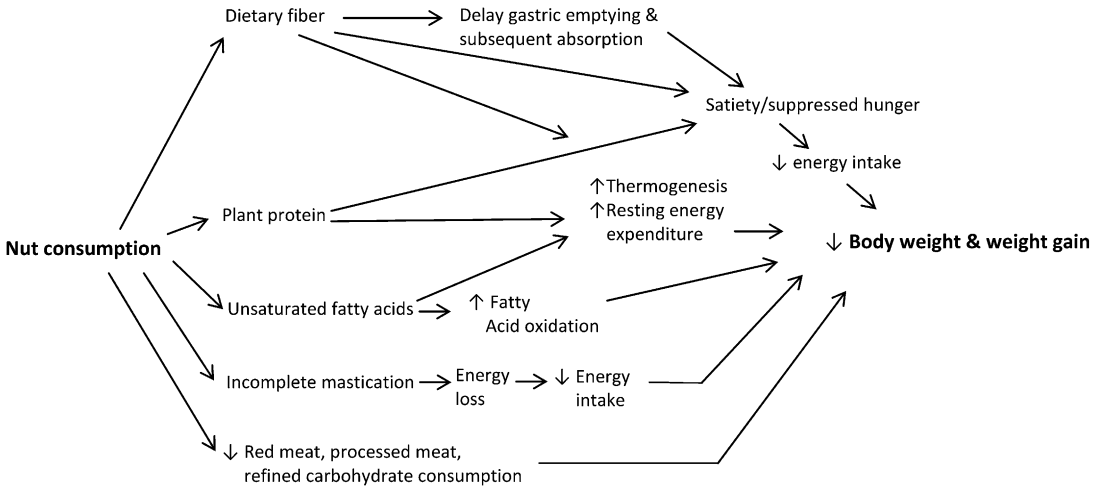

FIGURE 2. Conceptual framework of potential mechanisms linking nut consumption to decreased body weight and weight gain.

beyond "eat less" to also include "eat better-quality foods" because food quality is likely to influence energy balance independent of food quantity. Overly simplified messages focused on reducing intakes of certain macronutrients (eg, dietary fat) to prevent obesity may have led to concerns related to, for example, the fat and energy content of nuts. Because nuts are apparently protective against weight gain despite their high (mostly healthy) fat content, nut consumption may be illustrative of our need to focus messages around overall diet quality instead of single nutrients to improve health.

In terms of public health recommendations, a handful of nuts (~1 ounce or 28 g) daily is beneficial for the prevention of obesity and T2D because they are good sources of unsaturated fats, vegetable proteins, plant sterols, fiber, and antioxidants. Compared with other nuts, walnuts contain much higher amounts of both n–6 and n–3 PUFAs (24). Our recent analysis suggests that higher consumption of walnuts is particularly beneficial for the prevention of T2D. Therefore, nuts (particularly walnuts) can be incorporated as a component of a healthy diet to reduce the risk of obesity and diabetes. Future studies should determine whether walnuts possess additional benefits in comparison to other nuts.

In conclusion, higher nut consumption does not appear to cause greater weight gain; rather, nuts may be beneficial for weight control by contributing to satiety and potentially improving long-term adherence to healthful diets. Because weight gain is generally very gradual and difficult to detect and combat, small diet and lifestyle changes such as the replacement of less healthful food items (eg, red or processed meats, refined-grain products) with nuts and other healthy foods to avoid increased caloric intake can make a big difference and presents a tremendous opportunity for obesity and chronic disease prevention.

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