

Tree Nuts and Peanuts as Components of a Healthy Diet^{1,2}

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Abstract

Nuts have been part of the diet for thousands of years. In 2003, a Qualified Health Claim was approved, stating that eating 1.5 oz (42 g) of nuts per day may reduce the risk of heart disease. Usual intakes fall short of this recommendation. About one-third of Americans report consuming nuts (tree nuts or peanuts) on any one day. Seven percent of Europeans report eating nuts, but the amount eaten by European nut consumers (31 g/d) is larger than that of Americans (21 g/d). Nuts are an excellent source of vitamin E and magnesium. Individuals consuming nuts also have higher intakes of folate, β -carotene, vitamin K, lutein+zeaxanthin, phosphorus, copper, selenium, potassium, and zinc per 1000 kcal. Regular nut consumption increases total energy intake by 250 kcal/d (1.05 MJ/d), but the body weight of nut consumers is not greater than that of nonconsumers. Nuts are an excellent source of phytochemicals (phytosterols, phenolic acids, flavonoids, stilbenes, and carotenoids). The total phenolic constituents probably contribute to the total antioxidant capacity of nuts, which is comparable to broccoli and tomatoes. To improve guidance on the use of nuts in the diet, the position of nuts in typical food patterns needs to be addressed. The 2005 MyPyramid includes nuts in the meat and beans group. Yet, nuts are rarely consumed as meat substitutes. Because ~60% of the nuts consumed in the U.S. are eaten as snacks, emphasizing their use as a healthy snack may be more effective than inclusion within a food group. J. Nutr. 138: 1736S–1740S, 2008.

Throughout history, nuts have been part of the diet around the world. Records of eating pistachios date back to the Stone Age of 7000 BC. Early descriptions of diets and food intakes indicate that the Romans, Persians, and Arabs all used ground nuts to thicken stews and sauces; that practice later extended to Europe. During exploration of Asia, nuts made their way from Persia to China and became a highly prized delicacy. In the Scandinavian countries, nuts were dried and stored as a food to use in the long, harsh winters (1).

Today, nuts and seeds continue to be enjoyed world-wide in a variety of ways, as recipe ingredients, spreads, snacks, and as a delicacy. In 2003, a qualified health claim (QHC)⁷ was approved by the FDA for nuts and cardiovascular disease, which read, "Scientific evidence suggests but does not prove that eating 1.5 ounces (42 g) per day of most nuts, as part of a diet low in saturated fat and cholesterol, may reduce the risk of heart disease." Consuming 1.5 oz (42 g) of nuts per day would contribute ~250 kcal/d (1.05 MJ/d). There is little information about whether this recommended intake is feasible and consistent with nut intakes reported by various population groups. The aim of this review, therefore, is to evaluate patterns of nut consumption in different populations, assess their impact on nutrient and phytochemical intakes, and determine how individuals frequently position nuts in the overall diet.

Total nut consumption

As interest in the health effects of nuts and seed consumption grows, so does the need to examine reliable data on nut consumption. In the past, most of the consumption information was based on food disappearance or market data for various regions or populations. Although consumption of specific types of nuts by individuals is available from dietary intake surveys, evaluating total nut intake is complicated by the fact that nuts

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⁷ Abbreviations used: EPIC, European Prospective Investigation into Cancer and Nutrition; QHC, qualified health claim; RDA, recommended dietary allowance; WWEIA, What We Eat in America.

are consumed not only in their whole form and as spreads but also as components of dishes and commercial products (breads, cereals, sweets, candy, etc.). The European Prospective Investigation into Cancer and Nutrition (EPIC) study, a large, multicenter prospective cohort in 10 Western European countries, assessed nut (tree nuts and peanuts) and seed intake from various dietary sources using detailed 24-h recalls in a 37,000-subject subset of the EPIC population (2). The 24-h recalls were collected using a computerized program (EPIC-Soft), which was standardized across the 10 European countries participating in EPIC.

The EPIC study determined the population mean intake and mean portion sizes in individuals reporting nut and seed consumption from all sources on the day that the 24-h recall was administered (2). The intake of nuts and seeds is reported as that consumed as whole, from hidden sources, or from spreads. The intake of total nuts (tree nuts, peanuts, and unspecified nuts) consumed whole was 2.23 g/d for the entire population (i.e. consumers and nonconsumers combined). The mean intake of total nuts varied ~8-fold from northern to southern Europe, ranging from 0.61 g/d in Sweden to 4.83 g/d in Spain. The relatively low mean intakes reflect the fact that only ~7% of the population surveyed consumed any type of nut (tree nuts, peanuts, or unspecified nuts) on the day that the 24-h recall was administered. Among tree nut consumers, the mean portion size of total tree nuts varied from 20.3 g/d in northern Europe (Denmark, Norway, and Sweden) to 29.1 g/d in Southern Europe (southern France, Greece, Italy, and Spain). This significant low-to-high gradient of intake was strengthened by the proportion of the population consuming tree nuts, which increased from 2.0% in the north to 6.3% in the south. The consumption of total tree nuts was highest in Spain where 8.3% of the population consumed ~34.7 g on the day that the 24-h recall was administered. The mean intake of peanuts in the entire population was significantly higher in central European regions (northern France, Germany, Netherlands, UK; 1.5 g/d) than in either the North (0.7 g/d) or the South (0.8 g/d). A similar trend was apparent for the portion size of peanuts among consumers on the day of the 24-h recall (44.9 g/d in the central regions compared with 39.6 in the north and 37.6 in the south). For both total tree nuts and peanuts, differences by gender were also apparent from the EPIC data. Men reported a significantly larger portion size of total tree nuts (28.5 g/d) than women (23.1 g/d), although a higher percentage of women (4.8%) indicated consumption of total tree nuts than men (3.7%) on the day of the 24-h recall. Similarly, the portion size of peanuts was significantly higher in men (46.5 g/d) than in women (35.1 g/d), although the percentage of peanut consumers was relatively equal by gender. From the EPIC data, almost 50% of total nut consumption was from tree nuts, with walnuts, almonds, pistachios, and hazelnuts making up 86% of all tree nut consumption. Peanut consumption accounted for ~37% of total nut consumption and the intake of unspecified nuts and seeds accounted for the rest. In the entire EPIC population surveyed by 24-h recalls, ~4% consumed tree nuts, 2.3% consumed peanuts, and 1.3% reported consumption of seeds. The intake of tree nuts, peanuts, and seeds from hidden sources was higher in terms of percentage of consumers but lower in terms of portion size. Most of the intake of spreads was from peanuts, although the portion size of peanut spread (25.1 g/d) was lower than that of whole peanuts (39.6 g/d) among consumers. In the Netherlands, Norway, and Sweden, peanuts were more popular than tree nuts.

This comprehensive study of nut and seed consumption in 10 European countries shows that intake varies widely with geo-

graphical region and, presumably, cultural and gender influences on food patterns. Intakes were the highest in Mediterranean countries, where ~8% of the surveyed population consumed ~33.8 g/d, or ~1.25 oz/d, of total nuts.

In the United States, nut consumption data has been derived from the 2001–2004 What We Eat in America (WWEIA)/NHANES (unpublished data), where nuts were given increased emphasis. During a 24-h dietary recall, an automated multiple pass method was used to obtain a more complete and accurate estimate of food consumption. After the individual listed all of the food and beverages consumed, the operator probed for forgotten food items. Nuts were on the list of potentially forgotten foods and individuals were asked specifically if nuts in any form or type were consumed in the previous 24-h period. In the WWEIA/NHANES 2001–2004 survey of 17,306 individuals, aged ≥ 2 y, 34% of those surveyed reported consuming nuts either as snacks, peanut butter, or as recipe ingredients. Six percent reported eating nuts as snacks, 8% as peanut butter, and 25% as foods that contained nuts as ingredients. Nut consumption among all individuals surveyed was 7.3 ± 0.36 (SEM) g/d. Among nut users, it was 21.4 ± 0.83 g/d. If nuts were consumed as snacks or as whole nuts, the mean consumption was 53.0 ± 2.17 g/d and was slightly higher for men (57 g/d) than for women (51 g/d). Mean intake of specific types of nuts eaten as snacks was led by peanuts at 25.8 g/d, followed by mixed nuts (that contained some peanuts) (10.4 g/d), cashews (6.3 g/d), almonds (4.1 g/d), pistachios (3.5 g/d), pecans (1.3 g/d), and walnuts (1.1 g/d). Tree nuts totaled 27 g/d. Of the foods that contributed nuts as ingredients in recipes or foods, candy was the top contributor at 46%, followed by baked items/desserts (24%), cookies (17%), ready-to-eat cereal (9%), and entrees (4%).

Thus, a higher percent of Americans (34%) report nut consumption than do Europeans (~7%) (tree nuts, peanuts, and unspecified nuts). However, the mean amount of nuts consumed by nut consumers in Europe (30.8 g/d) is higher than that in the US (21 g/d). This is only ~50–60% of the 1.5 oz (42 g) recommended in the QHC.

Contribution of nutrients and other food components from nuts and seeds

The nutrient composition of tree nuts (almonds, Brazil nuts, cashews, hazel nuts, macadamias, pecans, pine nuts, pistachios, and walnuts) and peanuts is summarized in Table 1. One and one-half ounces of tree nuts or peanuts provides >10% of the adult male recommended dietary allowance (RDA) (31–50 y of age) for protein, iron, magnesium, phosphorus, zinc, copper, thiamin, and vitamin E. In addition, 1.5 oz (42 g) of tree nuts provides >10% of the adult male RDA for vitamin B-6 and selenium and this amount of peanuts provides >10% of the adult male RDA for niacin, pantothenic acid, and total folate. In WWEIA/NHANES 2001–2004, nuts made an important contribution to the total nutrient intakes of Americans who include nuts as snacks in their diets. Among individuals consuming nuts as snacks, nuts contributed between 25 and 35% of the following nutrients and diet components: fat, polyunsaturated fat, monounsaturated fat, linoleic acid, magnesium, copper, and vitamin E (unpublished data). However, among adults ≥ 19 y, the mean energy intake was significantly greater for both nut users and nut snackers than for nonusers. In comparison to male nonusers who consumed ~2529 kcal/d (10.63 MJ/d), nut users consumed an additional 248 kcal/d (1.04 MJ/d) ($P < 0.001$) and the nut snackers consumed an additional 345 kcal/d (1.45 MJ/d) ($P < 0.01$). Among females, nut users consumed an additional 225 kcal/d (0.95 MJ/d) and nut snackers consumed an addi-

TABLE 1 Nutritional content of 1.5 oz (42 g) of tree nuts or peanuts

Nutrients ¹	Tree nuts ²	% RDA ³	Peanuts	%RDA ³
Food energy, <i>kcal (MJ)</i>	271 (1.14)		249 (1.05)	
Protein, <i>g</i>	6.28	11	10.07	18
Total fat, <i>g</i>	26.06		21.12	
MUFA, ⁴ <i>g</i>	13.301		10.478	
PUFA, <i>g</i>	7.877		6.674	
Linoleic acid, <i>g</i>	7.322	43	6.672	39
Linolenic acid, <i>g</i>	0.518	32	0.001	0.1
Carbohydrate, <i>g</i>	7.68		9.15	
Fiber, <i>g</i>	3.3	9	3.4	9
Calcium, <i>mg</i>	44	4	23	2
Iron, <i>mg</i>	1.66	21	0.96	12
Magnesium, <i>mg</i>	87	21	75	18
Phosphorus, <i>mg</i>	182	26	152	22
Potassium, <i>mg</i>	259	6	280	6
Sodium, <i>mg</i>	2	0.1	3.0	0.2
Selenium, μ g	92.8	169	3.2	6
Zinc, <i>mg</i>	1.56	14	1.41	13
Copper, <i>mg</i>	0.605	67	0.3	33
Vitamin C, <i>mg</i>	0.6	1	0	0
Thiamin, <i>mg</i>	0.218	18	0.186	16
Riboflavin, <i>mg</i>	0.090	7	0.042	3
Niacin, <i>mg</i>	0.84	5	5.752	36
Pantothenic acid, <i>mg</i>	0.26	5	0.593	12
Vitamin B-6, <i>mg</i>	0.17	13	0.109	8
Folate, μ g	21	5	62	16
Vitamin B-12, μ g	0	0	0	0
Vitamin A (RAE), ⁴ μ g	1	0.1	0	0
β -Carotene, μ g	11		0	
Lycopene, μ g	0		0	
Lutein + zeaxanthin, μ g	64		0	
Vitamin E as AT, ⁴ <i>mg</i>	2.9	19	2.95	20

¹ Source: WVEIA, NHANES 2001–2004, 1 d, 19+ y (unpublished data; USDA, Food Surveys Research Group, www.ars.usda.gov/foodsurvey/).

² Tree nut values expressed as the mean for almonds, Brazil nuts, cashews, hazelnuts, macadamias, pecans, pine nuts, pistachios, and walnuts.

³ Values expressed as a percent of the RDA for males 31–50 y of age except for fiber, potassium, sodium, linoleic acid, linolenic acid, and pantothenic acid, which are expressed as a percent of the adequate intake.

⁴ MUFA, monounsaturated fatty acids; RAE, retinol activity equivalents; AT, α tocopherol.

tional 271 kcal/d (1.14 MJ/d) compared with nonusers reporting total energy intakes of 1769 kcal/d (7.43 MJ/d). To adjust for the differences in mean daily energy intakes by nut use, mean intakes of nut eaters were compared with nonusers on a per-1000 kcal (4.20 MJ) basis (Table 2). Nutrients that were consumed in significantly higher amounts included vitamins E and K, food folate, β -carotene, lutein + zeaxanthin, magnesium, phosphorus, copper, selenium, potassium, and zinc, and those that were significantly lower included vitamin B-12, retinol, lycopene, and sodium. Body weight status by nut use and gender for adults showed did not differ in those classified as overweight even though they reported eating up to 250 additional kcal/d (1.05 MJ/d) with nuts in the diet (unpublished data). On the contrary, obese women (BMI ≥ 30) were less likely to consume nuts than nonconsumers (30 vs. 36%).

Nuts are excellent sources of vitamin E and magnesium. More than 90% of the U.S. population does not meet the current intake recommendation for vitamin E, an important antioxidant nutrient that has been shown to protect immune function and to

inhibit oxidative damage to cells (3). An analysis of the U.S. diet showed that it is difficult to consume the recommended intake of vitamin E while keeping fat intakes within recommended limits and that inclusion of nuts or seeds appears to be the most efficient way to obtain this combined result (4). Almonds and sunflower seeds are particularly good sources of this important vitamin. Despite having the highest amount of α -tocopherol per serving among food groups in the U.S. food supply, nuts and seeds ranked only 7th as intake sources for men and 12th for women, due to their infrequent use (3).

The majority of the U.S. population also falls short of the recommended intake for magnesium. This mineral is required by numerous enzymes involved in nucleic acid metabolism and thereby affects multiple physiologic processes (5). Chronically low intakes are associated with risk of osteoporosis, hypertension, diabetes, and heart disease (6,7). It is thus important to note that population studies show mean and median intakes that fall well below current recommendations. For example, recent NHANES data showed that men consumed ~ 350 mg/d and women consumed 250 mg/d, relative to RDA of 420 and 320 mg/d for men and women, respectively (8). Although magnesium is found in most whole foods, much is lost with processing. Inclusion of nuts and seeds can make a large contribution toward protection against the chronic insufficiency of magnesium intake that is widespread in the U.S. population. All nuts and seeds contain magnesium, but Brazil nuts, pumpkin seed kernels, almonds and cashews are particularly rich sources.

TABLE 2 Daily intakes (per 1000 kcal) of selected vitamins and minerals for individuals 19 y and older who are nonconsumers and consumers of nuts^{1,2}

		Consumers	
	Nonconsumers	All	Out-of-hand
Vitamins			
E, <i>mg</i>	3.0	3.9***	4.8***
Food folate, μg	101	107**	124***
B-12, μg	2.44	2.46	2.09**
Retinol, μg	195	204	174**
β -Carotene, μg	988	1094	1321**
Lycopene, μg	3121	2637*	2421*
Lutein+zeaxanthin, <i>g</i>	703	820*	1183*
K, μg	43.3	49.3*	67.2*
A, μg RAE	288	307*	296
Thiamin, <i>mg</i>	0.76	0.8*	0.75
Riboflavin, <i>mg</i>	1.04	1.08*	1.01
Niacin, <i>mg</i>	10.9	11.6***	11.4
B-6, <i>mg</i>	0.86	0.93***	0.90
Minerals			
Magnesium, <i>mg</i>	124	145***	169***
Phosphorus, <i>mg</i>	607	632***	664***
Copper, <i>mg</i>	0.6	0.7***	0.8***
Sodium, <i>mg</i>	1623	1537***	1483***
Selenium, μg	50.4	50.6	57.8***
Potassium, <i>mg</i>	1285	1321*	1390**
Zinc, <i>mg</i>	5.5	5.7	5.9*
Theobromine, <i>mg</i>	16.9	24.9***	20.6
Calcium, <i>mg</i>	395	416**	398
Iron, <i>mg</i>	7.3	7.5*	7.3

¹ Values are means. Asterisks indicate different from nonconsumers, * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

² Source: WVEIA, NHANES 2001–2004, 1 d, 19+ years (unpublished data; USDA, Food Surveys Research Group, www.ars.usda.gov/foodsurvey/).

In addition to being a rich source of several essential vitamins and minerals, monounsaturated fatty acids and PUFA, and fiber, most tree nuts and peanuts provide an array of phytochemicals that may promote health and reduce the risk of chronic disease (9). Although many of these bioactive components of plant food remain to be fully identified and characterized, broad classes include the carotenoids, phenolic acids, phytosterols, and polyphenolic compounds such as flavonoids and stilbenes (10).

Phytosterols lower serum LDL cholesterol by inhibiting dietary cholesterol absorption, with an effective dose ~ 2 g/d (11). The phytosterol content ranges from 95 mg/100 g in Brazil nuts to 280 mg/100 g in pistachios. This amount is comparable to concentrations found in chocolate and flax seed (12), though it is much lower than the amount formulated into some manufactured "functional food" products.

Carotenoids, specifically α - and β -carotene, β -cryptoxanthin, lutein, and zeaxanthin, are found in low concentrations ($\mu\text{g}/100$ g) in most nuts but at 1–3 mg/100 g in pistachios. No carotenoids have been reported in Brazil nuts, macadamias, or peanuts.

Plant phenols, including phenolic acids, flavonoids, and stilbenes, are also present in nuts. Walnuts are particularly rich in total phenols, with 1625 mg gallic acid equivalents/100 g (13). The stilbene resveratrol is found in peanuts and pistachios at 84 and 115 $\mu\text{g}/100$ g, respectively, in contrast to the 98–1803 $\mu\text{g}/100$ mL in red wine (14,15). Though complete information remains to be collected, the flavonoid content of nuts, as provided in the 2006 USDA Database for the Flavonoid Content of Selected Foods, includes the following totals for nuts: pecans, 34; almonds, 15; and pistachios and hazelnuts, 12 mg/100 g. No flavonoids have been detected in Brazil or macadamia nuts. Proanthocyanidins, oligomers of catechins, are found in almonds, cashews, hazelnuts, pecans, pistachios, peanuts, and walnuts, with concentrations varying from 9 to 494 mg/100 g in cashews and pecans, respectively (16). While most nuts contain small amounts of the antioxidant nutrients vitamin C and selenium, they are especially rich in vitamin E. The total phenolic constituents in nuts appear to contribute substantially to their total antioxidant capacity which, using the oxygen radical absorbance capacity assay, range from 204 (pine nuts) to 5095 (pecans) μmol Trolox equivalents/serving (7–179 μmol Trolox equivalents/g) comparable or greater to that found in a serving of beans (147–301), broccoli (700), carrots (741), and tomato (415) (17). Importantly, the phenols in almonds have been found to be bioavailable and act as antioxidants *in vivo* (18).

In sum, nut phytochemicals have been associated with an array of bioactivities, including antioxidant, antiviral, antiproliferative, hypocholesterolemic, and antiinflammatory actions potentially capable of affecting the initiation and progression of several pathogenic processes. For example, both observational evidence on nut intake (19) and clinical data from almond and walnut interventions (20,21) indicate their beneficial impact on inflammation [see article by Jenkins et al. in this symposium (22)].

Position of nuts in food or diet patterns

Nuts contain important nutrients that are consumed inadequately in the diet. The current dietary guidelines mention the nutritional value of nuts but do not specify nuts as a specific food group. Instead, nuts and seeds are part of the meat and beans group in the 2005 MyPyramid. One-half ounce (14 g) of nuts or seeds or 1 tablespoon (15 g) of peanut butter is considered to be nutritionally equivalent to 1 oz (28 g) of lean meat, poultry, or fish. A 2000-kcal (8.40 MJ) diet plan with 5.5-oz equivalents (154 g) from the meat and beans group could contain, therefore, 3 oz (84 g) meat and 2.5 tbsp (37.5 g) peanut butter or 1.25 oz

(35 g) nuts or seeds. A 2800-kcal (11.76 MJ) diet plan with 7-oz equivalents (196 g) of meat and beans could contain 4 oz (112 g) meat and 3 tbsp (45 g) peanut butter or 1.5 oz (42 g) nuts or seeds, the amount included in the QHC.

However, it is difficult to place nuts in a typical U.S. diet as a meat replacement, because the amount of meat recommended is already low compared with the usual intake for some groups. For example, whereas Pyramid recommendations range from 5- to 7-oz equivalents/d (140–196 g/d) for adults, depending on calorie requirement level, men aged 30–39 y consume 7.9-oz equivalents (221 g)/d. Based on such comparisons, the USDA currently estimates that adult men need to decrease current meat group intakes by 20% to meet recommendations. Women tend to have mean meat group intakes closer to current recommendations, but a considerable proportion of women also exceed these recommendations. Because nuts are rich sources of fat and oils, many Americans think of them as alternatives to fat and oils instead of meat and bean substitutes. Alternatively, nuts could also be positioned in a plant protein group along with legumes. This would require changing the basic food group components in MyPyramid, however. Because $\sim 60\%$ of the nuts consumed in the US are consumed as snacks, emphasizing the use of nuts as a healthy, tasty snack may be more effective than positioning them within a food group. For example, replacing snacks high in refined carbohydrates with nuts could have a positive impact on nutrient density and risk of chronic disease.

Ways to increase nut consumption have been proposed by MyPyramid and the Mediterranean diet educational tools. One approach involves using nuts as a condiment for various foods. Some examples are: add slivered almonds to steamed vegetables, add toasted nuts to vegetable stir-frys, sprinkle nuts on top of low-fat ice cream or frozen yogurt, add nuts to green salads instead of cheese or meats, and use ground nuts in sauces or as part of the flour in cakes and cookies.

Research needs

National 24-h dietary recalls in the US and Europe show that about one-fourth to one-third of the populations surveyed eat nuts on any single day. Actual intakes may be higher, because nuts are often eaten as snacks or added to mixed dishes in the diet, which individuals often fail to remember. To better evaluate the total intake of nuts, dietary assessment tools need to be developed that specifically address when and how nuts are consumed, the types and amounts of various nuts eaten, and how individuals primarily use nuts in their diets (as a snack or in recipes). To better evaluate the dietary role of nuts in the diet, research should be done on the placement of nuts in the diet. Nuts could be positioned in the diet in 4 ways: 1) as a substitute for meat; 2) as a plant protein source with legumes; 3) as a source of fat and oil; or 4) as a separate category of nuts and seeds. An assessment of how individuals think about nuts as a component of their diet will assist in making appropriate, population-based dietary guidance recommendations. This information is critical to increase per capita nut consumption from ~ 3 to 7 g/d to the QHC recommendation of 42 g/d. Data on trends in nut consumption should be examined and tracked. If nut consumption is related to chronic disease, good data on long-term nut use is needed. A better understanding of the bioavailability of nutrients from nuts is also needed. A good biomarker of nut consumption would be helpful for tracking intake and health risks. Some possibilities might include serum or erythrocyte membrane fatty acid profiles.

The QHC recommends an intake of 1.5 oz nuts/d (42 g/d). The 2001–2004 NHANES data show that 6% of the individuals surveyed reported eating nuts "out-of-hand" and consumed a

mean of 53 g nuts/d. These individuals met the QHC standard. Yet, there was no evidence that weight status changed significantly with nut use [see Mattes et al. in this issue (23)]. Data on what foods nuts replace in the diet, and how the dietary pattern changes with increased nut consumption, are needed. It is interesting that compared with nonusers of nuts, more Americans consuming nuts out-of-hand met the MyPyramid serving recommendations for meat/meat alternates (79 vs. 45%; $P < 0.001$) and oil (53 vs. 16%; $P < 0.001$) while staying within their discretionary energy allotment (8 vs. 5%; $P < 0.05$). This implies that the nuts consumed replaced other sources of energy in the diet.

Despite the promising results suggesting a link between nut phytochemicals and health outcomes, complete profiles of these ingredients are lacking for most nuts and relatively little direct information from studies on nuts is available on the bioavailability, distribution, metabolism, and elimination of these compounds. Similarly, new data are required to describe the impact on nut phytochemicals of cultivation, varieties, storage, and processing, including thermal treatments (15,24).

Other articles in this supplement include references (25–28).

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