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Nutrient Profiles of Vegetarian and Nonvegetarian Dietary Patterns

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ABSTRACT

Background Differences in nutrient profiles between vegetarian and nonvegetarian dietary patterns reflect nutritional differences that can contribute to the development of disease.

Objective Our aim was to compare nutrient intakes between dietary patterns characterized by consumption or exclusion of meat and dairy products.

Design We conducted a cross-sectional study of 71,751 subjects (mean age=59 years) from the Adventist Health Study 2. Data were collected between 2002 and 2007. Participants completed a 204-item validated semi-quantitative food frequency questionnaire. Dietary patterns compared were nonvegetarian, semi-vegetarian, pesco vegetarian, lacto-ovo vegetarian, and strict vegetarian. Analysis of covariance was used to analyze differences in nutrient intakes by dietary patterns and was adjusted for age, sex, and race. Body mass index and other relevant demographic data were reported and compared by dietary pattern using χ^2 tests and analysis of variance.

Results Many nutrient intakes varied significantly between dietary patterns. Nonvegetarians had the lowest intakes of plant proteins, fiber, beta carotene, and magnesium compared with those following vegetarian dietary patterns, and the highest intakes of saturated, *trans*, arachidonic, and docosahexaenoic fatty acids. The lower tails of some nutrient distributions in strict vegetarians suggested inadequate intakes by a portion of the subjects. Energy intake was similar among dietary patterns at close to 2,000 kcal/day, with the exception of semi-vegetarians, who had an intake of 1,707 kcal/day. Mean body mass index was highest in nonvegetarians (mean=28.7 [standard deviation=6.4]) and lowest in strict vegetarians (mean=24.0 [standard deviation=4.8]).

Conclusions Nutrient profiles varied markedly among dietary patterns that were defined by meat and dairy intakes. These differences are of interest in the etiology of obesity and chronic diseases.
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AWARENESS OF POSSIBLE DIFFERENCES IN NUTRIENT profiles is important when comparing dietary patterns and their associations with disease. Previous studies have shown that dietary patterns characterized by lower meat intake[1] are associated with lower risk of disorders, such as the metabolic syndrome,[2,3] diabetes,[3,4] cardiovascular disease,[5-7] and certain types of cancers.[8,9] Variations in nutrient content can account for these observed differences in health outcomes.

The Adventist Health Study 2 (AHS-2) provides a rich data resource to address these questions. With 45% of the 96,335 study subjects being vegetarian and approximately 8% strict vegetarians, it is presently one of the very few large cohort studies that include a high proportion of vegetarians. Associations between vegetarian dietary patterns and health outcomes can be addressed with adequate power.

This report describes the intakes of major nutrients, vitamins, and minerals in dietary patterns that are characterized by varying animal and plant food consumption. Relevant demographic and socioeconomic data, such as age, education, and marital status, as well as other lifestyle factors such as physical activity, alcohol consumption, and smoking, were included in this study as they may be of relevance when comparing dietary patterns. To show possible associations that differing dietary patterns might have with health-relevant outcomes, body mass index (BMI) was similarly reported and briefly discussed.

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METHODS

The analyses are based on cross-sectional data obtained between 2002 and 2007 from a 50-page self-administered questionnaire.[10] The number of subjects in the present analysis included 71,751 US and Canadian participants from the

AHS-2 cohort whose dietary data had been released for analysis.[10] The study was reviewed and approved by the Institutional Review Board of Loma Linda University, Loma Linda, CA, and informed consent was obtained from all participants.

Race and ethnicity were stratified into black (African American, West Indian/Caribbean, African, or other black) and white (white non-Hispanic, Hispanic, Middle Eastern, Asian, Native Hawaiian/other Pacific Islander, or American Indian) subjects. Education was stratified into the following categories: completed high school diploma or less; some college; and bachelors, masters, or higher university degrees.

Participants reported anthropometric data on height (without shoes in feet and inches) and weight (wearing light clothes in pounds), which had previously been demonstrated to have good validity.[11] BMI was calculated as weight (kg)/height (m^2). Alcohol intake and tobacco use were defined as never, past, or current consumption.

Assessment of Intake of Nutrients, Vitamins, and Minerals

The food frequency questionnaire (FFQ) includes >204 hard-coded foods and space for approximately 50 write-ins, all relating to the diet during the previous 1 year. It consists of two major sections. The first section includes fruits, vegetables, legumes, grains, nuts, oils, dairy, fish, eggs, meats, and beverages; the second consists of approximately 70 commercially prepared products, such as dietary supplements, dry cereals, and vegetarian protein products. Pictures of common foods or beverages typically served together were included with the questionnaire to assist participants in estimating portion sizes. The questionnaire was mailed to each subject, completed at home, and then returned to AHS-2. The FFQ has been validated against 24-hour recall data.[12,13] In this report, intakes from supplements are combined with dietary intakes to form total intakes.

FFQ data were entered using the Nutrition Data System for Research (version 4.06, Nutrition Coordinating Center). Nutrient composition of foods was based on the Nutrition Data System for Research 2008 database, which contains >20,000 foods that are annually updated while maintaining nutrient profiles true to the version used for data collection.[14]

Dietary Patterns

Dietary patterns were defined by level of animal food intake stratified in five categories.[15] Nonvegetarians were defined as those consuming some meat (red meat, poultry, at least once per month), and the total of meat and fish more than one time per week. Semi-vegetarians might consume dairy products and/or eggs, eat some meat (red meat and poultry) one or more times per month, and the total of fish and meat one or more times per month but less than once a week. Pesco vegetarians were subjects consuming fish one or more times per month but who consumed red meat and poultry less than one time per month. There were no restrictions on dairy or egg intake. Lacto-ovo vegetarians were those who reported consuming the total of meat, poultry, or fish less than once a month, also with no restrictions on eggs and or dairy products. Strict vegetarians were subjects who reported consuming each of the following not at all or less than one time per month: meat (red meat, poultry), fish, eggs, milk, and dairy products.

Nutrient intakes were standardized to 2,000 kcal by multiplying observed nutrient by the ratio 2,000/measured kcal. Total caloric intake was calculated by summing information from all dietary sources captured in the FFQ. Percentages of energy intake for major nutrients were reported.

Statistical Analysis

On average, 6% to 7% of dietary data were missing for any particular food item and were filled by guided multiple imputation.[16] Dietary patterns were then compared according to selected demographic variables. χ^2 tests (categorical variables) and analysis of variance (ANOVA) (continuous variables) were used for these comparisons. Percentiles (5th, 50th, and 95th) for nutrient intakes stratified by dietary pattern were reported.

Analysis of covariance with Sidak's adjustments for multiple comparisons was used to test nutrient and BMI differences between dietary patterns. Nutrient intakes were logarithmically transformed for statistical testing. Mean values are reported stratified by dietary pattern and adjusted for age, sex, or race. Mean intake values that differed by ≥20% between dietary patterns were marked.

Analyses were carried out using the statistical software packages IBM SPSS Statistics 20.0.0.1 (2012, SPSS Inc) and R 2.13.1: A Language and Environment for Statistical Computing (2011, R Foundation for Statistical Computing). Type I error rate was set at 0.05.

RESULTS

Basic demographic information is reported in Table 1. Significant differences by dietary pattern were seen for all variables. Across all dietary patterns, 30- to 55-year-olds comprised the largest group ($P<0.001$). The proportions of men among semi- or strict vegetarian were 3 percentage points higher than in nonvegetarians. The nonvegetarians and pesco vegetarian groups had relatively high proportions of black subjects (29.4% and 31.6%, respectively) compared with 24.3% overall.

Across dietary patterns, lacto-ovo vegetarians had the highest proportion of college graduates (60.1%). Lacto-ovo vegetarians had the lowest proportion of low household incomes and strict vegetarians had the highest (28.2% vs 38%). Lacto-ovo and strict vegetarians had the highest proportions of married subjects (78.1% and 76.2%). The proportion of those engaging in 45 minutes or more of vigorous physical activity was generally similar across dietary patterns, with the highest proportion in nonvegetarians (32.5%) and the lowest in lacto-ovo vegetarians (27.9%).

Nonvegetarians had the highest proportion of subjects who had used alcohol or tobacco at some point in their lives (41.7% and 26.2%, respectively) and the highest proportions of current users (11.8% and 2%, respectively).

Nonvegetarians had the highest BMI values (mean=28.7; standard deviation [SD]=6.4) and the highest proportion of obese subjects (33.3%) when compared with any other dietary pattern. Strict vegetarians had the lowest BMI (mean=24.0; SD=4.8) and the lowest proportion of obese subjects (9.4%). Analysis of covariance showed that after adjustments for age, sex, race, and physical activity, dietary

Table 1. Basic socioeconomic and lifestyle characteristics of the Adventist Health Study 2 cohort by dietary pattern

	Nonvegetarian (n=33,634)	Semi-vegetarian (n=4,042)	Pesco vegetarian (n=6,583)	Lacto-ovo vegetarian (n=21,799)	Strict vegetarian (n=5,694)	*P* value[a]
	←		%[c]		→	
Age group (y)						<0.001
30-54	47.1	39.2	40.4	39.3	40.1	
55-69	33.0	33.4	33.1	31.3	32.9	
70 and older	20.0	27.4	26.5	29.1	26.9	
Sex						<0.001
Female	64.5	67.3	66.7	63.5	63.2	
Male	33.5	32.7	33.3	36.6	36.8	
Race						<0.001
Black	29.4	14.4	31.6	20.7	16.9	
White	70.6	85.6	68.4	89.3	83.1	
Education						<0.001
High school or less	24.6	23.0	19.6	15.2	18.5	
Some college	30.7	28.1	26.8	24.7	27.7	
College degree	44.6	48.9	53.6	60.1	53.9	
Marital status						<0.001
Never married	6.6	4.9	5.9	4.7	5.5	
Married or living as married	70.1	71.3	71.9	78.1	76.2	
Vigorous physical activity						<0.001
≥45 min/day	32.5	29.4	31.9	27.9	29.2	
Alcohol consumption						<0.001
Never	46.6	61.1	62.4	74.1	66.8	
Past	41.7	34.3	33.2	24.0	32.8	
Current	11.8	4.4	4.4	1.9	0.4	
Smoking						<0.001
Never	71.8	78.8	81.4	86.9	82.7	
Past	26.2	20.8	18.2	13.0	17.2	
Current	2.0	0.4	0.4	0.1	0.1	
BMI[b]						<0.001
<25	29.4	38.8	46.6	50.3	66.9	
25-29.9	37.3	37.0	35.5	33.0	23.7	
≥30	33.3	24.2	17.9	16.7	9.4	
	←		*mean*±*SD*[c]		→	
BMI	28.7±6.4	27.3±5.6	26.2±5.2	25.9±5.2	24.0±4.8	

[a] χ^2 tests were used to test differences between dietary pattern and *P* values are reported.
[b] BMI=body mass index.
[c] SD=standard deviation.

pattern was significantly associated with BMI ($P<0.001$), with nonvegetarians having much higher mean BMI values than the vegetarian groups. BMI values, including 95% CI, were nonvegetarians (mean=28.6; 95% CI 28.6 to 28.7), semi-vegetarians (mean=27.4; 95% CI 27.3 to 27.6), pesco vegetarians (mean=26.1; 95% CI 26.0 to 26.2), lacto-ovo vegetarians (mean=26.1; 95% CI 26.0 to 26.2), and strict vegetarians (mean=24.1; 95% CI 24.0 to 24.2).

Table 2 reports 5th, 50th, and 95th percentiles for each nutrient. In many cases, nutrient intakes were skewed. For nutrients, values at the 95th percentiles were generally two to three times higher than those at the 5th percentiles. For a few nutrients, and for most vitamins and minerals, this ratio was much higher. More than 50% of both lacto-ovo vegetarians and strict vegetarians reported zero intakes of docosahexaenoic acid, and the 5th percentiles of vitamin B-12 intake (0.4 μg/day) and vitamin D intake (0.1 μg/day) in strict vegetarians were low.

Table 3 summarizes mean nutrient intakes, including standard errors. Intakes of animal-derived proteins and fats were highest in nonvegetarians. The Figure illustrates these contrasts for different protein fractions. The mean percentage of energy derived from animal protein was 2.6 times higher in nonvegetarians than in lacto-ovo vegetarians. Intakes of plant protein, glucose, and fiber were lowest in nonvegetarians. Intakes of vitamins associated with fruits and vegetables were lower in nonvegetarians than in other groups, and intakes of vitamins B-12 and D were highest in pesco vegetarians and nonvegetarians, respectively.

Total calorie intake was lowest in semi-vegetarians. There was little difference between semi-vegetarians and other nonstrict vegetarians for dietary calcium. Intakes of dairy protein were higher in non- and semi-vegetarians than lacto-ovo vegetarians.

Pesco vegetarians had intake values for most variables that were close to those of lacto-ovo vegetarians. However, animal protein intake was comparatively higher, as was intake of arachidonic acid. Intakes of n-3 fatty acids and vitamin E were overall highest in pesco vegetarians.

Lacto-ovo vegetarians had considerably lower intakes of dairy fat and protein than nonvegetarians. Strict vegetarians had the lowest intakes of saturated, *trans*-fat, and arachidonic acid, and the highest intakes of fiber, soy protein, and vitamin C, folate, beta carotene, and vitamin E. Calcium and iron intakes were lowest in strict vegetarians.

DISCUSSION

The present study found that mean nutrient intakes often differed greatly across dietary groups. Contrasts were usually strongest between strict vegetarians and nonvegetarians. Previous studies have shown that plant-based dietary patterns or diets restricted in animal products are associated with both lower cardiometabolic risk and lower coronary heart disease event rates.[4,17-19] These findings might be related to the sizeable differences in nutrient composition between the dietary patterns.

Energy-dense nutrients, such as total fat, saturated fat, and *trans* fat, which have often been associated with higher rates of vascular disease,[20] were highest in nonvegetarians and lowest in strict vegetarians. In addition, vegetarians had higher intakes of fiber in the form of fiber-rich foods, such as fruits, vegetables, and nuts,[21] which have been associated with lower rates of several chronic diseases.[20,22,23] The higher intake of long-chain n-3 fatty acids in pesco vegetarians might be protective, as these fatty acids have been associated with lower rates of sudden cardiac death and possibly prostate cancer.[24]

The results showed that there were small amounts of animal protein consumed by strict vegetarians. This might be due to the rare consumption of some animal-derived foods (less than one time per month) or alternatively might be artifacts of the food database used to evaluate certain recipes.

Strict vegetarians had the highest intakes of vitamins that are commonly associated with fruits. However, differences were less pronounced after taking into account the intake of supplements, as strict vegetarians used less supplements than subjects with other dietary patterns (data not shown).

In strict vegetarians, low dietary intakes of vitamin B-12 and D, calcium, and n-3 fatty acids, in addition to iron and zinc, have often been of concern.[25] In the present study, mean intakes of these nutrients were above minimum requirements[26] in strict vegetarians. The fortification of many foods can provide relatively high mean intakes of these nutrients that are sometimes marginal among strict vegetarians living in other geographic and cultural contexts. However, relatively low intakes of vitamin B-12 and D (Table 2) are of concern for a small proportion of Adventist strict vegetarians in the United States, as can be seen in the very low intakes at the 5th percentile.

Marked differences in BMI were seen among the dietary groups (see Table 1). Strict vegetarians were the only group with a mean BMI value (24.0) below the cut-off point defining overweight status (25.0). There was a clear association between higher proportions of obesity, higher mean levels of BMI, and dietary patterns characterized by progressively higher intakes of meat and dairy products. The contrast was stark when comparing nonvegetarians, who had a 33.3% prevalence of obesity and an adjusted mean BMI of 28.6, with strict vegetarians, who had 9.4% obesity rate and an adjusted mean BMI of 24.1.

These marked differences in BMI are of particular interest given that total energy intakes were similar between the dietary patterns, and mean macronutrient composition and micronutrient intakes were markedly different between the dietary patterns. Some studies have suggested that the source and composition of dietary energy intake can affect body weight independent of total energy consumption,[27] and our findings are consistent with these observations.

Smaller studies of vegetarian subjects have also shown lower BMI levels for vegetarians when compared with nonvegetarians.[28,29] A large study, the Epic-Oxford study,[30] which, to our knowledge, has the highest numbers of vegetarian subjects besides the AHS-2, also reported similar results. However, BMI levels were markedly higher in our American study across all dietary pattern groups when compared with the UK subjects.[30]

The observed differences in obesity between dietary patterns that were seen in our study and in previous investigations might be of particular interest in view of the rising prevalence of obesity in both industrialized and economically developing countries.[31]

Table 2. The 5th, 50th, and 95th percentiles of dietary and total nutrient intakes (mean nutrient intake values standardized to 2,000 kcal/day) by dietary pattern in the Adventist Health Study 2 cohort

	Nonvegetarian			Semi-Vegetarian			Pesco Vegetarian			Lacto-Ovo Vegetarian			Strict Vegetarian		
	Percentiles			Percentiles			Percentiles			Percentiles			Percentiles		
	5th	Median	95th	5th	Median	95th	5th	Median	95th	5th	Median	95th	5th	Median	95th
Food intake (g/day)	1,324	2,776	4,822	1,277	2,625	4,379	1,406	2,874	4,877	1,458	2,799	4,534	1,501	2,974	4,767
Caloric intake (kcal/day)	836	1,773	3,408	753	1,609	3,037	863	1,815	3,387	918	1,803	3,210	910	1,791	3,269
Energy density (kcal/kg)	384	652	1,069	363	623	1,057	399	645	1,057	400	653	1,071	377	610	1,048
Carbohydrate (% energy)	37.8	53.4	68.1	42.5	56.2	70.3	43.0	56.9	71.0	43.9	57.0	69.8	47.7	61.7	75.2
Protein (% energy)	10.7	14.9	20.5	10.2	14.2	19.4	10.6	14.5	20.0	10.6	14.1	19.0	10.4	14.1	19.5
Plant protein (% energy)	4.8	8.5	13.7	6.5	10.6	15.6	7.4	11.4	16.9	7.8	11.7	16.6	10.0	13.5	18.6
Animal protein (% energy)	2.2	5.9	12.2	1.0	3.1	7.7	0.8	2.6	7.0	0.5	1.9	6.3	0.1	0.5	1.4
Fat (% energy)	21.9	34.5	49.3	20.5	33.3	47.3	20.2	32.5	46.9	21.6	33.0	46.3	17.7	29.4	43.9
PUFA[a] (% energy)	5.4	8.8	13.3	5.5	9.4	13.9	5.8	9.4	14.2	6.2	9.8	14.3	5.7	9.5	14.4
MUFA[b] (% energy)	8.1	14.0	22.7	7.4	13.4	21.9	7.2	13.3	22.5	7.8	13.4	21.5	6.1	12.0	21.6
SFA[c] (% energy)	4.9	8.6	13.9	4.3	7.7	12.6	3.8	6.7	11.1	4.1	7.0	11.4	3.0	5.0	8.2
Total carbohydrate (g)	189	267	341	212	281	352	215	285	355	219	285	349	238	309	376
Total sugar (g)	61	106	178	66	108	176	66	108	174	67	106	164	68	107	176
Total fiber (g)	16.2	29.8	46.1	21.0	34.6	50.7	23.3	37.4	53.7	23.6	37.3	52.2	33.7	46.4	61.2
Total protein (g)	53.5	74.7	103	50.8	70.8	97.0	52.8	72.7	100	53.1	70.6	95.1	52.2	70.7	97.3
Plant protein (g)	24.0	42.7	68.3	32.7	52.8	78.2	37.0	56.9	84.3	39.2	58.6	83.0	49.9	67.7	92.8
Animal protein (g)	10.8	29.4	61.2	4.8	15.3	38.6	3.9	13.2	35.0	2.5	9.6	31.3	0.7	2.5	7.1
Dairy protein (g)	1.4	9.3	29.4	0.7	7.7	30.0	0.4	4.5	23.7	0.5	4.8	25.7	0.2	0.6	2.4
Soy protein (g)	0.0	2.8	17.7	0.0	5.9	22.6	0.8	8.5	27.5	1.3	8.0	25.1	1.3	10.9	31.3
Total fat (g)	48.7	76.7	110	45.5	74.0	105	44.9	72.1	104	48.1	73.4	103	39.3	65.4	97.6
PUFA (g)	11.9	19.6	29.6	12.3	20.8	31.0	12.9	21.0	31.5	13.9	21.8	31.9	12.8	21.1	32.1
MUFA (g)	17.9	31.0	50.4	16.4	29.7	48.6	16.0	29.5	50.0	17.3	29.7	47.7	13.6	26.7	48.1
SFA (g)	10.9	19.1	30.8	9.5	17.0	27.9	8.5	14.9	24.7	9.2	15.6	25.3	6.7	11.2	18.2
TFA[d] (g)	1.3	3.9	9.1	1.0	3.5	8.7	0.6	2.7	7.2	0.9	3.2	7.9	0.3	1.7	5.1
n-3 (g)	1.2	2.1	3.9	1.1	2.0	3.7	1.3	2.2	4.1	1.1	2.0	3.5	1.0	1.8	3.5
Linoleic acid (g)	10.1	17.1	26.4	10.8	18.6	27.9	11.0	18.5	28.0	12.4	19.7	28.8	11.5	19.1	29.1
Arachidonic acid (mg)	18.4	71.5	198	4.1	19.2	66.7	2.7	32.6	130	0.0	6.0	40.2	0.0	0.0	6.3
DHA[e] (mg)	3.2	102	706	0.0	3.1	411	0.0	98.4	762	0.0	0.0	253	0.0	0.0	1.8
Vitamin B-6 (mg)	1.5	3.1	72.4	1.7	3.4	85.1	1.8	3.5	86.8	1.8	3.3	75.9	1.9	3.2	81.2
Vitamin B-12 (μg)	2	7.1	64.5	1.6	8.3	75.4	1.6	8.5	88.6	1.5	8	80.7	0.4	6.3	89.1

(*continued on next page*)

Table 2. The 5th, 50th, and 95th percentiles of dietary and total nutrient intakes (mean nutrient intake values standardized to 2,000 kcal/day) by dietary pattern in the Adventist Health Study 2 cohort (*continued*)

	Nonvegetarian			Semi-Vegetarian			Pesco Vegetarian			Lacto-Ovo Vegetarian			Strict Vegetarian		
	Percentiles			Percentiles			Percentiles			Percentiles			Percentiles		
	5th	Median	95th	5th	Median	95th	5th	Median	95th	5th	Median	95th	5th	Median	95th
Vitamin C (mg)	70	250	1,660	84.3	273	1,939	101	308	1,862	95.8	271	1,701	109	293	1,810
Folate (μg)	356	672	1,822	403	731	1,959	427	766	1,934	427	729	1,870	457	723	1,845
Beta carotene (μg)	1,485	5,525	21,983	1,685	5,861	21,820	2,284	7,417	31,853	1,969	6,303	25,823	2,554	8,474	39,071
Vitamin D (μg)	1.4	6.1	30.3	0.7	5.5	32	0.9	5.8	30.3	0.5	4.6	28	0.1	2.4	24.5
Vitamin E (mg)	6.8	20	504	7.9	26.1	561	8.4	26.9	511	8.5	24.7	510	8.9	18.5	481
Calcium (mg)	535	1,072	2,790	575	1,195	3,107	574	1,125	2,770	577	1,145	2,854	520	933	2,556
Iron (mg)	12.1	20	71.4	13.6	21.7	61.8	14.4	22.4	75.6	14.7	22.1	61	16.2	22.2	53.1
Potassium (mg)	2,197	3,487	5,091	2,390	3,627	5,258	2,589	3,853	5,521	2,547	3,667	5,161	2,934	4,120	5,922
Magnesium (mg)	271	448	966	320	492	1,087	340	519	1,061	341	514	1,063	433	591	1,162
Sodium (mg)	1,852	3,272	7,301	1,848	3,346	7,448	1,595	3,101	6,734	1,931	3,432	7,304	1,475	3,066	7,043
Phosphorus (mg)	984	1,359	1,872	994	1,360	1,865	1,018	1,366	1,823	1,028	1,348	1,805	1,044	1,370	1,710
Zinc (mg)	7.4	11.9	44.9	7.3	11.6	47.4	7.2	11.5	43.9	7.5	11.5	44.9	7.9	11.3	41.5

[a]PUFA=polyunsaturated fatty acid.
[b]MUFA=monounsaturated fatty acid.
[c]SFA=saturated fatty acid.
[d]TFA=*trans*-fatty acid.
[e]DHA=docosahexaenoic acid.

Table 3. Mean nutrient intake values with standard errors (mean nutrient intake values standardized to 2,000 kcal/day) stratified by dietary pattern with adjustments made for sex, race, and age in the Adventist Health Study 2[a]

	Nonvegetarian		Semi-Vegetarian		Pesco Vegetarian		Lacto-Ovo Vegetarian		Strict Vegetarian	
	Mean	SE[b]	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Caloric intake (kcal/day)	1,893	4	1,707	11	1,933	9	1,896	5	1,894	9
Carbohydrate (% energy)	51.4	<0.1	53.9	0.1	54.5	0.1	54.3	0.1	58.1	0.1
Protein (% energy)	14.7	<0.1	13.7	<0.1	14.2	<0.1	13.7	<0.1	13.6	<0.1
Plant protein (% energy)	8.5	<0.1	10.3*	<0.1	11.1*	<0.1	11.4*	<0.1	13.0*	<0.1
Animal protein (% energy)	6.2	<0.1	3.4*	<0.1	3.0*	<0.1	2.4*	<0.1	0.6*	<0.1
Fat (% energy)	33.8	<0.1	32.2	0.1	31.3	0.1	31.9	0.1	28.2	0.1
Total carbohydrate (g)	266	0.2	283	0.7	284	0.5	286	0.3	309	0.6
Total sugar (g)	110	0.2	113	0.5	111	0.4	110	0.2	112	0.5
Total fiber (g)	30.4	<0.1	34.9*	0.1	37.7*	0.1	37.5*	0.1	46.7*	0.1
Total protein (g)	75.8	0.1	71.8	0.2	74.3	0.2	72.0	0.1	72.3	0.2
Plant protein (g)	43.9	0.1	54.1*	0.2	58.2*	0.2	59.7*	0.1	69.2*	0.2
Animal protein (g)	31.8	0.1	17.6*	0.2	16.0*	0.2	12.2*	0.1	3.1*	0.2
Dairy protein (g)	11.8	<0.1	10.2	0.1	7.7*	0.1	7.5*	0.1	0.7*	0.1
Soy protein (g)	4.9	<0.1	8.0*	0.1	10.5*	0.1	10.2*	0.1	13.1*	0.1
Total fat (g)	78.1	0.1	74.2	0.3	73.4	0.2	73.6	0.1	66.1	0.2
PUFA[c] (g)	20.2	<0.1	21.1	0.1	21.5	0.1	22.1	<0.1	21.6	0.1
MUFA[d] (g)	32.4	0.1	30.5	0.2	30.9	0.1	30.3	0.1	28	0.1
SFA[e] (g)	19.9	<0.1	17.4	0.1	15.8*	0.1	16	<0.1	11.6*	0.1
TFA[f] (g)	4.4	<0.1	4	<0.1	3.1	<0.1	3.6	<0.1	2.1*	<0.1
n-3 (g)	2.3	<0.1	2.1	<0.1	2.4	<0.1	2.1	<0.1	2	<0.1
Linoleic acid (g)	17.6	<0.1	18.8	0.1	19	0.1	19.9	<0.1	19.5	0.1
Arachidonic acid (mg)	84.1	0.3	27.2*	0.7	43.6*	0.6	13.4*	0.3	2.6*	0.6
DHA[g] (mg)	182	1.2	69.8*	3.6	187	2.8	33.8*	1.5	18.2*	3
Vitamin B-6 (mg)	13.5	0.2	14.9	0.5	15.7	0.4	13.6	0.2	14.4	0.4
Vitamin B-12 (μg)	22.1	0.4	24.3	1.2	26.5	1	24.2	0.5	23.3	1
Vitamin C (mg)	488	3.5	530	10	568	7.8	497	4.3	531	8.4
Folate (μg)	848	2.9	912	8.2	926	6.5	889	3.6	888	6.9
Beta carotene (μg)	8,830	84.6	8,987	242	11,275*	190	10,002	106	13,300*	204
Vitamin D (μg)	10.6	0.1	9.9	0.2	9.8	0.2	8.6	0.1	6.3*	0.2

(*continued on next page*)

Table 3. Mean nutrient intake values with standard errors (mean nutrient intake values standardized to 2,000 kcal/day) stratified by dietary pattern with adjustments made for sex, race, and age in the Adventist Health Study 2[a] (*continued*)

	Nonvegetarian		Semi-Vegetarian		Pesco Vegetarian		Lacto-Ovo Vegetarian		Strict Vegetarian	
	Mean	SE[b]	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Vitamin E (mg)	122	1	131	2.9	132	2.3	116	1.3	101	2.4
Calcium (mg)	1,333	4	1,410	11.4	1,352	9	1,332	5	1,156	9.6
Iron (mg)	32.9	0.3	34.1	0.9	34.6	0.7	34.1	0.4	31.6	0.8
Potassium (mg)	3,550	4.8	3,694	13.6	3,910	10.7	3,745	5.9	4,234	11.5
Magnesium (mg)	509	1.3	554	3.7	581	2.9	567	1.6	652*	3.1
Sodium (mg)	3,788	10.5	3,808	30	3,537	23.6	3,851	13.1	3,531	25.3
Phosphorus (mg)	1,391	1.4	1,381	4.1	1,394	3.2	1,363	1.8	1,371	3.5
Zinc (mg)	18.7	0.1	18.6	0.2	18.4	0.2	17.9	0.1	16.3	0.2

[a]Analysis of covariance was used in testing differences between dietary patterns. Values were logarithmically transformed for statistical testing. Values for effects of dietary pattern were $P<0.001$ for all reported nutrients and are therefore not indicated in an individual column.
[b]SE=standard error.
[c]PUFA=polyunsaturated fatty acid.
[d]MUFA=monounsaturated fatty acid.
[e]SFA=saturated fatty acid.
[f]TFA=*trans*-fatty acid.
[g]DHA=docosahexaenoic acid.
*Significant contrast ($P<0.05$) and a mean difference $\geq$20% when compared with nonvegetarian dietary pattern as the group of reference.

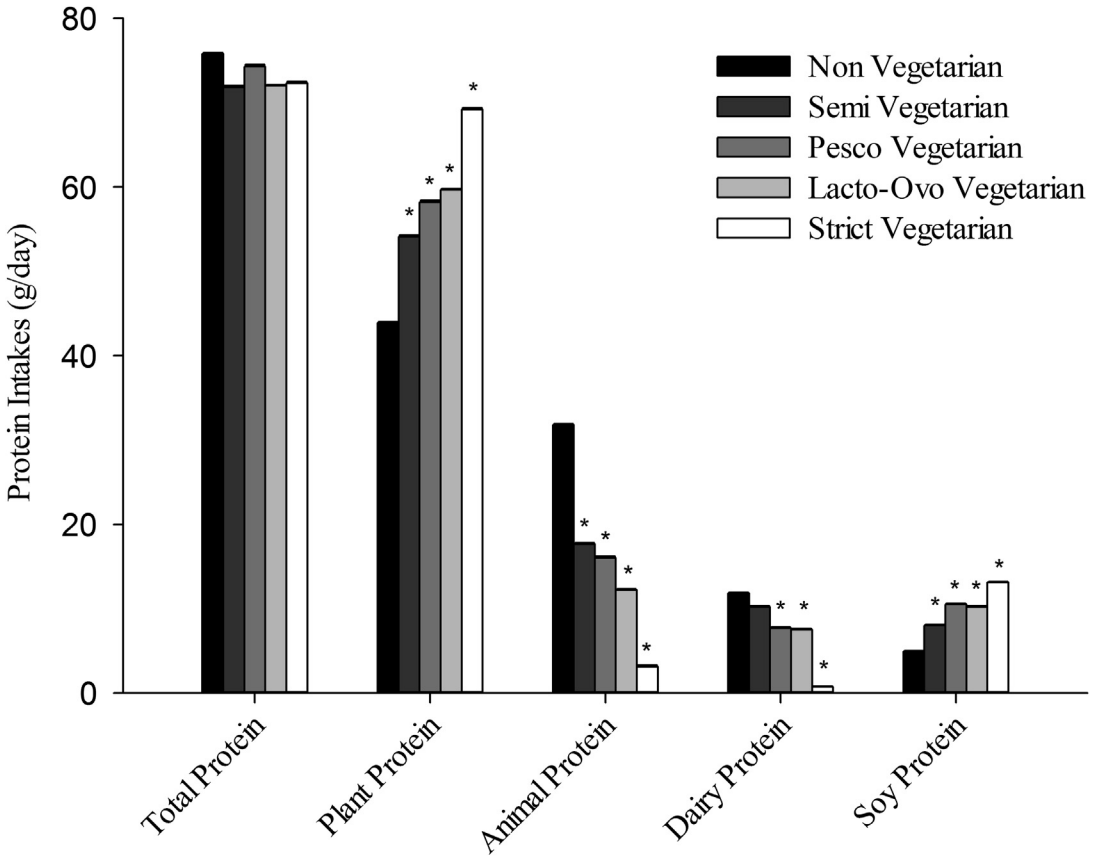

Figure. Dietary mean protein intakes standardized to 2,000 kcal/day by dietary pattern in the Adventist Health Study 2. Adjustments were made for age, sex, and race. *Significant contrast ($P<0.05$) and a mean difference $\geq$20% when compared to nonvegetarian dietary pattern as the group of reference.

When comparing unadjusted energy intakes of AHS-2 US lacto-ovo vegetarians with UK vegetarians (data not shown), the total energy intake in the United States was 4.7% lower for men and 1.2% higher for women. Percentage energy intakes in the United States were higher for carbohydrates by 7% for men and 2.2% for women. Energy percentage intakes of protein were 3.9% higher for men and equal for women. Energy percentage intakes of fat were higher by 1.5% for men and 5.6% for women. Energy percentage intakes of polyunsaturated fatty acids were higher by 67.7% for men and 80.8% for women. Energy percentage intakes for saturated fatty acids were lower by 25.7% for men and 25.1% for women.

Dietary fiber intakes, measured in grams per day, were 62.1% higher for men and 60% higher for women in US vegetarians than the corresponding non-starch polysaccharide values in the United Kingdom. Dietary intakes of vitamins were often much higher in the US lacto-ovo vegetarians for both men and women; this was true for vitamins B-12, C, folate, and vitamin D, while vitamin E intake was lower in US women and higher in US men when compared to the United Kingdom. Mean intakes of iron, magnesium, and zinc were higher in the United States, often markedly so, while dietary calcium and potassium intakes were lower in the United States for both sexes.

Some of the observed differences between US and UK vegetarians might be a result of fortification of foods, or the relative high intake of nuts in US Adventists.[32] There appear to be dissimilarities in vegetarian dietary habits between countries, although reported differences might be partly attributable to differing dietary assessment methods or differences in the dietary tables used.

CONCLUSIONS

The present study provides new data on dietary intakes in a large population. Dietary patterns defined by intakes of animal-derived foods are associated with large differences in nutrient, vitamin, and mineral intakes in this large study population. These dietary patterns identify strongly contrasting groups of subjects. Associations between diet patterns and health outcomes, perhaps partially mediated by the markedly different dietary intakes and BMI values, are of interest and invite continued investigation.

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STATEMENT OF POTENTIAL CONFLICT OF INTEREST

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