NIH Public Access
Author Manuscript
J Acad Nutr Diet. Author manuscript; available in PMC 2014 December 01.

Published in final edited form as:
J Acad Nutr Diet. 2013 December ; 113(12): 1610–1619. doi:10.1016/j.jand.2013.06.349.

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

Nutrient Profiles of Vegetarian and Non Vegetarian Dietary Patterns

Nico S. Rizzo,
med. Dr., PhD, Asst. Professor, Department of Nutrition, School of Public Health, Loma Linda University, Loma Linda, CA, USA. 24951 North Circle Drive, Loma Linda, CA 92350, USA. Tel: +1 909 558 4300 ext. 47167, Fax: +1 909 558 4095, nrizzo@llu.edu

Karen Jaceldo-Siegl,
DrPH, Asst. Professor, Department of Nutrition, School of Public Health, Loma Linda University, Loma Linda, CA, USA. Tel: +1 909 558 4300 ext. 87580, Fax: +1 909 558 4095, kjaceldo@llu.edu

Joan Sabate, and
MD, DrPH, Professor, Department of Nutrition, School of Public Health, Loma Linda University, Loma Linda, CA, USA. Tel: +1 909 558 4300, Fax: +1 909 558 4095, kjaceldo@llu.edu

Gary E. Fraser
PhD, Professor, Department of Epidemiology, School of Public Health, Loma Linda University, Loma Linda, CA, USA. Tel: +1 909 558 4300, Fax: +1 909 558 4095, efraser@llu.edu

Abstract

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

Objective—To compare nutrient intakes between dietary patterns characterized by consumption or exclusion of meat and dairy products.

Design—Cross-sectional study of 71751 subjects (mean age 59 years) from the Adventist-Health-Study-2. Data was collected between 2002 and 2007. Participants completed a 204-item validated semi-quantitative food frequency questionnaire. Dietary patterns compared were: non vegetarian, semi vegetarian, pesco vegetarian, lacto-ovo vegetarian and strict vegetarian. ANCOVA was used to analyze differences in nutrient intakes by dietary patterns and were adjusted for age, and sex and race. BMI and other relevant demographic data were reported and compared by dietary pattern using chi-square tests and ANOVA.

Results—Many nutrient intakes varied significantly between dietary patterns. Non vegetarians had the lowest intakes of plant proteins, fiber, β-Carotene, and Mg than those following vegetarian dietary patterns and the highest intakes of saturated, trans, arachidonic, and docosahexaenoic fatty

Correspondence to: Nico S. Rizzo.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

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 2000 kcal/d with the exception of semi vegetarians that had an intake of 1713 kcal/d. Mean BMI was highest in non-vegetarians (mean; standard deviation [SD]) (28.7; [6.4]) and lowest in strict vegetarians (24.0; [4.8]).

Conclusions—Nutrient profiles varied markedly between dietary patterns that were defined by meat and dairy intakes. These differences can be of interest in the etiology of obesity and chronic diseases.

Keywords

Dietary Pattern; Nutrient Profile; Vitamins; Minerals; Vegetarian

INTRODUCTION

Awareness of possible differences in nutrient profiles is of importance 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 may 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. Thus 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, marital status and income 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 may have with health relevant outcomes, BMI was similarly reported and briefly discussed.

SUBJECTS AND METHODS

The analyses are based on cross-sectional data obtained between 2002–2007 from a 50-page self-administered questionnaire[10]. The number of subjects in the present analysis included 71751 U.S. 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, California, 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,

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Native Hawaiian/other Pacific Islander, or American Indian) subjects. Education was stratified into three categories: completed high school diploma or less; some college; 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, that had previously been demonstrated to have good validity.[11] BMI was calculated as weight/length^2. Alcohol intake and tobacco use were defined as never, past or current consumption.

Assessment of Intake of Nutrients, Vitamins, and Minerals

The FFQ includes more than 204 hard-coded foods and space for approximately 50 writeins, all relating to the diet during the previous one year. It consists of two major sections. The first section includes fruits, vegetables, legumes, grains, nuts, oils, dairy, fish, eggs, meats, and beverages, and 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 (NDS-R, Nutrition Coordinating Center, Minneapolis, MN, USA). Nutrient composition of foods was based on the NDS-R 2008 database, which contains over 20000 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]. Non vegetarians were defined as those consuming some meat (red meat, poultry, at least once per month), and the total of meat and fish >1 time/week. Semi vegetarians may consume dairy products and/or eggs, eat some meat (red meat and poultry) ≥1 time/month, and the total of fish and meat ≥1 time/month but <1 time/week. Pesco vegetarians were subjects consuming fish ≥1 time/month but who consumed red meat and poultry <1 time/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 <1/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 2000 kcal by multiplying observed nutrient by the ratio 2000/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.

NIH-PA Author Manuscript NIH-PA Author Manuscript NIH-PA Author Manuscript

Statistical Analysis

On average 6–7% 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. Chi-square tests (categorical variables) and ANOVA (continuous variables) were used for these comparisons. Percentiles (5^{th}, 50^{th} and 95^{th}) for nutrient intakes stratified by dietary pattern were reported.

ANCOVA 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 (SPSS Inc., Chicago, IL, USA) and R 2.13.1: A Language and Environment for Statistical Computing (R Foundation for Statistical Computing, Vienna, Austria). 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 non vegetarians. Non-vegetarians and pesco vegetarians had relatively high proportions of blacks (respectively 29.4% and 31.6%), compared to 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. 38.0%). Lacto-ovo and strict vegetarians had the highest proportions of married subjects (78.1% and 76.2%). The proportion of those engaging 45 minutes or more in vigorous physical activity was generally similar across dietary patterns with the highest proportion in non vegetarians (32.5%) and the lowest in lacto-ovo vegetarians (27.9%).

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

Non vegetarians had the highest mean BMI values (28.7, SD 6.4) and the highest proportion of obese subjects (33.3%) when compared to any other dietary pattern. Strict vegetarians had the lowest BMI (24.0, SD 4.8) and the lowest proportion of obese subjects (9.4%). ANCOVA showed that after adjustments for age, sex, race and physical activity dietary pattern was significantly associated with BMI ($P<0.001$) with non vegetarians having much higher mean BMI values than the vegetarian groups. Mean BMI values including confidence intervals (CI) were: non vegetarians (28.6; CI 28.6–28.7), semi vegetarians (27.4; CI 27.3–

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

27.6), pesco vegetarians (26.1; CI 26.0–26.2), lacto-ovo vegetarians (26.1; CI 26.0–26.2) and strict vegetarians (24.1; CI 24.0–24.2).

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 2–3 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 DHA, and the 5th percentiles of vitamin B12 intake (0.4μg/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 non vegetarians. Figure 1 illustrates these contrasts for different protein fractions. The mean percentage of energy derived from animal protein was 2.5 times higher in non vegetarians than in lacto-ovo vegetarians. Intakes of plant protein, glucose, and fiber were lowest in non vegetarians. Vitamins associated with fruits and vegetables were lower in non vegetarians than in other groups, whereas intakes of vitamins B12 and D were highest in non-vegetarians.

Total calorie intake was lowest in semi vegetarians. There was little difference between semi vegetarians and other non-strict 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 Omega 3 fatty acids, vitamin E and D were highest in pesco vegetarians.

Lacto-ovo vegetarians had significantly lower intakes of dairy fat and protein than non vegetarians. Strict vegetarians had the lowest intakes of saturated, trans-fat, and arachidonic acid and the highest intakes of fiber, soy protein and vitamins C, folate, β-carotene and E. Calcium and iron intakes were also lowest in strict vegetarians.

DISCUSSION

The present study found that mean nutrient intakes often differed greatly across dietary groups. Contrasts were usually greatest between strict vegetarians and non vegetarians. Previous studies have shown that plant-based dietary patterns or diets restricted in animal products are associated with both lower cardio-metabolic risk and lower coronary heart disease event rates [4;17–19]. These findings may 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 non vegetarians 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 has been associated with lower rates of several chronic diseases[20;22;23]. The higher intake of long chain omega-3 fatty acids in

NIH-PA Author Manuscript NIH-PA Author Manuscript NIH-PA Author Manuscript

pesco vegetarians may 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 may be due to the rare consumption of some animal-derived foods (less than one time per month) or alternatively may 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 B12 and D, calcium, and omega-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 may provide relatively high mean intakes of these nutrients that are sometimes marginal among strict vegetarian living in other geographic and cultural contexts. However, relatively low intakes of vitamin B12 and D, (Table 2) are of concern for a small proportion of Adventist strict vegetarians in the U.S., as can be seen in the very low intakes at the 5th percentile.

Marked differences in BMI were seen between the dietary groups (see Table 1). Strict vegetarians were the only group with a mean BMI value (24.0 kg/m^2) below the cut-off point (25.0 kg/m^2) defining overweight status. 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 non vegetarians who had 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 whereas 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 may 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 to non vegetarians[28;29]. A large study, the Epic-Oxford study[30], which to our knowledge has the highest numbers of vegetarian subjects beside the AHS-2, also reported similar results. However, BMI levels were markedly higher in our American study across all dietary pattern groups when compared to the U.K subjects[30].

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

NIH-PA Author Manuscript NIH-PA Author Manuscript NIH-PA Author Manuscript

Comparing AHS-2 Americans with British lacto-ovo vegetarians, reported total energy intake in the U.S. was 5% lower in men and 1.8% higher in women, than in the U.K. Energy-adjusted consumption of U.S. lacto-ovo vegetarians (men; women) was (12.5%; 7.8%) higher for carbohydrates, (5.1%; 9.5%) higher for total fat, (23.2%; 22.8%) lower for SFA, and (74.6%; 89.0%) higher for PUFA, than in the U.K.

Dietary fiber intakes, measured in g/day, were (62.1%; 60.1%) higher in American vegetarians than the corresponding non-starch polysaccharide figures in the U.K. Dietary intakes of vitamins were often much higher in the U.S. lacto-ovo vegetarians, this being true for vitamins B12, C, folate, and vitamin D, although intakes of vitamin E were similar. Iron, magnesium, and zinc were higher in the U.S., often markedly so, while dietary calcium and potassium intakes were lower in the U.S.

Some of the observed differences between U.S. and U.K. vegetarians may be due to fortification of foods, or the relative high intake of nuts in U.S. Adventists[32]. Thus there appear to be dissimilarities of vegetarian dietary habits between countries, although reported differences may 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. Thus, 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.

Acknowledgments

Funding Disclosure

This work was supported by the National Institutes of Health Grant 1R01-CA-94594. Nico S. Rizzo was supported by the National Institute of Food and Agriculture Grant 2010-38938-20924.

Reference List

1. Willett W. Lessons from dietary studies in Adventists and questions for the future. Am J Clin Nutr. 2003; 78:539S–543S. [PubMed: 12936947]
2. Rizzo NS, Sabate J, Jaceldo-Siegl K, Fraser GE. Vegetarian dietary patterns are associated with a lower risk of metabolic syndrome: the adventist health study 2. Diabetes Care. 2011; 34:1225–1227. [PubMed: 21411506]
3. Vang A, Singh PN, Lee JW, Haddad EH, Brinegar CH. Meats, processed meats, obesity, weight gain and occurrence of diabetes among adults: findings from Adventist Health Studies. Ann Nutr Metab. 2008; 52:96–104. [PubMed: 18349528]
4. Tonstad S, Butler T, Yan R, Fraser GE. Type of vegetarian diet, body weight, and prevalence of type 2 diabetes. Diabetes Care. 2009; 32:791–796. [PubMed: 19351712]
5. Fraser GE. Diet as primordial prevention in Seventh-Day Adventists. Prev Med. 1999; 29:S18–S23. [PubMed: 10641813]

NIH-PA Author Manuscript NIH-PA Author Manuscript NIH-PA Author Manuscript

6. Toohey ML, Harris MA, DeWitt W, Foster G, Schmidt WD, Melby CL. Cardiovascular disease risk factors are lower in African-American vegans compared to lacto-ovo-vegetarians. J Am Coll Nutr. 1998; 17:425–434. [PubMed: 9791838]
7. Fraser GE, Shavlik DJ. Risk factors for all-cause and coronary heart disease mortality in the oldest-old. The Adventist Health Study. Arch Intern Med. 1997; 157:2249–2258. [PubMed: 9343002]
8. Kiani F, Knutsen S, Singh P, Ursin G, Fraser G. Dietary risk factors for ovarian cancer: the Adventist Health Study (United States). Cancer Causes Control. 2006; 17:137–146. [PubMed: 16425091]
9. Singh PN, Fraser GE. Dietary risk factors for colon cancer in a low-risk population. Am J Epidemiol. 1998; 148:761–774. [PubMed: 9786231]
10. Butler TL, Fraser GE, Beeson WL, et al. Cohort profile: The Adventist Health Study-2 (AHS-2). Int J Epidemiol. 2008; 37:260–265. [PubMed: 17726038]
11. Bes-Rastrollo M, Sabate J, Jaceldo-Siegl K, Fraser GE. Validation of self-reported anthropometrics in the Adventist Health Study 2. BMC Public Health. 2011; 11:213. [PubMed: 21466678]
12. Jaceldo-Siegl K, Knutsen SF, Sabate J, et al. Validation of nutrient intake using an FFQ and repeated 24 h recalls in black and white subjects of the Adventist Health Study-2 (AHS-2). Public Health Nutr. 2010; 13:812–819. [PubMed: 19968897]
13. Jaceldo-Siegl K, Fan J, Sabate J, et al. Race-specific validation of food intake obtained from a comprehensive FFQ: the Adventist Health Study-2. Public Health Nutr. 2011; 14:1988–1997. [PubMed: 21557864]
14. Schakel SF, Sievert YA, Buzzard IM. Sources of data for developing and maintaining a nutrient database. J Am Diet Assoc. 1988; 88:1268–1271. [PubMed: 3171020]
15. Fraser GE. Vegetarian diets: what do we know of their effects on common chronic diseases? Am J Clin Nutr. 2009; 89:1607S–1612S. [PubMed: 19321569]
16. Fraser G, Yan R. Guided multiple imputation of missing data: using a subsample to strengthen the missing-at-random assumption. Epidemiology. 2007; 18:246–252. [PubMed: 17259903]
17. Sacks FM, Kass EH. Low blood pressure in vegetarians: effects of specific foods and nutrients. Am J Clin Nutr. 1988; 48:795–800. [PubMed: 3414588]
18. Rizzo NS, Sabate J, Jaceldo-Siegl K, Fraser GE. Vegetarian dietary patterns are associated with a lower risk of metabolic syndrome: the adventist health study 2. Diabetes Care. 2011; 34:1225–1227. [PubMed: 21411506]
19. Fraser GE. Associations between diet and cancer, ischemic heart disease, and all-cause mortality in non-Hispanic white California Seventh-day Adventists. Am J Clin Nutr. 1999; 70:532S–538S. [PubMed: 10479227]
20. Bhupathiraju SN, Tucker KL. Coronary heart disease prevention: Nutrients, foods, and dietary patterns. Clin Chim Acta. 2011
21. Fraser, GE. Diet, Life Expectancy and Chronic Disease. New York: Oxford University Press; 2003.
22. Aune D, Chan DS, Lau R, et al. Dietary fibre, whole grains, and risk of colorectal cancer: systematic review and dose-response meta-analysis of prospective studies. BMJ. 2011; 343:6617.
23. Flight I, Clifton P. Cereal grains and legumes in the prevention of coronary heart disease and stroke: a review of the literature. Eur J Clin Nutr. 2006; 60:1145–1159. [PubMed: 16670693]
24. Leitzmann MF, Stampfer MJ, Michaud DS, et al. Dietary intake of n-3 and n-6 fatty acids and the risk of prostate cancer. Am J Clin Nutr. 2004; 80:204–216. [PubMed: 15213050]
25. Craig WJ. Health effects of vegan diets. Am J Clin Nutr. 2009; 89:1627S–1633S. [PubMed: 19279075]
26. Dietary Reference Intakes(DRIs): Estimated Average Requirements. Food and Nutrition Board, Institute of Medicine, National Academies. Washington DC: THE NATIONAL ACADEMIES PRESS ed.; 2012. http://www.nap.edu
27. Moussavi N, Gavino V, Receveur O. Could the quality of dietary fat, and not just its quantity, be related to risk of obesity? Obesity (Silver Spring). 2008; 16:7–15. [PubMed: 18223605]
28. Haddad EH, Tanzman JS. What do vegetarians in the United States eat? Am J Clin Nutr. 2003; 78:626S–632S. [PubMed: 12936957]

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

29. Cade JE, Burley VJ, Greenwood DC. The UK Women's Cohort Study: comparison of vegetarians, fish-eaters and meat-eaters. Public Health Nutr. 2004; 7:871–878. [PubMed: 15482612]
30. Davey GK, Spencer EA, Appleby PN, Allen NE, Knox KH, Key TJ. EPIC-Oxford: lifestyle characteristics and nutrient intakes in a cohort of 33 883 meat-eaters and 31 546 non meat-eaters in the UK. Public Health Nutr. 2003; 6:259–269. [PubMed: 12740075]
31. Popkin BM. Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases. Am J Clin Nutr. 2006; 84:289–298. [PubMed: 16895874]
32. Fraser GE, Sabate J, Beeson WL, Strahan TM. A possible protective effect of nut consumption on risk of coronary heart disease. The Adventist Health Study. Arch Intern Med. 1992; 152:1416–1424. [PubMed: 1627021]

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

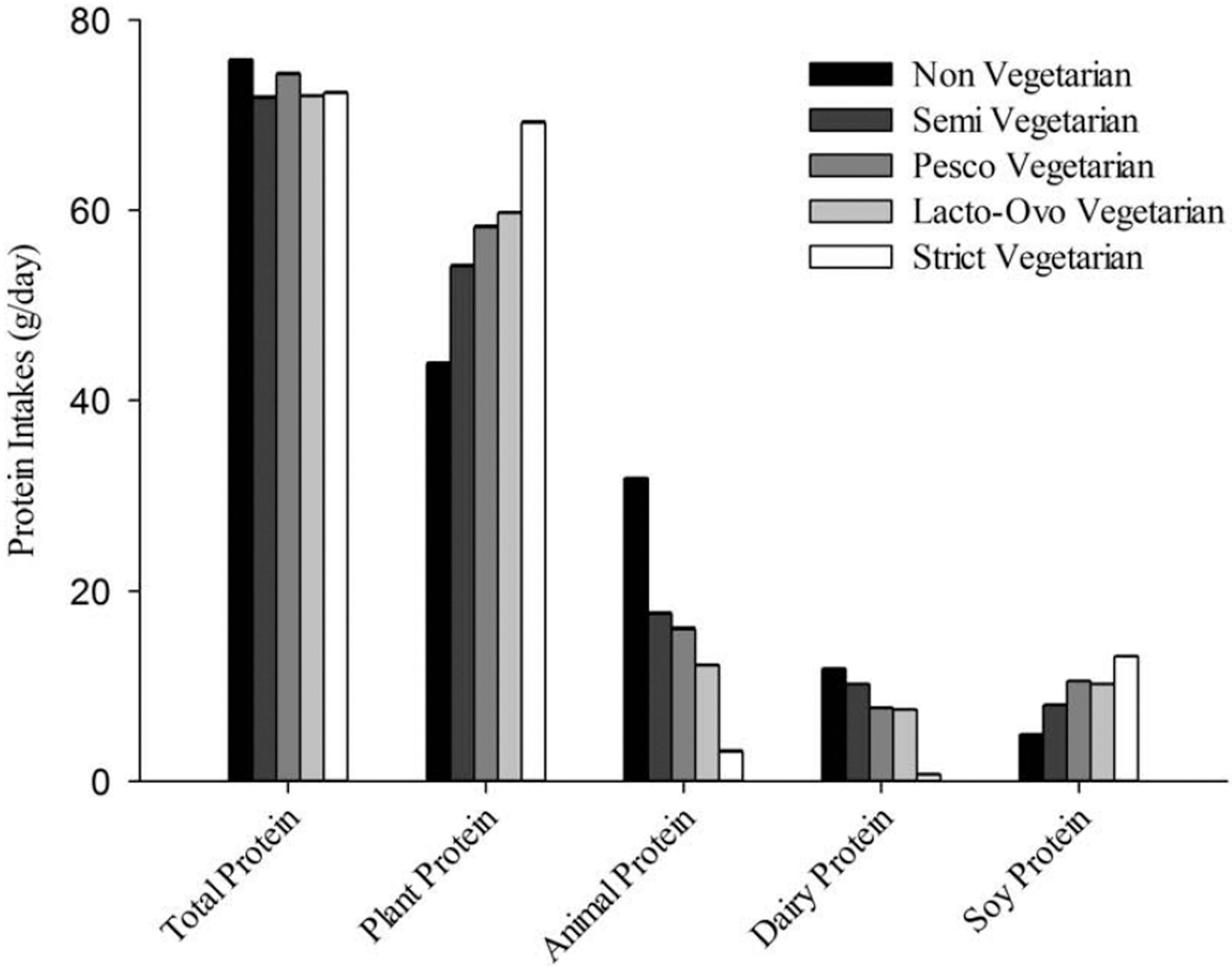

Figure 1.

Dietary mean protein intakes by dietary pattern in the AHS-2. Adjustments were made for age, sex and race.

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

TABLE 1

Basic socio economic and lifestyle characteristics of the AHS-2[a] cohort expressed as percentages or mean [SD[d]] by dietary pattern.

	Non Vegetarian (n=33634)	Semi Vegetarian (n=4042)	Pesco Vegetarian (n=6583)	Lacto Ovo Vegetarian (n=21799)	Strict Vegetarian (n=5694)	p^b
Age Group (years)						**<0.001**
30 – 54.9	47.1	39.2	40.4	39.3	40.1	
55 – 69.9	33.0	33.4	33.1	31.3	32.9	
≥70	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	
Vigorous Physical Activity (min/day)						**<0.001**
≥45	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[c] (kg/m^2)						**<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	

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

	Non Vegetarian (n=33634)	Semi Vegetarian (n=4042)	Pesco Vegetarian (n=6583)	Lacto Ovo Vegetarian (n=21799)	Strict Vegetarian (n=5694)	*P*[b]
≥30	33.3	24.2	17.9	16.7	9.4	
Mean[SD[d]]	28.7[6.4]	27.3[5.6]	26.2[5.2]	25.9[5.2]	24.0[4.8]	

[a] AHS-2=Adventist Health Study 2.

[b] Chi-square tests were used to test differences between dietary pattern and *P* values are reported.

[c] BMI=Body mass index.

[d] SD=Standard Deviation.

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

TABLE 2

The 5th, 50th and 95th percentiles of dietary and total nutrient intakes standardized to 2000 kcal/day by dietary pattern in the AHS-2^{a} cohort.

	Non Vegetarian			Semi Vegetarian			Pesco Vegetarian			Lacto Ovo Vegetarian			Strict Vegetarian		
	5th	Percentiles Median	95th	5th	Percentiles Median	95th	5th	Percentiles Median	95th	5th	Percentiles Median	95th	5th	Percentiles Median	95th
Food Intake (g/d)	1324	2776	4822	1277	2625	4379	1406	2874	4877	1458	2799	4534	1501	2974	4767
Caloric Intake (kcal/d)	836	1773	3408	753	1609	3037	863	1815	3387	918	1803	3210	910	1791	3269
Energy density (kcal/kg)	384	652	1069	363	623	1057	399	645	1057	400	653	1071	377	610	1048
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^{b} (% 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^{c} (% 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^{d} (% 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^{b} (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^{c} (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^{d} (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^{e} (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
Omega 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

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

	Non Vegetarian			Semi Vegetarian			Pesco Vegetarian			Lacto Ovo Vegetarian			Strict Vegetarian		
	5th	Percentiles Median	95th	5th	Percentiles Median	95th	5th	Percentiles Median	95th	5th	Percentiles Median	95th	5th	Percentiles Median	95th
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[h] (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 B6 (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 B12 (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
Vitamin C (mg)	70	250	1660	84.3	273	1939	101	308	1862	95.8	271	1701	109	293	1810
Folate (μg)	356	672	1822	403	731	1959	427	766	1934	427	729	1870	457	723	1845
β-Carotene (μg)	1485	5525	21983	1685	5861	21820	2284	7417	31853	1969	6303	25823	2554	8474	39071
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
Ca (mg)	535	1072	2790	575	1195	3107	574	1125	2770	577	1145	2854	520	933	2556
Fe (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
K (mg)	2197	3487	5091	2390	3627	5258	2589	3853	5521	2547	3667	5161	2934	4120	5922
Mg (mg)	271	448	966	320	492	1087	340	519	1061	341	514	1063	433	591	1162
Na (mg)	1852	3272	7301	1848	3346	7448	1595	3101	6734	1931	3432	7304	1475	3066	7043
P (mg)	984	1359	1872	994	1360	1865	1018	1366	1823	1028	1348	1805	1044	1370	1710
Zn (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] AHS-2=Adventist Health Study 2.

[b] PUFA=Poly Unsaturated Fatty Acid.

[c] MUFA= Mono Unsaturated Fatty Acid.

[d] SFA= Saturated Fatty Acid.

[e] TFA=Trans Fatty Acid.

[h] DHA= Docosahexaenoic Acid.

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

TABLE 3

Mean nutrient intake values with standard errors (SE) standardized to 2000 kcal/d stratified by dietary pattern with adjustments made for sex, race and age in the AHS-2[a]

	Non Vegetarian		Semi Vegetarian		Pesco Vegetarian		Lacto Ovo Vegetarian		Strict Vegetarian	
	Mean	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Caloric Intake (kcal/d)	1890	4	1713	12	1937	9	1899	5	1894	10
Carbohydrate (% Energy)	53.1	<0.1	56.6	0.1	56.8	0.1	57.2	0.1	61.7	0.1
Protein (% Energy)	15.2	<0.1	14.4	<0.1	14.9	<0.1	14.4	<0.1	14.5	<0.1
Plant Protein (% Energy)	8.8	<0.1	***10.8**	<0.1	***11.6**	<0.1	***11.9**	<0.1	***13.8**	<0.1
Animal Protein (% Energy)	6.4	<0.1	***3.5**	<0.1	***3.2**	<0.1	***2.4**	<0.1	***0.6**	<0.1
Fat (% Energy)	35.1	<0.1	33.4	0.1	33	0.1	33.1	0.1	29.8	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
[b]PUFA (g)	20.2	<0.1	21.1	0.1	21.5	0.1	22.1	<0.1	21.6	0.1
[c]MUFA (g)	32.4	0.1	30.5	0.2	30.9	0.1	30.3	0.1	28	0.1
[d]SFA (g)	19.9	<0.1	17.4	0.1	***15.8**	0.1	16	<0.1	***11.6**	0.1
[e]TFA (g)	4.4	<0.1	4	<0.1	***3.1**	<0.1	3.6	<0.1	***2.1**	<0.1
Omega 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
[f]DHA (mg)	182	1.2	***69.8**	3.6	187	2.8	***33.8**	1.5	***18.2**	3

NIH-PA Author Manuscript NIH-PA Author Manuscript NIH-PA Author Manuscript

	Non Vegetarian		Semi Vegetarian		Pesco Vegetarian		Lacto Ovo Vegetarian		Strict Vegetarian	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Vitamin B6 (mg)	13.5	0.2	14.9	0.5	15.7	0.4	13.6	0.2	14.4	0.4
Vitamin B12 (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
β-Carotene (μg)	8830	84.6	8987	242	* **11275**	190	10002	106	* **13300**	204
Vitamin D (μg)	10.6	0.1	9.9	0.2	9.8	0.2	8.6	0.1	* **6.3**	0.2
Vitamin E (mg)	122	1	131	2.9	132	2.3	116	1.3	101	2.4
Ca (mg)	1333	4	1410	11.4	1352	9	1332	5	1156	9.6
Fe (mg)	32.9	0.3	34.1	0.9	34.6	0.7	34.1	0.4	31.6	0.8
K (mg)	3550	4.8	3694	13.6	3910	10.7	3745	5.9	4234	11.5
Mg (mg)	509	1.3	554	3.7	581	2.9	567	1.6	* **652**	3.1
Na (mg)	3788	10.5	3808	30	3537	23.6	3851	13.1	3531	25.3
P (mg)	1391	1.4	1381	4.1	1394	3.2	1363	1.8	1371	3.5
Zn (mg)	18.7	0.1	18.6	0.2	18.4	0.2	17.9	0.1	16.3	0.2

ANCOVA was used in testing differences between dietary patterns. Values were logarithmically transformed for statistical testing. Values for effects of dietary pattern was $P<0.001$ for all reported nutrients and are therefore not indicated in an individual column.

[*] Significant contrast ($P<0.05$) and a mean difference ≥20% when compared to non vegetarian dietary pattern as the group of reference.

[a] AHS-2=Adventist Health Study 2.

[b] PUFA=Poly Unsaturated Fatty Acid.

[c] MUFA= Mono Unsaturated Fatty Acid.

[d] SFA= Saturated Fatty Acid.

[e] TFA=Trans Fatty Acid.

[f] DHA= Docosahexaenoic Acid.