# Food and nutrient intake of Hallelujah vegetarians

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## Keywords

Vegetarians, Fruit, Vegetables, Diet, Nutrition

## Abstract

Reports the results of a survey of followers of the mostly raw, pure vegetarian, Hallelujah diet, which is promoted by the Hallelujah Acres Foundation in the USA. Seven-day semi-quantitative dietary records kept by 141 followers of the diet were collected and analyzed for nutrient intake. Claims self-reported improvements in health and quality of life after adoption of the diet were significant ($p < 1E\text{-}07$). Mean daily consumption of fruits and vegetables was 6.6 servings and 11.4 servings, respectively. Salads, fruits, carrot juice and grain products provided 60-88 per cent of most nutrients. The mean energy intake was 1,460kcal/day for women and 1,830kcal/day for men. Claims that, with some modifications, this diet pattern allows people to adopt a low calorie diet sufficient in most nutrients.

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## Introduction

Several agencies have jointly issued dietary guidelines for healthy people, including at least five servings of fruits and vegetables a day to maintain health and prevent disease (Deckelbaum *et al.*, 1999). Fruits and vegetables have been linked with many health benefits, including lower risk of heart disease (Gaziano *et al.*, 1995), cancer (La Vecchia and Tavani, 1998; Steinmetz and Potter, 1996; WCRF/AICR, 1997), and other diseases (La Vecchia *et al.*, 1998). Fruits and vegetables may also be linked to the improvement of disease status (Appel *et al.*, 1997; Gonzalez and Isaacs, 1999; Hildenbrand *et al.*, 1995). Low fat diets, usually vegetarian or near-vegetarian, have been used to combat coronary artery disease and diabetes (Barnard *et al.*, 1983, 1992; Gould *et al.*, 1995; Ornish *et al.*, 1998).

A large amount of anecdotal evidence shows great health benefits from following the Hallelujah diet. As a beginning of our investigation of this diet and lifestyle, we have taken a food intake survey to quantify actual intakes among individuals who follow the Hallelujah diet. By measuring nutrient intakes we gain a better understanding of why people experience health benefits when following this diet and similar diets. Also, we discover whether this dietary pattern is sustainable and sufficient in supplying all nutrients necessary for excellent health and what changes, if any, would be necessary to meet the needs of individuals in special situations.

While several diet surveys have been conducted of vegetarians (Janelle and Barr, 1995; Leblanc *et al.*, 2000; Wilson and Ball, 1999), including vegans (Abdulla *et al.*, 1981; Haddad *et al.*, 1999), no survey of mostly raw food vegans has ever been reported. Because food selection among raw food vegetarians is quite different from conventional vegetarian diets, conclusions about the nutritional intake of vegetarian diets do not apply to raw food vegetarians a priori.

A population following the Hallelujah diet has been identified. It is estimated that over a million people have had experience with this

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diet, including individuals living in New Zealand, Australia, South Africa, Europe, and Asia. Details of food selection and philosophy of the Hallelujah diet have been published (Malkmus, 1995). Briefly, the diet consists of raw fruits and vegetables, carrot juice, a dehydrated barley grass juice, raw nuts and seeds, olive oil, flax seed oil, cooked vegetables, whole grain products, tubers, and a vitamin B12 supplement. All animal products (all meats, eggs, dairy products) except for butter are eliminated. Soy products and legumes are consumed very sparingly. Excluded along with the animal products are refined flour, refined sugars, refined, bleached, deodorized vegetable oils, hydrogenated fats, and table salt.

Seven-day dietary records were collected from volunteers of this population and analyzed for food selection and nutritional content. Comparisons were made with the dietary reference intakes (DRI) and NHANES III (Third National Health and Nutrition Examination Survey) data.

## Methodology

### Subjects

People who had attended a three-day seminar in order to more fully understand the diet were selected as potential subjects. Many of these people had self-reported health benefits from implementing the diet for a short period of time. Various aspects of vegetarian nutrition and implementation of the diet were covered in the seminar. As a result of this training and perceived personal benefits, it was reasoned that these people would have a good understanding of how to implement the diet and would also have strong motivation to follow the diet consistently. A total of 870 surveys were mailed to households of potential subjects. Each adult in the same household was invited to photocopy and complete a survey separately.

### Survey

Since no information had been previously collected on the eating patterns of this population, it was believed that a seven-day dietary record would be the best way to capture a reliable intake of this population. Potential subjects were instructed to keep a record of all foods eaten for seven days, using common household measurements, units, or number of items as a means of quantifying the amount consumed. Recipes for mixed foods were requested. Examples of the type of information required were provided to the potential participants.

Dietary records were completed with various degrees of detail and quantification. Surveys were excluded that did not contain sufficient detail of food items or sufficient quantification.

Along with the dietary survey, participants were asked to fill out the MOS SF-36 general health survey (Ware and Sherbourne, 1992) and quality of life scale (Flanagan, 1982) for their current health and retrospectively for their health before their dietary change. Demographic information and a five-stage physical activity estimate were also collected.

### Analysis

The dietary surveys were examined by entry of the foods and amounts into a nutritional analysis program (Food Processor, version 7.20, 1998, ESHA Research, Eugene, Oregon). This program allowed the entry of many food items in common measurements as well as weights or volumes. Recipes, provided by participants for mixed foods, were also entered as food items.

The population mean intakes of nutrients were compared to the DRI, using the EAR (estimated average requirements) where available or AI (adequate intake) for nutrients for which there is no RDA (recommended daily allowance) (Food and Nutrition Board, Institute of Medicine, 1999; 2000a, b; 2001). Individual energy intakes were compared to their specific RDIs as well, accounting for age, gender, weight, and physical activity level by utilizing the profile capability of the Food Processor software. The RDI for energy was calculated from the equations in the 1989 US RDA (Food and Nutrition Board, National Research Council, 1989), multiplied by an activity factor (1.6 and 1.5 for lightly active men and women, respectively). The student's *t*-test was used to compare age and gender categorized intakes of nutrients in the NHANES III data set (Alaimo *et al.*, 1994; McDowell *et al.*, 1994) with this survey. Women between the ages of 30-69 and men ages 30-39 and 50-79 were compared with the NHANES III data; other age groups were excluded since they contained very few subjects (fewer than seven) per group.

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### Approximations in data entry

Within the extensive ESHA database, sources of nutrient data for foods were selected in descending order of completeness from the USDA nutrient database, release 12, (US Department of Agriculture, 1998) to other survey data, and then brand name foods with the most complete nutrition profile available. The most frequently used source was the USDA nutrient database since this population consumed a lot of fresh produce and very few packaged or processed food items.

Some vegetables, other than carrots, and fruits were made into juice in a household juice extractor. The whole vegetable was used to approximate the nutrient content of the juice. Carrot juice nutrient content was estimated from the USDA nutrient database in combination with an analysis of mineral content of California carrots (analytical microwave, nitric acid digestion, ICP detection, Anamol Laboratories, Ltd, Concord, Ontario) (unpublished data). The mineral content was also assayed of three samples of the dehydrated barley grass juice (Anamol Laboratories, Ltd, Concord, Ontario) to obtain an accurate measurement of minerals from this source.

## Results

### Subject demographics

A total of 870 surveys were mailed to potential participants; 174 surveys were completed and returned. Response was highest (~ 50 per cent) among those who had contact information listed on the Hallelujah Acres Website. Inclusion of contact information on the Website was an indication that these people were actively living and promoting this diet and lifestyle; this subgroup produced 114 of the 174 surveys received. From the 174 surveys, a subset of 141 surveys was selected that met the criteria of semi-quantified food intake. Data is only reported on this subset of 141 surveys, since an analysis of the culled surveys showed significant differences in reported average energy intake, suggesting inadequate food recording.

Of the 141 surveys selected for inclusion in the analysis, 87 were from women and 54 were from men. Ages and body mass index (mean ± SD) for the women were 53 ± 10 years and 21.5 ± 3.8kg/m$^2$ and for the men were 57 ± 13 years and 22.9 ± 2.9kg/m$^2$. One man and 15 women were underweight with a BMI (body mass index, kg/m$^2$) less than 18.5. Subjects had followed this vegetarian diet for a mean time of 28 months.

### Quantitative health assessment

A total of 136 and 132 pairs of current and retrospective SF-36 and quality of life surveys were returned, respectively. As shown in Table I the subjects perceived that their quality of life had improved significantly ($p <$ 1E-21, paired $t$-test) due to their dietary change. All sub-scales of the SF-36 general health questionnaire showed dramatic improvement as well (all $p <$ 1E-07, paired $t$-test), with the average changing from 65 before to 88 after their dietary changes, on a scale of 0 to 100.

### Servings of food consumed daily

The analysis of food choices revealed that an average of 6.6 servings of fruit and 11.4 servings of vegetables were eaten on a daily basis. This does not include any contribution from the dehydrated barley grass juice. In addition to the fruits and vegetables, 4.4 servings of fats and oils, 0.4 servings of dry beans and nuts, and 3.2 servings of breads, cereals, and pastas were consumed daily.

### Food selection

A summary of the food selection and daily quantity consumed by this group is given in Table II. Fruits, carrot juice, salads and raw vegetables, and grain products were the primary foods. There was not a heavy reliance on grain products or legumes and soy products as the basis of the diet. All of the fruit and the majority of the vegetables were eaten uncooked. Added fats, oils, and salad

**Table I** Quantitative self-reported health improvement due to dietary change

| Measure | Before | Current |
|---|---|---|
| **Quality of life, (scale 1-7)** | 5.05 ± 0.9 | 5.9 ± 0.7 |
| **SF-36, (scale 0-100)** | | |
| **Physical functioning** | 78 ± 24 | 92 ± 12 |
| **Role physical** | 58 ± 40 | 89 ± 26 |
| **Bodily pain** | 61 ± 26 | 84 ± 18 |
| **General health** | 61 ± 27 | 90 ± 11 |
| **Vitality** | 49 ± 25 | 78 ± 18 |
| **Social functioning** | 77 ± 24 | 94 ± 14 |
| **Role emotional** | 68 ± 40 | 90 ± 24 |
| **Mental health** | 71 ± 20 | 87 ± 10 |

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**Table II** Food selection and daily consumption

| Food item | Number who consumed food item | Total[a] mean consumed (g/day) | >0 Mean[b] consumed (g/day) |
|---|---|---|---|
| **Fruits** | 140 | 646 | 651 |
| **Carrot juice** | 137 | 459 | 472 |
| **Salad and raw vegetables** | 141 | 452 | 452 |
| **Grain products** | 139 | 142 | 144 |
| **Potato/squash** | 129 | 70.9 | 77.5 |
| **Cooked vegetables** | 136 | 70.5 | 73.1 |
| **Legumes/soy products** | 103 | 42.2 | 57.8 |
| **Mixed foods** | 81 | 29.8 | 51.9 |
| **Oil/dressing** | 133 | 28.9 | 30.6 |
| **Nuts/seeds** | 127 | 18.0 | 20.0 |
| **Dehydrated barley grass juice** | 140 | 17.5 | 17.6 |
| **Animal products** | 82 | 17.0 | 29.3 |
| **Psyllium seed product** | 101 | 5.3 | 7.4 |

**Notes:**
[a] 141 subjects total
[b] >0 mean is only for those who actually consumed this food item

dressing (~30g/d) are used by the majority of the group. There was not an extreme avoidance of animal foods, since 82 people (58 per cent) consumed some animal product during their recorded week of food intake.

Food sources of energy, protein, vitamins and minerals are summarized in Table III. In Table III foods are ranked according to their contribution of the seven vitamins and six minerals shown. These seven food categories accounted for 82-94 per cent of the nutrient intake. Unheated foods (dehydrated barley grass juice, carrot juice, fruit, salad, and nuts) accounted for 55 per cent of the caloric intake. Fruits were the largest single source of energy followed by grain products, carrot juice, and salads and raw vegetables. Protein was similarly widely distributed in the diet. Grain products were the largest source of protein, followed by salads and raw vegetables, fruits, and carrot juice. Salads were the single largest source of calcium,

**Table III** Contribution of foods to relative nutrient intake. Per cent of total intake shown

| | Food item[a] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Salad and raw vegetables | Fruits | Carrot juice | Grain products | Dehydrated barley grass juice | Nuts/ seeds | Potato/ squash | Sum per cent of total intake |
| **Energy** | 8.2 | 25.7 | 11.4 | 18.6 | 3.6 | 6.1 | 4.4 | 78.0 |
| **Protein** | 15.6 | 11.2 | 11.2 | 22.0 | 5.9 | 7.1 | 4.1 | 77.1 |
| **Vit A** | 17.3 | 3.6 | 62.3 | 0.4 | 7.0 | 0.0 | 3.3 | 93.9 |
| **B1** | 15.0 | 16.2 | 20.6 | 16.8 | 6.2 | 5.7 | 4.4 | 84.9 |
| **B2** | 17.9 | 16.9 | 14.8 | 13.0 | 14.7 | 3.8 | 2.3 | 83.4 |
| **B3** | 16.8 | 14.1 | 12.1 | 22.2 | 4.7 | 5.6 | 6.2 | 81.7 |
| **B6** | 15.4 | 32.9 | 28.2 | 6.0 | 0.1 | 1.7 | 5.2 | 89.5 |
| **Vit C** | 27.8 | 23.3 | 10.2 | 0.1 | 7.0 | 0.1 | 2.1 | 70.6 |
| **Vit E** | 15.5 | 14.6 | 1.5 | 6.8 | 29.7 | 15.7 | 0.6 | 84.4 |
| **Ca** | 21.0 | 11.8 | 16.4 | 11.4 | 9.5 | 4.2 | 1.6 | 75.9 |
| **Cu** | 14.3 | 21.2 | 17.1 | 10.9 | 6.0 | 9.7 | 6.5 | 85.7 |
| **Fe** | 22.8 | 11.7 | 11.7 | 18.9 | 9.4 | 5.2 | 4.1 | 83.8 |
| **Mg** | 16.6 | 19.8 | 13.8 | 14.7 | 9.1 | 9.8 | 4.5 | 88.3 |
| **P** | 16.9 | 10.2 | 17.8 | 19.8 | 5.3 | 9.0 | 4.6 | 83.6 |
| **K** | 20.8 | 24.8 | 24.2 | 3.5 | 12.6 | 1.9 | 4.3 | 92.1 |
| **Zn** | 14.5 | 9.2 | 19.0 | 18.8 | 7.9 | 9.5 | 3.3 | 82.2 |

**Note:** [a] Items are listed in rank of importance of contribution to intake of vitamins and minerals followed by carrot juice, fruits, grain products, and dehydrated barley grass juice.

When the ranks for the individual nutrients were summed, salads contributed the most nutrients overall, followed by fruits, carrot juice, grain products, dehydrated barley grass juice, nuts and seeds, and potatoes. Even though only a small amount of dehydrated barley grass juice and nuts and seeds were consumed, they contributed a significant portion of the daily nutrient intake.

The main sources of fat were oils and dressings (33 per cent), nuts and seeds (18 per cent), and grain products (13 per cent). The two main sources of sodium were grain products (29 per cent) and other foods (15 per cent), which include a soy product used as an alternative salt product.

The psyllium seed hull product used by this population has a substantial amount of added ascorbic acid (390mg/8g serving), which skewed the relative contribution of vitamin C from foods. When this supplemental vitamin C is removed from the analysis, salads contribute 37 per cent of the vitamin C, fruits 31 per cent, carrot juice 14 per cent, and dehydrated barley grass juice 9 per cent, with a mean daily intake of 329mg of vitamin C.

Fiber intake was quite high. The main sources of fiber were fruit (28 per cent), vegetables (21 per cent), grain products (13 per cent), and carrot juice (10 per cent).

**Nutritional assessment of dietary intake**

Keeping in mind the food choices described above we can now examine the nutritional content of the diet. A summary of the macronutrient content of the recorded food intakes is shown in Table IV, along with a comparison to the general population, as reported from NHANES III. The percent of NHANES reported in Tables IV and V is from comparisons made in age and gender specific groups, converted to percents, and then averaged over all analyzed subgroups.

Total energy intake was significantly lower for men under 70 years of age ($p < 0.002$) and for women under 50 years of age ($p < 0.05$). The mean energy intake was 73 per cent of the RDI, taking into account gender, BMI, and self-reported activity level (most individuals engaged in light activity) (see Figure 1).

Carbohydrates accounted for 67 per cent of total energy intake. There was no consistent, significant difference in the carbohydrate intakes between this survey and NHANES III data. After accounting for the higher fiber intake, the metabolically active carbohydrate was only 10 per cent higher than intakes reported in NHANES III.

Energy from fat accounted for approximately 24 per cent of total energy. There was a wide variation in fat consumption depending on the amounts of salad dressing used and the amounts or regularity of nut and seed consumption. The ratio of $n$-6 to $n$-3 PUFAs was about 2:1, though there was a great deal of variation in individual intakes (range from 0.4 to 13.8). Consumptions of cholesterol and saturated fat were very low.

Protein intake was very low in this population. Mean intake was 0.66g/kg body weight. While the intake of calcium was lower than in the general population ($p < 0.03$), the ratio of calcium:protein (mg:g) was about 15:1.

Intakes of vitamins and minerals are summarized in Table V. Riboflavin and iron intakes were not significantly different from intakes in the general population. Vitamins A, B6, C, and E (for women), folate, copper, and potassium were significantly higher than intakes reported in NHANES III, while intakes of vitamin B12, phosphorus, sodium, and zinc were all significantly lower. Beta-carotene intake was especially high, well into the range used in supplementation experiments.

Table VI gives a comparison of nutrient intakes with the EAR or AI, as available. As seen with most pure vegetarian populations, intakes of vitamin B12, vitamin D, and calcium were all below DRI values for almost every individual in this study. Selenium and zinc intakes were also below the EAR for 82 individuals (58 per cent) and 88 individuals (62 per cent), respectively. Vitamin B12 intake was expectedly low except for seven individuals who regularly consumed nutritional yeast, which is fortified with cyanocobalamin. The population had adequate intakes of thiamin, riboflavin, and vitamin B6. Intakes of niacin, biotin, and pantothenic acid were lower than the standard recommendation in 28 (20 per cent), 70 (50 per cent), and 60 (42 per cent) individuals, respectively.

Intakes of magnesium, manganese, and phosphorus were adequate as well. The higher DRI for iron for premenopausal

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**Table IV** Summary of macronutrient content of recorded food intake

| Macronutrients | Men Mean ‹ SD | Women Mean ‹ SD | Per cent of NHANES[a] |
|---|---|---|---|
| **Energy, calories** | 1,830.0 ± 474.0[nt] | 1,460.0 ± 360.0[nt] | 82 |
| **Protein, g** | 47.2 ± 13.36****** | 37.3 ± 9.3****** | 54 |
| **Carbohydrate, g** | 329.0 ± 91.0[nt] | 261.0 ± 63.0[nt] | 121 |
| **Fiber, g** | 47.0 ± 14.0***** | 38.0 ± 10.0***** | 261 |
| **Sugar, g** | 160.0 ± 53.0 | 130.0 ± 42.0 | |
| **Other carbohydrate, g** | 122.0 ± 42.0 | 93.0 ± 22.0 | |
| **Fat-total, g** | 51.3 ± 22.1***** | 43.6 ± 21.0** | 60 |
| **SFA, g** | 9.4 ± 4.6****** | 8.2 ± 4.4***** | 33 |
| **MUFA, g** | 19.6 ± 10.9[nt] | 16.6 ± 10.3[nt] | 63 |
| **PUFA, g** | 16.4 ± 8.5[ns] | 13.6 ± 7.4[nt] | 87 |
| **Unclassified** | 5.9 | 5.2 | |
| **Trans-fatty acids, g** | 0.9 ± 0.9 | 0.7 ± 0.8 | |
| **n-3 fatty acids, g** | 5.3 ± 5.2 | 4.8 ± 4.7 | |
| **n-6 fatty acids, g** | 11.0 ± 6.1 | 8.9 ± 5.0 | |
| **Cholesterol, mg** | 28.0 ± 33.0****** | 22.0 ± 27.0****** | 10 |

**Notes**:
[a] Age and gender specific data from NHANES III (Alaimo *et al.*, 1994; McDowell *et al.*, 1994)
[nt] No trend of significant differences in all sub-groups
[ns] Not significantly different ($p > 0.05$) from NHANES III for all sub-groups
*Significantly different from NHANES III ($p < 0.05$)
** Significantly different from NHANES III ($p < 0.01$)
*** Significantly different from NHANES III ($p < 0.001$)
**** Significantly different from NHANES III ($p < 0.0001$)
***** Significantly different from NHANES III (1E-5 < $p$ < 1E-10)
****** Significantly different from NHANES III ($p$ < 1E-10)

women made their intake relatively low. More women than men had marginal vitamin and mineral intakes. The dehydrated barley grass juice contains a small amount of kelp, a reliable source of iodine.

## Discussion

Dietary patterns are chosen for many reasons. Some common reasons are cultural and ethnic background, economic constraints, convenience, and perceived health benefits. As shown above, many of the participants in this study reported various health benefits and improvements in their quality of life by choosing to follow the dietary pattern described and analyzed in this report. Furthermore, these health improvements strengthened their belief in the ideological truth of this diet. In addition to personal motivation, many of these people demonstrate this dietary pattern to others, so they have incentive to live and eat as they believe others should eat as well. Therefore, adherence to the general principles of this diet was quite high. This allowed an excellent opportunity to examine this diet in a free-living population.

This study was simplified by the inclusion of highly motivated subjects and the limited amount of processed foods consumed. Most food composition information was from the USDA nutrient database. Most of the foods consumed were commonly recognized fresh produce, and ordinary carbohydrate foods. Two uncommon foods that were consumed by almost all of the subjects were carrot juice and the dehydrated barley grass juice. A mineral analysis of these products was carried out to provide good estimations of their contribution to the nutrient intake.

One important question is whether such ideologically motivated subjects would record foods that did not fit their ideal food list. Animal products, a strictly prohibited category of foods in this diet, were reported to be consumed by 82 people (58 per cent) of this group in small amounts (29g/day by those who did consume). This evidence indicates that these subjects made an effort to record honestly their true food intake.

Populations with such high consumption of fruits and vegetables (~1,700g/day, 18 servings) are rare. The average American man and

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**Table V** Summary of vitamin and mineral content of recorded food intake

| | Men Mean ‹ SD | Women Mean ‹ SD | Percent of NHANES[a] |
|---|---|---|---|
| **Vitamins** | | | |
| **Vit A, RE** | 8,110.00 ± 3,409.0***** | 6,740.00 ± 3,210.0***** | 663 |
| **$\beta$-carotene, mg** | 40.80 ± 16.7 | 33.90 ± 15.8 | |
| **Thiamine, mg** | 2.35 ± 1.10[nt] | 1.97 ± 1.16[nt] | 132 |
| **Riboflavin, mg** | 2.04 ± 1.06[ns] | 1.74 ± 1.06[ns] | 95 |
| **Niacin, mg** | 18.00 ± 7.4*** | 14.80 ± 6.89[nt] | 70 |
| **Vit B6, mg** | 3.94 ± 1.80* | 3.22 ± 1.50**** | 193 |
| **Vit B12, $\mu$g** | 0.65 ± 1.17****** | 0.51 ± 0.89****** | 12 |
| **Biotin, $\mu$g** | 37.00 ± 11.8 | 29.00 ± 10.1 | |
| **Vit C, mg** | 481.00 ± 182.0***** | 442.00 ± 177.0***** | 433 |
| **Vit D, $\mu$g** | 0.46 ± 0.66 | 0.28 ± 0.29 | |
| **Vit E, a-TE[b], mg** | 17.00 ± 6.3[nt] | 14.90 ± 5.9*** | 172 |
| **Folate, $\mu$g** | 594.00 ± 177.0*** | 487.00 ± 158.0*** | 187 |
| **Vit K, $\mu$g** | 406.00 ± 300.0 | 326.00 ± 246.0 | |
| **Pantothenic acid, mg** | 6.35 ± 2.14 | 5.19 ± 1.86 | |
| **Minerals** | | | |
| **Calcium, mg** | 687.00 ± 209.0* | 577.00 ± 156.0** | 78 |
| **Copper, mg** | 2.38 ± 0.65** | 1.97 ± 0.60***** | 162 |
| **Iron, mg** | 17.00 ± 5.0[ns] | 14.00 ± 3.8[ns] | 104 |
| **Magnesium, mg** | 483.00 ± 141.0* | 392.00 ± 117.0* | 141 |
| **Manganese, mg** | 6.30 ± 2.06 | 4.95 ± 1.35 | |
| **Phosphorus, mg** | 1,100.00 ± 365.0[nt] | 857.00 ± 241.0[a] | 77 |
| **Potassium, mg** | 6,400.00 ± 1,748.0*** | 5,420.00 ± 1,560.0***** | 201 |
| **Selenium, $\mu$g** | 54.30 ± 24.9 | 67.00 ± 152.1 | |
| **Sodium, mg** | 1,510.00 ± 600.0****** | 1220.00 ± 4406.0* | 44 |
| **Zinc, mg** | 8.30 ± 2.5***** | 6.70 ± 1.8** | 62 |

**Notes**:
[a] Age and gender specific data from NHANES III (Alaimo *et al.*, 1994; McDowell *et al.*, 1994)
[b] $\alpha$-tocopherol equivalents
[nt] No trend of significant differences in all sub-groups
[ns] Not significantly different ($p > 0.05$) from NHANES III for all sub-groups
* Significantly different from NHANES III ($p < 0.05$)
** Significantly different from NHANES III ($p < 0.01$)
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**** Significantly different from NHANES III ($p < 0.0001$)
***** Significantly different from NHANES III (1E-5 $< p <$ 1E-10)
****** Significantly different from NHANES III ($p <$ 1E-10)

woman consumes 3.3 and 3.7 daily servings of fruits and vegetables, respectively (Serdula *et al.*, 1995). In Spain, men and women daily consumed 7.8 and 7.5 servings of fruits and vegetables as part of their Mediterranean diet (Agudo *et al.*, 1999); 74 per cent of their population consumed at least five servings a day, compared with only 20 per cent here in the USA (Serdula *et al.*, 1995). Raising the standard higher (10-15 servings a day) would indicate the necessity of radically changing our food consumption patterns to gain better health.

The mean protein intake of this population, 0.66g/kg/day, is slightly above the mean minimum physiological requirement for protein reported by the FAO/WHO/UNU to be 0.6g/kg/day (FAO/WHO/UNU, 1985). Adults, but not growing children, can adapt to low protein intakes, even low intakes of only cereal proteins (Millward, 1998; Sherman, 1920). Oxidation rates of essential amino acids (lysine in particular) are lowered (Millward, 1998; Young, 1998; Young and Marchini, 1990) and salvage of urea nitrogen from the lower bowel is increased (Langran *et al.*, 1992). Thus, the body's amino acid and nitrogen metabolism become more efficient with adaptation to low protein intake. It is not clear from laboratory studies whether individuals successfully adapt to very low protein intakes or their bodies learn to accommodate a protein shortage and compromise some vital functions

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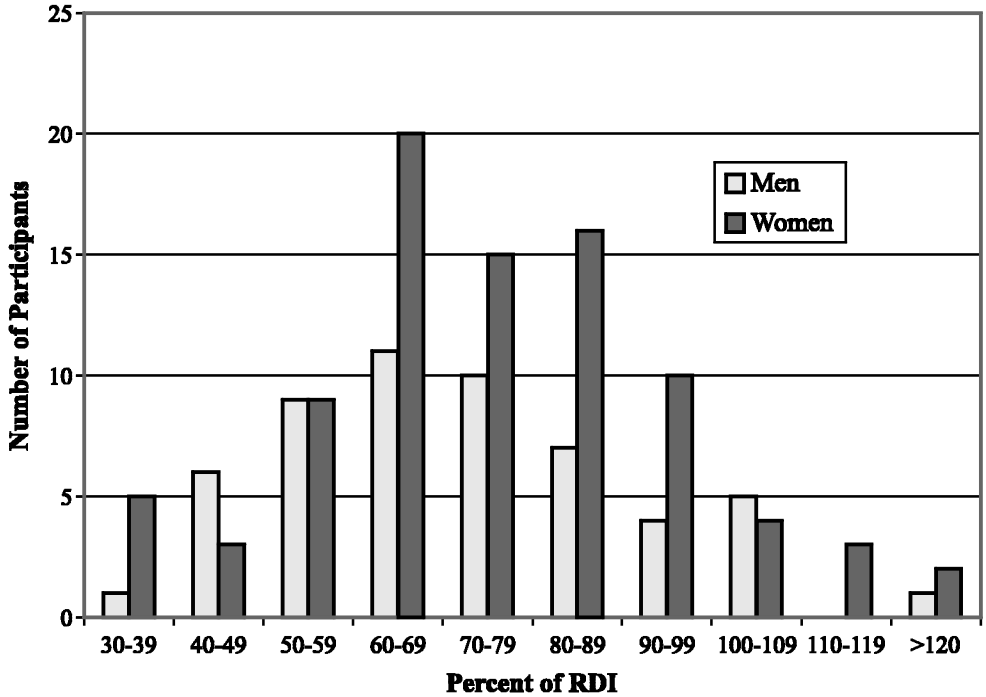
**Figure 1** Histogram of daily energy intake as a percentage of individual recommended daily intakes (RDI) (specific to gender, weight, and activity level)




**Note: RDIs were determined by Food Processor (v 7.20). Resting energy expenditure was calculated from the equations in the 1989 US RDA, and multiplied by an activity factor (1.6 and 1.5 for lightly active men and women, respectively). Men (N=54) and women (N=87) are analyzed separately**

over a long period of time (Young and Marchini, 1990; Young and Pellett, 1987). The best measure for successful adaptation is long-term physical performance, vitality, and possibly immune function. Further studies are planned to evaluate the long-term effects of this low protein diet.

A positive calcium balance may be possible for this study group, even though the mean calcium intakes were 690 and 580mg/day for men and women, respectively, because of low intakes of protein and sodium (Nordin *et al.*, 1993). Higher intakes of potassium (Sebastian *et al.*, 1994) and balanced intakes of magnesium (Evans *et al.*, 1990; Fatemi *et al.*, 1991) also improve the calcium balance. From the equation presented by Frasetto *et al.*, (1998) the renal net acid excretion of this study group, using the mean intakes of protein and potassium, is slightly negative, indicating a slightly basic condition, as would be expected with a vegan diet (Dwyer *et al.*, 1985). While it is possible that pure vegetarians need less calcium, this has not yet been demonstrated in a controlled study. Further studies are needed to ensure that a positive calcium balance is achieved following this dietary pattern.

Non-heme iron, as found in plants, is less absorbable than the heme iron of flesh foods, so the DRI is set 1.8 times higher for vegetarians (Food and Nutrition Board, Institute of Medicine, 2001). The high intake of vitamin C, including the common practice of adding lemon juice to salads, could significantly improve iron absorption. Iron utilization could be impaired by sub-optimal vitamin B12 status (Dong and Scott, 1982).

Zinc intake was also low, since fruits and vegetables are not rich sources of zinc. Half of the zinc was provided by the raw fruits, vegetables, carrot juice, and dehydrated barley grass juice. Since phytates are not present in high concentrations in these foods, zinc should be well absorbed from these plant sources. The phytate content of this diet is probably lower than most vegetarian diets since whole grain products and legumes only contributed 17 per cent of the total fiber. Further studies are required to determine if zinc status is compromised following the diet surveyed here.

Vitamin D and vitamin B12 intakes were both low, as usually seen in vegan diets. Vitamin D can be made from adequate sun exposure, though some pure vegetarians have been shown to have low wintertime vitamin D

**Table VI** Comparison to nutrient intake recommendations

| Nutrient | Number of participants with intake less than EAR/AI: Men, 54 total | Women, 87 total |
|---|---|---|
| Vitamin B12[a] | 50 | 84 |
| Vitamin D[b] | 54 | 87 |
| Calcium[b] | 52 | 87 |
| Selenium[a] | 18 | 64 |
| Zinc[a] | 39 | 49 |
| Thiamin[a] | 0 | 3 |
| Riboflavin[a] | 2 | 3 |
| Niacin[a] | 8 | 20 |
| Vitamin B6[a] | 0 | 1 |
| Biotin[b] | 14 | 56 |
| Vitamin C[a] | 0 | 0 |
| Vitamin E[a] | 1 | 6 |
| Folate[a] | 0 | 12 |
| Pantothenic acid[b] | 16 | 44 |
| Copper[a] | 0 | 0 |
| Iron[c] | 2 | 19 |
| Magnesium[a] | 10 | 12 |
| Manganese[b] | 2 | 16 |
| Phosporus[a] | 1 | 10 |

**Notes:**
[a] Comparison to EAR
[b] Comparison to AI
[c] Comparison to iron EAR for vegetarians (Food and Nutrition Board Institute of Medicine, 2001); comparison to EAR – 1 women <EAR, 0 men <EAR

status (Dagnelie and van Staveren, 1994; Lamberg-Allardt *et al.*, 1993; Outila *et al.*, 2000). High fiber diets may increase endogenous vitamin D losses (Batchelor and Compston, 1983). Vitamin D status of this population has not yet been investigated.

Vitamin B12 cannot be reliably made endogenously. Of this study group, 40 per cent consumed no animal products, the food source of vitamin B12. A recent study revealed that metabolic vitamin B12 function was compromised in about 50 per cent of tested individuals following this diet (Donaldson, 2000). A supplemental source of vitamin B12 is recommended for individuals (and especially for infants, children, pregnant women, and nursing mothers) following this diet.

It is interesting to note that the absolute carbohydrate consumption was only slightly higher than intakes reported in NHANES III, though the percentage of energy from carbohydrates was much higher (67 per cent vs 50 per cent NHANES III). This restriction of carbohydrates, principally by limiting the amount of cooked food eaten, resulted in an overall lower intake of energy.

This dietary pattern, both in food choices and timing of eating, allows people to adopt a low calorie diet that is sufficient in most nutrients with little effort in restricting the amount of food eaten. This dietary pattern, when implemented and supplemented carefully, meets the criteria for calorie restriction with adequate nutrition, which has been shown in many species to increase the average and maximum lifespan of animals, and to reverse and prevent chronic degenerative diseases (Weindruch and Walford, 1988). On low energy diets great care must be taken to ensure adequate nutrition; if energy intake is too low (< 50 per cent of DRI) one is at risk of seriously compromising their health.

Some modifications of this dietary pattern, to provide vitamins B12 and D, and higher intakes of iron, selenium, zinc and protein, may be necessary for successful long-term health. Regular consumption of nutritional yeast would help ensure adequate nutrition for this vegan population; 1.5 tablespoons of Red Star nutritional yeast (16g) contains 8g of protein, 8$\mu$g of cyanocobalamin, 0.5mg of iron, 3mg of zinc, and 22$\mu$g of selenium. The use of supplemental vitamin B12 and supplemental vitamin D during the winter at high latitudes would cover the most critical deficiencies of this diet.

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