

A COMPARISON OF VEGETARIAN DIETS AND THE STANDARD WESTERNIZED
DIET IN NUTRIENT ADEQUACY AND WEIGHT STATUS

A Thesis

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Introduction and Problem Statement

Currently, Americans eat in a state of indulgence. Americans prefer large meals and portions, which leads to excessive energy consumption (1). They also prefer high fat meals and fast foods; however, there are several negative impacts on health from these eating habits. The typical Western diet is commonly high in total fat, saturated fat, simple sugars and energy-dense food, which increases the risk to develop obesity. Therefore, the rates of obesity-related chronic diseases have become a public health concern. In 2010, over 27 million (approximately 11%) adults were diagnosed with a type of heart disease (2). Nearly 20 million Americans had cancer as of 2010 while 21 million Americans had diabetes mellitus. To combat the increased risk of chronic disease resulting from Westernized dietary patterns, a large amount of Americans are turning to different lifestyles and dietary changes.

On average, Americans spend \$30-50 billion annually on weight-loss diets to combat obesity (3). The approaches described in these plans vary greatly, including promoting or limiting specific foods while emphasizing others. Recently, many new diets have arisen that diverge from the normal Westernized diet. For reasons such as weight loss, lower blood pressure, lower risk of hypertension, etc., many individuals make dietary choices to exclude meat products and eat only plant-based foods (4). Altogether, these diets fall into the category of vegetarian diets. Within this term, there are many variations to these dietary plans. A vegan diet is one that excludes all meat products and only consumes vegetables, fruits, legumes, grains, nuts, and seeds. Some vegetarian diets include dairy products (lacto-vegetarian diet), or egg products (ovo vegetarian diet), or both (lacto-ovo vegetarian diet) along with the foods included in

vegan diets. About 3% of Americans can be considered vegetarians and 8% of Americans do not eat meat (5). Many vegetarians choose this lifestyle because it brings several health benefits such as lower blood cholesterol levels, lower risk of heart disease, lower blood pressure levels, lower risk of hypertension, and type 2 diabetes (4). Following a vegetarian diet has also been associated with a lower BMI and lower overall cancer rates compared to a non-vegetarian diet. However, vegetarian diets can be deficient in vitamin B-12, calcium, vitamin D, zinc, iron, long-chain fatty acids, and protein that present additional challenges in obtaining nutritional adequacy. Therefore, understanding the current trends in vegetarian diets and the dietary composition will provide valuable information to promote healthy approaches to dietary modification.

Purpose

The purpose of this research is to compare the benefits and disadvantages of several types of diets. It seems that much of the available data is inconsistent. Therefore, these diets warrant a closer look to find a better understanding of their benefits and drawbacks. These diets will include vegan diets, lacto-ovo vegetarian diets, and the Western non-vegetarian diet. The markers that will be compared will be protein status, vitamin B-12 status, Iron status, calcium status, and weight status among others.

Related Research

Nutrient Adequacy

Despite the potential health benefits of a vegetarian diet, concerns about the quantity and bioavailability of specific nutrients linger. One nutrient that is of concern for vegetarian diets is adequate protein intake. The Academy of Nutrition and Dietetics states that vegetarians have the same protein requirements even though their protein

source comes from non-animal sources(4). However, it may be more difficult to reach these requirements because vegetables, grains, legumes, and seeds are not complete proteins. Proteins are considered complete if they contain all of the amino acids required to support protein synthesis (6). Complete proteins come from animal products except for soy which is the only plant protein to contain all of the essential amino acids. To ensure adequate intake of all amino acids, foods must be selected in a complementary fashion to achieve all of the required amino acids. It may also be difficult to meet protein requirements because plant proteins are not as bioavailable for the body to use in comparison to animal proteins. Protein intake in child vegetarians was significantly lower than omnivore children in Taiwan (7). But, both of these groups met the recommended intakes for protein in Taiwan. At the same time, similar relationships were found, but in older adults (8).

Because vitamin B12 is only found in animal sources, it is another nutrient of concern in vegetarian diets (4). According to the Academy of Nutrition and Dietetics, vegetarians may develop a deficiency of Vitamin B12 because the vitamin is not contained in any plant food. Vitamin B12 must be obtained through fortified grains or vitamin supplements. Lacto-ovo vegetarians do not have this issue because they obtain enough vitamin B12 through egg and dairy products. Vitamin B12 status exclusively between vegetarians and non- vegetarians has been explored. Non-vegetarians consumed a significantly higher amount of vitamin B12 than all vegetarians and vegans (9). Also, only 3% of the vegan subjects met their daily vitamin B12 requirements. Twenty-one percent of vegans were deficient in serum vitamin B12 whereas only 1% of non-vegetarians were deficient.

Iron is another nutrient of concern for vegetarians. The iron contained in vegetables is in the nonheme form, which is less bioavailable to the body than the heme form (4). Because of the amount of iron absorbed from the diet, iron intake is recommended to be 2 times higher than non- vegetarians to ensure the same amount to be absorbed. Vegetarians have been shown to have higher intake of iron in their diets compared to non- vegetarians (10). This is consistent with previous literature (7). However, the children who participated in the study had low ferritin levels, indicative of low iron stores in their cells. This is important because iron is available to the body once it is absorbed from the blood stream and stored as ferritin (4). Nonheme iron is not as readily absorbed as heme iron.

Finally, it has been proposed that calcium status may be poor in vegetarians. The leading sources of dietary calcium are from dairy products, which are animal products. Calcium is also obtained from dark green leafy vegetables; however, like iron, calcium obtained from plant foods is also less bioavailable. It has been found that calcium consumption in vegetarians is well below the DRIs for calcium (4), further compounded by the lower level of absorption from plant sources. Calcium intakes in vegetarian women have been higher than any other group studied (10). Calcium intake was less than 75% of the recommended intakes for all subjects elsewhere (7). Inadequate intakes of calcium can have numerous impacts on the body, especially putting someone at risk for osteoporosis. Therefore, calcium intake may be an issue for a larger population than vegetarians alone.

Weight Status

Following a vegetarian diet has been associated with lower BMI and rates of obesity, compared to non-vegetarians (4). At the same time, those who have been following the diet for less than 5 years had similar weights to omnivores. Therefore, the diet must be followed for the long term in order to reap its benefits of lower body weight. There was no significant difference in BMI distribution between vegetarians and non-vegetarians (7). However, there was a higher percentage of obese individuals in the omnivore group. Also, there was a higher percentage of overweight individuals who follow a vegetarian diet. It has been also found that adolescent vegetarian boys and girls had significantly lower BMI values when compared to a reference mean and they also had significantly lower body weights when compared to the reference mean (8).

Another measurement used to assess weight status is skinfold thickness. Skinfolds can be taken on the abdomen, suprailiac, and thigh, but is most of the time measured at the tricep. A skinfold measurement indirectly measures the amount of body fat underneath the skin. Vegetarians lose skinfold thickness in the short term, but do not lose weight (11). It was concluded that these subjects may have leaner body mass. The same study concluded that this reduction in skinfold thickness can be due to a negative energy balance in vegetarians. The opposite effect was found too. The skinfolds of vegetarian children and their parents were not different from their omnivore counterparts (3). It was determined that these subjects were the same because they followed unrestricted vegetarian diets (lacto-ovo vegetarian diets). Vegetarian children and adolescents had significantly lower tricep and suprailiac skinfolds when compared to the reference mean (11). However, young adult vegetarians did not have the lower

skinfold thickness. One hypothesis for this happening is that a vegetarian diet slows growth, but vegetarians grow normally in the long term.

Biochemical Indices

Some blood markers may be different between vegetarians and non-vegetarians. One marker that can be observed is blood cholesterol levels. Cholesterol is a fat found in the body and moves through the blood in several forms. Several studies have found that vegetarians have a lower amount of low density lipoprotein (LDL) circulating through their blood (4). Some factors of a vegetarian diet that can bring this about include higher amounts of fiber, nuts, soy, and plant sterols and, lower levels of saturated fats. This can be associated with lower accounts of heart disease. Lifelong vegetarians have a 24% less chance and lifelong vegans have a 57% less chance of experiencing a heart attack compared to omnivores. Vegetarians had higher serum triglyceride (circulating fats) (12). At the same time, the non-vegetarians had higher amounts of total cholesterol and LDL levels. There was no difference in HDL (“good” cholesterol) levels between the two groups.

Another blood measurement that has been studied between vegetarians and non-vegetarians is blood pressure. Blood pressure can be defined as the force that blood puts on the blood vessel walls as it passes through them. Blood pressure is a blood measurement used to assess cardiovascular risk. Non-vegetarians had a significantly higher systolic (when the heart flexes) blood pressure than vegetarians (12). However, both vegetarians and vegetarians had blood pressures that were within recommended guidelines. Vegans, partial vegetarians, and lacto-ovo vegetarians all had lower blood pressures than non-vegetarians (13). However, conflicting results have

been found. It was found that vegetarians and lacto-ovo vegetarians had blood pressures in the normal range and had no significant differences between their values (14).

Another blood measurement that can be compared in people with different diets is serum glucose. High blood glucose is a medical diagnosis called diabetes. Diabetes is a chronic illness that is a health concern for many populations. Several studies have researched blood glucose levels in different diets. Vegan and lacto-ovo vegetarians had one half the risk for type 2 diabetes when compared to non- vegetarians (15). However, long term adherence to a vegan diet or a conventional diabetes diet within prescribed guidelines can both actually significantly lower Hb A1c (a long term measure of blood glucose) (16). There were not significant differences found between the groups though.

Methods

Purpose and Objectives

The literature has addressed some of the difference between vegetarian diets and non-vegetarian diets for nutritional adequacy and health outcomes. It seems that each of these diets have unique strengths and weaknesses. Therefore, an individual following a vegetarian diet needs adequate education to ensure nutritional adequacy while also reaping the other health benefits. More studies are needed to find a clearer picture about the nutritional adequacy and health outcomes associated with these diets.

Research Questions

- Identify the proportion of US adults following a vegetarian diet.

- Examine differences in adequacy of key nutrients between vegetarians and non-vegetarians.
- Identify if there are significant differences in weight status between vegetarians and non- vegetarians.

Data Source

The data that we analyzed and interpreted was retrospective data from the National Health and Nutrition Examination Survey (NHANES). This survey is a national program run by the national Center for Health Statistics from the Center for Disease Control and Prevention (CDC) (17). NHANES evaluates and monitors health and nutrition status of the US population and is taken on a regular basis. Interviews across the country are held to acquire demographic, health, socioeconomic, and nutrition related information, as well as physical measurements. The prevalence of chronic diseases and risk factors are measured too.

The survey is now implemented on a two year cycle. Certain groups are focused on more than others in order to obtain accurate and viable information. These groups include young people, the elderly, low income, certain ethnicities, and pregnant women. The information is collected by trained professionals in both private homes and mobile examination centers.

Subjects

Data was examined from individuals between the ages of 21 and 65 using the NHANES data from 1999-2007. Subjects who were pregnant or out of the age range were excluded. For subjects to be included, they must have completed the age, weight, height, current health status, and diet history portions of the survey.

Data Collection

NHANES gathered the information in several ways. Demographic information was collected through home and on site questionnaires (18). The onsite questionnaires were completed in mobile examination centers (MECs).

To collect dietary intake, NHANES took 24- hour recalls through phone and in person interviews. The in person interviews occurred in MECs. The 24- hour recall was taken by using the multiple pass approach as a standard measurement. The data was collected using the NHANES computer-assisted dietary interview system (CADII). (19)

Food group intakes were estimated using the MyPyramid Equivalents database (MPED) to identify individuals consuming milk and eggs, meat products, or no animal products (20). The 24- hour recalls were used to quantify the amounts of food groups that the participants consumed.

Body measures of participants were collected in the NHANES MECs by trained professionals (21). The staff who took the measurements were trained health technicians and trained recorders to guarantee accurate measurements. The measurements followed standard regulations. These measures include, but were not limited to, body mass index (BMI), waist circumference (WC), skinfold thickness, and head circumference.

Data Preparation

The subjects were divided into 3 groups: vegans, vegetarians, and non-vegetarians based on the meat oz equivalents estimated from MPED and their 24-hour recall. Participants who did not eat any meat were designated as vegan. Participants who ate only eggs and milk, but no meat were designated as vegetarians. Participants

who ate any type of meat and/ or any animal products were designated as non vegetarians.

Weight status was determined using BMI and WC. Obesity was classified into weight categories resulting from BMIs into underweight, normal, overweight, and obese by <18.49, 18.5-24.9, 25-29.9, and >30 kg/m², respectively. Central obesity was assessed using waist circumference. Individuals will be stratified into groups based on >88 cm for females and 102 cm for males.

Nutritional adequacy of nutrient intakes was examined using estimates from the 24-hr recalls. Total nutrient intakes per day were obtained from the data. The percent of recommended intakes were computed by dividing estimated intakes for each nutrient of interest by the recommended intake level for each. Individuals who consumed at least 100% of the recommended intake were classified as meeting the nutrient need.

Data Analysis

Once subjects are divided into their respective groups, a frequency analysis of each type of diet was taken to estimate % following a vegetarian, vegan, or non vegetarian diet. Differences in mean nutrient intakes, percent of recommended intakes and body measures across the designated diets were compared using ANOVA with post hoc comparisons. To examine differences in % meeting nutrient needs and weight status categories by diet group, chi square analyses were conducted.

A significance level was set a priori at $p < 0.05$ for all measurements.

This data was formatted for analysis using SPSS (version 19.0). All analyses were performed using the SPSS Complex Samples (version 19.0) to account for the stratified, multi-staged and complex sampling techniques used in choosing the subjects.

Results

Amount of Diet Modifications

Dietary intakes of 20,510 participants were evaluated for meat intake patterns and vegetarianism. Approximately 2% (n=366) were classified as vegan and 7% (n=1309) of our participants were identified as vegetarian. The remaining 18,835 participants (91.5%) were classified as non-vegetarians. Therefore, approximately 10% of the nation can be considered to follow some type of a vegetarian diet ($p < .01$, Table 1).

| Total | | | | | | |
|------------------------|----------|----------|----------|----------|----------|----------|
| Dietary Pattern | n | % | n | % | n | % |
| vegan | 366 | 1.8% | 149 | 1.2% | 217 | 2.3% |
| lacto-ovo | 1309 | 6.7% | 463 | 4.6% | 846 | 8.9% |
| omnivore | 18835 | 91.5% | 9635 | 94.2% | 9200 | 88.8% |

Table 1: Percent following Dietary Patterns

Nutritional Adequacy

Results are summarized in table 2. They show a significant difference between all of the nutrients. These differences are seen between all three groups. However, there are some exceptions. Vegans had a significantly lower intake of vitamin C than both non-vegetarians and lacto-ovo vegetarians. But, all three groups intake met the recommended amounts. Vegans also had a lower of magnesium compared to both non-vegetarians and lacto-ovo vegetarians. This time, vegans only consumed 78% of the recommended needs. Finally, lacto-ovo vegetarians had a significantly higher intake of fiber (85% of need) than did both the vegan (70% of need) and meat eater

groups (76% of need). All three groups did not meet the recommended intake for fiber, however.

Vegans did not meet the protein threshold with an average intake of 70% of the EAR. Both lacto-ovo vegetarians and meat eaters met the recommended amount for protein with 110% and 170% respectively. Vegans very well might have had lower protein stores since the protein they consume is not absorbed efficiently as explained in the literature review above.

Vegans also had an inadequate intake of vitamin B12. They consumed an average of 54% of the EAR while lacto-ove vegetarians and non-vegetarians consumed 178% and 283% respectively. Only 12% of vegan subjects met their B12 requirement. This is a higher rate than in the Glising article where 3%v of vegans met their requirement. Approximately 82% of meat eaters met their B12 requirement.

All groups were deficient in calcium intakes. Vegans had the least amount of intake with 44% of the adequate intake. Vegetarians and omnivores consumed double the calcium that vegans did. This may put the subjects at risk for osteoporosis and bone disease.

All three groups met the EAR for iron with each group consuming at least double the recommended amount. Vegans consumed 194% while vegetarians consumed 294% and omnivores consumed 320%. Remember, vegans are recommended to consume 2 times the EAR to account for the lack of bioavailability of plant proteins.

| Raw intakes | Total | Vegan | Vegetarian | | P |
|------------------------------------|----------------|----------------|-------------------|----------------|----------|
| Protein (gm) | 86.14 (0.47) | 33.45 (1.4) | 52.97 (0.97) | 89.59 (0.49) | <0.001 |
| Dietary fiber (gm) | 16.06 (0.15) | 14.64 (0.92) | 18.07 (0.5) | 15.94 (0.15) | <0.001 |
| Vitamin B12 (mcg) | 5.44 (0.06) | 1.08 (0.1) | 3.57 (0.13) | 5.66 (0.07) | <0.001 |
| Vitamin C (mg) | 88.39 (1.47) | 62.1 (4.56) | 95.72 (4.35) | 88.36 (1.4) | <0.001 |
| Calcium (mg) | 935.39 (7.26) | 534.12 (27.59) | 994.22 (23.1) | 938.83 (7.12) | <0.001 |
| Magnesium (mg) | 299.9 (2) | 205.79 (10.42) | 297.03 (5.81) | 301.93 (2) | <0.001 |
| Iron (mg) | 15.83 (0.1) | 9.68 (0.46) | 14.7 (0.31) | 16.03 (0.11) | <0.001 |
| Zinc (mg) | 12.53 (0.1) | 4.96 (0.23) | 8.63 (0.18) | 12.96 (0.1) | <0.001 |
| Potassium (mg) | 2776.8 (15.52) | 1590.6 (64.54) | 2461.2 (46.8) | 2822.8 (15.87) | <0.001 |
| Folate (DFE) | 553.18 (4.88) | 413.94 (21.7) | 587.82 (15.08) | 553.35 (4.86) | <0.001 |
| Energy-adjusted^a | | | | | |
| Protein (gm) | 38.66 (0.14) | 23.03 (0.61) | 28.99 (0.26) | 39.66 (0.14) | <0.001 |
| Dietary fiber (gm) | 7.42 (0.06) | 10.32 (0.46) | 9.86 (0.24) | 7.18 (0.06) | <0.001 |
| Vitamin C (mg) | 2.43 (0.02) | 0.76 (0.11) | 2.03 (0.07) | 2.49 (0.02) | <0.001 |
| Calcium (mg) | 41.87 (0.7) | 53.69 (5.51) | 54.68 (2.09) | 40.7 (0.65) | <0.001 |
| Magnesium (mg) | 421.89 (2.64) | 385.91 (17.1) | 553.53 (9.62) | 412.93 (2.49) | <0.001 |
| Iron (mg) | 137.61 (0.71) | 153.99 (5.83) | 166.33 (2.63) | 135.19 (0.68) | <0.001 |
| Zinc (mg) | 7.2 (0.04) | 6.93 (0.25) | 8.2 (0.16) | 7.14 (0.04) | <0.001 |
| Potassium (mg) | 5.61 (0.04) | 3.5 (0.12) | 4.79 (0.1) | 5.71 (0.04) | <0.001 |
| Folate (DFE) | 1281.1 (5.53) | 1271.0 (63.67) | 1400.3 (19.7) | 1272.6 (5.28) | <0.001 |
| Protein (gm) | 253.56 (1.92) | 289.0 (11.48) | 332.18 (7.66) | 247.19 (1.81) | <0.001 |
| Percent of Need | | | | | |
| Protein (g) | 164.66 (0.99) | 70.14 (3.34) | 110.03 (2.43) | 170.45 (1.05) | <0.001 |
| Dietary fiber (gm) | 76.49 (0.73) | 69.69 (4.38) | 86.05 (2.39) | 75.92 (0.7) | <0.001 |
| Total Folate (mcg) | 172.87 (1.52) | 129.36 (6.78) | 183.69 (4.71) | 172.92 (1.52) | <0.001 |
| Vitamin B12 (mcg) | 271.97 (3.23) | 53.95 (5.12) | 178.43 (6.47) | 283.04 (3.33) | <0.001 |
| Vitamin C (mg) | 147.31 (2.45) | 103.49 (7.6) | 159.53 (7.25) | 147.26 (2.33) | <0.001 |
| Potassium (mg) | 59.08 (0.33) | 33.84 (1.37) | 52.37 (1) | 60.06 (0.34) | <0.001 |
| Calcium (mg) | 77.95 (0.6) | 44.51 (2.3) | 82.85 (1.92) | 78.24 (0.59) | <0.001 |
| Magnesium (mg) | 113.17 (0.75) | 77.66 (3.93) | 112.09 (2.19) | 113.94 (0.76) | <0.001 |
| Iron (mg) | 316.53 (2.09) | 193.7 (9.18) | 294.06 (6.23) | 320.55 (2.1) | <0.001 |
| Zinc (mg) | 184.26 (1.44) | 72.98 (3.41) | 126.92 (2.7) | 190.61 (1.5) | <0.001 |

Data presented as Mean (SE)

^aNutrient per 1,000 kcals

^bData expressed as intakes as a percent of DRI (EAR/AI) levels

Table 2: Mean differences in nutrients intakes by dietary pattern

| Met DRI | Total | Vegan | Vegetarian | Omnivore | P |
|---------------------------|--------------|--------------|-------------------|-----------------|----------|
| Protein (gm) | 78.2% | 24.9% | 49.3% | 81.3% | <0.001 |
| Dietary fiber (gm) | 23.5% | 19.7% | 31.2% | 23.0% | <0.001 |
| Total Folate (mcg) | 58.0% | 35.2% | 59.7% | 58.3% | <0.001 |
| Vitamin B12 (mcg) | 79.3% | 11.7% | 57.7% | 82.2% | <0.001 |
| Vitamin C (mg) | 46.8% | 34.5% | 52.4% | 46.6% | <0.001 |
| Potassium (mg) | 8.2% | 2.0% | 6.4% | 8.5% | <0.001 |
| Calcium (mg) | 24.9% | 9.6% | 27.8% | 25.0% | <0.001 |
| Magnesium (mg) | 52.2% | 24.5% | 50.1% | 52.9% | <0.001 |
| Iron (mg) | 95.8% | 68.4% | 89.0% | 96.8% | <0.001 |
| Zinc (mg) | 78.2% | 26.2% | 56.2% | 80.8% | <0.001 |

Table 3: Percentage meeting the DRI for Selected Nutrients by Dietary Pattern

Weight Status

For weight status, the BMI and waist circumference of all three groups were compared. Our results are depicted in tables 3 and 4. Vegans were significantly less likely to overweight or obese (or significantly more likely to be normal weight). Vegans had significantly lower mean BMI and waist circumference values as well. The average person in each group would be considered overweight with a BMI between 25 and 30. Omnivores are most likely to be overweight and obese, but only by a small amount. Very few subjects of all three groups would be considered underweight. All of the groups on average surpassed the threshold for waist circumference, but only by a little. However, increases in waist circumference are correlated with increased risk of comorbidities.

| Measure | Total | Vegan | Omnivore | Omnivore | P |
|--------------------------------------|--------------|--------------|--------------|--------------|--------|
| Body Mass Index (kg/m**2) | 28.5 (0.08) | 27.6 (0.4) | 27.1 (0.26) | 28.6 (0.08) | <0.001 |
| Waist Circumference (cm) | 96.9 (0.22) | 93.3 (1.03) | 93.1 (0.63) | 97.2 (0.21) | <0.001 |
| Waist Circumference (% of threshold) | 102.3 (0.24) | 100.9 (1.14) | 100.7 (0.72) | 102.4 (0.22) | 0.011 |

Data presented as Mean (SE)

Table 4: Mean differences in obesity markers by dietary pattern

| BMI categories | Total (n=7347) | Vegan (n=116) | Vegetarian (n=387) | Omnivore (n=6844) | P |
|----------------|-------------------|------------------|-----------------------|----------------------|--------|
| Underweight | 1.8% | 2.7% | 2.8% | 1.7% | <0.001 |
| Normal Weight | 31.3% | 37.4% | 38.6% | 30.7% | <0.001 |
| Overweight | 33.4% | 29.7% | 32.4% | 33.6% | <0.001 |
| Obese | 33.5% | 30.2% | 26.2% | 34.1% | <0.001 |

Table 5: Differences in BMI Categories by Diet Pattern

Discussion and Conclusion

Recently, Americans have diverged from the typical westernized diet of “meat and potatoes” .As many as 11% of Americans have been found to be following either a vegan or vegetarian diet (5). Americans have begun to avoid meat products in an effort to lose weight and to prevent developing diabetes mellitus, hypertension, cancer, etc. These diets have been shown to be effective in promoting longevity and healthy lifestyles. However, there is concern that these diets may be inadequate in certain nutrients such as protein, iron, and calcium that are mainly found in meat products that these diets avoid (4).

Results of protein intake are consistent with related research. Another project found that protein intake in vegetarian adults was significantly lower than their omnivore counterparts (8). As discussed before, protein is less bioavailable in plant sources than animal sources (4). So, it may be difficult for vegans and vegetarians to receive the correct amount of protein in their diets through plants alone. Inadequate protein intake may lead to muscle loss and/or protein deficiency, which would be harmful to an individual's health. It may be beneficial for vegans and vegetarians to eat vegetable proteins in a complimentary way or add a protein supplement to their daily routine.

These results were also consistent with research related to Vitamin B12. Only 12% of vegans met the requirement for daily Vitamin B12 in our results. One study found that 3% of vegans met their daily need for B12 (9). While these results do not match up consistently, they both demonstrate that vitamin B12 is a concern for this population. Vitamin B12 is responsible for making red blood cells and other bodily functions such as maintaining healthy DNA and nerves. Low intakes of vitamin B12 can lead to megaloblastic anemia, which can be detrimental to the body. Vegans and vegetarians can obtain enough vitamin B12 through fortified grains or vitamin supplements (4).

This research found a discrepancy from past studies in iron status of vegans. One study found that vegetarians had a higher intake of iron compared to non-vegetarians (10). Our results showed that non-vegetarians on average consumed about double the amount of iron than vegans did. However, the issue of bioavailability remains. Therefore, it should be recommended that vegans should follow the guidelines published by the Academy of Nutrition of Dietetics(4). A low intakeof iron may

lead to iron deficiency anemia. Vegans can prevent this by eating dark green leafy vegetables with a calcium source or take an iron supplement.

Another result that was consistent with past research was calcium. Results demonstrated that vegans only received approximately 44% of their calcium need. Another study found that vegans only met 75% of the DRI for calcium (7). Even though vegans were short on their need for calcium, less than 25% of vegetarians and omnivores met their need for calcium as well. Therefore, calcium is a nutrient of concern for all groups. Low intakes of calcium may lead to osteoporosis and risk for broken bones. Calcium can be obtained by vegans with dark green leafy vegetables, tofu, soy milk, and dietary supplements. Meat eaters and vegetarians can obtain calcium through milk, cheese, and yogurt as well as through supplementation.

This study's results demonstrate a significant difference between vegans, vegetarians, and non-vegetarians in regard to weight status. Vegans and vegetarians are less likely to be overweight and obese and more likely to be normal weight. Most vegans and vegetarians had healthy waist circumferences. Omnivores had higher than recommended waist circumferences. Other studies did not find this. One study found that there was no difference in BMI status between the groups (7). There was a higher percentage of omnivores in the obese category than the other groups. Whether some vegans and vegetarians are obese and overweight because of their lifestyle or change in diet, this study cannot determine. These weight differences may be due to an intake of high fiber foods that stimulate a feeling of satiety or the increased intake of low energy dense foods. Due to the high amount of vitamins, minerals, and even phytochemicals in plant based foods, vegans and vegetarians may have a reduced risk

for chronic diseases such as heart disease, cancer, and diabetes. Most importantly, vegans and vegetarians may be at lower risk for chronic diseases because they have healthier weight statuses.

While all three diets can be healthy, it is the healthcare professional's responsibility to educate their patient/ client on these results and how to meet their daily nutritional needs. A healthcare provider can study the differences between these two diets or consult a registered dietitian to further understand the effects of these diets on the body. It is the individual's responsibility to understand their nutritional needs and make sure they can fulfill them. Ideally, a client will meet with a registered dietitian when trying to decide on changing their dietary habits.

This project shows that more research is needed to observe long term effects of these diets on weight status and nutritional status. More research is needed to observe the long term effects of these diets on diseases such as heart disease, diabetes, and obesity. Researchers can also study other measurements between the groups such as calories, fat intake, blood pressure, and blood sugar levels to further understand the differences between these groups.

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