ORIGINAL ARTICLE

Differences in dietary intake between Turkish vegans and omnivores: a cross-sectional study

Buse Sarikaya [1] * , Aslı Yiğit [2] , Şule Aktaç [1] , Fatma Esra Güneş [3]

1. Marmara University, Faculty of Health Sciences, Department of Nutrition and Dietetics, İstanbul, 34854, Turkey. Email: buse.sarikaya@marmara.edu.tr / suleaktac@hotmail.com
2. Süleyman Demirel University, Isparta, 32260, Turkey. Email: asliyigit@sdu.edu.tr
3. Medeniyet University, Faculty of Health Sciences, Department of Nutrition and Dietetics. İstanbul, 34685, Turkey. Email: fatmaesra.gunes@medeniyet.edu.tr

ABSTRACT

Background: Veganism is gaining more interest in Turkey, however, there is limited data on the nutritional intake of Turkish vegans. **Aims:** This cross-sectional online study aimed to evaluate the nutritional intake of Turkish vegans and compare their macro and micronutrient intake with Turkish omnivores. **Subjects and Methods:** This cross-sectional online study was conducted in İstanbul from October 2019, until December 2019. 108 Turkish adult vegans and 108 omnivores completed a sociodemographic questionnaire and a 3-day dietary recall online. The energy, macro-, and micronutrient intake were evaluated from the dietary recall via the dietary analysis program BEBIS 8.1, using the Turkish Food composition database. The dietary intake was compared to the Turkey Dietary Guideline. The Healthy Eating Index 2015 (HEI – 2015) was calculated as a diet quality indicator. Statistical analyses were performed with SPSS version 22.0. **Results:** Mean protein intake was 66.16 ± 21.69 g in vegan women and 74.87 ± 21.90 g was in omnivorous women ($p < 0.05$), and 75.53 ± 29.09 g in vegan men and 88.89 ± 28.48 g in omnivorous men ($p > 0.05$). Both male and female vegans had significantly higher dietary intakes of thiamine, vitamin C, iron, magnesium, potassium, and copper; with significantly lower intakes of riboflavin, vitamin B12, vitamin D, calcium, iodine, phosphorus, zinc compared to omnivores of both sexes. Vitamin B12, riboflavin and calcium intakes were below the recommendations in vegans as compared to omnivores for both sexes ($p < 0.001$). Vegan participants showed a significantly higher intake of total fruits, vegetables, nuts, seeds, and legumes compared to omnivorous participants ($p < 0.001$). HEI – 2015 scores were 58.18 ± 13.20 in vegans and 68.74 ± 7.72 in omnivores ($p < 0.001$). **Conclusions:** Turkish vegans, in our study, had a well-balanced and healthy macronutrient intake with lower saturated fatty acids (SFA) and higher fiber intake. However, vegans showed a lower intake of micronutrients such as vitamin B12 and calcium. This indicates a need for greater care toward ensuring recommended daily intake of these specific micronutrients. Further research is required to evaluate dietary intake and nutritional biomarkers in Turkish vegans for the long-term effects of vegan diets.

Keywords: dietary assessment, dietary intake, macronutrients, micronutrients, vegan diet.

ARTICLE INFORMATION

* **Corresponding author:** Buse Sarikaya, Tel. +90 216 (777 57 01). E-mail: buse.sarikaya@marmara.edu.tr

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1 Introduction

A vegan diet is characterized by the exclusion of all animal-derived foods, including milk, dairy products, eggs, and even honey [1, 2]. A vegan diet commonly comprises of large amounts of fruits, vegetables, grains, legumes, and nuts, and is generally high in dietary fiber, beta-carotene, vitamin C, and magnesium. However, the exclusion of all animal products from the diet increases the risk of certain nutritional deficiencies [3]. There are some concerns about this restrictive dietary pattern. Indeed, if not appropriately planned, following a vegan diet might result in a reduced intake of specific nutrients such as n-3 fatty acids, vitamin D and B12, iron, zinc, and calcium [4-6]. Vegan diets have been associated with several positive health outcomes, such as lower body mass index (BMI) [7], lower prevalence of chronic diseases [1, 6, 8, 9], a significantly reduced risk of total cancer incidence [10], and regulation of glycemic control [11]. People may adopt a vegan lifestyle for health, ecological, religious, cultural, and taste-related reasons [12]. With motivations such as animal protection or excessive exploitation of environmental resources, it can be said that vegan diets will be gaining more popularity in Western societies [6, 13].

An adequate and balanced diet is essential for biological processes such as growth and development, being healthy, and being active in the life cycle. The development of food and nutrition policies at the national level, are formed by determining the nutritional and health status of the population. Therefore, food and nutrition research are the main tool for understanding changes in diet, nutritional status, and nutritional problems of a nation. Current nutritional issues in Turkey include obesity, chronic energy deficiency, iron deficiency anemia, and vitamin B12 and folate deficiency [14]. According to the Turkish Nutrition and Health Survey (TNHS)-2010 [15], iron, zinc, and calcium intakes were found to be lower than the recommended daily intake. Calcium, vitamin B1, zinc, vitamin B6, vitamin A, vitamin B2, vitamin D, and folate deficiencies are common problems in Turkish population [14 - 16]. According to the FAO food balance sheets, the amount of energy and macronutrients per capita was increased in Turkey over the last decades [17]. As for the trends in macronutrient intake, there was a significant increase in amount of energy provided from fat [14].

Geographically divided into seven regions, Turkish food culture varies by region. A wide variety of dishes prepared in Turkish cuisine are primarily based on beef, mutton, and lamb. Vegetarianism and veganism are not very common in Turkey although it is becoming more and more popular. Turkish cuisine is principally based on meat, milk, and grains, and vegan products are not as varied, affordable, nor as accessible compared to other countries in Europe. Therefore, vegans in Turkey may face the challenge of finding a variety of food and meeting their nutritional requirements [18]. Regarding the literature on vegan dietary patterns, there is limited information on the trends of veganism and how it has changed over time in Turkey. Moreover, to the best of our knowledge, there is limited data on the nutritional intakes or nutritional status of Turkish vegans. We hypothesized for vegans, the daily intake of micronutrients such as vitamin B12 and calcium may not meet the requirements outlined in the Turkey Dietary Guidelines. Therefore, this study aims to determine the dietary intakes of vegan adults in Turkey and compare them with their omnivorous counterparts.

2 Subjects and Methods

2.1 Study design

A cross-sectional online survey was conducted in İstanbul from October 2019, until December 2019. 108 vegan participants were recruited through the online account of The Vegan Association of Turkey. 108 omnivorous participants were recruited using social media with the inclusion criteria except for following a vegan or vegetarian diet. Inclusion criteria were defined as: health participants between 18 – 60 years of age, were following a vegan diet followed for at least three (3) months, omnivores were consuming at least two servings of meat a week, and reports with clearly defined dietary details could be provided by participants. Exclusion criteria were defined as: obesity (BMI ≥ 30 kg/m^2), if following a vegetarian diet, severe illness (cancer, myocardial infarction, or stroke), and pregnant or lactating women. All the invitees received an email with an invitation letter to participate in the survey. Informed consent was obtained from all participants included in the study. The study received the approval of Marmara University Faculty of Medicine Non-Interventional Clinical Research Ethics Committee (Protocol number 09.2019.293).

2.2 Dietary assessment

The consumption of food was assessed with a 3-day dietary recall, including two working days and a day at the weekend within the same week. To minimize errors caused by the portion sizes not being correctly determined in the food consumption record, participants received instructions for completing these records. Portion sizes of foods were described in household measures, standard weights of food items, and photographs [19] of the portions [16] were sent attached as online documents. The type and quantity of all consumed foods and beverages, as well as the preparation technique and recipes for prepared foods, were accurately and completely recorded by each participant as plain text. All food record data collected online were manually entered in a dietary analysis computer program BEBIS 8.1 [20], which uses the Turkish Food composition database. The daily intake of energy, and macro and micronutrients was calculated. All presented data were based on dietary intake only and did not include vitamin and mineral supplements or fortified foods. The estimated macronutrient and micronutrient levels among vegans and omnivores were compared to the Recommended Daily Allowance (RDA) according to the Turkey Dietary Guideline[16]. The diet quality was evaluated by Healthy Eating Index – 2015 (HEI – 2015) [21, 22], which conforms to the US dietary guidelines [22, 23] and adapted to the Turkey Dietary Guidelines [16, 23] for this study. The HEI – 2015 is a 13-component measurement system consisting of adequacy and moderation of the food groups and nutrients with a100 – point measure of diet quality. A HEI score of 80 or more indicates a good diet; scores between 50 and 80 suggest that a diet needs improvement, and scores less than 50 are considered to be a poor diet [24].

2.3 Other measures

The questionnaire also included questions related to lifestyle. Participants were asked to include sociodemographic variables (sex, age, education, and the years following a vegan diet), and anthropometric data (body weight and height). Body Mass Index (BMI) was calculated using the formula: weight

(kg)/height (m^2) and classified as underweight, normal, or overweight according to the World Health Organization BMI classification [25].

2.4 Statistical analyses

Power analysis of the study was performed with G*Power 3.1.9.7. software. The sample size was calculated with the assumption that a change primary outcome variable (protein in g) at significance $p < 0.05$ and power of 95 % [4]. The Kolmogorov-Smirnov Test and Shapiro-Wilk Test were applied to analyze normal distribution. Differences between measurements and groups were analyzed using the Independent Sample *t*-Test for parametric variables and the Mann-Whitney U test for nonparametric variables. A two-tailed $p < 0.05$ value was considered statistically significant. Pearson's Chi-square and Fisher's Exact Test were applied to sets of two or more categorical variables. All statistical analyses were performed with SPSS (version 22.0; SPSS, Inc, Chicago).

3 Results

3.1 Participant characteristics

A summary of the main characteristics of the participants is given in Table 1. Participants who had a BMI ≥ 30 (n=17), who did not specify their sex (n=2), and those < 18-year-old (n=2) were excluded from the study. In total there were 216 participants, 108 participants were following a vegan diet (n=91 [84.0 %] women and n=17 [15.7 %] men) and 108 (n=88 [81.5 %] women and n=20 [18.5 %] men) were omnivores. There were no statistically significant differences between vegans and omnivores regarding age, body weight, and BMI. There was no significant difference in BMI classification. In both groups, women were higher in number than men. Most of the participants had bachelor's degrees in both groups (72.2 % vegans and 93.5 % omnivores).

3.2 Energy, macro- and micronutrient intake

Table 2 presents the energy and nutrient intakes of vegan and omnivores. Mean energy intake was higher in both vegan women and men than omnivore women and men however, this difference was not significant (differed 41.27 kcal in women and 89.41 kcal in men). Mean protein intake was 8.71 g/day higher in vegan women than omnivorous women ($p < 0.05$) while this difference was 13.36 g/day in men ($p > 0.05$). Moreover, no difference was observed in intake of energy, carbohydrate, and total fat among both sexes for the vegan and the omnivorous participants. For both women and men, dietary fiber intake was significantly higher ($p < 0.001$), and intake of saturated fat was significantly lower in vegans compared with omnivores ($p < 0.001$). Regarding the intake of dietary lipids, vegan women had a lower intake of saturated fatty acids (SFA), cholesterol, and a higher intake of polyunsaturated fatty acids (PUFA), and n-3 and n-6 compared with omnivorous women. While vegan men had a

Table 1. Comparison of sociodemographic characteristics of Turkish vegans (n=108) and Turkish omnivores (n=108)

Characteristics	Vegans (n=108)	Omnivores (n=108)	p-value
	Mean ± SD	Mean ± SD	
Age (y)	29.87 ± 5.23	30.19 ± 7.46	0.185[b]
Body weight (kg)	58.01 ± 9.94	59.27 ± 9.17	0.257[b]
BMI (kg/m^2)			
- Women	20.73 ± 2.22	20.86 ± 2.08	0.706[a]
- Men	22.98 ± 2.35	23.82 ± 1.40	0.797[a]
	n (%)	n (%)	
Sex			
- Women	91(84.3)	88 (81.5)	0.588[c]
- Men	17(15.7)	20 (18.5)	
BMI classification			
- Underweight	13 (12.0)	12 (11.1)	0.411[c]
- Normal	88 (81.5)	93 (86.1)	
- Overweight	7 (6.5)	3 (2.8)	
Education			
- High School	7 (6.5)	2 (1.9)	0.170[c]
- Bachelor's degree or Masters' degree	101 (93.5)	106 (98.1)	
Duration of the diet			
- 3 – 6 months	16 (14.8%)	-	
- 6 – 12 months	19 (17.6%)	-	
- More than one year	74 (67.6)	-	

Independent t test[a], Mann-Whitney U test[b], Pearson Chi-Square[c], Fisher's Exact Test[d]

Table 2. Comparison of energy and nutrient intake of Turkish vegans and Turkish omnivores

Energy and nutrients	Women			Men		
	Vegans (n=91)	Omnivores (n=88)	p-value	Vegans (n=17)	Omnivores (n=20)	p-value
Energy (kcal)	1821.94 ± 376.95	1863.21 ± 459.27	0.570[b]	1952.62 ± 590.72	2147.95 ± 676.14	0.244[b]
Protein						
- (g)	66.16 ± 21.69	74.87 ± 21.90	0.006[b]	75.53 ± 29.09	88.89 ± 28.48	0.091[b]
- (% of the energy)	14.63 ± 4.35	16.27 ± 3.60	0.002[b]	15.48 ± 4.05	16.80 ± 3.56	0.298[a]
Fat						
- Total (g)	82.84 ± 23.36	83.50 ± 26.02	0.881[b]	88.02 ± 34.98	89.99 ± 40.21	0.821[b]
- (% of the energy)	40.72 ± 6.54	40.16 ± 6.67	0.571[a]	40.46 ± 9.19	37.25 ± 9.50	0.257[b]
- Saturated (g)	11.62 ± 4.73	28.34 ± 10.82	<0.001[b]	10.60 ± 4.15	31.15 ± 13.97	<0.001[a]
- Saturated (% of the energy)	5.72 ± 1.91	13.66 ± 3.74	<0.001[b]	4.95 ± 1.60	12.59 ± 3.81	<0.001[a]
- Monounsaturated (g)	26.01 ± 11.66	27.39 ± 9.14	0.210[b]	27.51 ± 13.47	28.62 ± 13.37	0.803[a]
- Polyunsaturated (g)	30.44 ± 12.02	20.85 ± 10.64	<0.001[b]	29.77 ± 13.06	21.18 ± 14.79	0.015[b]
▪ n-3	2.69 ± 1.73	2.14 ± 1.60	0.013[b]	1.97 ± 0.77	3.39 ± 4.96	0.478[b]
▪ n-6	27.68 ± 11.13	18.32 ± 9.47	<0.001[b]	27.15 ± 12.43	18.74 ± 11.02	0.012[b]
▪ n-3/n-6	0.10 ± 0.05	0.13 ± 0.10	0.023[b]	0.08 ± 0.03	0.19 ± 0.17	0.013[b]
Cholesterol (mg)	0.000	269.61 ± 166.12		0.000	361.71 ± 200.06	<0.001[b]
Carbohydrates						
- (g)	201.29 ± 49.72	199.70 ± 60.50	0.847[a]	216.30 ± 70.82	233.26 ± 81.71	0.508[a]
- (% of the energy)	44.26 ± 6.89	42.83 ± 7.80	0.098[b]	44.50 ± 9.83	43.51 ± 8.56	0.745[a]
Dietary fiber (g)	44.58 ± 12.30	29.45 ± 30.93	<0.001[b]	43.64 ± 9.74	22.40 ± 9.95	<0.001[a]
Vitamins						
- Vitamin A (mcg RE)	1362.90 ± 870.00	1728.60 ± 266.01	0.465[b]	1149.90 ± 448.39	1192.85 ± 710.35	0.563[b]
- Thiamine (mg)	1.41 ± 0.54	0.86 ± 0.24	<0.001[b]	1.41 ± 0.51	1.01 ± 0.67	0.003[b]
- Riboflavin (mg)	0.94 ± 0.30	1.48 ± 0.61	<0.001[b]	0.97 ± 0.26	2.03 ± 1.39	<0.001[b]
- Niacin (NE)	12.72 ± 5.27	13.88 ± 6.85	0.202[b]	14.03 ± 4.90	17.38 ± 11.03	0.594[b]
- Vitamin B6 (mg)	1.90 ± 0.55	1.51 ± 0.51	<0.001[b]	1.92 ± 0.51	1.57 ± 0.50	0.046[a]
- Vitamin B12(mcg)	1.57 ± 4.75	6.90 ± 26.46	<0.001[b]	0.47 ± 0.69	16.94 ± 32.23	<0.001[b]
- Folate (mcg)	179.30 ± 58.31	141.24 ± 65.79	<0.001[b]	162.48 ± 36.28	132.76 ± 49.22	0.047[a]
- Vitamin C (mg)	184.74 ± 79.18	125.82 ± 73.85	<0.001[b]	179.65 ± 10.19	109.98 ± 93.68	0.011[b]
- Vitamin D (mcg)	0.59 ± 1.20	2.46 ± 7.86	<0.001[b]	0.68 ± 1.24	1.53 ± 1.21	0.002[b]
- Vitamin E (mg)	20.66 ± 7.77	18.33 ± 8.29	0.061[b]	20.90 ± 1.05	18.12 ± 10.57	0.286[b]
Minerals						
- Iron (mg)	19.28 ± 5.76	12.89 ± 4.12	<0.001[b]	19.04 ± 4.41	13.21 ± 5.03	0.001[a]
- Calcium (mg)	581.77 ± 188.00	800.57 ± 253.00	<0.001[a]	585.69 ± 135.22	801.90 ± 329.61	0.013[a]
- Iodine (mg)	121.13 ± 53.12	164.88 ± 55.62	<0.001[a]	104.30 ± 40.74	183.47 ± 64.13	<0.001[b]
- Phosphorus (mg)	1114.46 ± 334.52	1243.32 ± 364.88	0.010[b]	1162.79 ± 282.92	1308.91 ± 483.04	0.280[a]
- Magnesium (mg)	458.15 ± 155.14	319.32 ± 103.16	<0.001[b]	439.67 ± 126.00	318.48 ± 142.42	0.006[b]
- Sodium (mg)	2677.90 ± 1151.02	3921.10 ± 1300.90	<0.001[a]	2510.92 ± 955.92	4853.18 ± 2082.1	<0.001[b]
- Potassium (mg)	3604.37 ± 1032.34	2657.00 ± 851.00	<0.001[b]	3391.81 ± 648.38	2798.53 ± 1184.0	0.008[b]
- Zinc (mg)	9.18 ± 2.85	10.58 ± 3.24	0.002[b]	9.71 ± 1.89	11.54 ± 3.42	0.049[a]
- Copper (mg)	2.70 ± 0.97	1.81 ± 0.60	<0.001[a]	2.80 ± 0.82	1.93 ± 0.65	0.001[b]

Independent *t*-test[a], Mann-Whitney U test[b], microgram (mcg), milligram (mg), niacin equivalent (NE), retinol equivalent (RE)

lower intake of SFA compared to omnivorous men, there was no significant difference observed in monounsaturated fatty acids (MUFA) and n-3 intakes ($p > 0.05$). Vegan women had lower dietary intakes of protein than omnivorous women, while there was no difference among men.

There was no significant difference in niacin, Vitamin E, and Vitamin A in both sexes among vegans and omnivores. Vegans had significantly higher dietary intakes of thiamine, Vitamin C, iron, magnesium, potassium, and copper; while there were significantly lower intakes of riboflavin, Vitamin B12, Vitamin D, calcium, iodine, phosphorus, sodium, and zinc compared to omnivores for both sexes. Furthermore, vegans had higher intakes of vitamin B6 and folate than omnivores for both men and women.

3.3 Amino acid intake

Amino acid intake in vegan and omnivore participants is shown in Table 3. No statistical difference was observed in arginine and asparagine in women ($p > 0.05$). Male omnivorous participants showed a higher intake of all amino acids ($p < 0.005$).

Table 3. Amino acid intake in Turkish vegans and Turkish omnivores

Amino acids (mg/day)	Women			Men		
	Vegans (n=91)	Omnivores (n=88)	p-value	Vegans (n=17)	Omnivores (n=20)	p-value
Isoleucine	2511.39 ± 1052.17	3486.25 ± 1076.02	<0.001[b]	2445.41 ± 927.20	4493.91 ± 1305.90	<0.001[a]
Leucine	4098.30 ± 1698.37	5621.20 ± 1682.00	<0.001[b]	3957.10 ± 1512.63	7240.66 ± 2187.08	<0.001[a]
Lysine	2717.10 ± 1157.62	4480.90 ± 1584.98	<0.001[b]	2533.10 ± 1070.74	6015.22 ± 1952.14	<0.001[a]
Methionine	828.19 ± 327.23	1485.58 ± 492.90	<0.001[b]	828.73 ± 314.29	1906.07 ± 582.06	<0.001[a]
Cysteine	849.13 ± 355.63	978.61 ± 293.48	0.009[a]	840.01 ± 293.13	1330.54 ± 463.61	0.001[a]
Phenylalanine	2725.48 ± 1192.15	3208.06 ± 964.49	0.001[b]	2684.54 ± 1052.68	4164.30 ± 1262.50	0.001[a]
Tyrosine	1967.87 ± 1339.61	2555.62 ± 780.22	<0.001[b]	1757.84 ± 723.21	3266.45 ± 1030.55	<0.001[a]
Threonine	2080.35 ± 857.71	2810.35 ± 873.00	<0.001[b]	2036.64 ± 780.43	3480.96 ± 1106.88	<0.001[a]
Tryptophan	648.26 ± 264.32	835.38 ± 245.93	<0.001[b]	664.47 ± 234.55	1038.01 ± 316.35	0.001[b]
Valine	2827.50 ± 1104.51	3889.60 ± 1234.84	<0.001[b]	2795.70 ± 1024.56	4887.97 ± 1641.77	<0.001[a]
Arginine	3916.35 ± 1584.14	3847.62 ± 1416.28	0.791[b]	4014.64 ± 1816.63	5335.64 ± 2053.64	0.047[a]
Histidine	1293.30 ± 500.75	1819.50 ± 587.90	<0.001[a]	1277.77 ± 463.22	2410.20 ± 757.51	<0.001[a]
Alanine	5762.97 ± 2326.48	6108.44 ± 1963.41	<0.001[b]	2283.23 ± 762.40	4423.25 ± 1391.07	<0.001[a]
Asparagine	5763.00 ± 2326.48	6108.40 ± 1963.41	0.284[a]	5389.81 ± 2043.38	8255.96 ± 2503.29	0.001[a]
Glutamate	11982.88 ± 5246.98	14471.62 ± 3824.27	<0.001[b]	11798.28 ± 3671.86	17756.42 ± 5295.24	<0.001[a]
Glycine	2427.68 ± 930.12	2745.68 ± 921.71	0.037[b]	2449.88 ± 827.83	3661.00 ± 1339.32	0.002[a]
Proline	3674.60 ± 1756.69	5205.86 ± 1412.34	<0.001[b]	3666.66 ± 1197.27	6511.40 ± 2041.97	<0.001[b]
Serine	2845.58 ± 1165.98	3864.69 ± 4025.45	<0.001[a]	2773.03 ± 991.66	4427.79 ± 1280.70	<0.001[a]

Independent *t*-test[a], Mann-Whitney U test[b]

3.4 Percentage of recommended daily allowance when on a vegan diet

The percentage of RDA of energy and some nutrients in vegan and omnivorous participants is shown in Table 4. Vitamin B12 intake was significantly lower in vegans compared with omnivores in both sexes and was below the recommended amount per day (39.31 % vs 172.64 % in women and 11.76 % vs 423.50 % in men). The recommendations regarding iron intake are met by both

Table 4. Amino acid intake in Turkish vegans and Turkish omnivores

Energy and nutrients	Women				Men			
	R.I.	Vegans (n=91)	Omnivores (n=88)	p-value	R.I.	Vegans (n=17)	Omnivores (n=20)	p-value
Energy (kcal)	1800	101.21	103.51	0.570[b]	2200	88.75	97.63	0.244[b]
Protein (g)	55	120.29	136.13	0.006[b]	63	119.89	141.09	0.091[b]
Carbohydrate (g)	130	154.83	153.61	0.847[a]	130	166.39	179.43	0.508[a]
Dietary fiber (g)	25	178.35	117.81	<0.001[b]	25	179.54	89.60	<0.001[a]
Vitamin A (mcg RE)	650	209.67	265.94	0.465[b]	750	153.32	159.04	0.831[a]
Thiamine (mg)	1.1	128.77	78.61	<0.001[b]	1.2	117.65	84.16	0.003[b]
Riboflavin (mg)	1.1	85.61	134.61	<0.001[b]	1.3	75.11	156.15	<0.001[b]
Niacin (NE)	12	106.02	115.73	0.202[b]	14	100.25	124.17	0.598[b]
Vitamin B6 (mg)	1.3	146.75	116.70	<0.001[b]	1.3	147.96	121.15	0.052[b]
Vitamin B12 (mcg)	4	39.31	172.64	<0.001[b]	4	11.76	423.50	<0.001[b]
Folate (mcg)	330	54.33	42.80	<0.001[b]	330	49.23	40.23	0.047[a]
Vitamin C (mg)	95	194.47	132.45	<0.001[b]	110	163.32	99.98	0.011[b]
Vitamin E (mg)	11	187.83	166.65	0.061[a]	13	160.81	139.38	0.297[b]
Iron (mg)	11-16	175.33	117.24	<0.001[b]	11	173.10	120.13	0.001[a]
Calcium (mg)	1000	58.17	80.05	<0.001[a]	1000	58.56	80.19	0.013[a]
Phosphorus (mg)	550	202.63	226.06	0.010[b]	550	211.42	237.98	0.280[a]
Magnesium (mg)	300	152.71	106.44	<0.001[b]	350	125.62	90.99	0.005[b]
Sodium (mg)	2300	116.43	170.48	<0.001[a]	2300	109.17	211.00	<0.001[b]
Potassium (mg)	4700	76.68	56.53	<0.001[b]	4700	72.16	59.54	0.007[b]
Zinc (mg)	7.5-12.7	122.52	141.11	0.002[b]	9.4-16.3	103.32	122.76	0.049[a]
Copper (mg)	1.3	207.10	139.95	<0.001[b]	1.6	175.00	120.93	0.001[b]

Independent *t*-test[a], Mann-Whitney U test[b], R.I.: Recommended Intake

vegan (175.33 % in women and 173.10 % in men) and omnivorous participants (117.24 % in women and 120.13 % in men). Vegans showed lower calcium intake in comparison of calcium intake to the recommendations within each group, (58.17 % vs 80.05 % in women and 58.56 % vs 80.19 % in men).

Table 5. Food groups and food consumption in Turkish vegans (n=108) and Turkish omnivores (n=108)

Food group and foods	Vegans (n=108)	Omnivores (n=108)	p-value
Grains			
- White bread (g)	23.65 ± 41.54 (0-208)	65.65 ± 75.79 (0-343)	<0.001 [b]
- Whole grain (g)	22.56 ± 32.21 (0-173)	40.85 ± 58.23 (0-192)	0.252 [b]
- Rye flour products (g)	9.81 ± 25.80 (0-150)	4.37 ± 15.37 (0-80)	0.095 [b]
- Pasta (g)	23.08 ± 52.00 (0-200)	22.56 ±35.75 (0-150)	0.002 [b]
- Rice (g)	14.77 ± 25.87 (0-150)	9.61 ±15.72 (0-106)	0.624 [b]
- Bulgur wheat (g)	12.42 ± 15.53 (0-78)	11.02 ± 12.80 (0-66)	0.638 [b]
- Corn (g)	6.42 ± 17.93 (0-107)	5.17 ± 20.02 (0-150)	0.720 [b]
- Breakfast cereals (g)	1.52 ± 12.02 (0-115)	2.06 ± 7.75 (0-38)	0.004 [b]
- Other refined grains (g)	51.09 ± 47.27 (0-232)	63.35 ±77.33 (0-603)	0.516 [b]
- Total Grains (g)	165.41 ± 80.19 (16-458)	224.67 ±71.88 (33-603)	<0.001 [b]
Fruit and berries			
- Citrus fruits (g)	37.95 ± 53.26 (0-225)	24.26 ± 53.40 (0-336)	0.016 [b]
- Berries (g)	44.28 ± 150.24 (0-1476)	13.42 ± 38.47 (0-250)	<0.001 [b]
- Dry fruits (g)	5.77 ± 14.95 (0-75)	5.43 ± 16.50 (0-95)	0.846 [b]
- Other fruits (g)	151.91 ± 113.14 (0-700)	62.80 ± 89.33 (0-460)	<0.001 [b]
- Total Fruits (g)	239.93 ± 199.79 (0-1572)	105.98 ± 118.10 (0-605)	<0.001 [b]
Vegetables			
- Dark green (g)	48.47 ± 52.03 (0-270)	49.79 ± 47.91 (0-250)	0.408 [b]
- Roots (g)	31.18 ±49.43 (0-278)	21.35 ± 33.24 (0-147)	0.303 [b]
- Leeks (g)	36.51 ± 32.89 (0-171)	35.49 ± 25.55 (0-166)	0.541 [b]
- Mushrooms (g)	13.48 ± 32.57 (0-200)	2.48 ± 21.37 (0-220)	0.001 [b]
- Peas (g)	20.64 ± 37.50 (0-170)	16.07 ± 33.93 (0-170)	0.209 [b]
- Potatoes (g)	38.72 ± 61.12 (0-352)	33.89 ± 45.56 (0-232)	0.556 [b]
- Other vegetables (g)	199.19 ± 132.25 (0-691)	160.94 ± 101.21 (0-633)	0.036 [b]
- Total Vegetables	388.22 ± 165.05 (97-901)	319.03 ± 136.14 (50-928)	<0.001 [b]
Nuts, seeds, and legumes			
- Nuts and seeds (g)	44.69 ± 41.82 (0-178)	13.78 ± 29.05 (0-200)	<0.001 [b]
- Legumes (g)	64.90 ± 68.58 (0-269)	10.62 ± 13.77 (0-53)	<0.001 [b]
Eggs (g)	0.00 ± 0.00	29.23 ± 37.44 (0-280)	<0.001 [b]
Milk products			
- Milk (ml)	0.00 ± 0.00	68.62 ± 69.77 (0-294)	<0.001 [b]
- Yogurt (ml)	0.00 ± 0.00	174.86 ± 119.57 (0-515)	<0.001 [a]
- Cheese (g)	0.00 ± 0.00	42.04 ± 28.16 (0-150)	<0.001 [a]
Meats, fish, poultry			
- Meat (g)	0.00 ± 0.00	31.99 ± 32.36 (0-156)	<0.001 [b]
- Poultry (g)	0.00 ± 0.00	45.12 ± 53.68 (0-269)	<0.001 [b]
- Fish and Seafood (g)	0.00 ± 0.00	6.39 ± 24.80 (0-220)	<0.001 [b]
- Processed meat and poultry	0.00 ± 0.00	12.97 ± 17.26 (0-90)	<0.001 [b]
Fats and oils			
- Olive (g)	12.25 ± 18.28 (0-102)	7.77 ±10.30 (0-40)	0.171 [b]
- Olive oil (g)	4.40 ± 4.9 (0-24)	4.02 ± 4.76 (0-21)	0.644 [b]
- Other vegetable oils (g)	7.06 ± 8.06 (0-54)	7.59 ± 7.28 (0-40)	0.313 [b]
- Margarine (g)	3.93 ± 5.61 (0-22)	7.26 ±5.64 (0-34)	<0.001 [b]
- Butter (g)	0.00 ± 0.00	1.45 ± 3.90 (0-27)	<0.001 [b]
- Sesame butter (g)	4.20 ± 7.92 (0-33)	0.55 ± 2.40 (0-15)	<0.001 [b]
Soy products and soy milk			
- Soy products (g)	7.14 ± 29.00 (0-184)	0.00 ± 0.00	<0.001 [b]
Soy milk (ml)	144.10 ± 138.87 (0-600)	0.00 ± 0.00	<0.001 [b]
Sugar and sweets			
- Sugar, jams and chocolate (g)	5.93 ± 9.77 (0-50)	13.18 ± 17.47 (0-92)	0.003 [b]
- Grape molasses (g)	0.52 ± 3.30 (0-30)	0.09 ± 0.96 (0-10)	0.099 [b]
- Honey (g)	0.00 ± 0.00	0.81 ± 3.21 (0-20)	0.002 [b]
- Ice cream (g)	0.00 ± 0.00	6.91 ± 24. 57 (0-173)	<0.001 [b]

Independent *t*-test[a], Mann-Whitney U test[b]

3.5 Consumption of food groups

Table 5 presents food group consumption in vegans and omnivores. Consumption of total fruits were approximately 133.95 g/day higher ($p < 0.001$); total vegetables were approximately 69.19 g/day higher ($p<0.001$); legumes were approximately 54.28 g/day higher ($p<0.001$) in vegans than omnivorous participants. Moreover, the consumption of white bread differed by 42 g/day ($p < 0.001$), total grains differed by 59.26 g/day ($p < 0.001$), and margarine differed by 3.33 g/day ($p < 0.001$) between the groups.

3.6 Diet quality scores

Table 6 presents the total and component scores for the HEI – 2015. Mean HEI – 2015 scores were significantly higher in those with higher consumption of fruits, total vegetables, seafood, plant proteins, and lower intake of refined grains, sodium, and added sugar than in participants consuming fewer servings (all $p < 0.001$). The vegan diet obtained higher total score than omnivorous diet for the HEI – 2015 ($p < 0.001$). Vegans obtained a zero score for the dairy component since the alternatives for these products were classified under plant protein sources. Moreover, vegans obtained a 2.27 ± 1.85 score total protein regarding legumes included under this component however, this score was statistically lower than for omnivores ($p < 0.001$). The HEI – 2015 showed no difference for the whole grain, fatty acids, and added sugar between vegans and omnivores ($p > 0.05$).

4 Discussion

The health aspect of the vegan dietary pattern has attracted significant attention in the medical community, but some uncertainties in the literature remain [10]. This study investigated the nutritional intakes of Turkish vegans in comparison to omnivores. We found that vegans in our study met the daily requirements in energy and macronutrients however, calcium, riboflavin, and vitamin B12 intake was below the recommended amount. Considering that vitamin B12 is found in animal-derived foods, this result was predictable. Several studies have reported differences in nutritional intake between vegans compared to omnivores [4, 26-28]. Overall, in these studies, total energy, carbohydrate, and fat intake did not appear to be significantly different between the two diet groups. However, in the vegan groups compared to omnivores, protein intakes were typically lower whereas fiber intake was higher [4, 26, 27]. Contrary to these studies, Weikert et al. [28] reported a higher intake of protein and fat in German vegans compared to omnivores. Furthermore, Clarys et al. [4] showed that vegans had a lower total energy intake compared to omnivores in their study. In the present study, there was no difference in energy, fat, or carbohydrate intake between vegans and omnivores for both men and women in accordance with the previous studies[28, 29]. Similarly, protein intake in vegan women was lower compared to omnivorous women while there was no significant difference between vegan and omnivorous men. In a study investigating the nutritional status of vegans and vegetarians in the Turkish population, protein intake was found to be low in 58 % of the women and 50 % of the men[30].

In general, vegan diets have lower SFA content and higher fiber content than omnivorous diets, which is attributed to positive health outcomes [31]. Some studies have shown the lowest level of protein and SFA intake in vegan groups among other dietary patterns [4, 29, 32]. Similarly, in the present study, saturated fat intakes were lower in vegans than omnivores for both sexes. In accordance with other studies, dietary fiber intakes of vegans were higher compared to omnivorous groups in the present

Table 6. Total and component scores for HEI- 2015 in Turkish vegans (n=108) and Turkish omnivores (n=108)

Healthy Eating Index 2015 Components	Vegans (n=108)	Omnivores (n=108)	p-value
Adequacy			
- Total Fruit (includes fruit juice)	2.84 ± 1.57	1.59 ± 1.68	<0.001a
- Whole Fruit (all fruit forms except juice)	4.04 ± 1.53	2.41 ± 2.03	<0.001a
- Total Vegetables	5.21 ± 2.41	3.71 ± 1.84	<0.001a
- Greens and Beans	4.39 ± 1.14	3.12 ± 1.74	<0.001a
- Whole Grains	2.82 ± 3.65	3.72 ± 4.45	0.311a
- Dairy*	0.00 ± 0.00	4.29 ± 2.13	<0.001a
- Total Protein Foods	2.27 ± 1.85	4.96 ± 0.24	<0.001a
- Seafood and Plant Proteins	4.82 ± 0.87	2.25 ± 1.89	<0.001a
- Fatty Acids	8.91 ± 2.23	8.71 ± 2.27	0.403a
Moderation			
- Refined Grains	7.68 ± 2.62	5.17 ± 4.05	<0.001a
- Sodium	6.37 ± 3.45	3.02 ± 3.64	<0.001a
- Added Sugars	9.86 ± 0.74	9.66 ± 0.99	0.076a
- Saturated Fats	9.58 ± 1.74	5.51 ± 3.43	<0.001a
Healthy Eating Index 2015	68.74 ± 7.72	58.18 ± 13.20	<0.001a

study [4, 26-28, 32]. Vegans had a similar macronutrient intake with lower SFA and higher fiber intake, which can be considered healthy in the literature [31]. From polyunsaturated fatty acids, n-3 and n-6 are important and essential fatty acids and are obtained from food intake because they cannot be endogenously synthesized [33]. Some data suggest that a low n-3/n-6 ratio in the diet is associated with chronic inflammation and autoimmune diseases. It has been reported that the n-3/n-6 ratio in the Western diet model is around 1:15 or even lower. Due to the high consumption of plant-based oils and insufficient consumption of n-3 fatty acids, the n-3/n-6 ratio might be low in a vegan diet [34]. In the present study, lower n-3/n-6 ratios were found in vegan men and women compared to their omnivorous counterparts. Vegan men and women were found to have higher intakes of n-6 fatty acids compared to omnivorous men and women. Vegan women showed higher intakes of n-3 fatty acids while there was no difference between vegan men and omnivorous men in this study. It should be also noted that vegan sources of n-3 fatty acids mainly consist of ALA (a-linolenic acid) therefore, algae-based supplements should be considered to meet the recommendations of DHA (docosahexaenoic acid) and EPA (eicosapentaenoic acid) [5, 35].

Essential amino acids are required daily in sufficient amounts since they cannot be synthesized endogenously [36]. Essential amino acids can be found in adequate quantities in animal-based foods, but some of them are limited in certain plant foods [16]. In accordance with the study conducted by Schmidt et al. [36], lower intakes of leucine, isoleucine, valine, lysine, methionine, phenylalanine, and threonine were observed in vegan groups compared with omnivores in this study. Therefore, regular consumption of legumes and soy products combined with grains should be encouraged to meet adequate protein levels, and amino acids intake for vegans [5, 37].

The most critical issue that vegans encounter is the lack of riboflavin and vitamin B12 [16]. Similar to the study conducted by Kristensen et al. [27], we found lower riboflavin intakes in vegans compared to omnivores. Conversely, Schüpbach et al.[29] found no differences between vegan and omnivorous participants regarding riboflavin intake. The finding of lower intakes of vitamin B12 among vegans compared to omnivores in the present study is supported by other published studies [27-29, 32, 38, 39]. Vitamin B12 intake was found to be low in 71 % of the Turkish women who followed either a vegan or vegetarian diet [30]. Individuals who followed a vegan diet without supplementation for a long period can develop some issues, including anemia, and irreversible nerve damage related to vitamin B12 deficiency [16]. As vitamin B12 does not have a significant plant-based source, vegans should regularly consume vitamin B12 fortified foods or supplements [5].

Calcium deficiency is a major concern in vegans as the most reliable dietary sources for calcium are dairy products [40]. In accordance with our findings, previous studies also reported lower calcium intake in vegans [27-29, 32]. Vegans were found to have significant lower calcium intake levels than omnivores and to meet the Turkish nutrient targets for calcium. Following an unbalanced vegan diet for a long period could potentially impair bone metabolism. There is a clinical evidence of lower bone health in vegans compared to omnivores [41]. In this regard, the consumption of fortified products and supplements is recommended for vegans to meet dietary calcium requirements [42].

The most readily digested form of iron is heme iron found in meat, poultry, and fish. Thus, in vegan diets, most of the iron comes from non- heme iron sources, and the bioavailability of non- heme sources is influenced by some inhibitors such as phytates [5, 43]. Similar to other studies [26-28], vegans were found to present higher levels of iron intake compared to omnivores in our study. Due to the low bioavailability of plant-based sources of iron, regular monitoring of iron status is essential in vegan populations [29, 44]. In the present study, vegan participants displayed higher intakes of vitamin C, magnesium, and potassium compared to the omnivore group. In line with our findings, studies conducted by Sobiecki et al. [39], Kristensen et al. [27], Schüpbach et al. [29], and Weikert et al. [28] showed that vegan groups had higher intakes of vitamin C compared to omnivorous groups. A higher intake of vitamin C in vegans could also potentially increase the low bioavailability of non-heme iron found in plant-based foods [29]. Similar to the previous findings [27, 29, 38, 45], vegans in our study had higher intakes of magnesium, which is attributed to increased consumption of vegetables and fruits. Magnesium bioavailability is also affected by factors such as phytic acid and oxalate and should be considered when planning a vegan diet[29].

A healthy diet is not only a balanced diet in terms of macro and micronutrients. Furthermore, food diversity and consumption of processed foods, foods with high sugar, and fat content should be considered when evaluating a diet. It is recommended for vegans to consume legumes, nuts, and seeds as an alternative to meat to ensure adequate nutrient intake [16]. Similar to previous studies [26, 32], vegans showed significantly higher consumption of legumes, nuts, and seeds in our study. There was no significant difference in the consumption of both olive oil and other vegetable oils in our study between the groups. However, vegans exhibited a significantly lower margarine consumption in our research while Elorinne et al. [26] reported a statistically higher margarine consumption in their study. In accordance with the results of previous studies [26, 38], vegans (both men and women) showed statistically higher consumption of vegetables and fruits compared with omnivores. Refined cereals have lower dietary fiber, iron, and vitamin B groups compared to whole grains [16]. There was no significant difference in whole grain consumption among vegans compared to omnivores in the present study. However, Elorinne et al. [26] showed that vegans consumed a significantly higher amount of wholegrains. Alles et al. [32] reported higher

consumption of refined cereals and starch-containing foods in vegans compared to omnivores. In our study, consumption of refined grains and white bread was lower in vegans than omnivores. Similar to the previous studies [6, 27, 38, 46], we observed significantly lower consumption of sugars, jams, and chocolate among vegans compared with omnivores.

Concerning HEI – 2015 higher scores were found for Turkish vegans compared to omnivores. Vegan diet components including fruits, vegetables, low fat, and sodium content contributed to the high overall score for these components. Similar to our results, Clarys et al. [4] reported higher scores for vegans compared to omnivores (65.4 ± 8.3 vs 54.2 ± 9.0, respectively) when using the older HEI – 2010. Bruns et al. [47] found that vegans scored significantly higher when compared to omnivores (61 ± 10 vs 47 ± 9; $p < 0.001$) in their study when assessed by another adapted version of HEI – 2015 [47]. Our results have shown to be in line with other studies in the literature, that a reduction in animal-derived foods appears to be accompanied by increased overall diet quality. High scores in HEI were associated with positive health outcomes such as a lower risk of mortality, cardiovascular disease, cancer, and type 2 diabetes mellitus in a meta-analysis [48].

This study provides interesting insights about the diet quality of vegans in Turkey. Although there is no official information about the vegan population in Turkey, considering their dietary practices and lifestyle habits, vegans represent a relatively small proportion of the Turkish population. Participants were selected entirely from a convenience sample to represent the target population. However, this study has some limitations. The main limitation is the generalizability of the findings since this study was not based on a complex sample survey design. Under-reporting is an almost unavoidable limitation in diet records [49, 50]. Also, participants volunteering to take part in a study may have different characteristics from the general population of interest [51]. Another limitation was that physical activity, smoking, supplement intake, and fortified food consumption were not included. A possible constraint was that a vegan diet is unconventional and that some of the reported meals or food products were inaccessible in the database. However, this shortcoming was avoided in the current research by creating recipes with only fully validated food products. Having evaluated the data and dietary habits, several further lifestyle factors such as physical activity, consumption of supplements, alcohol, and smoking should be considered due to their impact on nutrition.

5 Conclusions

This study investigated the nutritional intakes of Turkish vegans and compared them with their omnivorous counterparts. Overall, in our study, vegans had a well-balanced and healthy macronutrient intake with lower SFA and higher fiber, vitamin C, magnesium, potassium intake, and HEI – 2015 scores. These aspects of vegan diets are associated with positive outcomes, including a lower risk of abdominal obesity, cardiovascular disease, hyperlipidemia, and hypertension. Conversely, vegans in our study failed to meet the target levels for several micronutrients. Vegans had lower B2, B12, calcium, zinc, iodine, and phosphorus intakes compared to their omnivorous counterparts. Nutritionists can play an essential role in educating vegans about specific sources and fortified foods that provide these nutrients. The results of this study provide a basis for further research evaluating dietary records and nutritional biomarkers in Turkish vegans and the long-term effects of vegan diets.

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