Progress in Nutrition 2018; Vol. 20, N. 2: 189-196 DOI: 10.23751/pn.v20i2.5319

Original article

Food and nutrient intake in Spanish vegetarians and vegans

Susana Menal-Puey, Manuel Morán del Ruste*, Iva Marques-Lopes*

Unit of Nutrition and dietetics, Faculty of Health Sciences and Sports, University of Zaragoza. Plaza. Huesca - E-mail: imarques@unizar.es.

Summary. *Objective:* Vegetarian and vegan diets have gained popularity in Spain. There is no available information about specific food, supplementary intake and macro and micronutrient profile in Spanish vegetarian population. This study aimed to determine and evaluate their dietary intake. *Methods:* One hundred two Spanish vegetarian and vegans completed a food frequency questionnaire from which their specific food consumption as well daily intake of macro and micronutrients was assessed and subsequently compared to Spanish Dietary Reference intakes. *Results:* In both groups the diet appeared well balanced with a healthy distribution of macronutrients and fatty acids and a high content of fiber. Vegan subjects showed higher intakes of vegetables, nuts and seeds as compared to vegetarians. At micronutrient level, almost all the vitamins and minerals intake covered Spanish Dietary Reference intakes. Intakes of vitamin B12 and D were below recommendations in both groups. In those micronutrients with a lower intake, higher proportions of vegetarians did meet recommendations as compared to vegans. *Conclusions:* Diet appeared well balanced regarding macronutrients and fiber. Almost all of the vitamins and mineral intake covered the Spanish DRIs, except B12 and D. Further studies with a large sample are needed to establish conclusions to the Spanish vegetarian population.

Key words: vegan foods, macronutrient, micronutrient intake, vegans, vegetarians.

Introduction

Vegetarian and vegan dietary patterns have been increasing in European countries and it has been reported that this growth is likely to continue (1-4). The number of vegetarians, and especially of the different types, is not well known in some countries, because estimates have been based on rather small samples or there has been wide variation in sampling methods types. In Spain, a growing proportion of the population is following a vegetarian or vegan diet. Nevertheless, no official data are available concerning the proportions of self-professed vegetarians and vegans in Spain. According to the 2012 Spanish Diet Survey (5), 1.5% to 2% of the investigated subjects abstain from consuming meat and fish, and according the Spanish Vegetarian Union, 30% or 40% of these could be vegans (6).

These dietary patterns have been accepted mainly in the context of increased concerns about animal welfare and environment, or ethical or moral values such as animal rights, health or a combination of these (7-9). Vegetarian dietary patterns are associated with lower body mass index, lower prevalence chronic diseases and lower all-cause mortality (10-13).

Previous studies have suggested that a vegan diet provides relatively large amounts of cereals, legumes, nuts, fruits and vegetables and is usually high in carbohydrates, n-6 fatty acids, dietary fibers, beta-carotene, folic acid, vitamin C, iron and magnesium. In contrast, the vegan diet is suggested to be relatively low in protein, saturated fat, long chain n-3 fatty acids, vitamin B12, vitamin D and zinc (2,3,14-16). Furthermore, vegans are more likely to use single-nutrient supplements compared to non-vegetarians (17). Although epidemiological studies have provided compelling evidence that well-balanced vegetarian diets are nutritionally adequate (11), concerns regarding the completeness of the restrictive vegan dietary pattern still remain, especially

* Both authors share equal authorship of this article

with regard to important nutrients including protein, calcium, iron and vitamin B-12 (3,4,15,18,19). In this sense, knowledge of nutrient intake and dietary pattern is essential to improve nutritional counseling and focus on dietary intake recommendations to improve food habits of vegans and vegetarians. Little information about intake of macro- and micronutrient intake in vegans is available and only a few studies previously reported the use of supplements in vegans (17,20). To the best of our knowledge, no available data about dietary pattern and nutrient intake among Spanish vegans and vegetarians exist and it is not known whether their food habits are adequate to meet nutrient requirements. The use of FFQ minimizes the error of day to day variability, and it is an effective, easily administrated, inexpensive tool (21-23) but it has a lower levels of detail, especially on groups with specific food groups intake as vegans, so the importance of including specific foods commonly consumed by vegans included supplements and fortified foods.

The present study is aimed at determining the food and supplementary intake as well as macro- and micronutrients in a sample of Spanish vegetarians and vegans.

Methods

Subjects

A cross-sectional food consumption and lifestyle study was conducted between January and March of 2015 with the collaboration of the Spanish Vegetarian Union. The data of 102 participants were included. The age range was 24-69 with mean ages of 41.9 ± 14.0 years for men and 35.8 ± 10.0 years for women. There were no specified exclusion criteria, except age (less than 20 years). The study was approved by the Clinical Research Ethical Committee of Aragón (CEICA) and all subjects volunteered to the study and gave written informed consent.

Dietary assessment

Information on usual food intake over the previous year was obtained with a 213-item semiquantitative food frequency questionnaire (FFQ) that was developed based on a previously validated FFQ in Spain (24). Extra items that were typically used by vegans and vegetarians were added to the validated FFQ such as: peas and beans, nuts, seeds and nuts/seeds spreads, vegetarians meat analogues, vegetable beverages (milk substitutes), ready to eat cereals, cooked cereals and grains, fortified foods and other vegan products, to assure that other nutrient sources of vegans/vegetarians were assessed using as reference food groups used in a previous validated FFQ for self-defined vegans (21).

Nutrient scores were calculated as frequency per nutrient composition of a specified portion size, where frequencies were measured in nine categories (>6 servings/d, 4-6 servings/d, 2-3 servings/d, 1 serving/d, 5-6 servings/wk, 2-4 servings/wk, 1 serving/wk, 1-3 servings/mo, and never or almost never) for each food item. Data of food intake were transformed into food consumption (in ml or g). Once the amount of each food item, in millilitres or grams, was known, nutrient intake scores were computed using an *ad hoc* computer program specifically developed in SPSS language syntax for this purpose. A trained dietitian updated the nutrient data bank using the latest available information included in food composition tables from Spain (25) and, if necessary, from foreign databases, such as the United States Nutrient Database (USDA) or Finnish Food Composition Database (Fineli®). Subjects who reported excessively high or low values for total energy intake (less than 800 Kcal/d in men and 600 Kcal/d in women, or more than 4.500 kcal/d in men and 3.700 kcal/d in women) were excluded because these extreme values are an indicator of low quality in the self-reported information. Also, subjects with missing values in variables of interest in the analysis were excluded.
The estimated macronutrient and micronutrient levels among vegetarians and vegans were compared to the Dietary Reference Intakes (DRI) according to Spanish standards (26,27).

Assessment of other variables

The questionnaire also included different questions related to lifestyle. Subjects were also asked to include sociodemographic variables (sex, age, years of vegan/vegetarian diet), anthropometric data (weight, height), health-related habits (alcohol consump-

tion and physical activity) and usual intake of vitamins, minerals or other nutrients supplements. Body Mass Index (BMI) was calculated as the self-reported weight in kilograms divided by the square of height in metres. The amount of physical activity was calculated in minutes per day. Intake of iron, calcium, vitamin B12, D and other supplements was divided into: never, occasionally and daily.

Statistical analysis

Of the 125 participants, 23 were excluded because of missing values, age limitation or unacceptable energy levels, as previously mentioned. Subjects describing themselves as vegans in the diet questionnaire, though declaring that they consumed animal products in the FFQ, were reclassified according to their answers given in the FFQ. Adjustments of food and nutrient intakes for total energy intake by regression analysis were performed using the residual method described previously by Willet et al (28). Descriptive statistics such as frequencies were calculated as well as means and standard deviations of the daily foods groups and nutrients intake. Normality of data was checked with the Kolmogorov-Smirnov test for vegetarians and with Shapiro-Wilk for vegans and data were tested with the appropriate parametric or non-parametric statistical tests. A two –sided 0.05 level of significance was defined and SPSS 22.0 SPSS Inc., Chicago IL, USA) statistic software was used.

Results

In total 102 subjects were included in this study. Basic data is reported in table 1. Forty subjects were following a vegan diet (39.2%) and 62 (60.8%) were vegetarians. Both groups showed a higher percentage of women. No significant differences were observed in BMI between vegetarians and vegans, which were at normal weight. Also no significant differences were seen in years of vegetarian/vegan diet and physical activity between vegetarians and vegans. Seventy percent of subjects reported usual B12 supplement intake in both groups being 59.7% in vegetarians and 40.3% in vegans.

Table 2 presents the mean (SD) intake of macronutrients in total and in the two dietary patterns. No differences were detected when comparing the energy intake of vegetarians (2390.6±603.6 kcal/day) to vegans (2579.5±529.6 kcal/day, p=0.201). Nevertheless, comparing energy to DRI according Spanish standards within each group, it was found a higher proportion of vegetarians bellow energy recommendations (43.5% vs. 17.5%, p=0.032) as compared to vegans.

Absolute macronutrient intake (g/day) as well as relative intakes (energy %) did not differed between vegetarians and vegans, whilst fatty acids profile differed significantly between the two groups. Vegans as compared to vegetarians showed a significantly higher polyunsaturated fatty acids (PUFA) intake, both in ab-

Table 1. Sociodemografic Characteristics of Study Subjects

	Total	Vegetarians	Vegans	P difference
Total (n)	102	62 (60.8)	40 (39.2)	0.0211
Men (n)	38	25 (65.8)	13 (34.2)	
Women (n)	64	37 (57.8)	27 (42.2)	
Age (years)	37.8±11.7	38.2±12.1	36.8±10.9	0.628
Body weight (kg)	64.3±13.1	65.7±13.4	61.1±12.0	0.151
Body mass index (kg/m^2)	22.5±3.3.	22.6±3.2	22.1±3.5	0.589
Years of diet	7.5±8.1	7.8±8.7	6.6. ±6.7	
Physical activity (minutes per week)	251.9±224.5	247.7±238.7	261.8±191.7	0.798
Usual B_{12} supplement intake (n)	72 (70.6)	43 (59.7)	29 (40.3)	0,027

*Data are given as the mean ± SD or as the number of subjects and percentage as appropriate. * Mann-Whitney U Test.*

Table 2. Macronutrient intake in total, vegetarians and vegan subjects.

	Total	Vegetarians	Vegans	P value
Total energy (kcal)	2445.6±605.7	2390.6±603.6	**2579.5**±529.6	0.201
Protein (g)	83.7±12.2	82.4±12.1	86.5±12.4	0.664
% Energy	13.6±2.0	13.5±2.0	14.1±1.9	0.252
Carbohydrate (g)	318.9±43.6	322.6±46.2	311.0±37.1	0.283
% Energy	52.2±6.3	52.6±6.6	51.3±5.6	0.412
Total Fibers (g)	62.3±12.2	60.5±11.8	66.5±12.6	0.045
Fat (g)	86.3±27.0	83.7±26.5	92.8±27.6	0.166
% energy	31.7 ±5.6	31.5±5.8	32.1±5.2	0.687
MUFA (g)	38.6±10.5	38.2±10.7	39.4±10.3	0.687
% Energy	14.2±3.4	14.2±3.7	14.3±3.3	0.924
PUFA (g)	22.5±6.3	21.4±6.7	25.0±4.4	0.020
% Energy	8.1±2.1	7.8±2.2	9.01±1.4	0.016
SFA (g)	14.9±4.7	16.7±5.0	13.2±3.1	0.021
% Energy	5.9±1.6	6.4±1.7	5.1±1.0	0.092
Cholesterol (mg)	82.1±94.5	114.0±96.8	9.6±19.5	0.001

*Data are given as the mean ± SD. * Mann-Whitney U Test. MUFA (Monounsaturated fatty acids); PUFA (polyunsaturated fatty acids); SFA (saturated fatty acids)*

solute (25.0±4.4 vs. 21.4±6 7 g/day, p= 0.020) and relative intake (9.01±1.4 vs. 7.8±2.2 % energy, p=0.016) and lower saturated fatty acids (SFA) intake (16.7±5.0 vs. 13.2±3.1 g/day, p=0.021 and 6.4±1.7 vs. 5.1±1.0 % energy, p=0.092).

In both groups, macronutrient intake and fatty acid profile intakes were balanced and within the macronutrient recommendations according DRI for Spanish population. Fibers intake was significantly higher in vegans as compared to vegetarians and were above the amount recommended per day.

Micronutrient intake in total as well as in vegetarians and vegans is reported in table 3.

No significant differences were observed between vegetarians and vegans for calcium, phosphorous, magnesium, potassium, sodium and vitamins A, B6, folate, C, D and E intake. On the other hand, vegans had a higher intake of vitamin B1 (5.8 vs. 10.9 mg/day, p=0.004) and B2 (5.4±3.9 vs. 10.3±11.5, p= 0.006) compared to vegetarians. On the other hand, vegetarians showed a higher intake of vitamin B12 as compared to vegans (1.9±1.1 vs. 1.4±0.7 mcg/day, p= 0.053). Comparing micronutrient intake to DRI according Spanish standards within each group, a higher proportion of vegetarians reported lower calcium (12.2% vs. 5.0%, p=0.053), and vitamin D (85.5% vs. 60.0%, p=0.041) intake. In both groups almost fifty percent of subjects consumed less vitamin B12 than DRI levels (45.6% of vegetarians and 42.5% of vegans) with no differences between groups.

Table 4 presents food group intake in total and in vegetarians and vegan subjects. Typical components of vegan and vegetarian diets such as fruits, vegetables, nuts, legumes and beans showed higher intakes in both groups, although with a wide range within each group.

Vegan subjects showed a significantly higher intake of vegetables (705.4±337.5 vs. 522.7±264.4 g/day, p= 0.001), nuts (30.0±21.8, 44.9±36.6 g/day, p=0.026), seeds (5.4±4.4 vs. 9.0±8.0, p= 0,057) and vegetarians meat analogues (100.3±92.2 vs. 55.5±47.8 g/day, p=0.006) as compared to vegetarians. No statistical differences were observed in vegetable beverages, fresh

Table 3. Micronutrient intake in total, vegetarians and vegan subjects.

	Total	Vegetarians	Vegans	P value
Calcium (mg)	1076±263.0	1098.2±252.9	1035.8±285.3	0.332
Zinc (mg)	12.3±1.9	12.3±1.8	12.3±2.3	0.949
Phosphorous (mg)	1679±245.4	1666.3±250.1	1709.0±241.2	0.481
Iron (mg)	25.4±4.3	24.9±4.2	26.7±4.4	0.107
Magnesium (mg)	723.5±135.7	707.4±139.3	761.1±124.5	0.107
Potassium (mg)	6102±1338.7	6061.6±1349.5	6205.2±1364.2	0.664
Sodium (mg)	1663.9±585.1	1655.1±630.2	1698.0±482.5	0.766
Total vitamin A (mcg)	1682.0±822.2	1706.1±689.1	1644.2±1100.9	0.760
Vitamin B1 (mg)	7.3±7.3	5.8±3.9	10.9±11.6	0.004
Vitamin B2 (mg)	6.8±7.2	5.4±3.9	10.3±11.5	0.006
Vitamin B6 (mg)	3.2±0.7	3.2±0.7	3.4±0.7	0.290
Vitamin B12 (mcg)	1.8±1.0	1.9±1.1	1.4±0.7	0.053
Folate (mcg)	849.1±177.2	838.0±174.9	874.5±187.4	0.404
Vitamin C	396.9±207.0	399.2±220.4	395.3±179.6	0.939
Vitamin D	1.6±1.3	1.8±1.3	1.4±1.1	0.356
Vitamin E	21.0±4.5	20.4±4.6	22.3±3.9	0.091

*Data are given as the mean ± SD. * Mann-Whitney U Test.*

and dried fruit, nuts and seeds butter, peas and beans, vegetable oils, dessert and sweets, salty snacks and wheat germen.

Discussion

In this study, energy intake was similar to recent previous studies carried out in European countries (2-4). Although there was no significant difference in energy intake between the two groups, a higher proportion of vegetarians failing to reach energy requirements was observed, as compared to vegans as found in recent studies (19).

At the macronutrient level, the vegetarian and vegan diet can be considered healthy since the distribution of macronutrients corresponds well to that proposed by Spanish DRI. Specifically, a high PUFA-SFA ratio has been observed in this study in both groups, as found by other authors (3,29), is considered beneficial for human health and similarly, a high dietary fiber intake provides specific benefits in relation to gastrointestinal and metabolic functions and overall mortality (30-32).

In this study vegans tended to eat fewer pastries, desserts and sweets although it did not reach statistical significance possibly due to the wide variation in these groups` consumption. A previous study found a lower added sugar and sweets in vegans as compared to omnivores (3,33).

In this study both groups showed higher intakes of vitamin A such as found by other authors (15,17,20). In contrast to these findings, a previous study found lower vitamin A intakes (3). These opposing results could be due to different methods of calculating vitamin A (retinol activity equivalents (RAEs) from beta-carotene, other carotenoids and retinol).

Almost fifty vegetarians and vegans included in this study showed a low intake of vitamin B12, which corresponds to previous findings (3,14,19). Nevertheless, mean intakes were higher as compared to other studies, possibly due to fortified foods consumed. Without supplementation the low dietary intake of vitamin B12 among vegans and vegetarians could en-

Table 4. Mean daily intakes of specific food groups in total, vegetarian and vegan subjects.

	Total	Vegetarians	Vegans	P difference
Total dairy (g)	66.9±174.3	95.1±92.0	-0.5±1.1	0.022
Eggs (g)	15.5±25.5	22.6±17.5	-1.0±2.2	0.000
Vegetable beverages (g)	256.7±191.7	231.5±179.7	314.9±209.7	0.075
Fruit and fruit juices(g)	623.5±357.0	579.5±380.3	723.0±363.7	0.121
Dried fruit (g)	12.2±15.2	12.6±11.3	11.1±10.3	0.678
Cooked cereals and grains (g)	143.4±64.8	145.9±67.9	137.6±58.0	0.601
Vegetables (g)	677.5±298.2	522.7±264.4	705.4±337.5	0.011
Nuts (g)	34.5±27.7	30.0±21.8	44.9±36.6	0.026
Seeds (g)	6.5±7.8	5.4±4.4	9.0±8.0	0.057
Nuts and seeds spreads (g)	3.8±4.1	3.7±3.6	3.9±3.7	0.809
Peas and beans (g)	72.0±33.0	72.6±33.5	70.6±32.3	0.810
Vegetarian meat analogs (g)	69.0±67.9	55.5±47.8	100.3±92.2	0.006
Vegetable oils (g)	24.8±15.4	24.1±13.5	26.3±19.4	0.565
Pastry	27.5±30.1	29.6±33.1	22.6±20.7	0.344
Desserts, sweets and sweeteners (g)	27.3±25.8	29.7±29.1	21.8±15.3	0.213
Salty snacks (g)	64.1±51.4	67.8±56.1	55.8±38.2	0.345
Miscellaneous: wheat germen (g)	7.2±8.7	7.6±8.9	6.4±8.4	0.559

*Data are given as the mean ± SD. * Mann-Whitney U Test.*

hance risk of pernicious anemia and polyneuropathy. In contrast, our results showed very high intakes of vitamin B2 as compared to other studies (3). In the Spanish diet, nuts and vegetables, known to be good sources of riboflavin, are commonly consumed, which may explain these results. In the present study, intake of dietary sodium in vegetarians and vegans was low and similar to other previous studies, which also showed lower sodium intake among vegans and vegetarians (3,29,34). This fact might be due to a lower intake of processed foods, which usually contain high amounts of salt (35).

Even though the intake of zinc, iron and calcium in vegetarians and vegans of this study met the Spanish DRI, the absorption of these minerals might not be correspondingly high due less bioavailability (36). However, it is well established that the bioavailability of iron increases with ascorbic acid and other organic acids (37). In this study, vitamin C intake was high, thus potentially compensating for low bioavailability of iron in plan-based foods (18). On the other hand, it has previously been proposed that iron intake in vegans should be 1.8 times higher than in omnivores (8); in this study iron intake among vegetarians and vegans met this recommendation.

To examine whether the mineral and vitamin intake among these subjects has a negative or positive health effect, pertinent biochemistry of study participants should be done. Furthermore, a healthy diet is not only a balanced diet in terms of macro-and micronutrients. Other components such as processed food, heated food, other sources of nutrients (vegetarian meat analogs, milk substitutes, nuts, seeds or nut and seed spreads) are important in evaluating a diet. One of the main strengths of the present study was the evaluation of specific food intake commonly used in vegetarians and vegans. Report of the consumption of vegetarian meat analogs, nut and seed spreads and other components such as wheat germ are scarce (16). Also, only one study reported previously salty snacks,

pastry or desserts among this population (16). In this way, attention should be paid to improve health food choices among this population.

Whereas the number of vegans and vegetarians included in some other studies exceeds the number in our study, by far most, they did not include a dietary intake assessment with specific food. Also, other recent studies addressed dietary intake in a small number of subjects (2,3,4). However, it is important to be cautious when drawing conclusions based on a small sample, which may be not representative of the Spanish vegetarian and vegan population. Another potential source of bias arises from the fact that the included vegans and vegetarians were subjects who voluntarily completed the FFQ questionnaire and possibly may be more concerned about healthy lifestyle, including a heathy and balanced diet as also mentioned in a recent study (3). This might explain the good compliance with recommendations of macronutrient level and most micronutrients.

Overall in this sample of Spanish vegetarians and vegans, at the macronutrient level, the diet appeared well balanced with a healthy distribution of macronutrients and fatty acids and a high content of fiber. At the micronutrient level, almost all of the vitamins and mineral intake covered the Spanish DRIs, which may be in part explained by fortified foods. In those micronutrients with a lower intake, higher proportions of vegetarians did meet recommendations as compared to vegans.

This is a study of a relatively small sample of vegetarians and vegans and more studies are needed to make general conclusions regarding dietary and supplementary intake in this population.

Acknowledgements

The authors are grateful to the Spanish Vegetarian Union and to the participants for their cooperation.

References

1. Vinnari M, Montonen J, Härkänen T, Männistö S. Identifying vegetarians and their food consumption according to self-identification and operationalized definition in Finland. Public Health Nutr. 2009 Apr;12(4):481-8.
2. Clarys P, Deliens T, Huybrechts I, Deriemaeker P, Vanaelst B, De Keyzer W, Hebbelinck M, Mullie P. Comparison of nutritional quality of the vegan, vegetarian, semi-vegetarian, pesco-vegetarian and omnivorous diet. Nutrients. 2014 Mar 24;6(3):1318-32.
3. Kristensen NB, Madsen ML, Hansen TH, Allin KH, Hoppe C, Fagt S, Lausten MS, Gøbel RJ, Vestergaard H, Hansen T, Pedersen O. Intake of macro- and micronutrients in Danish vegans. Nutr J. 2015 Oct 30;14(1):115.
4. Schüpbach R, Wegmüller R, Berguerand C, Bui M, Herter-Aeberli I. Micronutrient status and intake in omnivores, vegetarians and vegans in Switzerland. Eur J Nutr. 2015 Oct 26.
5. 2012 Spanish Diet Survey . http://www.west-info.eu/files/Report188.pdf
6. Spanish Vegetarian Union. . http://www.unionvegetariana.org/estad%C3%ADsticas-n%C3%BAmero-de-vegetarianos-en-espa%C3%B1
7. Carlsson-Kanyama A, González AD. Potential contributions of food consumption patterns to climate change. Am J Clin Nutr. 2009 May;89(5):1704S-1709S.
8. Craig WJ, Mangels AR; American Dietetic Association. Position of the American Dietetic Association: vegetarian diets. J Am Diet Assoc. 2009 Jul;109(7):1266-82
9. Fox N, Ward K. Health, ethics and environment: a qualitative study of vegetarian motivations. Appetite. 2008 Mar-May;50(2-3):422-9.
10. Tonstad S, Stewart K, Oda K, Batech M, Herring RP, Fraser GE. Vegetarian diets and incidence of diabetes in the Adventist Health Study-2. Nutr Metab Cardiovasc Dis. 2013 Apr;23(4):292-9.
11. Le LT, Sabaté J. Beyond meatless, the health effects of vegan diets: findings from the Adventist cohorts. Nutrients. 2014 May 27;6(6):2131-47.
12. Appleby PN, Crowe FL, Bradbury KE, Travis RC, Key TJ.. Mortality in vegetarians and comparable nonvegetarians in the United Kingdom. Am J Clin Nutr. 2015 Dec 9. pii: ajcn119461.
13. Orlich MJ, Singh PN, Sabaté J, Fan J, Sveen L, Bennett H, Knutsen SF, Beeson WL, Jaceldo-Siegl K, Butler TL, Herring RP, Fraser GE. Vegetarian dietary patterns and the risk of colorectal cancers. JAMA Intern Med. 2015 May;175(5):767-76.
14. Davey GK, Spencer EA, Appleby PN, Allen NE, Knox KH, Key TJ. EPIC-Oxford: lifestyle characteristics and nutrient intakes in a cohort of 33 883 meat-eaters and 31 546 non meat-eaters in the UK. Public Health Nutr. 2003 May;6(3):259-69.
15. Rizzo NS, Jaceldo-Siegl K, Sabate J, Fraser GE. Nutrient profiles of vegetarian and nonvegetarian dietary patterns.J Acad Nutr Diet. 2013 Dec;113(12):1610-9.
16. Orlich MJ, Jaceldo-Siegl K, Sabaté J, Fan J, Singh PN, Fraser GE. Patterns of food consumption among vegetarians and non-vegetarians. Br J Nutr. 2014 Nov 28;112(10):1644-53.
17. Haddad EH, Berk LS, Kettering JD, Hubbard RW, Peters WR. Dietary intake and biochemical, hematologic, and im-

mune status of vegans compared with nonvegetarians. Am J Clin Nutr. 1999 Sep;70(3 Suppl):586S-593S.
18. Hunt JR. Bioavailability of iron, zinc, and other trace minerals from vegetarian diets. Am J Clin Nutr. 2003 Sep;78(3 Suppl):633S-639S.
19. Shridhar K, Dhillon PK, Bowen L, Kinra S, Bharathi AV, Prabhakaran D, Reddy KS, Ebrahim S. Nutritional profile of Indian vegetarian diet-the Indian Migration Study (IMS). Nutr J. 2014 Jun 4;13:55. doi: 10.1186/1475-2891-13-55.
20. Draper A1, Lewis J, Malhotra N, Wheeler E. The energy and nutrient intakes of different types of vegetarian: a case for supplements? Br J Nutr. 1993 Jan;69(1):3-19.
21. Dyett P, Rajaram S, Haddad EH, Sabate J. Evaluation of a validated food frequency questionnaire for self-defined vegans in the United States. Nutrients. 2014 Jul 8;6(7):2523-39.
22. Subar AF, Thompson FE, Kipnis V, Midthune D, Hurwitz P, McNutt S, McIntosh A, Rosenfeld S. Comparative validation of the Block, Willett, and National Cancer Institute food frequency questionnaires : the Eating at America's Table Study. Am J Epidemiol. 2001 Dec 15;154(12):1089-99.
23. de la Fuente-Arrillaga C1, Ruiz ZV, Bes-Rastrollo M, Sampson L, Martinez-González MA. Reproducibility of an FFQ validated in Spain. Public Health Nutr. 2010 Sep;13(9):1364-72.
24. Martin-Moreno JM, Boyle P, Gorgojo L, Maisonneuve P, Fernandez-Rodriguez JC, Salvini S, Willett WC. Development and validation of a food frequency questionnaire in Spain. Int J Epidemiol. 1993 Jun;22(3):512-9.
25. Spanish Food Database, BEDCA. http://www.bedca.net/
26. Ingestas dietéticas de referencia (IDR) para la población española. Federación Española de Sociedades de Nutrición, Alimentación y Dietética (FESNAD). Eunsa, Pamplona, 2010.
27. Dietary Reference Intakes (DRI) for the Spanish Population—2010. Act Diet. 2010; 14(4) :196-197
28. Willett WC, Howe GR, Kushi LH. Adjustment for total energy intake in epidemiologic studies. Am J Clin Nutr. 1997 Apr;65(4 Suppl):1220S-1228S; discussion 1229S-1231S.
29. Clarys P, Deliens T, Huybrechts I, Deriemaeker P, Vanaelst B, De Keyzer W, Hebbelinck M, Mullie P. Comparison of nutritional quality of the vegan, vegetarian, semi-vegetarian, pesco-vegetarian and omnivorous diet. Nutrients. 2014 Mar 24;6(3):1318-32.
30. Virtanen JK, Mursu J, Tuomainen TP, Voutilainen S. Dietary fatty acids and risk of coronary heart disease in men: the Kuopio Ischemic Heart Disease Risk Factor Study. Arterioscler Thromb Vasc Biol. 2014 Dec;34(12):2679-87.
31. Martínez-González MA, Sánchez-Tainta A, Corella D, Salas-Salvadó J, Ros E, Arós F, Gómez-Gracia E, Fiol M, Lamuela-Raventós RM, Schröder H, Lapetra J, Serra-Majem L, Pinto X, Ruiz-Gutierrez V, Estruch R; PREDIMED Group. A provegetarian food pattern and reduction in total mortality in the Prevención con Dieta Mediterránea (PREDIMED) study. Am J Clin Nutr. 2014 Jul;100 Suppl 1:320S-8S
32. Bingham SA, Day NE, Luben R, Ferrari P, Slimani N, Norat T, Clavel-Chapelon F, Kesse E, Nieters A, Boeing H, Tjønneland A, Overvad K, Martinez C, Dorronsoro M, Gonzalez CA, Key TJ, Trichopoulou A, Naska A, Vineis P, Tumino R, Krogh V, Bueno-de-Mesquita HB, Peeters PH, Berglund G, Hallmans G, Lund E, Skeie G, Kaaks R, Riboli E; European Prospective Investigation into Cancer and Nutrition. Dietary fibre in food and protection against colorectal cancer in the European Prospective Investigation into Cancer and Nutrition (EPIC): an observational study. Lancet. 2003 May 3;361(9368):1496-501.
33. Beezhold B, Radnitz C, Rinne A, DiMatteo J. Vegans report less stress and anxiety than omnivores. Nutr Neurosci. 2015 Oct;18(7):289-96.
34. Janelle KC, Barr SI. Nutrient intakes and eating behavior scores of vegetarian and nonvegetarian women. J Am Diet Assoc. 1995 Feb;95(2):180-6, 189, quiz 187-8.
35. World Health Organization. Creating an enabling environment for meeting held by WHO and the Food Standards Agency, United Kingdom. Geneva, WHO, 2010.
36. Hallberg L, Hulthén L. Prediction of dietary iron absorption: an algorithm for calculating absorption and bioavailability of dietary iron. Am J Clin Nutr. 2000 May;71(5):1147-60.
37. Teucher B, Olivares M, Cori H. Enhancers of iron absorption: ascorbic acid and other organic acids. Int J Vitam Nutr Res. 2004 Nov;74(6):403-19.

Correspondence:
Iva Marques Lopes
Faculty of Health Sciences and Sports,
University of Zaragoza. Plaza. Universidad, 3;
22002 - Huesca, Spain.
Tel. +34 974239391
Fax +34 974239392
E-mail: imarques@unizar.es