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ORIGINAL CONTRIBUTION

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Does the diet of the Balearic population, a Mediterranean type diet, still provide adequate antioxidant nutrient intakes?

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Summary *Aims* To evaluate the intake of antioxidant nutrients, as important components of the diet of the Balearic population, a typical Mediterranean type diet, as well as socio-demographic, lifestyle and dietary factors that could be associated to their consumption. *Methods* Cross sectional survey: dietary information (replicated 24-h recall) and socio-demographic and lifestyle data were collected from a representative sample of the Balearic Islands population ($n = 1200$, 498 males and 702 females) aged 16–65 years (response rate 77.22 %). A Dietary Antioxidant Quality Score (DAQS) was computed considering the risk of inadequate intakes (< 2/3 RDI) for selenium, zinc, β-carotene, vitamins C and E. This score (ranged from 0, very poor dietary antioxidant quality, to 5, high quality diet) was divided into quartiles. Those pertaining to the lower quartile were defined as low antioxidant consumers and compared to those in the upper quartile in terms of their socio-demographic, lifestyle and dietary characteristics. *Results* Inadequate intakes (< 2/3 RDI) were estimated in nearly half of the sample for zinc, β-carotene and vitamin E. Of the study population, 12.4 % were identified as low antioxidant consumers according to DAQS. Pertaining to lower socio-economic and educational level and being born in a non-Mediterranean Spanish region were the most important determinants for being a low antioxidant consumer. A diet high in saturated fat but low in total fat, fruit, vegetables and fibre also determined a low intake of antioxidants. *Conclusions* These findings suggest a possible departure from the traditional Balearic diet among certain groups of the Balearic Islands population, and this trend may be responsible for the observed low intake of antioxidant nutrients.

Key words Mediterranean diet – antioxidants – lifestyle – dietary patterns – Balearic Islands

Introduction

The Balearic Islands (Spain) are located in the Mediterranean Sea. In this area, the availability of fish, together with a temperate and homogeneous climate in an arid and mountainous geography allowed for the development of specific agriculture (dry crops) and livestock (mainly sheep, goats and pigs) that provided a confined but varied Mediterranean diet.

Until recently the likely health benefits of the Mediterranean diet were mainly attributed to its low content of saturated fatty acids and the high content of complex carbohydrates and dietary fibre. However, the benefits on health of the Mediterranean diet may be partly attributed to its antioxidant properties. While

EJN 512

there is no direct evidence that these antioxidants are central to the benefits of the Mediterranean diet, indirect evidence from epidemiological data and the increasing understanding of their mechanisms of action suggest that antioxidants may play a major role [1]. Most of the antioxidant components of the Mediterranean diet consist of vitamins and minerals as well as flavonoids and polyphenolic compounds contained in fruits, vegetables, beverages and olive oil [1, 2]. These food items can be considered the basis of the Mediterranean diet, together with other components. Therefore, the study of the consumption of some of the main antioxidant nutrients can be used as a proxy measure for the study of the Mediterranean diet in the Balearic Islands, not only because most of the benefits of this diet could be attributed to these nutrients but also because the antioxidants food sources are those commonly eaten in the Mediterranean diet [3–6].

Moreover, epidemiological evidence suggests that dietary patterns in the Mediterranean countries are changing rapidly, with increased consumption of animal products and saturated fat to the detriment of plant-based foodstuffs [7]. Reasons for this development can be found in the substantial socioeconomic changes throughout Europe over the past 40 years. In Spain, the most dramatic social and economic changes observed after the 1960s were the massive rural-urban migration accompanied by rapid urbanization processes, generalized incorporation of females into the paid work-force, GNP per capita increase etc. All these have led to an acceleration in dietary changes: changes in the organization of family life and home meals, increased food availability, the greater relevance of processed foods and the reduction in energy expenditure at work have induced the so-called *"Nutrition Transition"* in Spain, which is comparable to the loss of the Mediterranean diet observed in many other areas [8, 9]. The diet of the Balearic Islands has also been affected by the development of a tourist based economy. With the onset of tourism in the 1950s, new populations from other Spanish regions and other parts of the world arrived in the Balearic Islands. Currently, 10.4% people from abroad (6% from the present European Union, fifteen countries) and 26.8% from other regions of Spain are living in the Balearic Islands [10]. Now, the Balearic Islands reflect a mixture of cultures, and consequently new socio-demographic and lifestyle factors have been introduced. Furthermore, the degree of loss or adherence to the Mediterranean diet may be determined by socio-demographic and lifestyle variables.

The aim of this study was to evaluate the intake of antioxidant nutrients as one of the main components of the Mediterranean diet as consumed in the Balearic Islands, as well as the socio-demographic, lifestyle and other dietary factors that could be associated with this consumption.

Subjects and methods

Subjects

This study considered the cross-sectional data from the Nutrition Survey of the Balearic Islands (NSBI) that was carried out from 1999–2000 [11]. The study population consisted of all inhabitants of the Balearic Islands aged between 16 and 65 years. The sample was obtained by multi-step stratified random sampling procedures by age, gender and habitat, proportional to population density. Inclusion criteria stipulated to have been living in the Balearic Islands for two years before the study; this criterion was adopted in order to ensure that individuals were fully adapted to a regular life in the Balearic Islands, led usual activities and had adopted the customs of the immediate environment. Pregnant women were not considered in this study. The theoretical sample size was set at 1500 individuals, taking into account an anticipated 70% participation rate, and to provide a specific relative precision of 5% (type I error = 0.05; type II error = 0.10).

Anthropometric measurements

The anthropometric measures used in this study were height, weight, and body mass index (BMI, weight in kg/height^2 in meters).

Height was determined using a mobile anthropometer (Kawe, 44444, France) to the nearest mm, with the subject's head in the Frankfurt plane. Body weight was determined to the nearest 100 g using a digital scale (Tefal, sc 9210, France). The subjects were weighed in bare feet and light underwear, which was accounted for by subtracting 200–400 g from the measured weight. Prevalence of overweight and obesity was calculated according to BMI cut-off limits [12].

Questionnaires

Dietary questionnaires and an overall questionnaire incorporating questions related to socio-economic status, educational level and lifestyle factors were utilised. The dietary questionnaires included two 24-hour diet recalls. The 24-hour recall was carried out twice during the study period, the first in the warm season (May-September) and the second in the cold season (November-March). This was done to avoid the influence of seasonal variations. The questionnaires were administered in the subject's home. To avoid bias brought on by day-to-day intake variability, the questionnaires were administered homogeneously from Monday to Sunday. In order to estimate volumes and portion sizes, the household measures found in the subjects' own homes were used. Information on smoking habits, physical activity, and alcohol intake was collected using specific questionnaires [13, 14]. Social class was estimated by the occupation of the head of the family according to the methodology described by the Spanish Society of Epidemiology [15].

Food and nutrient intake

Conversion of food into nutrients was made using a self-made computerized program based on Spanish [16–18] and European Food [19] Composition Tables, and complemented food composition data available for Majorcan food items [20]. Information about traditional Balearic recipes was also utilized [21]. Food composition data were specific for raw and cooked foods. Identification of under-reported food intake was made using the following method: energy intake (EI)/basal metabolic rate (BMR) ratio: < 1.14 classified the individual as under-reporter [22].

Outcome variables: antioxidant nutrient intake

The outcome variables were the intake of certain vitamins and minerals that have been shown to act as dietary antioxidants: selenium, zinc, β-carotene, vitamin C and vitamin E. The consumption was estimated for each interviewed individual as the average intake reported in the two 24-hour recalls. The nutritional density of each antioxidant nutrient was calculated dividing the average intake of these nutrients by the total energy intake (MJ) in order to avoid bias caused by different intakes of energy. Since there are no current recommendations for intakes of antioxidant nutrients for the reduction of chronic diseases [23], diet adequacy in terms of its antioxidant nutrients was evaluated by comparison to Recommended Daily Intakes (RDI) for Spanish people [17] and to proposed RDI for Europeans [24] when no reference data was given for Spanish persons. The percentage of the RDI as well as the proportion of individuals with intakes below the RDI, 2/3 of the RDI and 1/3 of the RDI were calculated. The proportion of individuals with intakes below 2/3 of the RDI was the criterion used to estimate the risk of inadequate intake [25].

A dietary antioxidant quality score (DAQS) was computed considering the risk of inadequate intakes for the antioxidant nutrients considered. A value of 0 or 1 was assigned to each of the five antioxidant nutrients. Persons whose consumption was below 2/3 of the RDI for each antioxidant were assigned a value of 0, and persons whose consumption was at or above 2/3 of RDI were assigned a value of 1. Thus, the total dietary antioxidant quality score ranged from 0 (very poor quality) to 5 (high quality). In order to examine socio-demographic and lifestyle differences as well as food intake patterns for high and low consumers of antioxidants, the DAQS data were divided into the corresponding quartiles and comparisons were made between the upper and lower quartile. Those in the upper quartile were people with inadequate intakes (intakes below 2/3 RDI) of just one or any antioxidant; those in the lower quartile were those who presented an inadequate intake for 4 or 5 (all) antioxidant nutrients.

Determinants: socio-demographic, lifestyle and dietary variables

The explanatory variables were socio-economic, lifestyle, and dietary determinants that were thought to be associated with the intake of antioxidant nutrients in this population. The socio-demographic variables that were considered for this study included: age group (16–25 years; 26–45 years; 46–65 years); sex; region of origin (defined as being born in the Balearic Islands, East of Spain as representative of the Mediterranean coast, other parts of Spain and other countries); marital status (single, married, separated, divorced, widow); educational level (grouped according to years and type of education: low, less than 6 years at school; medium, 6 to 12 years of education; high, more than 12 years of education) and socio-economic level (based on occupation of head of household and classified as low, medium and high). The lifestyle aspects that were analysed are: Smoking habit (No; Yes, more than 1 cigarette a day; Occasionally, less than 1 cigarette a day); Physical activity (according to the level of exercise reported by interviewees during their free time and classified as sedentary, light, moderate and vigorous); and finally BMI classification according to established cut-off points: underweight (BMI < 18.5); normal weight (BMI = 18.5/ < 25); overweight (BMI = 25/< 30) and obese (BMI > 30) [12]. Components of the diet that were also considered as explanatory variables were the intake of fat and saturated fat (percentage of energy intake), fruit & vegetables (g/d) and total dietary fibre (g/d). Data about the consumption of these dietary components were divided into the corresponding quartiles. An adequate and balanced consumption of these dietary compounds roughly defines a healthy and/or Mediterranean dietary pattern [1–3, 5–7].

Statistics

Analyses were performed with SPSS version 10.0. Unpaired Student's t-test and ANOVA one-way test were used to test differences between means. Significant differences in proportions were calculated by means of χ^2. Spearman's rank correlation coefficient (*r*) was used to study the correlation between each dietary antioxidant intake and other antioxidant nutrients intakes. Logistic regression models with the calculations of corresponding adjusted odds ratios (OR) and 95% confidence intervals were used to examine possible differences between low and high antioxidant consumers. Univariate analysis was first carried out for all the socio-demographic and lifestyle variables as well as dietary factors that could determine a low or high intake of dietary antioxidants. Any factor that was significantly associated was considered as a candidate for the multivariate model (quartiles of total fat, saturated fat, fruit & vegetable and fibre consumption, age, place of birth, educational level, and socio-economic status). Sex was also included in the logistic regression model, despite of its statistical significance, in order to control for possible gender differences in dietary habits and antioxidant nutrient intakes. Multiple logistic regression analyses were used to simultaneously examine the effect of these variables on the antioxidant adequacy of the diet. Sequential Bonferroni's test was applied to control type-I error [26]. Level of significance for acceptance was *P*-value < 0.05.

Results

A total of 1554 subjects were originally included in the study but the final sample size was 1200 individuals (77.22% participation). Participation rate in females (87.5%) was higher than in males (66.22%). Non-participation rates included potential subjects declining to be interviewed as well as involuntary non-participation due to census error caused by address changes, missing persons or unavoidable impediments to survey collaboration. Under-reporters were excluded from the analysis of dietary patterns and nutrient intake in order to avoid respondent bias usually present in recall dietary methods.

Socio-demographic and lifestyle characteristics of study participants are shown in Table 1. More men than women formed part of the youngest age groups, were single and were born in the Balearic Islands. Also, men tended to have either lower or higher study level and pertain also to lower or higher socio-economic statuses when compared to women. Men had a higher prevalence of overweight than women, but women had a slightly higher prevalence of obesity than men. However, more women than men were categorized as being underweight or normal weight. Women tended to be less physically active than men (sedentary or light physical activity level) and men tended to perform more moderate and vigorous exercises. The prevalence of current smokers was similar between men and women, however, more women than men had never smoked and more men reported to smoke occasionally.

The percentage of energy (mean ± SD) from total fat (38.6% ± 8.5%) and SFA (13.3% ± 4%) were above the recommended (RDI) and the intake of fruit & vegetables (358 g/d ± 240 g/d) and dietary fibre (15.9 g/d ± 8.2 g/d) were lower than desirable, in comparison to the Intermediate Nutritional Objectives for the Spanish Population [28, 29] (Table 2).

Table 3 summarizes the sex differences observed in antioxidant nutrient intakes. Broadly we can observe that the average intakes of selenium and vitamin C were almost double the RDI in both sexes whereas intakes of zinc, β-carotene and vitamin E were lower than recommended. Inadequate antioxidant nutrient intakes (defined as intakes below 2/3 of RDI) were more prevalent for zinc, β-carotene and vitamin E in both men and women. We can also observe that there are some differences according to sex. If we look at the percent achievement of the recommendations (% of RDI), taking into account that RDI differs according to sex, we observe that males seem to present more adequate intakes of selenium, zinc and vitamin E compared to females, whereas women show greater adequacy in the intake of β-carotene and vitamin C (although the gender difference is not statistically significant for vitamin C).

The Spearman correlation analysis between the intakes of antioxidant nutrients (Table 4) showed that there were statistically significant positive associations between intakes of all antioxidant nutrients. This association was observed not only for the overall population, but also when the Spearman correlation analysis was carried out separately by genders (data not shown). The higher the consumption of one antioxidant nutrient the higher the consumption of all other antioxidants.

According to the Dietary Antioxidant Quality Score (DAQS), 12.4% of the population was classified as low antioxidant consumers (lower quartile of the score) and 35.4% of the sample was defined as high antioxidant consumers (upper quartile of the score). Table 5 shows the association between the DAQS and intake of dietary total fat, saturated fat, fruit & vegetables and fibre. People in the lower quartile of total fat consumption (Q1) were at higher risk (OR = 1.63) of being a low antioxidant consumer (lower quartile of DAQS) when compared to those in the upper quartile of total fat (Q4). The opposite trend was observed when only saturated fat was taken into consideration: people in the lower quartile of saturated fat intake (Q1 and Q2) were less likely to be a low antioxidant consumer (OR of Q1 = 0.63; OR of Q2 = 0.41) in relation to people with higher intakes of saturated fat. People in the lower quartiles of fruit & vegetables consumption were at higher risk of being a low antioxidant nutrient consumer (OR of Q1 = 2.54; OR of Q2 = 2.16; OR of Q3 = 3.30) when compared to those in the upper quartile (Q4). Lower intakes of fibre were also associated with higher risk of low antioxidant intake; however this association was only statistically significant when the third quartile of fibre was compared to

Table 1 Characteristics of the sample. Percentage of males and females in each socio-demographic and lifestyle category

	men (n = 498) (%)	women (n = 702) (%)	total (n = 1200) (%)	p-value*
Age group				
16–25 years	36.3	25.3	29.9	0.0001
26–45 years	40.8	41.2	41.0	
46–65 years	22.9	33.5	29.1	
Marital status				
Single	49.2	32.4	37.7	0.0001
Married	37.1	59.4	55.0	
Widow	1.0	3.0	2.6	
Separated	2.7	2.9	2.8	
Divorced	0	2.3	1.8	
Place of birth				
Balearic Islands	81.0	68.2	70.7	0.0001
Spanish East coast	2.1	5.7	5.0	
Other Spanish regions	14.2	21.1	19.8	
Other country	2.4	5.0	4.5	
Educational level				
Low (< 6 y)	18.9	15.5	16.2	0.0001
Medium (6–12 y)	64.2	70.8	69.4	
High (> 12 y)	17.0	13.7	14.4	
Socio-economic status				
Low	53.3	45.8	47.3	0.0001
Medium	31.5	45.2	42.4	
High	15.2	9.1	10.3	
BMI classification				
Underweight	2.0	5.3	4.6	0.0001
Normal weight	48.0	54.8	53.4	
Overweight	37.8	24.7	27.3	
Obese	12.2	15.1	14.6	
Physical activity				
Sedentary	34.6	42.3	40.9	0.0001
Light	41.3	51.5	49.7	
Moderate	17.8	5.2	7.4	
Vigorous	6.7	1.0	2.1	
Current smoking habit				
Yes	16.3	16.5	16.5	0.01
No	76.9	82.0	81.1	
Occasionally (< 1 cig/d)	6.7	1.5	2.4	

* P-values < 0.05 show that there is a statistically significant difference between sexes (χ^2-test)

Table 2 Description of food patterns of the Balearic Islands population and comparison to Intermediate Nutritional Objectives for the Spanish Population [29]

Dietary characteristics	Mean (SD)	Intermediate Nutritional Objectives for the Spanish population
% of Energy from proteins	17.94 (5.37)	≤ 15
% of Energy from CHO	42.78 (9.56)	> 50
% of Energy from total Fat	38.56 (8.50)	≤ 35
% of Energy from SFA	13.33 (4.03)	≤ 10
Fruit & vegetables (g/d)	357.27 (370.37)	> 550
Fibre (g/d)	15.12 (7.73)	> 22

the fourth (OR = 1.51). These associations remained statistically significant in the multivariate analysis.

Low antioxidant consumers were compared to high consumers in terms of their socio-demographic and lifestyle characteristics (Table 6). Multivariate analysis showed that younger age groups (26–45 years) were at higher risk of being low antioxidant consumers when compared to the 46–65 year age group (OR = 1.84). Those born in other Spanish regions (but not in the Spanish East coast) also showed a statistically significant increased risk (OR = 1.45) for being a low antioxidant consumer in relation to those born in the Balearic Islands. People with low educational level (OR = 1.87) and low (OR = 3.05) or medium (OR = 2.35) socio-economic category also had increased risk of being a low

Table 3 Description of the antioxidant nutrient daily consumption in the study population according to sex group

		mean ± SD		% of sample		
		intake/MJ[1]	% RDI[2]	< RDI	< 2/3 RDI	< 1/3 RDI
Se (μg)	Males	15.4 ± 8.1	237.3 ± 107.5**	5.4***	2.4	1.7
	Females	14.5 ± 5.6	178.98 ± 80.4	15.2	4.4	1.6
Zn (mg)	Males	1.3 ± 0.4	72.7 ± 33.9***	80.9***	48.3***	7.5
	Females	1.3 ± 0.5	59.7 ± 27.3	92.5	66.5	13.6
β-carotene (mg)	Males	433.7 ± 574.7***	56.1 ± 64.7***	85.0***	64.3***	52.4***
	Females	622.2 ± 749.7	78.8 ± 80.1	73.2	52.3	39.5
Vitamin C (mg)	Males	13.4 ± 13.4***	178.9 ± 144.6	37.1	24.8	8.8
	Females	17.2 ± 14.3	184.9 ± 145.0	34.4	20.9	5.5
Vitamin E (mg)	Males	1.1 ± 0.5**	76.1 ± 49.7**	78.6	51.4	14.3
	Females	1.2 ± 0.6	67.4 ± 39.9	83.5	58.6	16.1

[1] Daily intake of Antioxidant nutrients adjusted by total energy intake (MJ)
[2] *RDI* Recommended Dietary Intake for the Spanish population [25] with the exception of Se, whose RDI comes from the recommendations for the European Union [31].
Differences between sex groups were tested with Anova one-way test (for means) and χ^2-test (for proportions).
* p-value < 0.05; ** p-value < 0.01; *** p-value < 0.001. All p-values are corrected by sequential Bonferroni's Test to control type-1 error

Table 4 Array of Spearman correlation coefficients (r) between the intakes of antioxidant nutrients (nutrient density)

	Selenium	Zinc	β-Carotene	Vitamin C	Vitamin E
Se (μg/MJ)	–	0.39	0.11	0.09	0.15
Zn (mg/MJ)	0.39	–	0.17	0.13	0.10
β-carotene (mg/MJ)	0.11	0.17	–	0.48	0.31
Vitamin C (mg/MJ)	0.09	0.13	0.48	–	0.27
Vitamin E (mg/MJ)	0.15	0.10	0.31	0.27	–

All correlation coefficients are statistically significant (*P*-values < 0.001, corrected by sequential Bonferroni's test to control type-I error)

antioxidant consumer compared to those in the highest levels of studies or occupation. All other possible socio-demographic and lifestyle factors that could determine an increased risk of low antioxidant nutrient consumption were not significantly associated.

Discussion

According to the present study findings, low antioxidant consumers present different socio-demographic and dietary characteristics compared to high antioxidant consumers. These results suggest that, if any dietary intervention had to be carried out to enhance the consumption of antioxidant nutrients, this should be targeted to specific population sections and probably based on the promotion of a specific-type diet.

Results from this and previous studies [11, 27] suggest that there are some special features in the macronutrient and micronutrient content of the Balearic diet that represent a slight departure from the traditional Balearic diet and the healthy Mediterranean dietary pattern. Comparisons of the diet of the Balearic Islands with the intermediate nutritional objectives for the Spanish population [28] showed that the consumption of total fat and saturated fat is higher than desirable whereas vegetable, fruit, and fibre intakes are lower than recommended values.

This study has analysed the consumption of some vitamins and minerals that act as antioxidant nutrients and it was observed that a high percentage of the whole sample showed inadequate intakes of zinc, β-carotene and vitamin E. Nevertheless, it has to be pointed out that the intakes of selenium and vitamin C are above the recommendations. We should bear in mind that selenium is a trace element showing high variability depending on the origin of crops and the type of food item containing this element. Therefore, it is possible that the conversion of food into nutrients using food composition tables did not accurately estimate the real intake of selenium [18].

Several papers have reported inadequate intakes for some vitamins in the Spanish population: a meta-analysis that was carried out on the results of vitamin status studies performed in Spain over 10 years showed that a rather high number of people had intakes below that recommended for vitamins A and E, although the percentage of subjects with inadequate intakes of vitamin C was small [29]. The eVe study also showed that mean in-

European Journal of Nutrition (2005) Vol. 44, Number 4

Table 5 Dietary determinants of low and high antioxidant consumers expressed as the percentage of low and high antioxidant consumers in each quartile (Q1, Q2, Q3 & Q4) of % of energy from total fat and saturated fat (SFA) intake, fruit & vegetables consumption (g/d), and fibre intake (g/MJ/d) . Information in brackets indicates the mean intake ± SD in each quartile

Quartiles of consumption	Low antioxidant consumers[1] (n = 183) (%)	High antioxidant consumers[2] (n = 522) (%)	Crude OR[3] (95% CI)	Adjusted OR[4] (95% CI)
% Energy from Total Fat				
Q1 (27.20±5.23)	27.9	17.6	1.63 (1.15–2.33)*	3.38 (1.44–7.95)*
Q2 (35.74±1.59)	24.0	25.1	0.99 (0.70–1.41)	1.89 (0.89–3.98)
Q3 (40.92±1.50)	22.4	28.9	0.82 (0.70–1.41)	1.18 (0.59–2.35)
Q4 (48.90±4.63)	25.7	28.4	1.00 (ref.)	1.00 (ref.)
% Energy from SFA				
Q1 (7.82±1.98)	21.3	21.8	0.63 (0.44–0.90)*	0.24 (0.10–1.58)*
Q2 (11.63±0.71)	15.3	28.0	0.41 (0.28–0.60)*	0.24 (0.11–0.53)*
Q3 (14.18±0.76)	27.9	26.6	0.79 (0.57–1.10)	0.44 (0.23–0.84)*
Q4 (18.20±2.12)	35.5	23.6	1.00 (ref.)	1.00 (ref.)
Fruit & Vegetables (g/d)				
Q1 (203.90±92.2)	27.9	25.1	2.54 (1.70–3.79)*	1.71 (0.85–3.46)
Q2 (596.10±57.1)	24.6	23.8	2.16 (1.43–3.26)*	1.90 (0.94–3.84)
Q3 (825.86±81.5)	35.0	22.8	3.30 (2.22–4.90)*	3.19 (1.63–6.24)*
Q4 (1138.4±99.4)	12.6	28.4	1.00 (ref.)	1.00 (ref.)
Fibre (g/MJ)				
Q1 (7.00±2.01)	25.1	22.0	1.45 (0.99–2.10)	1.65 (0.83–3.27)
Q2 (11.81±1.17)	30.6	28.2	1.35 (0.92–1.88)	1.49 (0.76–2.92)
Q3 (16.47±1.52)	25.1	23.2	1.51 (1.05–2.18)*	2.13 (1.06–4.28)*
Q4 (25.32±7.12)	19.1	26.6	1.00 (ref.)	1.00 (ref.)

[1] Individuals who scored below the lower quartile of the Dietary Antioxidant Quality Score, DAQS (intake of 4 to 5 antioxidant nutrients below 2/3 RDI)
[2] Individuals who scored above the upper quartile of the Dietary Antioxidant Quality Score, DAQS (intake of 0 to 1 antioxidant nutrients below 2/3 RDI)
[3] Univariate analysis (logistic regression analysis considering the effect of one determinant)
[4] Multivariate analysis (multiple logistic regression analysis considering the simultaneous effect of several explanatory variables that were significantly associated in the univariate analysis: quartiles of total fat, saturated fat, fruit & vegetable and fibre consumption)
* P-values < 0.05, corrected by sequential Bonferroni's test to control type-I error

takes for vitamin A and E were below RDI for Spanish men and women [25]. The risk of inadequate intake of individual antioxidants differs according to sex. It has to be pointed out that women are more likely to present inadequacies in the micronutrient content of their diet compared to men, since their energy needs are lower but the requirements of micronutrients can be even higher than in men. Nevertheless, the intakes of β-carotene and vitamin C are significantly higher in females. It may reflect a higher consumption of fruit and vegetables among women, a trend also observed in previous studies [25, 30].

In order to obtain a clearer picture of socio-demographic, lifestyle and dietary determinants of overall low antioxidant intake, a Dietary Antioxidant Quality Score (DAQS) was created. Significant associations were found between the DAQS and age, educational level, occupational category, and place of birth. People from the lowest educational and socio-economic categories were identified as low consumers in both the univariate and multivariate analysis. Low antioxidant consumers were more likely to be born in Spanish regions other than the Balearic Islands and from the Spanish East coast. Younger age groups also showed a higher risk of being low antioxidant consumers. Despite the fact that any of the lifestyle variables were significantly associated to low antioxidant consumption, the odds ratios observed suggest that those with "less favourable lifestyle variables" such as smoking, sedentary level of physical activity or higher BMI were at higher risk of low antioxidant intakes.

Similar findings have also been observed in many studies carried out in other Mediterranean and not Mediterranean countries. A less healthy diet, less intake of fruit & vegetables, lower intake of vitamins and minerals is observed in determined groups of the population: younger generations, lower socioeconomic status, lower educational level, as well as people with a less healthy lifestyle (smokers, sedentary people, etc.) [31–41].

When the food patterns of low antioxidant consumers were assessed, we observed that a low antioxidant intake was associated with low intakes of total fat, fruit & vegetables, fibre and high intake of saturated fat. Low intake of total fat and high intake of saturated fat seem to be the main dietary determinants of low antioxidant intake. This may reflect a low intake of unsaturated

Table 6 Socio-demographic and lifestyle characteristics of low and high antioxidant consumers expressed as the percentage of low and high antioxidant consumers in each socio-demographic and lifestyle group

Socio-demographic and lifestyle variables	Low antioxidant consumers[1] (n = 183) (%)	High antioxidant consumers[2] (n = 522) (%)	Crude OR[3] (95% CI)	Adjusted OR[4] (95% CI)
Sex				
male	40.3	42.8	0.86 (0.56–1.30)	0.77 (0.48–1.33)
female	59.7	57.2	1.00 (ref.)	1.00 (ref.)
Age group				
16–25 years	31.7	29.5	1.56 (1.11–2.18)*	1.17 (0.76–1.81)
26–45 years	44.3	37.4	1.69 (1.23–2.30)*	1.84 (1.22–2.77)*
46–65 years	24.0	33.1	1.00 (ref.)	1.00 (ref.)
Marital status				
Single	40.4	38.5	1.13 (0.87–1.48)	
Divorced	0.5	1.9	0.30 (0.04–2.37)	
Widow	2.2	2.1	1.08 (0.47–2.47)	
Separated	5.5	2.7	1.87 (1.00–3.52)	
Married	51.4	54.8	1.00 (ref.)	
Place of birth				
Other country	3.9	5.0	0.79 (0.42–1.48)	0.80 (0.36–1.75)
Other Spanish regions	25.0	18.3	1.48 (1.09–1.99)*	1.45 (1.00–2.11)*
Spanish East coast	3.3	4.6	0.72 (0.38–1.46)	0.82 (0.36–1.88)
Balearic Islands	67.8	72.1	1.00 (ref.)	1.00 (ref.)
Educational level				
Low (< 6 y)	19.3	14.4	1.73 (1.05–2.85)*	1.87 (1.05–3.35)*
Medium (6–12 y)	67.3	69.9	1.11 (0.73–2.67)	0.93 (0.58–1.51)
High (> 12 y)	13.3	15.8	1.00 (ref.)	1.00 (ref.)
Socio-economic status				
Low	48.6	44.9	2.62 (1.29–5.32)*	3.05 (1.63–5.72)*
Medium	45.7	41.3	2.68 (1.31–5.46)*	2.35 (1.28–4.33)*
High	5.7	13.8	1.00 (ref.)	1.00 (ref.)
BMI classification				
Underweight	4.4	4.6	0.78 (0.40–1.52)	
Normal weight	51.4	55.4	0.79 (0.56–1.13)	
Overweight	26.8	25.5	0.92 (0.62–1–37)	
Obese	17.5	14.6	1.00 (ref.)	
Physical activity				
Sedentary	54.4	38.9	1.79 (0.79–4.07)	
Light	36.8	49.8	0.89 (0.38–2.05)	
Moderate-Vigorous	8.8	11.3	1.00 (ref.)	
Current smoking habit				
Yes	15.8	15.5	1.00 (0.55–1.83)	
Occasionally	1.8	2.7	0.42 (0.08–5.43)	
No	82.5	81.8	1.00 (ref.)	

[1] Individuals who scored below the lower quartile of the Dietary Antioxidant Quality Score, DAQS (intake of 4 to 5 antioxidant nutrients below 2/3 RDI)
[2] Individuals who scored above the upper quartile of the Dietary Antioxidant Quality Score, DAQS (intake of 0 to 1 antioxidant nutrients below 2/3 RDI)
[3] Univariate analysis (logistic regression analysis considering the effect of one determinant)
[4] Multivariate analysis (multiple logistic regression analysis considering the simultaneous effect of sex, age, place of birth, educational level, and socio-economic status)
* *P*-values < 0.05, corrected by sequential Bonferroni's test to control type-I error

fat that can be responsible for inadequate intakes of vitamin E. Moreover, people in the highest quartile of antioxidant intake not only show a high intake of total fat and low intake of saturated fat, but also the intake of fruit, vegetables and fibre is high.

Similar trends have been observed in other studies carried out in Spain in which intakes of fruit & vegetables were assessed [30, 40, 41]. It has also been demonstrated that a high intake of fruit is linked to a low intake of saturated fatty acids whereas a high intake of vegetables is associated to a high intake of monounsaturated fatty acids [41]. A study aimed to evaluate the dietary determinants of olive oil consumption in Spain (the main source of monounsaturated fatty acids in this country) showed that individuals with higher olive oil intake had significantly more favourable food profiles in line with Mediterranean diet patterns. Furthermore, the intake of vitamins E, C and carotenes was greater in men and women with higher olive oil consumption [2]. These previous and the present study would support the hypothesis that a higher consumption of olive oil promotes higher consumption of vegetables in the Mediterranean countries [42].

According to these results two different food patterns can be clearly distinguished in the two antioxidant consumer groups. The group with the highest consumption of antioxidants presents a diet more in line with the Mediterranean dietary pattern, not only because of the high intake of fruit, vegetables and fibre, but also because the intake of total fat is high whereas the intake of saturated fat is low, suggesting high intakes of unsaturated fat. On the other hand, those classified as low consumers of antioxidant nutrients present a less favourable diet: the intake of fruit, vegetable and fibre is slightly lower but the fat consumption is mainly in the form of saturated fat.

Furthermore, it is worth remembering that the correlation analysis of the intake of all antioxidants showed that the intake of each antioxidant nutrient was positively associated with the intake of all other antioxidants. This suggests that the risk of low intake of one antioxidant is accompanied by the risk of low intakes of all other antioxidants. Taking into account that the main food sources of the antioxidant nutrients analysed are fruit, vegetable, cereals and olive oil (main food sources of antioxidant nutrients in the Balearic diet, data not shown), low intakes of all antioxidants involve the consumption of a type of diet poor in these typically Mediterranean food items. Therefore, inadequacies in the intake of antioxidant nutrients tend to cluster and it may be the consequence of an overall unhealthy dietary pattern, different from the traditional Balearic and Mediterranean diet, among certain groups of the population. These findings would support the associations between dietary patterns and DAQS.

According to the results of this study, there seems to be a section of the Balearic Islands population at high risk of deficient antioxidant nutrient intake. There is no current evidence for the possible association between a decrease in the intake of antioxidant nutrients in specific groups of the Balearic Islands population and the consequent implications in the health status for these people. Nevertheless, what is of concern from these results is that the problem of low antioxidant intake is focussed within a very specific section of the population and it is associated with the presence of other dietary inadequacies. Although the current situation can not be considered serious, it may predict and predate a more important nutritional and public health problem in the future: the loss of the traditional Balearic Mediterranean diet towards a more western dietary pattern and the health consequences that these changes may have in this population. Therefore, before the onset of the adverse outcomes of this possible nutrition transition in the Balearic Islands, it would be reasonable and sensible to take robust action to prevent the loss of one of the most important and enjoyable elements of the Balearic culture: its traditional Mediterranean diet.

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