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Diet quality of a population sample from coastal north-east Spain evaluated by a Mediterranean adaptation of the Diet Quality Index (DQI)

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Abstract

Objective: To assess the adherence to the Mediterranean dietary pattern in the population from a coastal region from north-east Spain and its relationship to diseases, applying the Mediterranean Diet Quality Index (M-DQI) validated by the use of several biomarkers.
Design: Cross-sectional nutrition survey.
Setting: Population-based random sample derived from the Catalan Nutrition Survey.
Subjects: A total of 621 healthy adults.
Results: The Catalan representative sample presented a mean M-DQI score of 6·6 (SD 2·3, median 7, range 0–14). The percentage of adherence to the Mediterranean diet was 53 %; 10 % of subjects showed high adherence to the Mediterranean diet, while only 2 % were categorized as poorest adherence. The plasma fatty acid profile of the Catalan sample progressed with perfect regularity throughout the index ranges. Both EPA and DHA presented a significant correlation to the M-DQI ($r = -0{\cdot}410$ for EPA and $-0{\cdot}360$ for DHA). A significant increase in palmitic, oleic and α-linolenic acids and a significant decrease in stearic, linoleic and arachidonic acids content were also observed. The mean values for the M-DQI according to the clinical characteristics of the Catalan sample were also calculated.
Conclusions: The M-DQI has been demonstrated a suitable tool for assessment of an individual's nutritional status according to the Mediterranean dietary pattern and for clinical purposes. Although the current diet followed in Catalonia seems to agree with the main characteristics of the Mediterranean diet, the promotion of the Mediterranean pattern should be reinforced in the Catalan population, especially among young people.

Keywords
Mediterranean Diet Quality Index
Plasma fatty acids
Mediterranean region
Nutritional survey

The Mediterranean diet (MD) is an eating pattern characterized by a lifestyle and culture that has been reported to contribute to better health and quality of life for those who adhere to it(1–10). Among its advantages, recent findings from large cohort studies suggest that a high degree of adherence to the MD is associated with a significant reduction in mortality(11–13). Moreover, some intervention studies have demonstrated that adoption of a Mediterranean-type diet reduces several cardiovascular risk factors in subjects at risk or mortality in patients after a first cardiac event(14,15). The main components characterizing this dietary pattern are a high intake of vegetables, fruits, pulses, olive oil and non-refined cereals; a low intake of meat and saturated fats; a moderately high intake of fish (depending on the proximity to the sea); a low-to-moderate intake of dairy products; and a regular but moderate intake of ethanol, primarily in the form of wine and generally during meals(16).

Unfortunately, epidemiological evidence also suggests that dietary patterns in Mediterranean countries are changing rapidly, the main trends being a considerable increase in total energy availability; a notable increased consumption of fat, particularly that of animal origin; and a significant fall in energy availability from carbohydrates(17–19). A departure from the traditional diet might therefore be accompanied by the loss of its protective effects on health(20,21). This hypothesis justifies the extensive work done by several authors in devising

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methods to evaluate the adherence of a population to a Mediterranean diet pattern (MDP). Among these methods, the MD indices are created a priori based on current nutrition knowledge and attempt to make a global, general and qualitative evaluation of the quality of a diet(11,22–24). With this purpose, Gerber and colleagues successfully devised a dietary quality index suitable for evaluation of the MDP(25). This index, known as the Mediterranean Dietary Quality Index (M-DQI), was performed with the well-known Diet Quality Index (DQI) based on dietary guidelines developed in the 1990s by Patterson *et al.*(26) but incorporating the principal characteristics of the MD. One of the advantages of the M-DQI was its validation with four biological markers in a representative population sample from the French Mediterranean. Biomarkers of intake have largely been used to validate methods to estimate nutrient/food intake (24 h recall, etc.) and provide a more objective and complementary measure of dietary intake(27). However, such biomarkers have not been used to describe dietary patterns until recently(25,28–36). The M-DQI, applied in representative samples of the French(37) and the Croatian population(38), has not yet been applied to a Spanish Mediterranean population.

Therefore, the aim of the present study was to assess the quality of the diet of Catalonia, a Spanish coastal region, by using the M-DQI. In addition, to better understand and validate the utility of measures of overall diet with nutritional status and health, we compared the M-DQI with several nutritional and clinical biomarkers. The global fatty acid (FA) profile was used as a biomarker of intake. Moreover, established biomarkers of risk of CVD and obesity were also considered.

Subjects and methods

Subjects

The subjects were a subgroup of a larger sample (1600 subjects) randomly recruited in Catalonia, a coastal Mediterranean region in north-east Spain, for a cross-sectional nutritional survey(39). The sampling technique included stratification according to geographical area and municipality size, age and sex of inhabitants. The participation rate (65 %) in the present study can be regarded as representative of the adult population in Catalonia. Blood analysis and physiological and anthropometric measurements were obtained from 670 participants in a clinical session after informed consent. Only people who did not under-report their energy intake (ratio of energy intake to BMR $\geq 1\cdot14$, according to the Goldberg cut-off(40)) were considered for analysis. From the resulting 641 Catalans, twenty did not fast for >12 h before blood sampling and were excluded. The final sample consisted of 621 subjects, 261 men and 360 women. The study protocol was approved by the regional ethics committee, following the Declaration of Helsinki 1975 standards.

Lifestyle assessment and anthropometry

Smoking status was assessed by questionnaire during a face-to-face interview. Height (m) weight (kg), waist and hip circumferences (cm), and blood pressure (mmHg) were measured during the clinical session and BMI was calculated as weight (in kilograms) divided by the square of height (in metres). Height was determined using a mobile anthropometer to the nearest millimetre. Body weight (in underwear) was determined to the nearest 100 g using a digital scale. Waist and hip circumference (WC and HC) were measured using a non-stretchable measuring tape to the nearest centimetre. WC was measured at the navel in men, and midway between the bottom of the ribs and the top of the hip bone in women. HC was measured at the tip of the hip bone in men, and at the widest point between the hips and the buttocks in women. Blood pressure (BP) was measured twice with a mercury sphygmomanometer after a minimum of 10 min rest in the seated position.

The cut-off limits proposed by the International Diabetes Federation (2005) for the metabolic syndrome definition in relation to WC, HC, BP and HDL cholesterol (HDL-C) were applied to the present work(41). Only those diseases previously diagnosed and treated by a physician were taken into account for evaluation of the clinical characteristics of the Catalan sample. Furthermore, clinical characteristics pertaining to less than 15 % of the sample were not considered for the analyses.

Nutrition data

Data on food intake were obtained using an FFQ previously validated(42) and applied to other studies and surveys of the Spanish population(43,44). The FFQ, which asked the subject to recall average use over the past year, consisted of ninety-two items. The FFQ was arranged by food type and meal pattern. Frequency categories were based on the number of times that items were consumed per day, week or month. Daily consumption in grams was determined by dividing the reported intake by the frequency in days. Food values were converted into nutrient values by validated software developed by CESNID (the Centre for Superior Studies in Nutrition and Dietetics), which is based on Spanish tables of food composition(45).

Mediterranean Diet Quality Index

The M-DQI(25) is an adaptation of the DQI(26) to evaluate the MDP. The M-DQI was intended to describe food consumption in relationship to prevention of chronic diseases. Therefore, it includes variables present in the diet of the Mediterranean population that are assumed to be either healthy or unhealthy. An explanation for the selection of variables has been reported previously(25). A score from 0 to 2 is assigned to each of the seven food/nutrient groups according to the recommendations, when existing, or otherwise using the population intake tertiles (adjusted by energy) to assign cut-off points (Table 1).

Table 1 Construction of the Mediterranean Diet Quality Index (M-DQI) score and distribution of component sub-scores among a representative sample (*n* 621) from Catalonia, north-east Spain

	Score		
M-DQI component	0	1	2
SFA (% of energy)†	<10	10–13	>13
n	130	236	255
%	21·0	38·0	41·0
Cholesterol (mg)†	<300	300–400	>400
n	329	183	109
%	53·0	29·5	17·5
Olive oil (ml)‡	>27	16·8–27	<16·8
n	270	190	161
%	43·4	30·6	26·0
Fish (mg)‡	>85	53–85	<53
n	211	188	222
%	34·0	30·3	35·7
Meat (mg)‡	<94	94–138	>138
n	216	214	191
%	34·8	34·5	30·7
F&V (mg)‡	>665	445–665	<445
n	246	204	171
%	39·6	32·8	27·6
Cereals (mg)‡	>179	125–179	<125
n	201	193	227
%	32·4	31·1	36·5

F&V, fruit and vegetables.
†Score based on the recommendations of the National Research Council and the American Heart Association.
‡Score based on population intake tertiles derived using intake of Mediterranean components adjusted by energy.

Each group score decreases with higher intake of the corresponding food/nutrient if current guidelines consider it as beneficial for health, while it increases with higher intake if it is considered unhealthy. The group scores were summed to give a total score for the M-DQI, ranging from 0 (maximum adherence to MDP) to 14 (minimum adherence to MDP). The lower the M-DQI value, the healthier is the diet. We classified the scores as follows: good (0–3), medium–good (4–7), medium–poor (8–11) and poor (12–14). For the fish variable, both white and fatty fish were included. The cereal group consisted of all kinds of bread, pasta and breakfast cereals. Both cooked and raw red, yellow and green vegetables and all fresh fruit form the fruit and vegetables (F&V) group. Non-components of the M-DQI also evaluated were alcohol (including beer, wine, liquor and spirits), red wine, pulses, pastries (including all kind of cakes, cookies and sweets), dairy products (including all types of milk and yoghurts, but not cheese) and cheese. The percentage of adherence to the MD was calculated as:

$$\text{Adherence}\,(\%) = \left(1 - \frac{\text{M} - \text{DQI mean}}{14}\right) \times 100.$$

Plasma fatty acid analysis

Blood samples were collected after the subjects had fasted for 12 h. Plasma was stored at −80°C before being analysed. For analyses, 100 μl plasma samples containing 20 μg tridecanoic acid (used as the internal standard) were saponified with sodium methylate. Then, samples were esterified with boron trifluoride–methanol at 100°C. After cooling to 25°C, fatty acid methyl esters (FAME) were isolated by adding n-hexane. Then, the FA profile was determined by fast-GC(46). Analyses were performed on a Shimadzu GC-2010 gas chromatograph (Kyoto, Japan) equipped with a flame ionization detector and a Shimadzu AOC-20i auto-injector. Separation of FAME was carried out on a capillary column (10 m × 0·1 mm internal diameter) coated with a SGE-BPX70 cross-linked stationary phase (70 % cyanopropyl polysilphenylene-siloxane, 0·2 μm film thickness) from SGE Europe Ltd (Milton Keynes, UK). Results were expressed as relative percentages of total FA.

Statistical analysis

Analyses were performed with the SPSS statistical software package version 12·0 (SPSS Inc., Chicago, IL, USA). Data are presented as means and standard deviations. Kolmogorov–Smirnov tests were carried out to check normality of variables. ANOVA and the Duncan test (for variables with three or more categories) were used to determine effect comparisons among groups for numeric variables following normality, whereas associations between categorical variables were tested with a χ^2 test. Correlations were carried out using the Spearman rank correlation. For all analyses, biomarker concentrations were log-transformed to improve normality and two-sided significance was determined at $P < 0{\cdot}05$.

Results

The mean age of the Catalan sample was 47·0 (SD 15·3) years. Of the participants, 15 % were older than 65 years and 17 % were younger than 30 years. Anthropometric and clinical characteristics of the participants are shown in Table 2. Men showed a higher prevalence of risk values for BMI, TAG, glucose and ratio of systolic to diastolic BP (SBP/DBP) than women. Among diagnosed pathologies, only depression/anxiety and rheumatoid arthritis had prevalence higher than 15 %. Women suffered more from rheumatoid arthritis, depression/anxiety and thyroid alterations than did men, whereas men suffered more from diabetes and myocardial infarction.

Mean daily consumption, adjusted to energy intake, for each of the seven components of the M-DQI according to sex is shown in Table 3. As expected, the consumption of olive oil, fish, F&V and cereals increased with perfect regularity with higher adherence to the MD in both genders. Conversely, the consumption of less desirable nutrients and foods decreased regularly with higher adherence to the MD. Higher MDQ-I scores were significantly associated with a lower consumption of pulses only in women, while the opposite trend was found for dairy products but only in men (Table 4). The MDQ-I for all subjects progressed significantly parallel to cheese

Table 2 Prevalence (expressed as %) of anthropometric and clinical characteristics according to sex among a representative sample (*n* 621) from Catalonia, north-east Spain

	Men (*n* 261)	Women (*n* 360)	All (*n* 621)	*P* value†
Anthropometric characteristics				
BMI $\geq$ cut-off‡	69·0	48·4	56·8	$<$0·0001
WC $>$ cut-off§	21·0	29·3	26·0	0·056
WHR $>$ cut-off||	12·9	11·5	12·0	0·674
CVD risk factors¶				
HDL-C $<$ cut-off††	32·0	33·9	33·1	0·661
TAG $>$ cut-off‡‡	23·0	7·9	13·9	$<$0·0001
Glucose $>$ cut-off§§	42·4	31·4	35·7	0·011
SBP/DBP $\geq$ cut-off||||	66·5	53·2	58·5	0·003
Smoker	34·8	30·3	32·1	0·287
Diagnosed pathologies				
Chronic bronchitis	8·0	5·3	6·3	0·218
Diabetes	8·5	3·3	5·4	0·011
Depression/anxiety	11·0	21·4	17·3	0·003
Embolism/stroke	1·5	1·0	1·2	0·603
Malignant tumours	1·0	1·6	1·4	0·545
Thyroid alterations	0·0	4·9	3·0	0·001
Myocardial infarction	4·5	1·3	2·6	0·027
Other heart diseases	6·0	6·6	6·3	0·693
Rheumatoid arthritis	19·0	27·6	24·2	0·027
Asthma	5·5	3·9	4·6	0·414

WC, waist circumference; WHR, waist:hip ratio; HDL-C, HDL cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure.

†χ^2 test.

‡Cut-off limits: BMI $\geq$ 25 kg/m^2.

§Cut-off limits: WC $>$ 102 cm in men; WC $>$ 88 cm in women.

||Cut-off limits: WHR $>$ 1·00 in men; WHR $>$ 0·90 in women.

¶Involved in the International Diabetes Federation definition of the metabolic syndrome (2005), with the exception of smokers.

††Cut-off limits: HDL-C $<$ 1·0 mmol/l in men; HDL-C $<$ 1·3 mmol/l in women.

‡‡Cut-off limits: TAG $>$ 1·7 mmol/l.

§§Cut-off limits: fasting plasma glucose $>$ 5·6 mmol/l or previously diagnosed type 2 diabetes.

||||Cut-off limits: SBP/DBP $\geq$ 130/85 mmHg or treatment of previously diagnosed hypertension.

Table 3 Intake values (adjusted by energy) across the Mediterranean Diet Quality Index (M-DQI) categories according to sex among a representative sample (*n* 621) from Catalonia, north-east Spain

		Good (score 0–3)†		Medium–good (score 4–7)‡		Medium–poor (score 8–11)§		Poor (score 12–14)||	
M-DQI component		Mean	SD	Mean	SD	Mean	SD	Mean	SD
SFA (% of energy)	Men	9·5^{a}	1·6	11·6^{b}	2·5	13·6^{c}	2·2	15·0^{d}	1·7
	Women	9·8^{a}	1·5	12·2^{b}	2·4	14·4^{c}	2·1	16·1^{d}	2·0
	All	9·7^{a}	1·5	12·0^{b}	2·5	14·1^{c}	2·2	15·5^{d}	1·9
Cholesterol (mg)	Men	245·2^{a}	80·3	324·2^{b}	151·8	352·3^{b}	136·2	371·2^{b}	81·1
	Women	239·7^{a}	67·5	288·9^{a}	104·5	341·3^{b}	136·5	378·4^{b}	85·9
	All	242·0^{a}	72·6	302·1^{b}	125·2	345·7^{c}	136·1	374·8^{c}	81·8
Olive oil (ml)	Men	26·9^{a}	11·6	25·3^{a}	13·1	18·6^{b}	12·4	10·2^{c}	6·4
	Women	32·0^{a}	9·9	24·1^{b}	9·6	21·9^{b}	10·6	5·5^{c}	3·6
	All	29·9^{a}	10·8	24·5^{b}	11·0	20·6^{c}	11·4	7·9^{d}	5·6
Fish (mg)	Men	91·5^{a}	55·7	77·8^{a,b}	50·9	63·7^{b}	49·3	60·3^{b}	38·7
	Women	98·2^{a}	47·9	82·8^{a,b}	52·4	69·7^{b,c}	49·0	56·8^{c}	47·8
	All	95·5^{a}	51·1	80·9^{a,b}	51·8	67·3^{b,c}	49·0	58·5^{c}	42·6
Meat (mg)	Men	89·7^{a}	27·5	128·9^{b}	72·5	154·4^{b}	59·6	141·3^{b}	35·3
	Women	84·3^{a}	42·3	112·8^{b}	51·2	139·5^{c}	61·8	172·5^{d}	52·4
	All	86·5^{a}	36·9	118·8^{b}	60·4	145·4^{c}	61·2	156·9^{c}	46·5
F&V (mg)	Men	792·3^{a}	281·0	658·9^{a,b}	324·2	508·1^{b}	346·1	334·3^{c}	133·4
	Women	727·4^{a}	254·7	659·7^{a,b}	256·3	567·5^{b}	297·0	329·7^{c}	232·6
	All	786·0^{a}	264·4	659·4^{b}	282·9	543·9^{c}	317·8	332·0^{d}	185·5
Cereals (mg)	Men	185·2^{a}	54·0	179·9^{a}	63·0	148·0^{b}	62·9	111·0^{c}	47·8
	Women	164·3^{a}	70·4	136·5^{a,b}	59·6	120·9^{b}	52·2	85·5^{c}	42·4
	All	172·8^{a}	64·8	152·8^{a,b}	64·5	131·7^{c}	58·0	98·2^{d}	46·1

F&V, fruit and vegetables.

^{a,b,c,d}Mean values within a row with unlike superscript letters were significantly different ($P < 0·05$, Duncan test). In all cases the *P* value for the linear trend (two-factor ANOVA) was $<$0·001.

†n_{total} 59 (9·5 %); n_{men} 25 (9·6 %); n_{women} 34 (9·4 %).

‡n_{total} 339 (54·6 %); n_{men} 139 (53·3 %); n_{women} 200 (55·6 %).

§n_{total} 212 (34·2 %); n_{men} 93 (35·6 %); n_{women} 119 (33·1 %).

||n_{total} 11 (1·7 %); n_{men} 4 (1·5 %); n_{women} 7 (1·9 %).

Table 4 Intake values (adjusted by energy) across the Mediterranean Diet Quality Index (M-DQI) categories according to sex among a representative sample (*n* 621) from Catalonia, north-east Spain

		Good (score 0–3)†		Medium–good (score 4–7)‡		Medium–poor (score 8–11)§		Poor (score 12–14)‖		
Non M-DQI component		Mean	SD	Mean	SD	Mean	SD	Mean	SD	*P* for trend¶
Pulses (mg)	Men	17·2	11·8	19·2	14·0	17·0	12·6	14·5	11·1	0·541
	Women	15·6^{a}	10·5	16·7a	10·4	14·5^{a}	10·3	7·4^{b}	8·6	0·018
	All	16·2^{a}	11·0	17·7^{a}	11·9	15·5^{a}	11·3	10·9^{b}	10·3	0·028
Dairy products†† (mg)	Men	243·3^{a}	188·3	355·7^{a,b}	280·5	396·2^{b}	301·9	442·3^{b}	248·3	0·018
	Women	363·1	240·0	365·1	231·3	435·0	290·5	450·7	267·9	0·126
	All	315·2^{a}	227·2	361·4^{a,b}	250·7	419·7^{a,b}	295·0	446·5^{b}	252·6	0·028
Cheese (mg)	Men	21·8	18·8	37·9	39·9	38·9	41·5	26·1	16·5	0·058
	Women	26·7	28·1	37·1	41·3	43·9	43·4	29·1	36·5	0·057
	All	24·7^{a}	24·8	37·4^{a,b}	40·7	41·9^{b}	42·6	27·6^{a}	27·7	0·003
Pastries (mg)	Men	9·3^{a}	9·8	28·1^{a}	35·2	47·4^{a,b}	51·1	74·9^{b}	62·2	$<$0·001
	Women	18·0^{a}	18·8	25·0^{a}	24·4	35·1^{a}	32·3	62·2^{b}	72·9	$<$0·001
	All	14·6^{a}	16·4	26·2^{a,b}	29·0	40·2^{b}	41·4	66·4^{c}	65·8	$<$0·001
Alcoholic beverages (ml)	Men	227·5	348·5	227·4	272·7	237·0	290·4	226·6	199·2	0·997
	Women	96·5	236·6	60·4	96·5	49·1	87·0	30·0	33·7	0·175
	All	149·9	306·4	122·9	200·0	124·2	215·6	128·3	172·1	0·779
Red wine (ml)	Men	110·5^{a}	137·5	74·2^{a,b}	115·7	56·0^{a,b}	87·0	2·8^{b}	4·8	0·159
	Women	42·4^{a}	66·2	25·6^{a,b}	61·0	13·6^{a,b}	36·1	1·8^{b}	3·3	0·042
	All	68·8^{a}	104·2	44·3^{a,b}	89·2	31·2^{a,b}	65·7	2·1^{b}	3·6	0·016

^{a,b,c}Mean values within a row with unlike superscript letters were significantly different ($P < 0·05$, Duncan test).

†n_{total} 59 (9·5 %); n_{men} 25 (9·6 %); n_{women} 34 (9·4 %).

‡n_{total} 339 (54·6 %); n_{men} 139 (53·3 %); n_{women} 200 (55·6 %).

§n_{total} 212 (34·2 %); n_{men} 93 (35·6 %); n_{women} 119 (33·1 %).

‖n_{total} 11 (1·7 %); n_{men} 4 (1·5 %); n_{women} 7 (1·9 %).

¶Two-factor ANOVA.

††Not including cheese.

consumption with one irregularity for the higher scores. However, there was no significant variation for cheese or total alcohol consumption across MDQ-I categories in both genders. Men and women with a higher adherence to the MD presented a significantly lower consumption of pastries, but a higher consumption of red wine.

Correlation coefficients with the M-DQI were calculated for the intake of macronutrients and some micronutrients (Table 5). Significant correlations were found for all macronutrients except for PUFA intake. Vitamins B_{12}, C, E and folic acid, and Na, Ca, K, Mg and Fe were the vitamins and minerals significantly correlating with the M-DQI. The coefficients of correlations for the seven components of the index were all significant ($P < 0{\cdot}001$). In addition, pulses, cheese, pastries and red wine significantly correlated with the M-DQI, but not dairy products or alcoholic beverages. Generally, women had a higher consumption of SFA and dairy products, while men consumed more meat, cereals, pulses and alcoholic beverages.

From the FA profile, only stearic, oleic, linoleic and α-linolenic acids, and arachidonic acid (AA), EPA and DHA correlated significantly with the M-DQI. Men showed a higher BMI and waist:hip ratio than women. Regarding biomarkers of CVD, the mean HDL-C concentration was higher in women than in men. In contrast, mean concentrations of LDL-C, TAG, glucose and both SPB and DBP were higher in men. Furthermore, only total cholesterol (TC), LDL-C, SBP and DBP correlated significantly with the M-DQI.

Gerber *et al.* used the amounts of EPA and DHA in erythrocytes as biomarkers of intake to validate the M-DQI(25). As expected, both FA decreased significantly as the M-DQI index range increased (Table 6). The same occurred with palmitic, oleic and α-linolenic acids. Stearic, linoleic and AA, as well as the n-6:n-3 ratio variation, increased significantly as the M-DQI index range increased – contrary to the aforementioned FA. No other significant changes were observed for the rest of the plasma FA profile.

In complementary correlation analyses, associations between foods and biomarkers were also examined. Oleic acid, α-linolenic acid, EPA and DHA were found to be reliable biomarkers of protective foods such as olive oil, nuts and fish, respectively; while palmitic acid, stearic acid and AA were associated with less healthful foods such as meat (data not shown).

Table 7 shows the clinical biomarkers of disease across the M-DQI categories according to sex. All variables progressed with perfect regularity throughout the index ranges for both sexes, but for the majority of the markers, the change in the mean value was significant only for the extreme ranges of the MDQ-I (0–3 *v.* 12–14).

The curve for the distribution of subjects according to M-DQI value (Fig. 1) showed that the median M-DQI score was 7 for both genders; a total of 64 % of subjects fell into the 0–7 score range, 62 % of them being female. Nearly 10 % of both men and women presented the healthiest diet (scores 0–3), while 1·9 % of women and 1·5 % of men showed the poorest diet (scores 12–14).

The mean M-DQI score was 6·6 (SD 2·3), showing non-significant differences between both genders (Table 8). The percentage of adherence to the MD was 53 %. According to age and for both genders, the older the subjects, the better M-DQI they had. The percentage of adherence to the MD was 45 %, 51 %, 57 % and 60 % for subjects aged ≤30 years, 31–50 years, 51–65 years and >65 years, respectively. Subjects who had elevated BMI showed a higher M-DQI score than subjects with normal values, while subjects with elevated SBP/DBP presented a higher adherence to the MD. Non-smokers presented a higher adherence to the MD than did smokers. Moreover, rheumatoid arthritic patients had lower values of the M-DQI than non-rheumatoid arthritic subjects. No other significant differences were found for the remaining clinical characteristics considered in the analyses.

Discussion

The assessment of the quality of the MD in a coastal region from north-east Spain was evaluated by applying the M-DQI. The regular progression of the variables incorporated into the M-DQI across the scores, as well as their high and significant correlation coefficients, gave a coherent set of results. Moreover, we also examined the intake of other food groups of interest. Cheese, dairy products and pastries were considered because they were the main contributors to SFA intake in the Catalan diet(47). This contribution justifies the significant positive correlation of cheese and pastries with the M-DQI. On the contrary, the lack of significance found in the correlation with dairy products could be explained by the fact that the negative effect of whole-fat milk and yoghurts on the M-DQI counteracted the positive effect of reduced-fat milk and yoghurt products. Pulses were also considered because the recent DAFNE (DAta Food Networking) databank study included pulses as a characteristic food group of the MD(48), which may explain their negative correlation with the M-DQI. Alcoholic beverages neither progressed across the M-DQI categories nor correlated with the M-DQI. However, when alcohol sources were considered, subjects with a poor diet showed a significantly lower amount of red wine intake than subjects with a good diet. Besides, red wine intake correlated negatively with M-DQI. This reflects that drinking red wine is an integrated part of the MD.

The correlations of dietary energy and fat intake with diet indices were not always significant(20). Consistent with the findings of others, our results showed that energy intake did not correlate with M-DQI, and correlation with macronutrients and micronutrients indicates healthful intakes for lower scores of the M-DQI(29,38). For example, carotenoids, folic acid and vitamin C are

Table 5 Daily intakes and correlation coefficients (*r*) with Mediterranean Dietary Quality Index (M-DQI) score according to dietetic parameters and biomarkers among a representative sample (*n* 621) from Catalonia, north-east Spain

	Men (*n* 261)		Women (*n* 360)		All (*n* 621)		
	Mean	SD	Mean	SD	Mean	SD	*r*
Energy (kcal)	2244·2	686·2	1981·9***	542·7	2092·1	603·0	0·045
Energy (MJ)	9·4	2·9	8·3***	2·3	8·8	2·6	0·045
Energy (kJ/kg)	123·1	43·0	129·3	43·5	126·7	43·3	0·061
Macronutrients							
Protein (% of energy)	18·3	3·0	18·9*	3·1	18·6	3·1	0·113**
Animal protein (% of energy)	12·5	3·2	13·5***	3·4	13·1	3·4	0·150***
Vegetal protein (% of energy)	5·8	1·1	5·4***	1·1	5·6	1·1	−0·340***
CHO (% of energy)	44·6	6·2	42·5***	5·7	43·4	5·9	−0·375***
Sugar (% of energy)	20·4	6·2	20·6	5·5	20·5	5·8	−0·136**
Complex CHO (% of energy)	24·2	5·7	22·0***	5·5	22·9	5·6	−0·257***
Fibre (g)	25·4	9·0	24·0	7·6	24·6	8·2	−0·435***
Total fat (% of energy)	37·1	6·1	38·5***	5·5	37·9	5·8	0·328***
SFA (% of energy)	12·0	2·7	12·6*	2·8	12·3	2·8	0·528***
MUFA (% of energy)	17·4	4·1	18·5**	5·5	18·0	4·9	−0·313***
PUFA (% of energy)	7·6	2·5	7·4	2·4	7·5	2·4	0·064
Micronutrients							
Cholesterol (mg)	319·5	136·8	299·0	115·7	307·6	124·6	0·332***
Ca (mg)	1043·1	500·7	1044·8	425·4	1044·1	457·0	0·115**
Na (mg)	4961·8	1748·5	4660·4*	1635·3	4787·1	1682·9	−0·098*
K (mg)	3682·5	1244·6	3522·4	1027·8	3589·7	1118·9	−0·140**
Mg (mg)	391·2	23·2	367·9*	107·1	377·1	114·2	−0·203***
Zn (mg)	10·3	3·7	9·7	3·0	10·0	3·3	0·035
P (mg)	1508·7	559·2	1442·4	456·7	1470·3	499·8	0·086
Fe (mg)	14·5	4·5	13·5***	3·8	13·9	4·1	−0·122**
Vitamin A (μg)	1237·0	818·4	1367·0	899·1	1312·4	865·0	−0·036
Carotenoids (μg)	4785·9	3828·1	5522·5*	4091·9	5212·9	3981·0	−0·170***
Vitamin B_1 (mg)	1·4	0·5	1·4	0·4	1·4	0·4	0·012
Vitamin B_2 (mg)	1·8	0·8	1·8	0·7	1·8	0·7	0·012
Niacin (mg)	22·2	7·8	20·5***	6·5	21·2	7·1	0·031
Vitamin B_6 (mg)	2·3	0·9	2·2*	0·7	2·2	0·7	−0·062
Folate (μg)	346·4	127·6	343·1	111·6	344·4	118·0	−0·256***
Vitamin B_{12} (μg)	8·4	4·7	7·8	4·5	8·0	4·6	0·108*
Vitamin C (mg)	167·8	88·2	175·6	76·1	172·3	81·2	−0·301***
Vitamin D (μg)	3·8	2·9	3·7	2·9	3·7	2·9	−0·085
Vitamin E (μg)	12·9	5·6	12·6	4·9	12·7	5·2	−0·116**
Foods							
Olive oil (ml)	22·6	13·0	24·1	11·1	23·5	11·9	−0·460***
Fish (mg)	75·2	51·5	80·7	51·3	78·4	51·4	−0·494***
Meat (mg)	129·6	63·6	117·8*	57·5	122·8	60·1	0·346***
F&V (mg)	619·8	337·2	642·2	284·4	632·8	306·6	−0·600***
Cereals (mg)	166·9	63·8	135·1***	61·6	148·5	62·5	−0·302***
Pulses (mg)	17·8	13·0	15·4*	10·5	16·4	11·6	−0·270***
Dairy products (mg)	354·5	277·0	388·5*	255·8	374·2	264·7	0·019
Cheese (mg)	34·2	36·5	36·8	39·9	35·7	38·5	0·181**
Pastries (mg)	34·0	42·4	28·4	29·0	30·8	34·6	0·230***
Alcohol (ml)	230·4	289·9	62·6***	142·5	133·1	204·5	−0·027
Red wine (ml)	70·0	108·5	22·8***	54·5	42·6	77·2	−0·134**
Biomarkers of intake†							
Stearic acid (18 : 0)	6·44	0·93	6·75***	0·74	6·62	0·82	0·222**
Oleic acid (18 : 1)	25·66	5·04	23·33***	3·78	24·31	4·31	−0·188*
Linoleic acid (18 : 2*n*-6)	31·19	5·90	33·93***	4·90	33·20	5·32	0·158*
α-Linolenic acid (18 : 3*n*-3)	0·32	0·15	0·30**	0·10	0·31	0·12	−0·230**
AA (20 : 4*n*-6)	6·60	1·57	7·00**	1·38	6·83	1·46	0·256**
EPA (20 : 5*n*-3)	0·58	0·38	0·58	0·36	0·58	0·37	−0·410**
DHA (22 : 6*n*-3)	2·15	0·74	2·24	0·53	2·20	0·62	−0·360**
Biomarkers of CVD and obesity							
BMI (kg/m^2)	27·3	4·0	25·9**	5·2	26·5	4·7	0·060
WHR	0·92	0·07	0·81***	0·07	0·86	0·07	0·060
SBP (mmHg)	129·6	18·4	123·0***	21·1	125·8	20·0	0·192***
DBP (mmHg)	81·2	10·4	78·4***	10·4	79·6	10·4	0·134***
TC (mmol/l)	5·10	0·93	5·00	1·01	5·04	0·98	0·193***
LDL-C (mmol/l)	3·25	0·80	3·04**	0·90	3·13	0·87	0·197***
HDL-C (mmol/l)	1·21	0·35	1·46***	0·36	1·36	0·36	−0·059
TAG (mmol/l)	1·34	0·96	0·94***	0·54	1·11	0·72	0·020
Glucose (mmol/l)	5·94	1·77	5·37***	1·07	5·61	1·36	0·083

CHO, carbohydrate; F&V, fruit and vegetables; AA, arachidonic acid; WHR, waist:hip ratio; SBP, systolic blood pressure; DBP, diastolic blood pressure; TC, total cholesterol; LDL-C, LDL cholesterol; HDL-C, HDL cholesterol.

Mean values were significantly different from those of men (one-way ANOVA) or significant *r* value: $^*P < 0{\cdot}05$, $^{**}P < 0{\cdot}01$, $^{***}P < 0{\cdot}001$.

†Expressed as percentage of total fatty acids; only those fatty acids that correlated with the M-DQI are shown.

Table 6 Plasma fatty acid levels (percentage of total fatty acids) across the Mediterranean Diet Quality Index (M-DQI) categories among a representative sample (*n* 621) from Catalonia, north-east Spain

	Good (score 0–3)†		Medium–good (score 4–7)‡		Medium–poor (score 8–11)§		Poor (score 12–14)‖	
Fatty acid	Mean	SD	Mean	SD	Mean	SD	Mean	SD
14 : 0	0·52^{a}	0·31	0·63^{b}	0·32	0·63^{b}	0·42	0·64^{b}	0·38
16 : 0¶	20·78^{a}	2·23	20·88^{a}	2·00	19·84^{b}	1·95	19·66^{b}	1·48
16 : 1	1·65^{a}	0·64	1·67^{a}	0·61	1·68^{a}	0·60	1·46^{b}	0·53
17 : 0	0·33	0·25	0·33	0·27	0·35	0·25	0·33	0·22
18 : 0¶	6·38^{a}	0·92	6·58^{a}	0·72	6·75^{b}	0·95	6·77^{b}	0·97
18 : 1¶	25·40^{a}	4·47	24·48^{b}	4·44	23·83^{c}	4·18	22·56^{d}	2·07
18 : 2*n*-6¶	32·20^{a}	5·23	32·84^{a}	5·62	33·91^{b}	5·05	35·77^{c}	1·96
18 : 3*n*-6	0·43	0·18	0·42	0·17	0·40	0·14	0·38	0·16
18 : 3*n*-3¶	0·34^{a}	0·13	0·32^{a}	0·11	0·29^{b}	0·12	0·26^{c}	0·11
20 : 0	0·11	0·28	0·12	0·29	0·13	0·29	0·14	0·15
20 : 1	0·13	0·09	0·13	0·07	0·13	0·07	0·14	0·02
20 : 2	0·20	0·17	0·21	0·31	0·21	0·16	0·23	0·18
20 : 3*n*-6	1·42	0·38	1·43	0·34	1·45	0·39	1·48	0·40
20 : 4*n*-6¶	6·37^{a}	1·44	6·58^{b}	1·53	7·34^{c}	1·40	7·44^{c}	0·84
22 : 0	0·03	0·11	0·03	0·48	0·04	0·16	0·06	0·19
24 : 0	0·12	0·07	0·13	0·29	0·14	0·09	0·14	0·08
22 : 5*n*-6	0·36	0·13	0·34	0·12	0·33	0·11	0·33	0·15
20 : 5*n*-3¶	0·75^{a}	0·36	0·58^{b}	0·40	0·53^{c}	0·33	0·36^{d}	0·31
22 : 6*n*-3¶	2·45^{a}	0·53	2·29^{b}	0·62	2·01^{c}	0·63	1·83^{d}	0·79
n-6:*n*-3¶	11·5^{a}	4·00	13·8^{b}	5·00	14·1^{b}	4·53	18·5^{c}	5·90

^{a,b,c,d}Mean values within a row with unlike superscript letters were significantly different ($P < 0{\cdot}05$, Duncan test).
†n_{total} 59 (9·5 %); n_{men} 25 (9·6 %); n_{women} 34 (9·4 %).
‡n_{total} 339 (54·6 %); n_{men} 139 (53·3 %); n_{women} 200 (55·6 %).
§n_{total} 212 (34·2 %); n_{men} 93 (35·6 %); n_{women} 119 (33·1 %).
‖n_{total} 11 (1·7 %); n_{men} 4 (1·5 %); n_{women} 7 (1·9 %).
¶The unique fatty acids for which *P* for trend was $<0{\cdot}05$ (one-way ANOVA).

Table 7 Clinical markers across the Mediterranean Diet Quality Index (M-DQI) categories according to sex among a representative sample (*n* 621) from Catalonia, north-east Spain

		Good (score 0–3)†		Medium–good (score 4–7)‡		Medium–poor (score 8–11)§		Poor (score 12–14)‖		
Clinical marker		Mean	SD	Mean	SD	Mean	SD	Mean	SD	*P* for trend¶
BMI (kg/m^{2})	Men	25·2^{a}	2·2	27·2^{b}	2·1	28·2^{b}	2·3	28·8^{b}	2·2	0·336
	Women	23·6^{a}	2·0	26·0^{b}	2·2	26·6^{b}	1·9	26·7^{b}	2·3	0·458
WHR	Men	0·87^{a}	0·02	0·90^{a}	0·03	0·92^{a}	0·03	1·00^{b}	0·05	0·053
	Women	0·77^{a}	0·03	0·81^{a}	0·04	0·82^{a}	0·04	0·87^{b}	0·05	0·125
SBP (mmHg)	Men	118·2^{a}	10·4	129·3^{b}	13·2	132·2^{b}	12·3	141·4^{c}	15·1	0·005
	Women	114·9^{a}	11·0	120·8^{b}	10·8	127·9^{c}	12·5	138·9^{d}	12·2	0·002
DBP (mmHg)	Men	78·3^{a}	7·3	80·5^{a}	7·2	82·8^{a}	7·5	86·6^{b}	7·4	0·164
	Women	71·5^{a}	7·1	78·3^{b}	7·4	80·2^{b}	7·3	83·7^{c}	7·5	0·009
TC (mmol/l)	Men	4·51^{a}	0·68	5·01^{a}	0·90	5·13^{a}	0·96	5·35^{b}	0·93	0·037
	Women	4·37^{a}	1·05	4·79^{a,b}	1·04	5·10^{b}	0·98	5·26^{b}	0·98	0·021
LDL-C (mmol/l)	Men	2·85^{a}	0·69	3·15^{a,b}	0·75	3·30^{b}	0·82	3·43^{b}	0·85	0·039
	Women	2·27^{a}	0·72	2·89^{a}	0·90	3·11^{a}	0·90	3·35^{b}	0·87	0·008
HDL-C (mmol/l)	Men	1·26^{a}	0·09	1·22^{a}	0·10	1·16^{a}	0·10	1·02^{b}	0·11	0·122
	Women	1·48^{a}	0·10	1·46^{a}	0·12	1·46^{a}	0·12	1·26^{b}	0·11	0·847
TAG (mmol/l)	Men	1·25^{a}	0·11	1·36^{b}	0·11	1·34^{b}	0·11	1·37^{b}	0·11	0·460
	Women	0·88^{a}	0·09	0·93^{a}	0·09	0·98^{b}	0·09	1·06^{b}	0·09	0·216
Glucose (mmol/l)	Men	5·14^{a}	0·56	5·81^{b}	1·52	6·12^{b}	1·95	6·05^{b}	1·92	0·283
	Women	5·19	0·93	5·31	0·95	5·35	1·23	5·56	1·16	0·455

WHR, waist:hip ratio; SBP, systolic blood pressure; DBP, diastolic blood pressure; TC, total cholesterol; LDL-C, LDL cholesterol; HDL-C, HDL cholesterol.
^{a,b,c,d}Mean values within a row with unlike superscript letters were significantly different ($P < 0{\cdot}05$, Duncan test).
†n_{total} 59 (9·5 %); n_{men} 25 (9·6 %); n_{women} 34 (9·4 %).
‡n_{total} 339 (54·6 %); n_{men} 139 (53·3 %); n_{women} 200 (55·6 %).
§n_{total} 212 (34·2 %); n_{men} 93 (35·6 %); n_{women} 119 (33·1 %).
‖n_{total} 11 (1·7 %); n_{men} 4 (1·5 %); n_{women} 7 (1·9 %).
¶Two-factor ANOVA.

regarded as micronutrients associated with healthful foods such as F&V, giving rise to negative correlation coefficients with the M-DQI. Conversely, vitamin B$_{12}$ is associated with less healthful foods such as meat and dairy products, which is the reason for the positive correlation observed with the M-DQI. The correlation coefficients were similar to or even higher than other reported values[29,38].

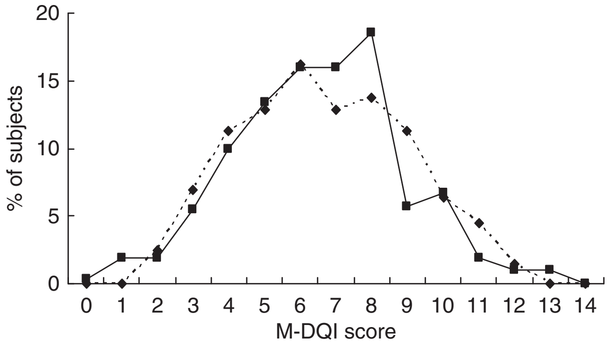

Fig. 1 Distribution of subjects (- - -◆- - -, men; —■—, women) according to score of the Mediterranean Diet Quality Index (M-DQI) among a population-based random sample (*n* 621) derived from the Catalan Nutrition Survey, Spain

With all this in mind, the components that were and were not included in the index showed that the M-DQI was successful in providing an overall assessment of food habits in Catalonia according to the MDP. Moreover, this adequacy was supported by the validation using biomarkers of nutrition intake. Biomarkers of protective foods correlated directly with a higher adherence to the MDP, while biomarkers of less healthful foods correlated inversely with a higher MDP adherence.

Palmitic and stearic acids have been associated with increased risk of CHD(49). As expected, participants with a lower MDP adherence had significantly higher plasma concentrations of stearic acid. Although palmitic acid was inversely related to the M-DQI, this finding agrees with the fact that a low-fat diet leads to a significant increase in palmitic acid incorporated in plasma phospholipids(50). Neuhouser *et al.* also reported this tendency for both saturated FA(30).

The fact that olive oil is the largest contributor of total fat (70 %) among the Catalan population(47) and 92 % of the MUFA present in foods is oleic acid (60–80 % of oleic acid intake coming from olive oil(51)) could be an explanation for its increasing content observed in our study across the M-DQI categories. Fish and nut intakes, for which beneficial effects on human health have been reported(52–54), are also characteristic of the Catalan population and could explain the increasing EPA, DHA and α-linolenic acid contents throughout the M-DQI categories.

Both EPA and DHA presented significant negative correlations with the M-DQI. Similar to our findings, Gerber *et al.* found a significant correlation between the DQI adapted for the French Mediterranean diet and marine FA(25). Conversely, Neuhouser *et al.* found no associations of EPA and DHA with the DQI(30). The variations in fish consumption patterns between subjects in Mediterranean regions and subjects in a Western region are likely to explain these observed differences.

Because both *n*-6 and *n*-3 PUFA are associated with a lower risk of CHD(55), the ratio is only weakly related to CHD risk(55,56). Nevertheless, it is generally accepted that the ratio of *n*-6 to *n*-3 in Western diets (20–30:1) is less than optimal and should be improved to approach recommendations (4–5:1)(57). As expected, the present study showed a gradual decrease of the *n*-6:*n*-3 ratio in participants with a better adherence to the MD. However, although the *n*-6:*n*-3 ratio of the subjects with a better adherence to the MD is lower than that of Western diets, it is still far from the recommendations.

In the present study, we also analysed the M-DQI in relation to clinical biomarkers. A significant inverse association was found between MDP adherence and TC and LDL-C levels, but not HDL-C. These findings are in agreement with Newby *et al.* and Panagiotakos *et al.*, who found that TC was negatively correlated with the DQI revised and the MD score, respectively(29,35); and with Álvarez-León *et al.*, who found no association between MD scores and HDL-C in a Canarian population(34). Furthermore, although Sofi *et al.* observed no influence of adherence to the MD on blood lipid levels, the addition of lifestyle habits to the MD score resulted in a significant association between scores and TC, LDL-C and TAG(36). However, in several other studies opposite results have been found(25,31–33). These differences could be due to different dietary patterns among populations as well as to the different indices used. For example, Kant and Graubard found different results when three different indices were applied to the same population(31).

Consistent with our findings, several studies found that adherence to dietary patterns was inversely associated with BP(31,32,34,35), but not with TAG(29,31,33,34) or glucose(32,36). The strong correlation between the M-DQI and BP could be due to the variables included in the M-DQI, which approximate those of an 'ideal' dietary pattern to reduce BP(58).

No consistent associations have been identified between dietary patterns and BMI, discrepancies being attributable to differences in control of confounders or in the dietary assessment methods(59). Thus, several studies have reported that adherence to the MD is inversely associated with BMI(8,31,32,35,60), while others have found no association(36,38,61,62). In the present study, subjects with a normal BMI presented a higher adherence to the MDP than those being overweight or obese. However, BMI did not differ significantly across the M-DQI categories. This fact could be due to the cross-sectional nature of the study. Thus, obese subjects could be following physicians' advice of increasing their adherence to a healthy dietary pattern. Moreover, obese people tend to under-report energy intake and overestimate the intake of healthy foods, resulting in lower scores. The large proportion of overweight and obese participants in our study could lead to an underestimation of the association between BMI and M-DQI.

The Catalan sample presented a mean M-DQI score of 6·6 (SD 2·3) and 53 % adherence to the MDP, which is at the borderline value of classification for good adherence

Table 8 Mediterranean Diet Quality Index (M-DQI) scores according to sex and age among a representative sample (*n* 621) from Catalonia, north-east Spain

	Sex				Age											
	Men (*n* 261)		Women (*n* 360)		≤30 years (*n* 107)		31–50 years (*n* 246)		51–65 years (*n* 177)		>65 years (*n* 91)			All (*n* 621)		
Clinical characteristic	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	*P* for trend†	Mean	SD	*P*‡
All subjects	6·7	2·3	6·5	2·3	7·7^{a}	2·2	6·8^{b}	2·2	6·0^{c}	2·3	5·6^{c}	2·3	<0·001	6·6	2·3	
Anthropometric characteristics																
BMI																
Normal (*n* 268)	6·4	2·3	6·2	2·3	7·6^{a}	2·1	6·7^{b}	2·3	6·2^{b}	2·3	5·3^{c}	2·0	<0·001	6·3	2·3	0·015
Elevated (*n* 353)§	7·2	2·4	6·8	2·3	7·7^{a}	2·4	6·8^{a}	2·0	7·0^{a}	3·0	5·5^{b}	2·4	<0·001	6·9	2·4	
WHR																
Normal (*n* 548)	6·8	1·7	6·2	2·8	7·2	2·3	6·9	2·2	6·9	2·1	5·6	2·7	0·245	6·4	2·4	0·735
Elevated (*n* 73)‖	6·7	2·5	6·5	2·3	7·7^{a}	2·3	6·9^{b}	2·2	5·7^{c}	2·3	5·7^{c}	2·2	<0·001	6·6	2·4	
CVD risk factors¶																
HDL-C																
Normal (*n* 415)	6·5	2·4	6·4	2·4	7·7^{a}	2·2	6·7^{b}	2·2	5·9^{c}	2·3	5·2^{c}	2·5	<0·001	6·5	2·4	0·271
Low (*n* 206)††	7·0	2·4	6·5	2·2	7·5^{a}	2·4	6·9^{a,b}	2·1	6·2^{b}	2·5	6·2^{b}	1·9	0·033	6·7	2·3	
TAG																
Normal (*n* 535)	6·5	2·5	5·8	2·0	6·3	1·5	6·9	2·5	5·8	2·2	5·9	2·6	0·340	6·3	2·3	0·274
Elevated (*n* 86)‡‡	6·7	2·3	6·5	2·4	7·7^{a}	2·2	6·8^{b}	2·2	6·0^{c}	2·4	5·5^{c}	2·3	<0·001	6·6	2·4	
Glucose																
Normal (*n* 399)	6·5	2·2	6·3	2·2	7·2	2·0	6·7	2·1	6·1	2·2	6·0	2·3	0·567	6·4	2·2	0·209
Elevated (*n* 222)§§	6·8	2·5	6·5	2·4	7·8^{a}	2·3	6·8^{b}	2·2	5·9^{c}	2·4	5·0^{c}	2·2	<0·001	6·6	2·4	
SBP/DBP																
Normal (*n* 258)	7·3	2·4	6·7	2·1	7·6	1·9	7·0	2·3	6·1	2·0	6·3	3·2	0·015	6·9	2·2	0·003
Elevated (*n* 363)‖‖	6·4	2·3	6·2	2·5	7·9^{a}	2·4	6·4^{b}	2·0	5·8^{b,c}	2·5	5·6^{c}	2·2	<0·001	6·3	2·4	
Smoker																
No (*n* 422)	6·4	2·4	6·2	2·3	7·6^{a}	2·4	6·5^{b}	2·1	5·9^{b,c}	2·4	5·4^{c}	2·3	<0·001	6·3	2·3	<0·001
Yes (*n* 199)	7·2	2·3	7·1	2·3	7·7	2·1	7·2	2·4	6·4	2·4	6·6	1·8	0·056	7·1	2·3	
Diagnosed pathologies¶¶																
Depression/anxiety																
No (*n* 514)	6·7	2·3	6·5	2·4	7·7^{a}	2·3	6·9^{b}	2·2	5·9^{c}	2·3	5·5^{c}	2·3	<0·001	6·6	2·4	0·508
Yes (*n* 107)	6·7	2·7	6·3	2·1	7·2	1·2	6·4	2·2	6·3	2·5	6·3	2·5	0·858	6·4	2·3	
Rheumatoid arthritis																
No (*n* 471)	6·8	2·3	6·6	2·3	7·7^{a}	2·3	6·8^{b}	2·2	6·0^{c}	2·3	5·7^{c}	2·1	<0·001	6·7	2·3	0·003
Yes (*n* 150)	5·8	2·4	6·0	2·3	7·8^{a}	1·3	6·6^{a,b}	2·2	6·0^{a,b}	2·4	5·5^{b}	2·4	0·137	6·0	2·0	

WHR, waist:hip ratio; HDL-C, HDL cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure.

[a,b,c] Mean values within a row with unlike superscript letters were significantly different ($P < 0{\cdot}05$, Duncan test).

†*P* value for linear trend according to age (two-factor ANOVA).

‡*P* value among groups within every clinical characteristic (one-way ANOVA).

§BMI ≥ 25 kg/m^2.

‖WHR > 1·00 in men; WHR > 0·90 in women.

¶Involved in the International Diabetes Federation definition of the metabolic syndrome (2005), with the exception of smokers.

††HDL-C < 1·0 mmol/l in men; HDL-C < 1·3 mmol/l in women.

‡‡TAG ≥ 1.7 mmol/l.

§§Fasting plasma glucose > 5.6 mmol/l or previously diagnosed type 2 diabetes.

‖‖SBP/DBP ≥ 130/85 mmHg or treatment of previously diagnosed hypertension.

¶¶Only those pathologies pertaining to more than 15 % of the Catalan sample were considered.

to the MD (score ≤7, adherence ≥50 %)(25). Our results suggest that although the current Catalan population still follows the MDP, it is being lost, mainly in the younger generations. This trend has also been reported in other Mediterranean regions(44,63–65). Taking into account that childhood obesity is unfortunately one of the pandemics of the 21st century(66), young age groups of the population should be a priority target for nutrition interventions to prevent obesity and diet-related diseases.

The fact that hypertensive and rheumatoid arthritic patients showed M-DQI values lower than non-hypertensive and non-rheumatoid arthritic subjects could also be explained by the cross-sectional design of the study. So, patients may have adopted a healthier diet, as has been observed in previous studies(44). For example, in the Catalan sample, patients suffering from these pathologies showed a significantly higher intake of olive oil than the rest of the subjects.

The main limitation of our study is its cross-sectional nature. Therefore, we cannot establish causal relationships but only generate hypotheses for the associations between diseases and biomarkers. Because of the large proportion of overweight and obese participants, under-reporting of energy intake and overestimated intake of ‘healthy’ foods may give rise to lower scores. Moreover, not all components of the M-DQI (i.e. F&V or cereals) are represented by our intake biomarkers.

However, the current investigation also has several strengths. First, we used a validated FFQ previously applied to other Spanish populations(42–44). Second, we employed an elevated number of biomarkers to confirm data obtained from the FFQ, because they are independent of participant’s memory and social factors.

In conclusion, the M-DQI has been demonstrated a suitable tool for measuring adequately the diet quality of the Catalan population since it correlates with intake of several macro- and micronutrients, and is supported by the regular progression of nutritional biomarkers across the scores. Recent data have shown reduced CVD risk factors(67–69), mortality(2) and prevalence of obesity(8) in people adhering to a MD. Consistent with these findings, significant associations between the M-DQI and some biomarkers of disease have been found, revealing that this index may have potential applications for clinical purposes as a predictor of groups at risk. The study also indicates that although the Catalan population still follows the traditional MD habits, they are disappearing, especially among young subjects, who appear to be a group at risk and the primary target for promotion of the MDP.

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