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Is the Mediterranean lifestyle still a reality? Evaluation of food consumption and energy expenditure in Italian and Spanish university students

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Abstract

Objective: To evaluate the correspondence of diet and lifestyle to the Mediterranean model in two groups of Italian and Spanish university students.
Design: A cross-sectional nutritional survey to determine BMI, dietary habits (FFQ), energy daily expenditure and lifestyle (SenseWear® Armband; BodyMedia Inc.), and to define the Mediterranean diet quality index (MDQI) in the different student groups.
Setting: Bologna (Italy) and León (Spain).
Subjects: The survey was carried out on 210 (105 Italian; 105 Spanish) university students (mean age 27·0 (SD 3·8) years) of two different Mediterranean areas, Bologna (Italy) and León (Spain).
Results: The frequency of consumption of some food groups showed differences related to nationality and gender. Some classic Mediterranean foods such as cereals and vegetables were generally consumed more frequently by Italian students; others such as fish and pulses by Spanish students. Percentage of overweight was higher among Spanish students in spite of their higher physical activity level.
Conclusion: Young generations seem to give up the traditional Mediterranean dietary pattern, adopting new dietary trends. Overweight appears to be related not only to physical activity level, but also to the poor MDQI.

Keywords
Mediterranean diet
Food consumption
Energy expenditure
Body mass index
University students

Inadequate dietary habits and insufficient physical activity in industrialized European countries are related to highly prevalent diseases such as CHD, obesity and osteoporosis[1–3]. The increasing level of overweight and obesity among both adults and children[4] worldwide underlines the need for adoption of effective strategies to reverse this trend, in order to prevent chronic diseases. Evidence from epidemiological studies supports a protective effect of the Mediterranean diet on weight gain and the development of type 2 diabetes[5,6]. Furthermore, several studies correlate this dietary pattern and lifestyle to the lower occurrence of coronary diseases[7] and cancer[8], and to the higher life expectancy[9] in the Mediterranean area than in other industrialized countries, suggesting that Mediterranean habits represent a good preventive strategy. Although different regions in the Mediterranean basin have their own diets, it is appropriate to consider these as variants of a single entity, characterized by the consumption of olives and olive oil, fruits, vegetables, fish and seafood, pulses and cereals[10].

Notwithstanding the recognized preventive effect of this diet, the evolution in food consumption in the Mediterranean countries is not encouraging because these countries have followed the trend towards higher shares of energy-dense food, their dietary habits at present resembling a more Westernized diet possibly due to the 'fast-food culture'[11,12]. Actually, many studies evaluating dietary habits in Mediterranean countries confirm the change in the Mediterranean eating behaviour towards an unhealthier type of diet[13], with a progressive narrowing of differences between Northern and Southern Europe[14].

In particular, university students living away from home develop unfavourable eating habits, showing a rapid change of the traditional diet in an undesirable direction[15] and lifestyle modification towards globalized behaviours[16]. Studies on the dietary habits of Mediterranean students indicate that they are consuming low amounts of vegetables and fish while increasing red meat and animal fat intake[17–21]. Dietary habits of young people are important to evaluate 'the present Mediterranean

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diet' and to compare it with the dietary patterns defined in the 1950s by Keys and subsequently re-appraised[22]. The dietary scheme corresponding to the Mediterranean diet is visualized as a food pyramid to constitute a nutrition education tool and guide for the general public and scientific community. The pyramid suggests daily consumption of fruit and vegetables (5–6 portions/d, each portion = 150 g) and cereals (2–3 portions/d, each portion = 50 g); weekly consumption of meat, fish and pulses (5 portions/week, each portion = 100 g); and moderate consumption of milk/dairy products (1 portion/d, each portion = 125 ml/or 50 g cheese) and wine (1 portion/d, each portion = 125 ml)[10]. Sparing consumption of sweets and sugar is also recommended.

In the present study, dietary habits and daily energy balance were evaluated in two groups of university students, from Bologna (Italy) and León (Spain), in order to verify the correspondence between their diet and the Mediterranean dietary model as represented by the food pyramid, and to evaluate the influence of different lifestyles on energy balance and BMI. The food pyramid represents an oversimplification of a complex dietary scheme, but it is known worldwide and easily understandable. So, although some food items (e.g. nuts) are neglected and meat, fish and pulses are considered altogether, we decided to use it as a criterion for a recommended Mediterranean diet. In any case, fish and pulses consumption was also evaluated separately in the different groups.

We chose to study Italian and Spanish students because, notwithstanding the protective role of the Mediterranean diet, Italy and Spain show a high incidence of metabolic diseases. This could be related to the high incidence (about 30 %) of overweight and obesity even among young people[4].

Methods

Subjects

The survey was carried out on 210 healthy undergraduate university students, aged 22–32 years, from two different Mediterranean areas: Bologna (Italy) and León (Spain). Students were invited to participate to the study during the university lessons by their own professors, who explained the aim of the study to them; inclusion criteria were similar socio-economic status (middle class), living alone or with friends, and a good healthy state at the anamnesis. Students attending university courses regarding medicine or nutrition were excluded, as were students usually using the university food service. During a period of 4 weeks, about a thousand students were contacted and, based on inclusion/exclusion criteria, 210 were enrolled and gave oral consent to enter the study. They were subdivided in four groups according to sex and nationality: sixty-five Italian girls, sixty Spanish girls, forty Italian boys and forty-five Spanish boys.

The BMI of each subject was calculated by measuring their weight and height using a precision balance and a stadiometer, respectively. On the basis of BMI, the subjects of each group were subdivided into weight classes using the following cut-off values: $\geq 30\,kg/m^2$ = obese; 29·9–25·0 kg/m^2 = overweight; 24·9–18·6 kg/m^2 = normal weight; $\leq 18{\cdot}5\,kg/m^2$ = underweight[23]. Daily activities and dietary habits of students were collected by questionnaires. All questionnaires were completed during spring–early summer.

FFQ

Nutrient and food intake was measured using the Willett FFQ[24,25], which has been validated for Mediterranean diet-based populations over a wide age range[26]. Full instructions to complete the questionnaire were given, together with a list of 120 different foods in which each food was characterized by a full description of usual serving size. A separate list reporting ingredients commonly used in different recipes was provided together with the questionnaire, allowing subjects to extrapolate the amount of each ingredient used in each preparation and to insert the correct amount of all ingredients in the FFQ. Each participant was asked to keep a detailed record of food consumption, starting from breakfast and ending at bedtime. They were also required to record the amount of food consumed and the methods of food processing. To estimate the portion size each participant was provided with a pictorial copy of standard meal/food sizes. The time frame of FFQ completion was over the past month.

All completed questionnaires were checked by a nutritionist for accuracy and completeness. Questionnaire data were evaluated using a database for nutritional analysis (Winfood; Medimatica Srl, Martinsicuro, Italy). The estimation of each diet as a whole was performed using the Mediterranean diet quality index (MDQI), a specific method to evaluate the adequacy of Mediterranean dietary habits in young and adult persons[21,27,28]. Briefly, following Gerber[27], a score was assigned to each nutrient or food considered depending on the adequacy of its intake compared with the recommended guidelines (0 = adequate; 1 = not completely adequate; 2 = not adequate). All scores were then summed, giving the total MDQI score for each subject. The best MDQI has a score of 0. Scores between 1 and 4 were considered as good; scores between 5 and 7 as medium to good; scores between 8 and 10 as under medium to poor; and scores between 11 and 13 as poor.

Food groups

To assess food consumption, foods were divided according to the classic 'basic food groups' elaborated by the Italian Institute of Research on Food and Nutrition[29] and corresponding to the food pyramid: group I (cereals, bread, rice, pasta, potatoes, biscuits); group II (fruit and

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vegetables); group III (milk, yoghurt, cheese); group IV (meats, fish, chicken, ham, eggs, pulses); and group V (oils, butter, margarine)[22].

Energy expenditure and daily activities

Daily energy expenditure was evaluated using the SenseWear® Armband (BodyMedia Inc., Pittsburgh, PA, USA), a wearable body-monitoring system which allows the collection and accurate analysis of metabolic and physical activity information in a free-living context. The SenseWear armband recorded physiological data, which were then analysed using the InnerView® software application version SenseWear 6·1 (BodyMedia Inc.).

All subjects wore the SenseWear armband on the right arm for three consecutive days, taking it off only while showering. The resulting energy expenditure data for each subject represent the mean of the 3 d recording.

To provide information about lifestyle all participants completed the International Physical Activity Questionnaire[30,31], which queried about occupational activity (transportation to and from work), household chores, sports, sedentary leisure-time activity, recreational activity and time of sleep. For each activity reported in the questionnaire, subjects filled in the frequency and duration.

Statistical analyses

Data are presented as means and standard deviations. The Student–Newman–Kuels test after ANOVA was conducted to compare the significance of differences between the two groups using the GraphPad Prism 4 statistical software package (GraphPad Software Inc., San Diego, CA, USA). $P < 0{\cdot}05$ was considered to indicate statistical significance.

Results

Subdivision of subjects into weight classes showed high percentages of overweight, particularly among Spanish students (girls: 37 %, boys: 45 %). Among Italian students overweight was present in 14 % of girls and 8 % of boys. No underweight or obese subjects were found in any group (Fig. 1).

Weekly frequency of food consumption in Italian and Spanish students is reported in Figs 2 and 3. Consumption

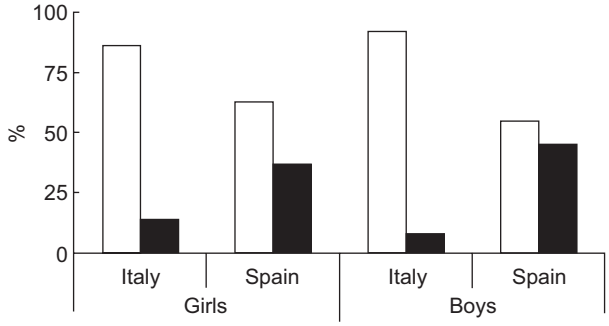

Fig. 1 Distribution of subjects according to nationality, sex and weight class (□, NW; ■, OW). Subjects were divided into weight classes according to BMI: ≥30 kg/m^2 = obese (OB); 29·9–25·0 kg/m^2 = overweight (OW); 24·9–18·6 kg/m^2 = normal weight (NW); ≤18·5 kg/m^2 = underweight (UW). No UW or OB subjects were detected in any group

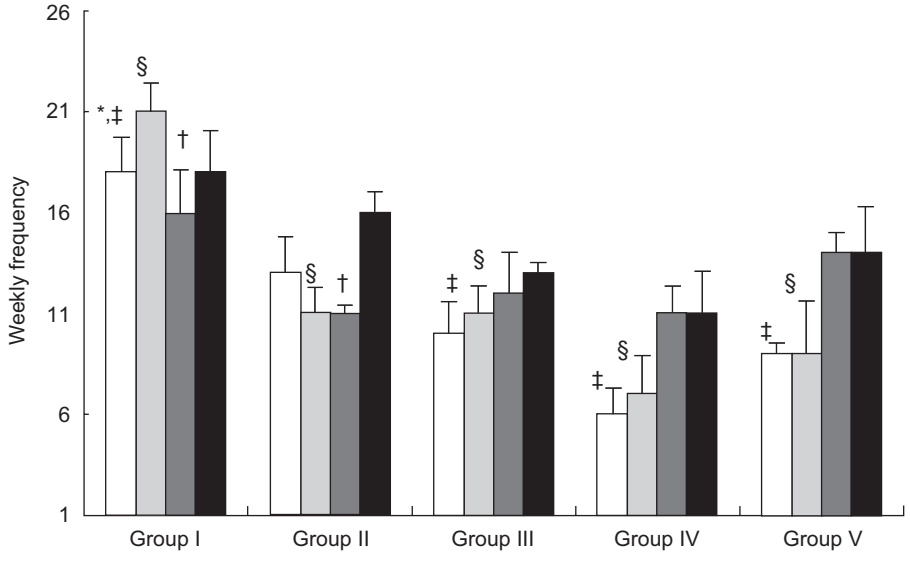

Fig. 2 Weekly frequency of food consumption in Italian (□, normal weight (NW); ▨, overweight (OW)) and Spanish (▩, NW; ■, OW) girls. Weekly consumption frequency was calculated according to dietary questionnaires for the different foods divided according to the classic 'basic food groups': group I (cereals, bread, rice, pasta, potatoes, biscuits); group II (fruit and vegetables); group III (milk, yoghurt, cheese); group IV (meats, fish, chicken, ham, eggs, pulses); and group V (oils, butter, margarine)[29]. Values are means with standard deviations represented by vertical bars. Statistical analysis was performed separately for each food group with the Student–Newman–Kuels test after ANOVA. Mean values were significantly different (at least $P < 0{\cdot}05$): *Italian NW *v.* OW; †Spanish NW *v.* OW; ‡Italian NW *v.* Spanish NW; §Italian OW *v.* Spanish OW

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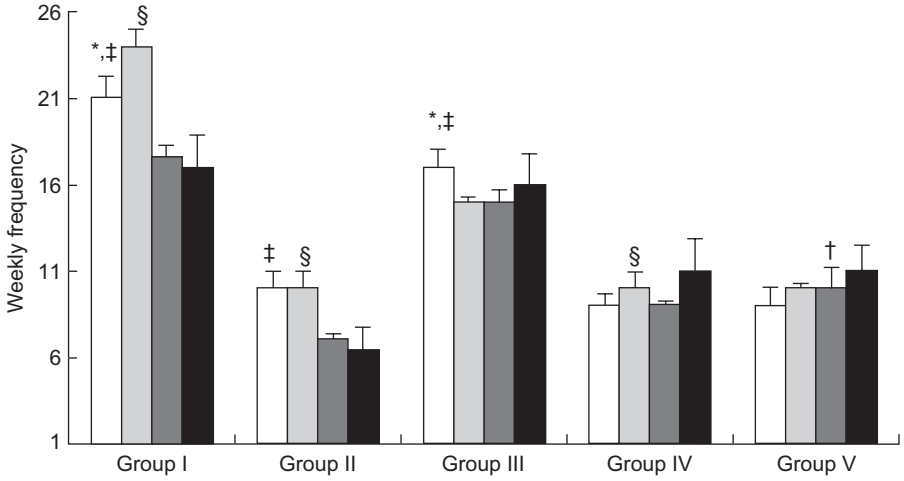

Fig. 3 Weekly frequency of food consumption in Italian (□, normal weight (NW); ▫, overweight (OW)) and Spanish (■, NW; ■, OW) boys. Weekly consumption frequency was calculated according to dietary questionnaires for the different foods divided according to the classic 'basic food groups': group I (cereals, bread, rice, pasta, potatoes, biscuits); group II (fruit and vegetables); group III (milk, yoghurt, cheese); group IV (meats, fish, chicken, ham, eggs, pulses); and group V (oils, butter, margarine)[29]. Values are means with standard deviations represented by vertical bars. Statistical analysis was performed separately for each food group with the Student–Newman–Kuels test after ANOVA. Mean values were significantly different (at least $P < 0{\cdot}05$): *Italian NW *v.* OW; †Spanish NW *v.* OW; ‡Italian NW *v.* Spanish NW; §Italian OW *v.* Spanish OW

Table 1 Macronutrient and alcohol intake in Italian and Spanish girls and boys

	Girls								Boys							
	Italy				Spain				Italy				Spain			
	NW		OW		NW		OW		NW		OW		NW		OW	
Macronutrient	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Carbohydrate (% of energy)	$54{\cdot}5^{a,b}$	6·8	$57{\cdot}4^{c,d}$	6·1	$41{\cdot}4^{a,c}$	8·1	$44{\cdot}1^{b,d}$	5·3	$55{\cdot}1^{g,h}$	5·5	$58{\cdot}0^{i}$	4·7	$44{\cdot}3^{g}$	6·3	$42{\cdot}4^{h,i}$	5·1
Protein (% of energy)	$14{\cdot}1^{a,b}$	2·5	$12{\cdot}3^{c,d}$	2·6	$16{\cdot}4^{a,c,e}$	2·6	$18{\cdot}0^{b,d,e}$	3·1	15·0	2·6	13·0	0·2	15·0	1·3	14·0	0·8
Fat (% of energy)	$30{\cdot}8^{a,b}$	7·3	$29{\cdot}1^{c,d}$	3·6	$39{\cdot}3^{a,c,e}$	5·8	$35{\cdot}0^{b,d,e}$	3·6	$29{\cdot}1^{g,h}$	2·5	$28{\cdot}3^{i,l}$	1·4	$37{\cdot}1^{g,k,l}$	4·1	$40{\cdot}1^{h,k,l}$	4·7
Alcohol (% of energy)	$0{\cdot}6^{a,b,c}$	0·4	$1{\cdot}2^{a,d,e}$	0·1	$2{\cdot}0^{b,d,f}$	1·0	$2{\cdot}9^{c,e,f}$	0·3	$0{\cdot}7^{g}$	0·3	$0{\cdot}6^{h}$	0·0	$3{\cdot}3^{g}$	0·2	$3{\cdot}4^{h}$	0·7

Macronutrient and alcohol intake was calculated in normal weight (NW) and overweight (OW) subjects as percentage of the daily energy intake. Statistical analysis was by the Student–Newman–Kuels test after ANOVA, comparing each group with all other groups.
^{a,b,c,d,e,f,g,h,i,j,k,l}Mean values within a row with unlike superscript letters were significantly different ($P < 0{\cdot}05$).

Table 2 Lipid intake in Italian and Spanish girls and boys

	Girls								Boys							
	Italy				Spain				Italy				Spain			
	NW		OW		NW		OW		NW		OW		NW		OW	
Lipid	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Cholesterol (mg/d)	$266{\cdot}3^{a,b}$	0·1	$272{\cdot}5^{c,d}$	0·2	$591{\cdot}9^{a,c}$	0·1	$679{\cdot}2^{b,d}$	0·3	$320{\cdot}2^{g,h}$	0·1	$414{\cdot}6^{i,j}$	0·1	$289{\cdot}8^{g,j,k}$	0·3	$789{\cdot}1^{h,j,k}$	1·0
SFA (g/d)	$26{\cdot}8^{a,b,c}$	4·5	$19{\cdot}0^{a,d,e}$	3·1	$37{\cdot}0^{b,d}$	4·1	$35{\cdot}6^{c,e}$	3·4	$31{\cdot}8^{g,h,i}$	1·0	$30{\cdot}0^{g,k,l}$	3·2	$27{\cdot}2^{h,j,l}$	0·1	$33{\cdot}6^{i,k,l}$	1·3
SFA (% of total)	$36{\cdot}5^{a}$	4·6	$29{\cdot}6^{a,b,c}$	4·1	$37{\cdot}9^{b}$	4·6	$39{\cdot}1^{c}$	3·8	$37{\cdot}7^{g,h,i}$	0·2	$35{\cdot}2^{g,j}$	1·3	$35{\cdot}3^{h,k}$	0·9	$37{\cdot}1^{i,j,k}$	1·2
PUFA (g/d)	$8{\cdot}6^{a,b}$	2·0	$7{\cdot}6^{c,d}$	1·3	$12{\cdot}0^{a,c}$	1·5	$11{\cdot}7^{b}$	2·3	9·0	3·2	10·0	1·0	9·0	2·0	10·0	1·3
PUFA (% of total)	11·7	2·5	11·8	2·8	12·4	1·9	13·2	2·4	10·9	3·6	12·7	1·5	12·7	2·1	12·1	1·7
MUFA (g/d)	$38{\cdot}1^{a}$	9·0	$37{\cdot}7^{b}$	8·5	$48{\cdot}5^{a,b}$	6·1	45·4	9·2	43·2	6·5	42·7	4·5	$40{\cdot}3^{g}$	6·5	$46{\cdot}0^{g}$	3·5
MUFA (% of total)	$51{\cdot}8^{a,b,c}$	2·0	$58{\cdot}6^{a,d,e}$	1·3	$49{\cdot}7^{b,d,f}$	2·1	$47{\cdot}7^{c,e,f}$	2·4	51·4	1·0	52·1	0·9	52·0	1·2	50·8	1·2

Lipid intake was calculated in normal weight (NW) and overweight (OW) subjects. Statistical analysis was by the Student–Newman–Kuels test after ANOVA, comparing each group with all other groups.
^{a,b,c,d,e,f,g,h,i,j,k,l}Mean values within a row with unlike superscript letters were significantly different ($P < 0{\cdot}05$).

of group I foods (cereals, bread, rice, pasta, potatoes, biscuits) was higher in Italian than in Spanish students and in overweight than in normal-weight students apart from Spanish boys. Consumption of group II foods (fruit and vegetables) was higher in girls than in boys in both countries. Normal-weight Italian girls consumed more

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Table 3 Vitamin, mineral and fibre intake in Italian and Spanish girls

		Italy				Spain			
		NW		OW		NW		OW	
Micronutrient	DRI	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Vitamin C (mg/d)	75	147·7^{a,b}	31·2	151·2^{c,d}	30·1	205·0^{a,c}	22·2	219·3^{b,d}	25·0
Vitamin D (μg/d)	5	3·2^{a,b,c}	0·4	2·3^{a,d,e}	0·7	4·1^{b,d,f}	0·6	5·2^{c,e,f}	0·2
Vitamin E (mg/d)	15	10·3^{a,b}	0·9	10·3^{c,d}	1·2	12·8^{a,c,e}	0·8	11·2^{b,d,e}	1·1
Ca (mg/d)	1000	798·8^{a,b,c}	30·2	891·4^{a,d,e}	21·5	1282·8^{b,d,f}	12·4	1422·4^{c,e,f}	10·0
Fe (mg/d)	18	10·9^{a,b}	1·2	11·3^{c,d}	0·8	13·6^{a,c}	1·2	14·0^{b,d}	1·3
Fibre (g/d)	30	18·0^{a,b,c}	1·0	25·0^{a,d,e}	1·2	20·6^{b,d}	0·5	20·9^{c,e}	0·2

DRI, Dietary Reference Intake[32].
Micronutrient intake was calculated in normal weight (NW) and overweight (OW) subjects. Statistical analysis was by the Student–Newman–Kuels test after ANOVA, comparing each group with all other groups.
^{a,b,c,d,e,f}Mean values within a row with unlike superscript letters were significantly different ($P < 0·05$).

Table 4 Vitamin, mineral and fibre intake in Italian and Spanish boys

		Italy				Spain			
		NW		OW		NW		OW	
Micronutrient	DRI	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Vitamin C (mg/d)	90	145·5^{a,b,c}	12·2	114·4^{a,d}	36·0	133·0^{b,c}	24·4	165·0^{c,d,e}	26·0
Vitamin D (μg/d)	5	2·6^{a}	0·1	3·0^{b,c}	0·1	2·5^{b,d}	0·8	3·1^{a,c,d}	0·6
Vitamin E (mg/d)	15	10·0	0·6	9·2	1·3	9·4	1·0	10·4	1·1
Ca (mg/d)	1000	905·2^{a,b,c}	35·1	745·2^{a,d,e}	32·5	1017·0^{b,d,f}	11·5	1219·0^{c,e,f}	24·0
Fe (mg/d)	10	10·8	1·7	10·5	1·6	11·2	0·3	12·2	0·2
Fibre (g/d)	30	20·6^{a,b}	0·2	20·9^{c,d}	0·3	17·7^{a,c,e}	0·3	15·8^{b,d,e}	0·1

DRI, Dietary Reference Intake[32].
Micronutrient intake was calculated in normal weight (NW) and overweight (OW) subjects. Statistical analysis was by the Student–Newman–Kuels test after ANOVA, comparing each group with all other groups.
^{a,b,c,d,e,f}Mean values within a row with unlike superscript letters were significantly different ($P < 0·05$).

Table 5 Mediterranean dietary quality index (MDQI) in Italian and Spanish girls and boys

	Individual MDQI component score							
Group	Meats	Fish	Cereals	Vegetables	Olive oil	Cholesterol	% SFA	Total score
Italian girls NW	1	1	0	2	0	0	2	6
Italian girls OW	1	1	0	2	0	0	2	6
Spanish girls NW	1	0	2	2	0	2	2	9
Spanish girls OW	1	1	2	2	0	1	1	8
Italian boys NW	2	1	0	2	0	0	2	7
Italian boys OW	2	2	0	2	0	1	2	9
Spanish boys NW	2	1	1	2	0	1	2	9
Spanish boys OW	2	2	1	2	0	2	2	11

In normal weight (NW) and overweight (OW) subjects, MDQI was calculated for food groups/nutrients based on dietary questionnaires and following Gerber[27]. Total score was calculated by adding single scores and considered as: 0 = very good; 1–4 = good; 5–7 = medium to good; 8–10 = under medium to poor; 11–13 = poor.

fruits and vegetables than overweight ones, while among Spanish students overweight girls had the highest frequency of consumption. Furthermore, fruit and vegetable consumption in Spanish boys was significantly lower than in Italian ones. Consumption of foods from group III (milk, yoghurt, cheese) was higher in boys, independent of weight class and nationality; normal-weight Italian girls showed the lowest consumption, as well as for group IV foods (meats, fish, chicken, ham, eggs, pulses). Among the foods of this group, fish and pulses were consumed more frequently (two or three times weekly) by Spanish students, particularly girls. Spanish girls also consumed more group V foods (oils, butter, margarine) than the other students, and in all groups olive oil consumption was prevalent.

Overall, energy intake in Italian students, subdivided into macronutrients and alcohol, substantially corresponded to a Mediterranean diet, while in Spanish students a low carbohydrate intake and a high fat and alcohol intake were observed (Table 1).

Regarding lipid intake (Table 2), corresponding to the prevalence of olive oil consumption, a high MUFA intake

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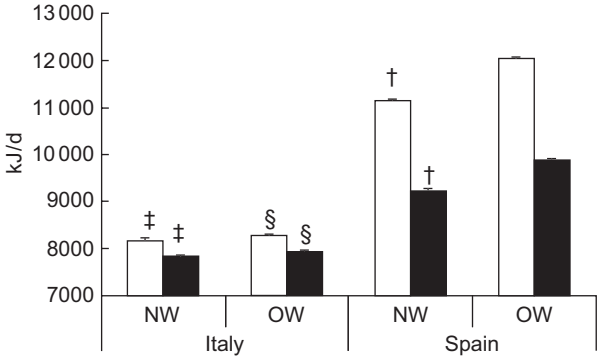

Fig. 4 Energy intake (□) and expenditure (■) in Italian and Spanish girls (NW, normal weight; OW, overweight). Energy intakes, calculated by dietary questionnaires, and energy expenditure, measured with the SenseWear® Armband (BodyMedia Inc., Pittsburgh, PA, USA) as reported in Methods, are expressed in kJ/d. Values are means with standard deviations represented by vertical bars. Statistical analysis was performed for intake and expenditure by the Student–Newman–Kuels test after ANOVA. Mean values were significantly different (at least $P < 0{\cdot}05$): *Italian NW *v.* OW; †Spanish NW *v.* OW; ‡Italian NW *v.* Spanish NW; §Italian OW *v.* Spanish OW. Furthermore, the difference between intake and expenditure was determined in each group, and was statistically significant (at least $P < 0{\cdot}05$) in Spanish NW and Spanish OW groups

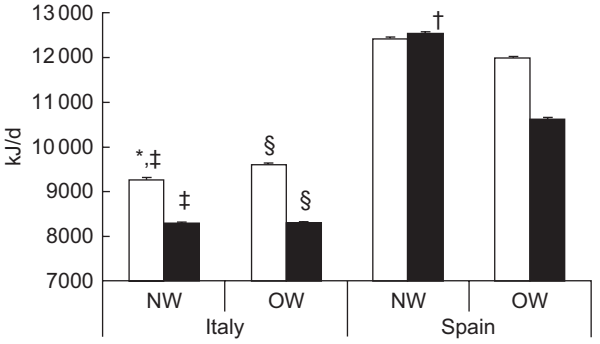

Fig. 5 Energy intake (□) and expenditure in (■) Italian and Spanish boys (NW, normal weight; OW, overweight). Energy intakes, calculated by dietary questionnaires, and energy expenditure, measured with the SenseWear® Armband (BodyMedia Inc., Pittsburgh, PA, USA) as reported in Methods, are expressed in kJ/d. Values are means with standard deviations represented by vertical bars. Statistical analysis was performed for intake and expenditure by the Student–Newman–Kuels test after ANOVA. Mean values were significantly different (at least $P < 0{\cdot}05$): *Italian NW *v.* OW; †Spanish NW *v.* OW; ‡Italian NW *v.* Spanish NW; §Italian OW *v.* Spanish OW. Furthermore, the difference between intake and expenditure was determined in each group, and was statistically significant (at least $P < 0{\cdot}05$) in Spanish OW and Italian OW groups

was detected in all groups; cholesterol intake was higher in Spanish girls and overweight boys than in the corresponding Italian groups.

In all students vitamin intake almost met the recommendations of the Dietary Reference Intakes[32], although differences were observed between Italian and Spanish groups (Tables 3 and 4). Regarding minerals, Ca intake was low in Italian students, particularly in overweight boys, and Fe intake was inadequate in all girls, particularly in Italian ones. Fibre consumption was generally lower than the recommended dietary intake.

The MDQI, reported in Table 5, showed medium to good total scores in Italian groups, except for overweight boys, while total scores ranged from medium to poor in Spanish students. According to this index, some nutrients such as SFA or food groups such as vegetables showed inadequate intakes in almost all groups.

Energy expenditure, as measured with the SenseWear armband, was higher in Spanish than Italian students, and in all groups apart from normal-weight Spanish boys energy intake was higher than expenditure (Figs 4 and 5).

Discussion

The reduced consumption of fruit, vegetables, pulses and fish observed in different Mediterranean countries[33] seems to indicate that the youngest generations give up traditional dietary patterns, and raises the question of whether the Mediterranean diet will persist in the future without being replaced by other 'modern' dietary habits[34–36]. In the present study both Italian and Spanish students consumed too much fat and insufficient vegetables, in agreement with other studies investigating the dietary habits of university students living away from home[21,37,38]. In our study, these modifications of the traditional Mediterranean diet appeared to be associated with a high incidence of overweight.

Overweight is often considered a consequence of reduced physical activity, and in the present study energy intake was higher than expenditure in almost all students. Since energy expenditure was higher in Spanish students than in Italian ones, the higher incidence of overweight in the former group could be due not only to an energy unbalance but also to the worst quality of the diet. This is in agreement with Gerber[27], who found that, especially in women, overweight is associated with poor MDQI score and obesity with medium–poor MDQI score. That energy balance is not the only determinant in the onset of overweight has been suggested also by Gazzaniga and Burns[39], who found that diet composition, independent of energy intake or physical activity, contributed to obesity in adolescents. Swinburn *et al.*[40] showed that adherence to a Mediterranean diet, and consequently a low MDQI score, is inversely associated with BMI and the odds of being overweight. In many studies the MDQI has been used to investigate whether different populations follow the Mediterranean diet and to what extent, revealing modifications in dietary habits among young people who showed low MDQI scores[33,41,42]. Our results are in agreement with these findings, although showing

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that Italian students respect Mediterranean dietary traditions more than Spanish ones. In fact, although the investigated groups had similar socio-economic and cultural characteristics, the trends of food consumption appeared different between the two: some classic Mediterranean foods such as cereals and fruit and vegetables were consumed more frequently in the Italian groups, while other foods such as fish and pulses were consumed more frequently in the Spanish groups.

On the other hand, the possibility that the disagreement between energy intake data and body weight could be related to the limits of the methods used to evaluate food consumption cannot be completely excluded. Although FFQ based on a 1-month period are generally recognized as more precise than 7 d ones[43,44], it is conceivable that the determination of energy intake cannot be absolutely accurate using this method because it is based on recall. Conversely, the measurement of energy expenditure by the SenseWear armband has been shown to be highly reliable both during rest and exercise. In particular, the new software SenseWear 6·1 used in the present study has decreased the discrepancy between direct calorimetry and armband measurement to less than 21 kJ[45–47].

Results presented in the current paper are in agreement with other studies reporting unfavourable dietary habits, particularly with regard to the consumption of fruit and vegetables[48], fat and sugar, dietary fibre[49] and fried/high-fat fast food[50,51], among university students from countries in Europe and elsewhere. Attending university brings about increased freedom and independence during which time young people have to learn how to take care of themselves, including from a nutritional point of view. The absence of the home environment could cause negative changes in the dietary habits of young people who have not had education on nutrition. Results obtained in the present study could indicate that many young adults lack the basic nutritional knowledge and food shopping and preparation skills necessary to maintain traditional dietary habits. Students attending university courses regarding medicine or nutrition were not enrolled in the study to avoid interference owing to specific knowledge about healthy eating; similarly, only students from the middle class were included to avoid interference from financial pressures and/or social settings.

Although our sample size was limited, the two populations studied were quite similar in different aspects such as socio-economic position, culture and age, thus allowing a reliable comparison between dietary habits in two areas of different Mediterranean countries. Notwithstanding some limitations, our data on the dietary habits of young healthy people could give information useful to address recommendations to rehabilitate Mediterranean food habits. It appears that there is a clear need to create health promotion programmes, with special emphasis on nutritional education, directed specifically to young people and utilizing media which are familiar to them, such as television, movies and the Internet. The recovery of traditional Mediterranean habits, together with the implementation of physical activity, could represent the key stones of these programmes, which need coordination among manufacturers, retailers and restaurants to drive innovation and increase consumer demand for whole Mediterranean products and foods. Creative thinkers in the industry could be vital for the development of new products within the Mediterranean tradition that could be embraced by consumers of all ages.

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M.B. carried out the survey in Spain. F.P., A.B. and M.M. collaborated in evaluating the data. All authors collected data from Italian university students by FFQ and the SenseWear armband. All authors have contributed to writing the paper.

References

1. Sánchez de Medina F & Zamora S (1995) Dieta y enfermedad coronaria. *Nutr Hosp* **X**, 152.
2. San Juan FPM (2006) Dietary habits and nutritional status of school aged children in Spain. *Nutr Hosp* **21**, 374–378.
3. Serra-Majem L, Bartrina AJ, Barba RL & Rubio DA (2006) Prevalence and determinants of obesity in Spanish children and young people. *Br J Nutr* **96**, Suppl. 1, S67–S72.
4. International Obesity Task Force (2005) *EU Platform Briefing Paper*. Brussels: IOTF.
5. Wahlqvist ML, Kouris-Blazos A & Wattanapenpaiboon N (1999) The significance of eating patterns: an elderly Greek case study. *Appetite* **32**, 23–32.
6. Schroder H (2007) Protective mechanisms of the Mediterranean diet in obesity and type 2 diabetes. *J Nutr Biochem* **18**, 149–160.
7. Bautista MC & Engler MM (2005) The Mediterranean diet: is it cardioprotective? *Progr Cardiovasc Nurs* **20**, 70–76.
8. Fernandez E, Gallus S & La Vecchia C (2006) Nutrition and cancer risk: an overview. *J Br Menopause Soc* **12**, 139–142.
9. Trichopoulou A, Orfanos P, Norat T *et al.* (2005) Modified Mediterranean diet and survival: EPIC-elderly prospective cohort study. *BMJ* **30**, 991–998.
10. Trichopoulou A & Lagiou P (1997) Healthy traditional Mediterranean diet: an expression of culture, history and lifestyle. *Nutr Rev* **55**, 383–389.
11. Martinez-Gonzalez MA, Holgado B, Gibney M, Kearney J & Martinez JA (2000) Definitions of healthy eating in Spain as compared to other Europe Member States. *Eur J Epidemiol* **16**, 557–564.
12. Alexandratos N (2006) The Mediterranean diet in a world context. *Public Health Nutr* **9**, 111–117.

13. Arvaniti F, Panagiotakos DB, Pitsavos C, Zampelas A & Stefanadis C (2006) Dietary habits in a Greek sample of men and women: the ATTICA study. *Cent Eur J Public Health* **14**, 74–77.
14. Naska A, Fouskakis D, Oikonomou E *et al.* (2006) Dietary patterns and their socio-demographic determinants in 10 European countries: data from the DAFNE databank. *Eur J Clin Nutr* **60**, 181–190.
15. Papadaki A, Hondros G, A Scott J & Kapsokefalou M (2007) Eating habits of university students living at, or away from home in Greece. *Appetite* **49**, 169–176.
16. Steptoe A, Wardle J, Cui W, Baban A, Glass K, Tsuda A & Vinck J (2002) An international comparison of tobacco smoking, beliefs and risk awareness in university students from 23 countries. *Addiction* **97**, 1561–1571.
17. Colic Baric I, Satalic Z & Lukesic Z (2003) Nutritive value of meals, dietary habits and nutritive status in Croatian university students according to gender. *Int J Food Sci Nutr* **54**, 473–484.
18. Mammas I, Bertsias G, Linarddakis M, Moschandreas J & Kafatos A (2004) Nutrient intake and food consumption among medical students in Greece assessed during a Clinical Nutrition course. *Int J Food Sci Nutr* **55**, 17–26.
19. Soriano JM, Molto JC & Mañes J (2000) Dietary intake and food patterns among university students. *Nutr Res* **20**, 1249–1258.
20. Czapska D, Ostrowska L, Stefanska E & Karczewski J (2005) Chosen dietary habits in a cohort of students of the Medical University of Bialystok in the years 2000–2003. *Rocz Panstw Zakl Hig* **56**, 149–155.
21. Skemiene L, Ustinaviciene R, Piesine L & Radisauskas R (2007) Peculiarities of medical students' nutrition. *Medicina* **43**, 145–152.
22. Serra-Majem L, Ribas L, Ngo J, Ortega R, Garcìa A, Pèrez C & Aranceta J (2004) Food, youth and the Mediterranean diet in Spain. Development of KIDMED, Mediterranean Diet Quality Index in children and adolescents. *Public Health Nutr* **7**, 931–935.
23. National Center for Health Statistics (1996) *NHANES III: Health, United States, 1995*. Hyattsville, MD: Public Health Service.
24. Willett WC, Sampson L, Stampfer MJ, Rosner B, Bain C, Hennekens CH & Speizer FE (1985) Reproducibility and validity of semiquantitative food frequency questionnaire. *Am J Epidemiol* **122**, 51–65.
25. Rimm EB, Giovannucci EL, Stampfer MJ, Colditz GA, Litin LB & Willett WC (1992) Reproducibility and validity of an expanded self-administered semi-quantitative food frequency questionnaire among male health professionals. *Am J Epidemiol* **135**, 1114–1126.
26. Martin-Moreno JM, Boyle P, Gorgojo L, Maisonneuve P, Fernandez-Rodriguez JC & Willett WC (1993) Development and validation of a food frequency questionnaire in Spain. *Int J Epidemiol* **22**, 512–519.
27. Gerber M (2006) Qualitative methods to evaluate Mediterranean diet in adults. *Public Health Nutr* **9**, 147–151.
28. Gerber M (2001) The comprehensive approach to diet: a critical review. *J Nutr* **131**, 3051–3055.
29. Istituto Nazionale di Ricerca per gli Alimenti e la Nutrizione (2003) *Linee guida per una sana alimentazione italiana*. Rome: INRAN.
30. Booth M (2000) Assessment of physical activity: an international perspective. *Res Q Exerc Sport* **7**, 114–120.
31. Craig CL, Marshall AL, Sjostrom M *et al.* (2003) International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc* **35**, 1381–1395.
32. Food and Nutrition Board, Institute of Medicine (2003) *Dietary Reference Intakes (DRIs): Recommended Intakes for Individuals, Vitamins and Elements*. Washington, DC: National Academies Press.
33. Hercberg S, Preziosi P, Galan P, Deheeger M, Papoz L & Dupin H (1991) Dietary intake of a representative sample of the population of Val-de-Marne; III. Mineral and vitamin intake. *Rev Epidemiol Sante Publique* **39**, 245–261.
34. Guerra A, Feldl F & Koletzko B (2001) Fatty acid composition of plasma lipids in healthy Portuguese children: is the Mediterranean diet disappearing? *Ann Nutr Metab* **45**, 78–81.
35. Avellone G, Di Garbo V, Panno AV, Cordova R, Abruzzese G, Rotolo G, Raneli G, De Simone R & Strano A (1994) Cardiovascular risk factors and dietary habits in secondary school children in southern Italy. *Int Angiol* **13**, 148–153.
36. Tur JA, Romaguera D & Pons A (2004) Food consumption patterns in a Mediterranean region: does the Mediterranean diet still exist? *Ann Nutr Metab* **48**, 193–201.
37. Arroyo I, Rocandio P, Ansotegui AL, Pascual AE, Salces BI & Rebato OE (2006) Diet quality, overweight and obesity in university students. *Nutr Hosp* **21**, 673–679.
38. Perez A, Hoelscher DM, Brown HS & Kelder SH (2007) Differences in food consumption and meal patterns in Texas school children by grade. *Prev Chronic Dis* **4**, A23.
39. Gazzaniga JM & Burns TL (1993) Relationships between diet composition and body fatness, with adjustment for resting energy expenditure and physical activity, in preadolescent children. *Am J Clin Nutr* **58**, 21–28.
40. Swinburn BA, Jolley D, Kremer PJ, Salbe AD & Ravussin E (2006) Estimating the effects of energy imbalance on changes in body weight in children. *Am J Clin Nutr* **83**, 859–863.
41. Poulain JP (1998) Mutation des pratiques et nouvelles formes d'equilibre alimentaire. In *Actes des IV Rencontres du Reseau Agronomique Mediterraneen*, pp. 77–93 [Agropolis, editor]. Avignon, France: Agropac.
42. Garcia-Closas R, Berenguer A & Gonzalez CA (2006) Changes in food supply in Mediterranean countries from 1961 to 2001. *Public Health Nutr* **9**, 53–60.
43. O'Neil PM (2001) Assessing dietary intake in the management of obesity. *Obes Res* **9**, 361–366.
44. Brunner E, Stallone D, Juneja M, Bingham S & Marmot M (2001) Dietary assessment in Whitehall II: comparison of 7 d diet diary and food-frequency questionnaire and validity against biomarkers. *Br J Nutr* **86**, 405–414.
45. Fruin ML & Rankin JW (2004) Validity of a multi-sensor armband in estimating rest and exercise energy expenditure. *Med Sci Sports Exerc* **36**, 1063–1069.
46. Jakicic JM, Marcus M, Gallagher KI, Randall C, Thomas E, Goss FL & Robertson RJ (2004) Evaluation of the SenseWear Pro Armband to assess energy expenditure during exercise. *Med Sci Sports Exerc* **36**, 897–904.
47. King GA, Torres N, Potter C, Brooks TJ & Coleman KJ (2004) Comparison of activity monitors to estimate energy cost of treadmill exercise. *Med Sci Sports Exerc* **36**, 1244–1251.
48. Debate RD, Topping M & Sargent RG (2001) Racial and gender differences in weight status and dietary practices among college students. *Adolescence* **36**, 819–833.
49. Huang TT, Harris KJ, Lee RE, Nazir N, Born W & Kaur H (2003) Assessing overweight, obesity, diet, and physical activity in college students. *J Am Coll Health* **52**, 83–86.
50. Sakamaki R, Amamoto R, Mochida Y, Shinfuku N & Toyama K (2005) A comparative study of food habits and body shape perception of university students in Japan and Korea. *Nutr J* **31**, 4–31.
51. Racette SB, Deusinger SS, Strube MJ, Highstein GR & Deusinger RH (2005) Weight changes, exercise, and dietary patterns during freshman and sophomore years of college. *J Am Coll Health* **53**, 245–251.