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(7,8) and cancer(9), and to the higher life expectancy(9) in the Mediterranean area than in other industrialized countries, suggesting that Mediterranean habits represent a good preventative 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
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 = 150 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). 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: ≥30 kg/m² = obese; 25–29.9 kg/m² = overweight; 18.5–24.9 kg/m² = normal weight; ≤18.5 kg/m² = 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, Martinisiculo, 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(23,27,28). 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...
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 < 0.05 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...
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

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 comparing each group with all other groups.

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

<table>
<thead>
<tr>
<th>Macronutrient (％ of energy)</th>
<th>Girls</th>
<th></th>
<th></th>
<th>Boys</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrate</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>NW</td>
<td>54.5±b</td>
<td>a,b</td>
<td>6.8</td>
<td>a,b</td>
<td>5.3</td>
<td>b</td>
</tr>
<tr>
<td>OW</td>
<td>55.1±h</td>
<td>a,b</td>
<td>5.5</td>
<td>h</td>
<td>4.7</td>
<td>g</td>
</tr>
<tr>
<td>Protein (%) of energy</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>NW</td>
<td>14.1±b</td>
<td>a,b</td>
<td>2.5</td>
<td>a,b</td>
<td>3.1</td>
<td>a</td>
</tr>
<tr>
<td>OW</td>
<td>15.0±l</td>
<td>a,b</td>
<td>2.6</td>
<td>l</td>
<td>1.3</td>
<td>b</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>NW</td>
<td>30.8±b</td>
<td>a,b</td>
<td>7.3</td>
<td>b</td>
<td>3.6</td>
<td>a</td>
</tr>
<tr>
<td>OW</td>
<td>29.1±l</td>
<td>a,b</td>
<td>2.5</td>
<td>l</td>
<td>1.4</td>
<td>a</td>
</tr>
<tr>
<td>Alcohol (%) of energy</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>NW</td>
<td>0.6±b,c</td>
<td>a,b,c</td>
<td>0.4</td>
<td>b,c</td>
<td>0.3</td>
<td>b</td>
</tr>
<tr>
<td>OW</td>
<td>0.7±l</td>
<td>a,b</td>
<td>0.6</td>
<td>l</td>
<td>0.2</td>
<td>b</td>
</tr>
</tbody>
</table>

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.

**Table 2** Lipid intake in Italian and Spanish girls and boys

<table>
<thead>
<tr>
<th>Lipid</th>
<th>Girls</th>
<th></th>
<th></th>
<th>Boys</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cholesterol (mg/d)</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>NW</td>
<td>266±a,b</td>
<td>a,b,c</td>
<td>0.1</td>
<td>c</td>
<td>591±c,d</td>
<td>c,d</td>
</tr>
<tr>
<td>OW</td>
<td>264±a,b</td>
<td>a,b,c</td>
<td>0.2</td>
<td>b,c</td>
<td>679±d,a,b</td>
<td>d,a,b</td>
</tr>
<tr>
<td>SFA (g/d)</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>NW</td>
<td>4±c</td>
<td>c</td>
<td>19±b,c</td>
<td>b,c</td>
<td>41±e</td>
<td>e</td>
</tr>
<tr>
<td>OW</td>
<td>4±c</td>
<td>c</td>
<td>37±d</td>
<td>d</td>
<td>35±e</td>
<td>e</td>
</tr>
<tr>
<td>PUFA (g/d)</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>NW</td>
<td>8±b</td>
<td>b</td>
<td>29±b,c</td>
<td>b,c</td>
<td>46±b,e</td>
<td>b,e</td>
</tr>
<tr>
<td>OW</td>
<td>6±b</td>
<td>b</td>
<td>39±b</td>
<td>b</td>
<td>39±b</td>
<td>b</td>
</tr>
<tr>
<td>PUFAs (% of total)</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>NW</td>
<td>11±c</td>
<td>c</td>
<td>2.5</td>
<td>c</td>
<td>11±d</td>
<td>d</td>
</tr>
<tr>
<td>OW</td>
<td>13±l</td>
<td>a,b</td>
<td>1.8</td>
<td>l</td>
<td>13±m</td>
<td>m</td>
</tr>
<tr>
<td>MUFA (% of total)</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>NW</td>
<td>38±a</td>
<td>a</td>
<td>9.0</td>
<td>a</td>
<td>45±b</td>
<td>b</td>
</tr>
<tr>
<td>OW</td>
<td>43±c</td>
<td>c</td>
<td>6.5</td>
<td>c</td>
<td>45±b</td>
<td>b</td>
</tr>
<tr>
<td>MUFA (% of total)</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>NW</td>
<td>51±a</td>
<td>a</td>
<td>2.0</td>
<td>a</td>
<td>52±a</td>
<td>a</td>
</tr>
<tr>
<td>OW</td>
<td>54±c</td>
<td>c</td>
<td>1.0</td>
<td>c</td>
<td>52±a</td>
<td>a</td>
</tr>
</tbody>
</table>

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.

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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...
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(34,35,36). 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 imbalance 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(35,41,42). Our results are in agreement with these findings, although showing
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\(^{35,34}\), 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.

Acknowledgements

The research protocol was approved by a locally appointed ethical committee and the informed consent of the subjects was obtained.

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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


