

Adolescents in southern regions of Italy adhere to the Mediterranean diet more than those in the northern regions



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ABSTRACT

There is a large amount of literature regarding the benefits of the Mediterranean diet in the adult population; however, there is growing curiosity about the individuals who naturally adhere to those principles early in life. The "Evaluation of Dietary Habits in Adolescents," carried out by the National Research Council of Italy in 2009, is a survey that aimed to assess the dietary habits and lifestyles of Italian adolescents and their adherence to the Mediterranean diet. We hypothesized that there would be differences across regions, with a higher adherence in Southern Italy compared with Northern Italy based on geography. The survey was conducted in 3 different geographic locations in Italy and included a convenience sample of adolescents who attended either a middle or high school. The participants were asked to fill out a questionnaire concerning demographic data, lifestyle factors, and eating patterns, and scores were assigned according to adherence to the Mediterranean diet, as calculated using Trichopoulou's Mediterranean diet scale. The final sample included 565 adolescents, between 12 and 19 years old, who attended school in the northeastern, northwestern, or southern regions of Italy in 2009. According to the findings, 38.6% of the respondents had scores indicating a low adherence to the Mediterranean diet, whereas only 14% had scores showing a high adherence. Teenagers from the Southern region showed the highest adherence. Those with a high adherence to the Mediterranean diet consumed higher quantities of fiber, iron, vitamin B6, vitamin C, folic acid, vitamin A, vitamin D, and monounsaturated fats.

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Abbreviations: BMI, body mass index; CNR, Italian National Research Council; INRAN, Istituto Nazionale di Ricerca per gli Alimenti e la Nutrizione; INRAN-SCAI, Italian National Food Consumption Survey.

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1. Introduction

Since the mid 1900s, investigators began reporting on the protective role that the Mediterranean diet has on several cardiovascular risk factors [1]. Although it soon became evident that the greatest strength of this diet was not due to a single nutrient but in the interaction of its components, subsequent studies tended to concentrate on the former. The Mediterranean diet is characterized by a high intake of vegetables, legumes, fruit, cereal (in particular, nonrefined ones), fish, and monounsaturated fats (particularly, olive oil); a moderate intake of milk products such as cheese and yogurt; moderate consumption of alcohol (wine); and a low intake of saturated fats and red meat [2]. (See Figure.)

Various authors have demonstrated that adherence to the Mediterranean diet reduces the individual's global cardiovascular mortality rate as well as the risk of developing diabetes, tumors, and neurodegenerative diseases, such as Alzheimer and Parkinson diseases [3].

Adolescence is a critical, complex phase in an individual's physical and emotional development [4], and diet and nutrition are an important aspect of one's life course. Poor eating habits formed during childhood and adolescence can potentially increase the risk of some typical adult diseases. A high percentage of obese children and adolescents now present metabolic complications, such as insulin resistance, type 2 diabetes, dyslipidemia, and hepatic steatosis. This is also called the metabolic syndrome, which was only found in adults until a decade ago [5]. These complications, together with hypertension and increased concentrations



Figure - Mean BMI for each region in relation to BMI percentiles for Italy by age and gender pan A girls and panel B boys.



of inflammatory mediators, predispose an obese child to cardiovascular events and premature adult death [6]. Some studies have even associated childhood/adolescent obesity to a higher risk of tumors in adulthood [7]. Childhood obesity also makes an individual more inclined to precocious puberty, polycystic ovary syndrome, nighttime sleep apnea, orthopedic complications, and psychological and social disturbances [8-10]. It should also be noted that obese children have a higher probability of becoming obese adults [11].

Several studies focusing on eating habits in Italian children and adolescents have been conducted [12-23]; however, adherence to the Mediterranean diet has never been specifically assessed.

Designed and implemented in 2009 by the Italian National Research Council (CNR) in Padova, Italy, the "Evaluation of Diet Habits in Adolescents" survey aimed to assess the eating habits of adolescents who attended middle and high schools in different geographic areas in Italy and to assess their adherence to the Mediterranean diet. We hypothesized that we would find considerable differences across regions and a higher adherence to the Mediterranean diet in the adolescents living in the Southern region.

2. Methods and materials

2.1. Study sample

In 2009 and using a convenience sample of students attending middle/high schools, 3 school districts were selected on a feasibility basis: Montichiari (in the province of Brescia, the region of Lombardy, located in Northwest Italy), Conegliano (in the province of Treviso, the Veneto region, located in Northeast Italy), Ostuni (in the province of Brindisi, the region of Puglia, located in Southern Italy). A total of 565 adolescents were asked to fill out the study questionnaires: 189 attending high schools in Montichiari (mean age, 16.7 \pm 1.3 years), 209 attending middle schools in Conegliano (mean age, 13.0 \pm 0.8 years), and 167 attending high schools in Ostuni (mean age, 15.9 \pm 1.1 years).

Authorization was acquired from the principal of each school involved, as national regulations require this when data collection is carried out in schools. In addition, parents provided written consent for each student participating in the survey.

2.2. The questionnaire

The questionnaire included 3 different sections. The first section focused on general demographic data. The second included lifestyle information, such as physical activity (weekly frequency and length of time spent practicing sports), the mean daily time spent watching television or sitting at a computer, smoking habits, nutritional supplement use, diet practices, and self-reported weight and height. The third section was a semiquantitative food frequency questionnaire that assessed the weekly food consumption of each student and included breakfast, morning snack, lunch, afternoon snack, dinner, and extra snacks. Nutrient and food intakes were assessed using the Willett food frequency questionnaire [24], which was validated for Mediterranean diet-based populations over a wide age range [25]. The questionnaire contained a list of 112 foods, and participants were asked to answer questions about their food intake over the previous week. Food item categories included were as follows:

- breakfast: milk, yogurt, fruits, fruit juice, cornflakes, muesli, cookies, bread, jam, sugar, honey, butter, snacks, and cakes;
- morning and afternoon snacks: yogurt, fruit juice, fruits, snacks, crackers, cookies, sugar, pizza, sandwiches, and other snacks;
- lunch and dinner: pasta or rice, potato dumplings, soup, parmesan/grana padana cheese, oil (olive oil, seed oil), butter, bread, breadsticks, veal/beef/pork, chicken breast, fish, cod sticks, cold cuts (different types), cured meats (such as salami, different types), cottage cheese, hard cheese, eggs, potatoes, fried potatoes, vegetables, legumes, fruits, and pizza; and
- extra: ice cream, various cakes, pastries, soft drinks, beer, wine, and coffee.

Food portion sizes were estimated using standard household measures such as a glass or a spoon; photographs of different defined portion sizes were also used (Appendix A presents a sample question). The images were obtained from the Winfood (MediMatica, Italy) computerized software program, which is routinely used to calculate nutrient and energy intake in Italy. The software uses the National Research Institute for Food and Nutrition (INRAN) and the European Institute of Oncology reference databases.

Four trained researchers, collaborating with the CNR, provided instructions during the questionnaire session and

were available to answer any questions posed by the students. When questionnaires were turned in, the researchers also checked them over for accuracy and completeness.

Self-reported heights and weights that were declared on the questionnaire were used to calculate body mass index (BMI), by dividing the weight of the subject by his height squared. Body mass index values for the participants who were 20 or younger were classified using the method by Cacciari et al [26].

2.3. The Mediterranean diet score

A score indicating the degree of adherence to the Mediterranean diet was calculated for each of the participants, using a method outlined by Trichopoulou et al [27] and revised to include fish by Hu et al [28]. For each participant, the degree of adherence to the Mediterranean diet was assessed using a 10-point scale that incorporated the salient characteristics of his/her diet; higher scores indicated a greater adherence to the diet. A value of 0 to 1 was assigned to each of the 9 dietary components. With regard to beneficial components (vegetables, legumes, fruits and nuts, cereal, and fish), participants whose consumption was below the median value, according to the Italian National Food Consumption Survey (INRAN-SCAI) 2005-06 Report [29] were assigned a score of 0, whereas those whose consumption was at or above the median were given a 1. With regard to components considered detrimental (meat, poultry, and dairy products), participants whose consumption was below the median level were assigned a score of 1; those whose consumption was at or above the median value were given a 0. Unlike for an adult population, experts recommend that adolescents avoid alcohol consumption. Thus, alcohol consumption for each participant was assessed, and values above 0.0 g/d were considered detrimental. Although all other food items were judged based on the INRAN-SCAI Report, the monounsaturated/saturated fat ratio was dichotomized based on median values for sex found in the sample of adolescents analyzed. Consumption of these fats higher than or equal to the median was assigned a value of 1. The total score ranged from 0 (minimal adherence) to 9 (maximal adherence).

In accordance with the work of Trichopoulou et al [2], the scores were then categorized into 3 classes regarding adherence to the Mediterranean diet: 0 to 3 was defined as low, 4 to 5 was defined as moderate, and 6 to 9 was defined as high.

2.4. Statistical analyses

The characteristics of the sample, stratified by region (Montichiari, Conegliano, and Ostuni) and class of adherence to the diet (low, medium, or high adherence), were expressed in terms of means \pm SDs, medians, or percentages. The comparisons between groups were made using the χ^2 test or the exact test for categorical variables. The generalized linear model procedure was applied for quantitative variables, after homoscedasticity was verified using Levine's test (in case of heteroscedasticity, Welch's analysis of variance was applied). The Mann-Whitney U or the Kruskal-Wallis test was considered for not normally distributed variables. Post hoc analyses

and Bonferroni adjustments were used to compare data. A SAS macro was used to carry out multiple comparisons after Kruskal-Wallis test for not normally distributed variables ("Kruskal-Wallis analysis with multiple comparisons" by Alan C. Elliott and Linda S. Hynan, version 10-15-2010). All analyses were carried out using SAS statistical software package version 9.3 (SAS Institute, Cary, NC, USA).

3. Results

3.1. Sample

The study sample characteristics are outlined in Table 1. The BMI of the participants, which was calculated from self-reported weight and height, was found to be significantly different in the 3 regions: Ostuni, $23.9 \pm 4.2 \text{ kg/m}^2$;

Montichiari, $21.7 \pm 2.7 \text{ kg/m}^2$; and Conegliano, $19.5 \pm 2.7 \text{ kg/m}^2$. Figure outlines the average BMI in each region in relation to BMI percentiles for the Italian population, according to sex and age [26].

With regard to physical activity, the region with the lowest percentage of participants who declared that they participated in sports activities was Ostuni (60.6%), with respect to 70.7% and 71.6% found in Montichiari and Conegliano, respectively (P = .0496).

Sedentarity, defined as time spent in front of the PC or watching TV, was slightly higher in Montichiari compared to Ostuni or Conegliano (P = .0005). The percentage of teenagers who admitted to smoking was significantly higher in Montichiari (23.3%) than in Ostuni (17.7%) and Conegliano (1%); however, the fact that the adolescents living in Conegliano were younger than those from the other two regions could have played a part.

Table 1 – Characteristics of the participan	ts in the 3 school distric	ts studied		
	Montichiari (BS), n = 189	Conegliano (TV), n = 209	Ostuni (BR), n = 167	Р
Age, y (means ± SD)	16.7 ± 1.3	13.0 ± 0.8	15.9 ± 1.1	M vs C < .0001 M vs O < .0001 C vs O < .0001
Sex, females (%)	48.7	53.1	44.9	0.2824
BMI, kg/m² (means ± SD)	21.7 ± 2.7	19.5 ± 2.7	23.9 ± 4.2	M vs C < .0001 M vs O < .0001 C vs O < .0001
Underweight	5.0	3.4	1.2	<.0001
Normal weight	88.4	92.1	59.0	
Overweight	5.5	4.6	27.1	
Obese	1.1	0.0	12.7	
Sports, yes, habitually (%) Sports, weekly frequency (%)	70.7	71.6	60.6	.0496
1, 2 times a week	30.0	44.3	35.0	
3, 4, 5+ times a week	70.0	55.7	65.0	.0426
Sports, time training lasted (%)				
1 h	16.1	22.2	26.0	.3108
1 ½ h	43.9	34.9	37.0	
≥2 h	40.0	43.0	37.0	
Time spent at the PC/TV (%)				
<1 h	9.8	19.3	15.9	.0005
1-2 h	45.7	54.6	56.1	
>2 h	44.6	26.1	28.1	
Use of supplements (vitamins, amino acids/protein, others) (%)	21.7	22.3	15.7	.2269
On a diet (%)	9.5	2.9	1.8	.0009
Smokes now (%)	23.1	1.0	17.7	<.0001
Smokes, cigarettes/day (means ± SD)	6.5 ± 4.1	3.0 ± 1.4	11.2 ± 6.8	M vs C 1.0000 M vs O .0018 C vs O .1183
Amount of water consumed (L/d) (means ± SD)	1.6 ± 0.6	1.6 ± 0.7	1.7 ± 0.8	M vs C 1.0000 M vs O 1.0000 C vs O 1.0000
Total calories, kcal, females (means ± SD)	2178.4 ± 705.1	2351.6 ± 741.1	2240.2 ± 819.4	.1670
Total calories, kcal, males (means \pm SD)	3042.2 ± 925.7	2704.0 ± 808.7	3257.1 ± 910.9	M vs C >.05 M vs O >.05 C vs O < .05

Post hoc analyses and Bonferroni adjustments were applied to compare data; for not normally distributed variables, a SAS macro was considered to perform multiple comparisons after Kruskal-Wallis test. Bold data indicates significance at P values <0.05. Table 2 – Comparison between INRAN-SCAI 2005, 2006, reference values and values identified in the samples from the current study

Components of the Mediterranean diet score

	INRAN-SCAI values (2005, 2006 ^a)	Values in the sample							
Females									
Vegetables (g/d)	153.8	171.4							
Legumes (g/d)	0	5.3							
Fresh and dried fruits (g/d)	182	165.2							
Cereals (g/d)	260.9	352.1							
Fish (g/d)	37.5	38.7							
Meat and chicken (g/d)	107.4	173.0							
Milk and milk products (g/d)	208.5	227.7							
Alcoholic beverages	0.0	0.0							
Males									
Vegetables (g/d)	165.6	128.6							
Legumes (g/d)	0	16.8							
Fresh and dried fruits (g/d)	118	192.9							
Cereals (g/d)	324	500.0							
Fish (g/d)	37.5	47.1							
Meat and chicken (g/d)	129.6	251.4							
Milk and milk products (g/d)	250.5	320.7							
Alcoholic beverages	0.0	0.0							
Values are expressed as medians. ^a Ref [29].									

The association between a specific region and the tendency to follow a hypocaloric diet was found to be significant. Almost 10% of the teenagers living in Montichiari

Table 3 – Distribution of the Mediterranean diet score and other characteristics of the sample studied										
	Mediterranean diet score									
	Score 0-3 (n = 218)	Score 4-5 (n = 268)	Score 6-9 (n = 79)	Р						
Data-gathering	centers (%)			.0719						
Montichiari Conegliano Ostuni	46.0 37.3 31.7	42.3 46.9 53.9	11.6 15.8 14.4	(P = .0196 for the dichotomized Mediterranean diet score 0-3 vs 4+)						
Sex, males (%)	49.5	51.9	50.6	.8777						
Age, y (means ± SD)	15.1 ± 1.9	15.1 ± 2.1	14.9 ± 1.8	1.0000						
BMI, kg/m ² (means ± SD)	21.3 ± 3.4	21.6 ± 4.0	21.1 ± 3.5	.7023						
Sports, habitually (%)	66.1	67.2	76.6	.2129						
Sports, 3+ times a week (%)	\$ 56.3	68.0	64.4	.0979						
Sports, >1 h each training session (%)	82.4	78.7	71.2	.2064						
Time spent at the PC/TV >2 h/d (%)	36.7	31.8	25.3	.1618						
Current smoker (%)	13.6	13.2	13.0	.9877						

declared that they were on a diet, compared to only 1.8% in Ostuni.

In regards to energy requirements, the mean daily caloric intake was found to be higher in the male participants living in Ostuni compared to those living in the other 2 regions. Among females living in the 3 regions, no significant differences were found concerning food intake.

3.2. Adherence to the Mediterranean diet (Mediterranean diet score)

To assign the adolescents a value of their Mediterranean diet adherence, the median values for Italian teenagers (10-17.9 years of age) by sex and according to the INRAN-SCAI 2005-6 Survey, along with the corresponding median values in our population samples, were used (Table 2).

The mean Mediterranean diet score was found to be 3.9 ± 1.5 . Of the total number of adolescents being monitored, 38.6% had a score indicating low adherence to the Mediterranean diet (a score of 0-3), 47.4% had a score indicating a moderate adherence (a score of 4-5), and only 14% had a score indicating a high adherence (a score of 6-9).

Table 3 shows score distribution with regard to the other characteristics of the population sample. A borderline significance was found for the regions studied. If we

Table 4 – Distribution of the Mediterranean diet score and

intake of various nutrients										
	Mediterranean diet score									
	Score 0-3	Score 4-5	Score 6-9	Р						
	Low adherence (n = 218)	Medium adherence (n = 268)	High adherence (n = 79)							
Total calories, kcal	2408.5	2674.99	2650.78	.0022						
Proteins, g	104.4	113.9	110.0	.0580						
Total fats, g	83.1	94.6	92.7	.1024						
Carbohydrates, g	324.7	358.2	378.0	<.0001						
Proteins, %	17.46	16.95	16.2	.0009						
Total fats, %	31.43	30.87	29.69	.1434						
Carbohydrates, %	50.43	51.88	53.69	.0033						
Oligosaccharides/ carbohydrates, %	36.36	36.13	38.44	.5853						
Total saturated fats, %	45.44	41.25	36.83	<.0001						
Fiber (g)/1000 kcal	7.23	8.33	9.28	<.0001						
Calcium, mg	946.12	998.74	873.16	.3655						
Iron, mg	11.98	14.23	15.95	<.0001						
Vitamin B6, mg	1.39	1.62	1.78	<.0001						
Vitamin C, mg	161.27	239.44	292.12	<.0001						
Folic acid, μ g	206.34	262.65	318	<.0001						
Vitamin A, μ g	905.16	1256.39	1450.25	<.0001						
Vitamin D, μ g	3.66	4.96	5.82	<.0001						
Cholesterol, mg	391.12	399.43	407.88	.3798						
Monounsaturated	28.9	34.08	37.22	<.0001						
Monounsaturated/ total fats, %	43.4	46.04	50.18	<.0001						
37-1		_								

Values are expressed as medians.

Bold data indicates significance at P values <0.05.

consider a dichotomized score of 0 to 3 (ie, low adherence) vs 4+ (ie, medium or high adherence), the association was significant and the teenagers from Ostuni showed the highest percentage of adherence to the Mediterranean diet. Correlations between adherence to the diet and other lifestyle aspects, such as physical activity, sedentarity, or BMI, were not found to be significant.

In Table 4, the median values relative to the daily caloric intake and categorized into macronutrients and micronutrients in reference to adherence to the Mediterranean diet are shown. As was to be expected, the adolescents whose diets most closely adhered to the Mediterranean diet assumed higher median values of carbohydrates, fiber, vitamin B6, vitamin C, folic acid, vitamin A, vitamin D, and monounsaturated fats (P < .05).

4. Discussion

The "Evaluation of Diet Habits in Adolescents" survey was designed to evaluate the dietary habits, lifestyles, and Mediterranean diet adherence by Italian adolescents living in various geographic areas in Italy. Although several studies on this topic have been carried out in Greece [30-35], Spain [36-39], and Cyprus [40], to our knowledge, this is the first study to analyze Italian adolescents and their adherence to the Mediterranean diet. Results from some previous studies in other Mediterranean countries have shown that the Mediterranean diet has a high nutritional quality, positively affects quality of life, has a protective effect against being overweight and obese in children/adolescents, and is associated with less time spent on sedentary activities.

According to our findings, a high adherence to the Mediterranean diet was found in only 14% of the respondents, and a moderate one, in 47.4%. Adherence to the Mediterranean diet appears to be dwindling in younger generations who appear to be gradually abandoning traditional diet patterns. As was expected, adolescents from Southern Italy were found to be more adherent to the Mediterranean diet (moderate or high adherence) in comparison to those from the other 2 areas. Ostuni, the region with the best adherence to the Mediterranean diet, also had a higher mean caloric intake and higher mean BMI. The mean daily caloric intake at this region even exceeded the diet requirements recommended by "Nutrient Intake Goal for the Italian population LARN" tables [41]. However, these same respondents reported that they dedicated little time for participation in physical activities (sports). It is well known that the Mediterranean diet alone does not protect against obesity. Indeed, only regular physical activity and a diet low in saturated fat but rich in fruits and vegetables can prevent obesity and reduce the risk of chronic adult conditions, such as stroke, hypertension, diabetes, dyslipidemia, cardiovascular diseases, and cancer [42].

The present study has some limitations. First, the use of a convenience sample in view of feasibility reasons: the small number of schools that were examined and the differences in the ages of the participants do not allow us to make generalizations. Studies based on large random samples that are representative of the Italian adolescent population are obviously warranted. Second, the weight of the participants was not measured by the investigators, a limit that is often encountered in epidemiological studies carried out in Italy [23]. Third, median caloric nutrient intakes of Italian teenagers, published in the INRAN-SCAI 2005-6 Survey report, were used to calculate the Mediterranean diet score of the adolescents. This was despite the fact that the results of the survey are only based on a 3-day food record and the present study was conducted for an entire week.

Despite these limitations, this study could provide useful information for addressing recommendations regarding the actual benefits of the Mediterranean diet. The Mediterranean diet should be viewed as not just food choices that synergistically work together to preserve health but as a lifestyle in which qualitative food characteristics are associated with quantitative ones (Parca diet) and with the addition of adequate physical activity. Lifestyle behaviors and adherence to the Mediterranean diet, in relation to health and diseases, warrant further investigation. This is particularly necessary with the number of studies reporting an increase in unhealthy dietary habits in the young Italian population as well as in other European populations [43].

School-based educational programs that inform students about the risks linked to an unhealthy diet and a sedentary lifestyle and provide creative and innovative ways to market and deliver the typical products of the Mediterranean diet (such as through vending machines) could be important steps to a more healthy future for younger generations.

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Appendix A.

Sample from the food frequency questionnaire used in the present study

The semiquantitative food frequency questionnaire was divided into 6 sections that were marked with different colors:

- Breakfast: yellow
- Morning and afternoon snack: orange
- Lunch: green
- Dinner: blue
- Extras: purple

The participants were asked: "How many times did you eat this food over the past week?" They were then asked to specify the number of times they ate a food from each category as well as to indicate the photograph most indicative of their serving sizes. Example: if every morning the participant had a cup of whole milk, he/she should complete the questionnaire in this way:

		How many times did you eat this food during last week?							st week?	1 time		amall	modium		Different
BR	EAKFAST	never	1	2	3	4	5	6	every day	every 2 weeks	1 time per month	portion	portion	large portion	portions*
ILK	whole	0	0	0	0	0	0	0	×	0	0	130 ml	200 ml	20 ml	
ž	partly skimmed	0	0	0	0	0	0	0	o	0	0	\searrow			

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