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Mediterranean diet in relation to body mass index and waist-to-hip ratio

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Abstract

Objective: The Mediterranean diet is rich in fat and starch, and hence may be related to overweight. We therefore investigated the relationship between adherence to a Mediterranean diet and body mass index (BMI) and waist-to-hip ratio (WHR).

Design and setting: Data were obtained from the control group of a network of case–control studies on cancer conducted in major teaching and general hospitals in four Italian areas between 1991 and 2002. An interviewer-administered validated 78-item food-frequency questionnaire was used to obtain information on the subjects' habitual diet. Information on socio-economic factors, lifestyle habits and anthropometric measures was also collected. A Mediterranean diet score (MDS) was derived on the basis of eight characteristics of the Mediterranean diet.

Subjects: Subjects were 6619 patients (3090 men, 3529 women) admitted to hospital for a wide spectrum of acute, non-neoplastic conditions, unrelated to known risk factors for cancer and long-term modifications of diet.

Results: In multiple linear regression models adjusted for age, study centre, education, tobacco smoking, occupational physical activity and total energy intake, the MDS was not related to BMI ($\beta = 0.05$ for men and -0.04 for women) or WHR ($\beta = 0.000$ and 0.001, respectively) in both sexes.

Conclusions: Adherence to the major characteristics of the Mediterranean diet is unrelated to BMI and WHR, confirming previous data from Greece and Spain.

Keywords
Mediterranean diet
Body mass index
Waist-to-hip ratio
Overweight
Obesity
Italy

The Mediterranean diet has long been related to a reduced incidence of coronary heart disease[1]. More recently, adherence to a Mediterranean diet has also been associated with increased survival in the elderly[2,3] and in the general population[4], and a reduced risk of cancers of the upper digestive and respiratory tracts[5].

Overweight is a major problem in Mediterranean countries, although its prevalence has been stable at about one-third of the population in Italy over the last 15 years[6]. It has been suggested that the Mediterranean diet, rich in fat (particularly from olive oil) and starch[7], may be related to overweight. However, in a longitudinal study conducted in Spain, weight increments were smaller, if anything, in participants with higher adherence to an 'a priori' defined Mediterranean dietary pattern[8]. Moreover, in a population sample of adults from Greece, adherence to a Mediterranean diet was unrelated to body mass index (BMI) and waist-to-hip ratio (WHR)[9], whereas in another study from Spain a higher BMI and risk of being obese were associated with a lower adherence to a traditional Mediterranean diet in both genders[10].

To provide further information on the issue, we analysed the associations between a Mediterranean diet score (MDS) and BMI and WHR using data from Italy.

Materials and methods

Subjects were 6619 adults (3090 men, 3529 women; median age 58 years) from the control group of a network of case–control studies conducted in four areas of northern, central and southern Italy[11]. These subjects were admitted to major teaching and general hospitals of the study areas for a wide spectrum of acute, non-neoplastic conditions, unrelated to known risk factors for cancer and long-term modifications of diet.

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An interviewer-administered validated 78-item food-frequency questionnaire (FFQ) was used to obtain information on the subjects' habitual diet[12,13]. We collected information also on education and other socio-economic factors, physical activity, tobacco smoking, alcohol drinking and coffee consumption. Self-reported information on height and weight at different ages was collected. Waist and hip circumference were measured by interviewers on 5234 subjects.

The MDS was defined a priori on the basis of eight characteristics of the traditional Mediterranean diet[2,5,9]; i.e. high monounsaturated/saturated fat ratio, moderate alcohol intake, high consumption of cereals, legumes, fruit and vegetables, and low consumption of meat and meat products, and milk and dairy products. The cut-off points for the items considered were set to the sex-specific median values. A point was attributed in the presence of each characteristic and none otherwise. For alcohol, a value of 1 was attributed to moderate drinkers (i.e. for men with consumption below 28 drinks per week and for women with consumption below 14 drinks per week), while a value of 0 was attributed to those with consumption above these values as well as to non-drinkers. The MDS was then calculated by summing up the points for each of the eight items. Thus, the score ranged between 0 (lowest adherence) and 8 (highest adherence).

Data analysis

Multiple linear regression analysis was applied to assess the association of MDS with BMI and WHR separately for men and women. The MDS was entered in the models as a continuous variable (with an increment equal to 1). Besides MDS, models with both BMI and WHR as dependent variable included terms for age, study centre, education, tobacco smoking, occupational physical activity and total energy intake.

Results

Table 1 gives the mean weekly intake of the food items contributing to the MDS according to MDS quintiles and sex. By definition, consumption of vegetables, legumes, fruit, cereals, and monounsaturated/saturated fat ratio increased, while dairy products, meat and alcohol consumption decreased, with increasing levels of the score.

Table 2 shows the coefficients (β) of the MDS, and of other factors included in the linear regression models, on BMI and WHR. In either sex, there was no relationship between the MDS and BMI ($\beta = 0.05$ for men and -0.04 for women) or WHR ($\beta = 0.000$ and 0.001, respectively). BMI was inversely related to education and smoking, and directly related to physical activity in both sexes. WHR was inversely related to education in women, but no consistent relationship emerged with other variables. Exclusion of energy intake from the model did not materially modify the estimates, nor did the inclusion of a term for BMI in the WHR models.

Discussion

Available information on the possible influence of the Mediterranean diet on weight, weight gain, BMI and other anthropometric measures is limited. In a prospective study of 6319 Spanish participants in the SUN (Seguimiento University of Navarra) cohort[8], subjects in the lowest quartile of adherence to a Mediterranean diet pattern showed a higher weight gain (+0.73 kg) than those in the highest quartile (+0.45 kg). The association, however, was no longer significant after allowing for relevant confounding factors. In a Greek study of 23 597 adult men and women[9], a 2-point increase in the score was found to correspond to increases of only a few grams in weight for both sexes. However, after allowance for

Table 1 Mean weekly intake* for food groups that are components of the Mediterranean diet score (MDS) by level of the score and sex among 3090 men and 3529 women. Italy, 1991–2002

	MDS, quintiles†									
	Men					Women				
	0–2 ($n = 524$)	3 ($n = 677$)	4 ($n = 716$)	5 ($n = 666$)	6–8 ($n = 497$)	0–2 ($n = 647$)	3 ($n = 777$)	4 ($n = 876$)	5 ($n = 704$)	6–8 ($n = 520$)
Vegetables	8.9 ± 1.9	11.2 ± 2.9	14.0 ± 3.8	16.0 ± 4.6	19.8 ± 4.8	12.0 ± 2.3	14.7 ± 4.0	17.9 ± 4.7	19.9 ± 4.2	23.3 ± 4.5
Legumes	0.5 ± 0.3	0.7 ± 0.4	0.9 ± 0.5	1.1 ± 0.5	1.3 ± 0.5	0.5 ± 0.3	0.7 ± 0.4	0.9 ± 0.5	1.0 ± 0.4	1.3 ± 0.4
Fruit	14.0 ± 4.1	18.4 ± 6.1	22.4 ± 6.8	25.6 ± 7.1	32.7 ± 7.2	23.4 ± 19.6	28.6 ± 9.0	34.2 ± 11.8	40.1 ± 10.4	47.3 ± 20.1
Dairy products	12.7 ± 3.2	11.0 ± 3.5	10.5 ± 3.6	8.9 ± 3.0	7.1 ± 2.0	13.9 ± 3.3	12.2 ± 3.5	12.0 ± 4.0	11.2 ± 3.3	9.3 ± 2.5
Cereals	27.9 ± 4.9	32.1 ± 7.4	33.0 ± 7.6	36.3 ± 6.7	40.8 ± 6.6	23.4 ± 8.1	24.8 ± 8.0	30.0 ± 10.6	31.3 ± 9.7	33.8 ± 7.5
Meat	8.4 ± 1.4	8.3 ± 2.0	7.7 ± 2.1	7.2 ± 1.6	6.6 ± 1.4	7.8 ± 2.5	7.1 ± 2.4	7.4 ± 3.7	7.4 ± 3.5	6.2 ± 2.2
Alcohol	36.7 ± 14.3	30.2 ± 14.4	25.9 ± 10.8	23.3 ± 10.3	18.5 ± 6.5	6.8 ± 3.8	6.6 ± 5.7	7.5 ± 6.5	6.5 ± 3.4	5.5 ± 2.2
Lipid ratio‡	1.2 ± 0.1	1.4 ± 0.2	1.5 ± 0.2	1.7 ± 0.2	1.9 ± 0.1	1.2 ± 0.1	1.3 ± 0.2	1.4 ± 0.2	1.6 ± 0.2	1.7 ± 0.2

*Portions or drinks per week.
†The sum does not add up to the total because of some missing values.
‡Monounsaturated/saturated fat ratio.

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Table 2 Coefficients (β) and 95% confidence intervals (CI), derived by multiple regression analysis, of body mass index (BMI) and waist-to-hip ratio (WHR) according to Mediterranean diet score (MDS), age, education, tobacco smoking and occupational physical activity. Italy, 1991–2002

	BMI ($kg\,m^{-2}$)*		WHR*	
	Men	Women	Men	Women
	($n = 3081$) (26.34 ± 3.43)† β (95% CI)‡	($n = 3510$) (25.38 ± 4.37)† β (95% CI)‡	($n = 2400$) (0.950 ± 0.078)† β (95% CI)‡	($n = 2834$) (0.830 ± 0.071)† β (95% CI)‡
MDS§	0.05 (−0.05, 0.14)	−0.04 (−0.15, 0.07)	−0.000 (−0.002, 0.002)	0.001 (−0.001, 0.003)
Age (years)				
<45	Referent	Referent	Referent	Referent
45–54	0.18 (−0.29, 0.65)	1.20 (0.75, 1.65)	0.022 (0.011, 0.034)	0.017 (0.009, 0.025)
55–64	0.12 (−0.34, 0.58)	1.36 (0.93, 1.84)	0.033 (0.022, 0.044)	0.030 (0.023, 0.039)
≥65	−0.30 (−0.77, 0.17)	0.78 (0.31, 1.25)	0.031 (0.020, 0.043)	0.043 (0.034, 0.051)
Education (years)				
<7	Referent	Referent	Referent	Referent
7–11	−0.10 (−0.39, 0.19)	−0.84 (−1.19, −0.49)	0.008 (0.000, −0.015)	−0.004 (−0.011, 0.002)
≥12	−0.67 (−1.04, −0.31)	−1.74 (−2.18, −1.30)	−0.003 (−0.012, 0.006)	−0.018 (−0.026, −0.010)
Tobacco smoking				
Never smoker	Referent	Referent	Referent	Referent
Ex-smoker	0.42 (0.12, 0.73)	0.12 (−0.36, 0.59)	0.009 (0.001, 0.016)	0.001 (−0.008, 0.010)
Current smoker (cigarettes/day)				
<15	−0.75 (−1.17, 0.32)	−1.24 (−1.66, −0.82)	0.003 (−0.008, 0.013)	−0.002 (−0.010, 0.006)
15–24	−0.65 (−1.05, 0.26)	−0.67 (−1.24, −0.11)	−0.001 (−0.011, 0.001)	−0.001 (−0.011, 0.010)
≥25	−0.57 (−1.10, −0.04)	−0.84 (−2.08, 0.40)	0.026 (0.012, 0.039)	0.013 (−0.010, 0.035)
Occupational physical activity				
Light	Referent	Referent	Referent	Referent
Moderate	0.23 (−0.10, 0.56)	0.56 (0.23, 0.89)	0.004 (−0.005, 0.012)	0.005 (−0.001, 0.011)
Heavy	0.30 (−0.02, 0.62)	0.83 (0.38, 1.28)	0.003 (−0.005, 0.011)	0.007 (−0.000, 0.015)

*The sum does not add up to the total because of some missing values.
†Mean±standard deviation.
‡Estimates from multiple linear regression models adjusted for age, study centre, education, tobacco smoking, occupational physical activity, total energy intake and MDS.
§Estimated for an increment equal to 1.

total energy intake, adherence to the Mediterranean diet was essentially unrelated to BMI and weakly related to WHR in women only. In a Spanish study of 1547 men and 1615 women[10], adherence to a traditional Mediterranean diet pattern was inversely related to BMI and obesity, with a multivariate relative risk of 0.61 for being obese in the top tertile of this score in both sexes.

The present large sample of men and women coming from different areas of Italy, and including information from a validated FFQ[12,13], therefore provides additional evidence that, after allowance for energy intake, socio-economic status and major lifestyle habits, adherence to the major characteristics of a Mediterranean diet is unrelated to BMI and WHR, confirming previous data from Greece[9] and Spain[8,10].

More than on a single dietary aspect, the interest of this study is related to the contribution of various food items, previously related to favourable health outcomes and overall survival, in a simple summary score[2,5,9].

This study has the limitation of being cross-sectional, thus limiting inference on the time sequence of the associations, but also has several strengths, including its large sample size, the validated FFQ, and the variable composition of the Mediterranean diet in northern, central and southern Italy. We also excluded subjects with chronic conditions leading to long-term modifications of diet and consequently anthropometric measures.

Height and weight were self-reported, and it is known that subjects tend to underestimate weight and overestimate height[14–16]. However, any such possible misreporting is unlikely be correlated to the indicators of Mediterranean diet considered in the present analysis. Waist and hip circumferences, on the other hand, were measured by trained interviewers.

In a similar study population, alcohol drinkers had a mean BMI similar to non-drinkers, but heavy drinkers were lighter[17]. Bread, vegetable and fruit consumption were non-significantly related to BMI. The main determinants of BMI were social class and education (inversely related) and smoking (inversely related for intermediate only)[17]. These factors were allowed for in our analyses.

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