Mediterranean diet in relation to body mass index and waist-to-hip ratio: the Greek European Prospective Investigation into Cancer and Nutrition Study

Antonia Trichopoulou, Androniki Naska, Philippos Orfanos, and Dimitrios Trichopoulos

ABSTRACT
Background: Adherence to a Mediterranean diet has been reported to increase longevity, but concerns have been expressed that such a diet may promote overweight and obesity.
Objective: The objective was to investigate whether adherence to the traditional Mediterranean diet, as operationalized in a Mediterranean diet score, is associated with body mass index (BMI) and waist-to-hip ratio (WHR).
Design: In a general population sample of 23,597 adult men and women participating in the Greek European Prospective Investigation into Cancer and Nutrition Study, a validated food-frequency questionnaire was interviewer-administered, and anthropometric, sociodemographic, physical activity, and other lifestyle characteristics were recorded. BMI and WHR were regressed on a score that reflects adherence to the traditional Mediterranean diet and potentially confounding variables.
Results: In models in which total energy intake was included, adherence to a Mediterranean diet was unrelated to BMI in both sexes and was weakly related to WHR only in women. When energy intake was not controlled for, a 2-point increase in the score was found to correspond to increases of 0.001 units in men and 0.004 units in women.
Conclusions: Adherence to a Mediterranean diet was essentially unrelated to BMI, with small differences depending on model choice and having no practical consequences. Overweight is a genuine problem in Greece and perhaps other Mediterranean countries, but it is likely to be related to limited physical activity in conjunction with excessive positive energy balance.

INTRODUCTION
A Mediterranean diet was proposed as a healthy eating pattern from ecologic evidence generated by the Seven Countries Study organized by Keys (1) and his colleagues in the 1950s. Interest in the Mediterranean diet was revived in the 1990s when a score was developed to operationalize adherence to the traditional Mediterranean diet (2). Since then several studies have evaluated adherence to a Mediterranean diet in relation to overall survival, occurrence of coronary artery disease, and survival of patients with coronary artery disease (2–9), and they have all reported beneficial effects of the Mediterranean diet. At the same time, however, concerns were expressed that the Mediterranean diet, which relies heavily on high intake of olive oil, may promote weight gain (10). Results from European Union–wide surveys also indicate that Mediterranean populations and in particular the Greek population that most closely adheres to the Mediterranean diet have a high prevalence of overweight and obesity (11 and unpublished observations). To investigate this issue, we studied adherence to a Mediterranean diet in relation to body mass index (BMI; in kg/m²) and waist-to-hip ratio (WHR) by using data from the Greek European Prospective Investigation into Cancer and Nutrition (EPIC) Study.

SUBJECTS AND METHODS
The study sample consisted of apparently healthy volunteers (men and women) 20–86 y old, recruited during a 5-y period (1994–1999) from around Greece, to participate in the Greek component of the European Prospective Investigation into Cancer and Nutrition (EPIC) study. EPIC is a prospective cohort study, conducted in 23 research centers in 10 European countries, under the coordination of the International Agency for Research on Cancer, with the aim to elucidate the role of biological, dietary, lifestyle, and environmental factors in the cause of cancer and other chronic diseases (12). Details on the design and methods of the EPIC Study and the Greek cohort were previously described in detail (6, 12). All procedures were in accordance with the Helsinki Declaration for human rights, all participants signed an informed consent form before enrollment, and the

study protocol was approved by the ethics committees of the International Agency for Research on Cancer and the University of Athens Medical School. A total of 28 572 volunteers were enrolled in the Greek EPIC cohort, but in total 3859 (12.6%) were excluded, because at enrollment they had been diagnosed with coronary artery disease (1128, 3.9%), cancer (455, 1.6%), diabetes mellitus (1676, 5.9%), or any combination of the 3 (330, 1.2%). Among the remaining 24 983 participants, 1386 (5.5%) were excluded because information was missing in one or more variables used in the present analysis. Thus, 23 597 individuals, 9612 men and 13 985 women, were included in the present study.

Standard measuring procedures were used to assess anthropometric characteristics, with subjects wearing light clothing with no restrictive underwear and no shoes. Body weight was measured to the nearest 100 g, and height was measured to the nearest 0.1 cm. BMI was then calculated. Waist and hip circumferences were measured by using a nonelastic tape and were recorded to the nearest 0.1 cm. Waist circumference was measured around the smallest circumference between the lowest rib and iliac crest, or, for obese subjects with no natural waist, midway between the lowest rib and iliac crest. Hip circumference was measured horizontally at the level of the greatest lateral extension of the hips. The respective WHR was then calculated.

Usual dietary intake over the past year was assessed through a validated, semiquantitative, interviewer-administered food-frequency questionnaire, which has previously been described in detail (6, 13, 14). A gradient of adherence to the traditional Greek Mediterranean diet was constructed from 9 nutritional components (2, 6) Values of 0 or 1 were assigned to each of the 9 indicated components, using as cutoff values the sex-specific medians among the participants (6). Subjects whose consumption of presumed beneficial components (vegetables, legumes, fruit and nuts, cereals, and fish) was below the median consumption were assigned a value of 0 and a value of 1 otherwise. In contrast, subjects with below the median consumption of presumed detrimental components (meat and meat products and dairy products, which are rarely nonfat or low-fat in Greece) were assigned a value of 1 and a value of 0 otherwise. For ethanol, a value of 1 was given to men who consumed quantities of ethanol from 10 g/d to <50 g/d, whereas for women the corresponding cutoffs were 5 g/d and 25 g/d. For lipid intake, the ratio of monounsaturated to saturated lipids, instead of polyunsaturated lipids, was used. Thus, a 10-point Mediterranean diet score was constructed that could take a value from 0 (minimal adherence) to 9 (maximal adherence).

Standard interviewing procedures were used to collect information on the participants’ sociodemographic characteristics and lifestyle variables (15). Concerning smoking, volunteers were categorized as never smokers, former smokers (quit smoking for ≥1 y before their enrollment), and current smokers. For the present study, current smokers were further divided into 2 subgroups: those who smoked ≤1pack (20 cigarettes) per day and those who smoked >1 pack/d. Regarding physical activity, a metabolic equivalent index (MET value) was computed by assigning a multiple of resting metabolic rate to each activity (household, professional, sporting, and other activities) (16). The average time spent on each of the activities was multiplied by the MET value of the activity, and all MET-hour products were summed to produce a total daily MET score, indicating the amount of energy per kilogram of body weight expended during an average day.

All statistical analyses were performed with the STATA statistical package (INTERCOOLED STATA 7.0 for Windows 98/NT; Stat Corp, College Station, TX). Spearman correlation coefficients of olive oil intake with Mediterranean diet score, vegetable consumption, and legume consumption and of energy intake with Mediterranean diet score were calculated, by sex. Descriptive data on BMI and WHR by sex and other study variables, including the Mediterranean diet score, were presented, and intakes of the nutritional components of the Mediterranean diet score by values of that score were calculated. Subsequently, the data were modeled through multiple linear regressions to assess the association of the Mediterranean diet score with BMI or, alternatively, WHR controlling for BMI. Analyses were performed separately for men and women. Potential confounders were age (<45, 45–54, 55–64, and ≥65 y, categorically), years of schooling (<6, 6–11, 12, and ≥13 y, categorically), smoking (never smokers, former smokers, current smokers of ≤1 pack/d, and current smokers of >1 pack/d, categorically), physical activity (per 3 MET-hours/d, continuously), and energy intake (per 2000 KJ, continuously). Because it has been argued that closer adherence to the Mediterranean diet is inextricably linked to higher energy intake (10), models were run with and without controlling for energy intake.

RESULTS

The distribution of the 23 597 eligible study participants at enrollment are shown in Table 1. The distribution is shown by important predictors of BMI and WHR, as well as by the Mediterranean diet score. These bivariate tabulations provide evidence that BMI increased with age, declined with educational attainment, was higher among nonsmokers than among smokers, declined with physical activity, and increased with the recorded energy intake among men but not among women. There is little evidence in these bivariate data that Mediterranean diet score was an important predictor of BMI. Similar patterns were evident with respect to the WHR. The data in this table, however, mostly serve descriptive purposes, because they do not accommodate the interrelations among the predictors of BMI and the resulting mutual confounding.

The mean daily intakes in grams of the nutritional variables that constitute the Mediterranean diet score, as well as olive oil, a key component of the Mediterranean diet, is shown in Table 2. Mean values are not powerful discriminators of patterns, but they do indicate that increasing Mediterranean diet score is, by definition, associated with increasing intake of vegetables, legumes, fruit and nuts, cereals, fish, olive oil, and ethanol and reduced intake of meat and dairy products. The crude Spearman correlation coefficient of energy intake with the Mediterranean diet score was 0.25 among men and 0.30 among women. Olive oil is an important component of the Mediterranean diet and was positively associated with intake of vegetables (Spearman r = 0.63 and 0.64 among men and women, respectively) and legumes (Spearman r = 0.36 and 0.34 among men and women). Olive oil was also strongly positively associated with the Mediterranean diet score (Spearman r = 0.47 and 0.51 among men and women), a fact that justifies concern that Mediterranean diet may promote obesity. All these correlation coefficients were highly significant (P < 10⁻⁴).
were translated for average-height men and women to a higher energy intake inextricably linked to higher energy intake and Mediterranean diet score with respect to WHR. However, we consider higher energy intake to be correlated with higher BMI and waist-to-hip ratio (WHR) by sex and selected nonnutritional variables, as well as by energy intake and Mediterranean diet score.

The dependence of BMI on Mediterranean diet score, controlling for potential confounding variables, is shown in Table 3. Among both men and women, BMI tended to be higher among older individuals, although the selective survival of leaner individuals affects the age patterns. Men and women with higher educational attainment and inferentially higher socioeconomic status tended to have a lower BMI. Increased physical activity was inversely associated with BMI, whereas increased energy intake was positively associated with it. In comparison to smokers, nonsmokers tended to have a higher BMI. After controlling for all these variables, Mediterranean diet score was not significantly associated with BMI among either men or women. If, however, we consider higher energy intake inextricably linked to better adherence to Mediterranean diet and we do not control for energy intake in the analysis, we find that closer adherence to the Mediterranean diet by 2 units was associated with a higher BMI by 0.21 among men and by 0.05 among women. These values were translated for average-height men and women to a higher weight by ~650 g among men and by ~150 g among women (the latter value being nonsignificant).

Multiple regression-derived coefficients and 95% CIs of the regression of the WHR on Mediterranean diet score, controlling for BMI and potentially confounding variables, including and excluding energy intake as a model covariate, are shown in Table 4. In the worst-possible scenario, that is, without controlling for energy intake, an increase of Mediterranean diet score by 2 units was associated with a trivial increase of WHR by ~0.001 among men and by 0.004 among women.

### DISCUSSION

In a large population-based investigation of 23,597 adult men and women who relied on a validated food-frequency questionnaire and standardized anthropometric measurements and interviewing procedures, we found that controlling for energy intake and other potentially confounding variables, including physical activity and socioeconomic status (as assessed by years of schooling), Mediterranean diet was unrelated to BMI (Table 3) and related to WHR only marginally and only among women (Table 4). If, however, we consider Mediterranean diet score to

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**Table 1**

Frequency distributions of study participants from the Greek European Prospective Investigation into Cancer and Nutrition (EPIC) Study at enrollment and BMI and waist-to-hip ratio (WHR) by sex and selected nonnutritional variables, as well as by energy intake and Mediterranean diet score.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>BMI (kg/m²)</td>
</tr>
<tr>
<td>Age (y)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;45</td>
<td>3405</td>
<td>27.70 ± 3.84²</td>
</tr>
<tr>
<td>45–54</td>
<td>2409</td>
<td>28.56 ± 6.74</td>
</tr>
<tr>
<td>55–64</td>
<td>1940</td>
<td>28.53 ± 3.94</td>
</tr>
<tr>
<td>≥65</td>
<td>1858</td>
<td>28.10 ± 4.05</td>
</tr>
<tr>
<td>Years of schooling (y)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;6</td>
<td>1163</td>
<td>28.28 ± 4.21</td>
</tr>
<tr>
<td>6–11</td>
<td>3827</td>
<td>28.55 ± 3.31</td>
</tr>
<tr>
<td>12</td>
<td>1164</td>
<td>27.94 ± 3.94</td>
</tr>
<tr>
<td>≥13</td>
<td>3458</td>
<td>27.76 ± 4.63</td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never smokers</td>
<td>2478</td>
<td>28.18 ± 3.64</td>
</tr>
<tr>
<td>Former smokers</td>
<td>3061</td>
<td>28.67 ± 5.56</td>
</tr>
<tr>
<td>Current smokers, ≤20 cigarettes/d</td>
<td>2096</td>
<td>27.58 ± 5.35</td>
</tr>
<tr>
<td>Current smokers, &gt;20 cigarettes/d</td>
<td>1977</td>
<td>27.96 ± 4.05</td>
</tr>
<tr>
<td>Physical activity (MET · h/d)</td>
<td></td>
<td></td>
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<tr>
<td>&lt;31</td>
<td>1985</td>
<td>28.44 ± 4.07</td>
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<tr>
<td>31–33.9</td>
<td>2488</td>
<td>28.24 ± 5.12</td>
</tr>
<tr>
<td>34–36.9</td>
<td>1835</td>
<td>28.06 ± 6.32</td>
</tr>
<tr>
<td>37–39.9</td>
<td>1295</td>
<td>27.90 ± 3.75</td>
</tr>
<tr>
<td>≥40</td>
<td>2009</td>
<td>28.04 ± 3.98</td>
</tr>
<tr>
<td>Energy intake (kJ)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;7000</td>
<td>1160</td>
<td>27.60 ± 3.80</td>
</tr>
<tr>
<td>7000–8999</td>
<td>2390</td>
<td>27.91 ± 3.65</td>
</tr>
<tr>
<td>9000–10,999</td>
<td>2696</td>
<td>28.06 ± 4.91</td>
</tr>
<tr>
<td>≥11,000</td>
<td>3366</td>
<td>28.61 ± 5.64</td>
</tr>
<tr>
<td>Mediterranean diet score (units)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–2</td>
<td>1264</td>
<td>27.61 ± 3.76</td>
</tr>
<tr>
<td>3–4</td>
<td>3660</td>
<td>28.19 ± 5.31</td>
</tr>
<tr>
<td>5–6</td>
<td>3567</td>
<td>28.25 ± 4.86</td>
</tr>
<tr>
<td>7–9</td>
<td>1121</td>
<td>28.39 ± 3.73</td>
</tr>
<tr>
<td>Total</td>
<td>9612</td>
<td>28.16 ± 4.80</td>
</tr>
</tbody>
</table>

¹ All main effects and interactions between sex and each variable with respect to BMI and WHR were significant except for the main effect of energy intake on BMI (P = 0.092) and the interaction between sex and Mediterranean diet score with respect to WHR (P = 0.813). MET, metabolic equivalents.
² ± SD (all such values).
Table 2
Mean daily intake for food groups and nutrients that are components of the Mediterranean diet score by level of that score and sex from the Greek European Prospective Investigation into Cancer and Nutrition (EPIC) Study.

<table>
<thead>
<tr>
<th>Dietary Component</th>
<th>Men by diet score</th>
<th>Women by diet score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0–2 (n = 1264)</td>
<td>3–4 (n = 3660)</td>
</tr>
<tr>
<td>Vegetables (g)</td>
<td>426.7 ± 3.80</td>
<td>522.2 ± 3.10</td>
</tr>
<tr>
<td>Legumes (g)</td>
<td>6.3 ± 0.12</td>
<td>8.7 ± 0.10</td>
</tr>
<tr>
<td>Fruit and nuts (g)</td>
<td>270.1 ± 3.56</td>
<td>349.5 ± 3.03</td>
</tr>
<tr>
<td>Dairy products (g)</td>
<td>277.1 ± 3.89</td>
<td>238.2 ± 2.58</td>
</tr>
<tr>
<td>Cereals (g)</td>
<td>165.0 ± 1.95</td>
<td>186.4 ± 1.29</td>
</tr>
<tr>
<td>Meat (g)</td>
<td>136.5 ± 1.63</td>
<td>132.0 ± 0.99</td>
</tr>
<tr>
<td>Fish (g)</td>
<td>15.5 ± 0.29</td>
<td>22.4 ± 0.26</td>
</tr>
<tr>
<td>Ethanol (g)</td>
<td>14.6 ± 0.70</td>
<td>18.3 ± 0.42</td>
</tr>
<tr>
<td>Olive oil (g)</td>
<td>36.4 ± 0.51</td>
<td>46.8 ± 0.33</td>
</tr>
<tr>
<td>Lipid ratio</td>
<td>1.40 ± 0.007</td>
<td>1.65 ± 0.006</td>
</tr>
<tr>
<td>MUFAs (g)</td>
<td>47.6 ± 0.43</td>
<td>54.4 ± 0.29</td>
</tr>
<tr>
<td>SFAs (g)</td>
<td>34.7 ± 0.34</td>
<td>34.6 ± 0.22</td>
</tr>
</tbody>
</table>

1. All values are x ± SEM. Because of the correspondingly higher energy intake, overall mean values were significantly higher (P < 0.01) among men than among women for all score items, except for the lipid ratio. Trends across score levels, among both men and women, were significant (P < 0.0001) on account of the score’s definition, except for the intake of saturated fatty acids among men to which several foods contribute. MUFA, monounsaturated fatty acid; SFA, saturated fatty acid.

2. For lipid ratio, the numerator (MUFA), the denominator (SFA), and olive oil (a substantial contributor to the numerator) are shown, in addition to the lipid ratio itself.

Table 3
Multiple-regression-derived coefficients and 95% CIs of the regression of BMI on Mediterranean diet score, controlled for potentially confounding variables from the Greek European Prospective Investigation into Cancer and Nutrition (EPIC) Study.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Men (n = 9612)</th>
<th>Women (n = 13 985)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45–54</td>
<td>0.66 (0.41, 0.92)</td>
<td>1.70 (1.48, 1.93)</td>
</tr>
<tr>
<td>55–64</td>
<td>0.46 (0.15, 0.76)</td>
<td>1.92 (1.67, 2.18)</td>
</tr>
<tr>
<td>≥65</td>
<td>−0.12 (−0.48, 0.23)</td>
<td>1.76 (1.46, 2.05)</td>
</tr>
<tr>
<td>P for trend</td>
<td>0.807</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Years of schooling (y)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6–11</td>
<td>0.09 (−0.24, 0.42)</td>
<td>−0.37 (−0.60, −0.14)</td>
</tr>
<tr>
<td>12</td>
<td>−0.46 (−0.90, −0.02)</td>
<td>−2.86 (−3.17, −2.56)</td>
</tr>
<tr>
<td>≥13</td>
<td>−0.67 (−1.06, −0.29)</td>
<td>−3.83 (−4.13, −3.52)</td>
</tr>
<tr>
<td>P for trend</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never smokers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Former smokers</td>
<td>0.41 (0.16, 0.66)</td>
<td>−0.16 (−0.46, 0.15)</td>
</tr>
<tr>
<td>Current smokers, ≤20 cigarettes/d</td>
<td>−0.65 (−0.93, −0.37)</td>
<td>−0.70 (−0.95, −0.46)</td>
</tr>
<tr>
<td>Current smokers, &gt;20 cigarettes/d</td>
<td>−0.42 (−0.71, −0.13)</td>
<td>−0.49 (−0.91, −0.07)</td>
</tr>
<tr>
<td>P for trend</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Physical activity (per 3 MET – h/d)</td>
<td>−0.10 (−0.15, −0.06)</td>
<td>−0.25 (−0.31, −0.19)</td>
</tr>
<tr>
<td>Energy intake (per 2000 kcal)</td>
<td>0.30 (0.23, 0.37)</td>
<td>0.29 (0.22, 0.36)</td>
</tr>
<tr>
<td>Mediterranean diet score (per 2 units)</td>
<td>0.08 (−0.03, 0.20)</td>
<td>−0.06 (−0.16, 0.04)</td>
</tr>
<tr>
<td>Mediterranean diet score (per 2 units) without control for energy intake</td>
<td>0.21 (0.10, 0.32)</td>
<td>0.05 (−0.04, 0.15)</td>
</tr>
</tbody>
</table>

1 A significant interaction between sex and Mediterranean diet score with respect to BMI was found (P < 0.0001). Interactions between sex on the one hand and age, years of schooling, smoking, and physical activity on the other hand with respect to BMI were significant (P < 0.05 in all instances). MET, metabolic equivalents.

2 P, 95% CI in parentheses (all such values).
the Mediterranean diet score was associated with an increase of \( \approx 650 \) g among average-height men and a nonsignificant increase of \( \approx 150 \) g among average-height women.

If higher BMI and WHR are inextricably linked to closer adherence to the Mediterranean diet, then control for these variables in cohort studies that evaluate Mediterranean diet score in relation to survival may overestimate the beneficial effect of this diet. We examined the extent of this overestimation from the results of a previous investigation in the Greek population (6). In that study, an increase of BMI by \( \approx 7 \) was associated with an increase in the mortality ratio by 5%, whereas an increase of WHR by \( \approx 0.17 \) was associated with an increase in the mortality ratio also by 5%. Thus, differences of BMI of \( \approx 0.21 \) and of WHR of \( \approx 0.004 \) (worst-case scenarios) would have overestimated the beneficial effect of a 2-point increase in the Mediterranean diet score by 0.15% and 0.12%, respectively. Thus, the beneficial effect of a 2-point increase in the Mediterranean diet score would have been reduced in absolute terms by <1% (ie, the reported mortality ratio of 0.75 would have become 0.753).

In a previous study that has analytically examined adherence to the Mediterranean diet in relation to BMI (17), a validated food-frequency questionnaire and standardized anthropometric measurements were used in a sample of 3162 adult men and women in Northeast Spain. The investigators reported that adherence to Mediterranean diet was inversely associated with BMI and the odds of being obese, but in their score for adherence to Mediterranean diet they did not adequately accommodate the intake of added lipids. Nevertheless, consumption of olive oil doubled from the lowest to the highest category of adherence to Mediterranean diet in both the Spanish study and our study, although in absolute terms, olive oil consumption is notably higher in the Greek population than in the Spanish population. Thus, our results and those of Shroder et al (17) are not incompatible, the apparent difference being explained by noninclusion of lipid intake in the score used by the Spanish investigators. Our results are also in line with the conclusions of a review that indicates that no consistent associations have been identified between various dietary patterns and either BMI or obesity, minor discrepancies being attributable to differences in control of confounding (18). The findings of this study also contribute to the growing body of evidence that indicates that diets high in lipids do not contribute to obesity over and beyond their possible high energy content (19, 20).

Strengths of our investigation are the large sample size, its reliance on the general population, the use of validated questionnaires and standardized measurements, the adherence to the traditional Mediterranean diet of large segments of the population, and the exclusion from the study sample of persons with prevalent morbidity that would have created patterns of inverse causation. A limitation of the study is its cross-sectional nature that imposes conclusion through inference, rather than on clear time sequence of putative causes and outcome.

In conclusion, we found that adherence to Mediterranean diet was essentially unrelated to BMI, small differences being dependent on model choice and having no practical consequences. Overweight is a genuine problem in Greece and perhaps other Mediterranean countries, but it is likely to be related to limited physical activity in conjunction with excessive positive energy intake of added lipids. Nevertheless, consumption of olive oil doubled from the lowest to the highest category of adherence to Mediterranean diet in both the Spanish study and our study, although in absolute terms, olive oil consumption is notably higher in the Greek population than in the Spanish population. Thus, our results and those of Shroder et al (17) are not incompatible, the apparent difference being explained by noninclusion of lipid intake in the score used by the Spanish investigators. Our results are also in line with the conclusions of a review that indicates that no consistent associations have been identified between various dietary patterns and either BMI or obesity, minor discrepancies being attributable to differences in control of confounding (18). The findings of this study also contribute to the growing body of evidence that indicates that diets high in lipids do not contribute to obesity over and beyond their possible high energy content (19, 20).

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### Table 4

Multiple-regression-derived coefficients and 95% CIs of the regression of waist-to-hip ratio on Mediterranean diet score, controlled for potentially confounding variables from the Greek European Prospective Investigation into Cancer and Nutrition (EPIC) Study.

<table>
<thead>
<tr>
<th>Smoking</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never smokers</td>
<td>0.008 (0.004, 0.011)</td>
<td>0.000 (0.004, 0.007, 0.003)</td>
</tr>
<tr>
<td>Current smokers, ≤20 cigarettes/d</td>
<td>0.006 (0.002, 0.010)</td>
<td>0.000 (0.004, 0.004)</td>
</tr>
<tr>
<td>Current smokers, &gt;20 cigarettes/d</td>
<td>0.015 (0.011, 0.019)</td>
<td>0.013 (0.007, 0.019)</td>
</tr>
</tbody>
</table>

### Notes

1. A significant interaction between sex and Mediterranean diet score with respect to waist-to-hip ratio was found (\( P < 0.0001 \)). Interactions between sex on the one hand and age, years of schooling, smoking, and physical activity on the other hand with respect to waist-to-hip ratio were significant (\( P < 0.01 \) in all instances). MET, metabolic equivalents.

2. \( \beta \); 95% CI in parentheses (all such values).
balance, brought about by the westernization of the Mediterranean diet.

AT is the principal investigator of the Greek EPIC project and the initiator of this study. AN implemented the study. PO is the principal biostatistician in this study. DT is the epidemiology consultant. None of the authors had a conflict of interest.

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