ELSEVIER

Nutrition 22 (2006) 449–456

NUTRITION

www.elsevier.com/locate/nut

Applied nutritional investigation

Association between the prevalence of obesity and adherence to the Mediterranean diet: the ATTICA study

Demosthenes B. Panagiotakos, Ph.D.[a,*], Christina Chrysohoou, M.D., Ph.D.[b], Christos Pitsavos, M.D., Ph.D.[b], and Christodoulos Stefanadis, M.D., Ph.D.[b]

[a] *Department of Nutrition and Dietetics, Harokopio University, Athens, Greece*
[b] *First Cardiology Clinic, School of Medicine, University of Athens, Athens, Greece*

Manuscript received April 17, 2005; accepted November 7, 2005.

Abstract

Objective: We evaluated the prevalence of obesity in relation to adherence to a Mediterranean diet.
Methods: We conducted a cross-sectional survey that randomly enrolled 1514 men (18 to 87 y old) and 1528 women (18 to 89 y old) with no history of cardiovascular disease. Anthropometric indices were measured and frequency of various foods consumed during a usual week was recorded. Adherence to a Mediterranean diet was assessed by a diet score that incorporated the inherent characteristics of this diet.
Results: Prevalences of overweight and obesity were 53% and 20% in men and 31% and 15% in women. An inverse relation was observed between diet score, waist-to-hip ratio ($r = -0.31$, $P < 0.001$), and body mass index ($r = -0.4$, $P < 0.001$) after adjusting for sex and age. Greater adherence to the Mediterranean diet (i.e., highest tertile) was associated with a 51% lower odds of being obese (odds ratio 0.49, 95% confidence interval 0.42 to 0.56) and a 59% lower odds of having central obesity (odds ratio 0.41, 95% confidence 0.35 to 0.47) compared with a non-Mediterranean diet (i.e., lowest tertile) after controlling for age, sex, physical activity status, metabolism, and other variables.
Conclusion: We observed an inverse relation between adherence to a Mediterranean dietary pattern and prevalence of obesity in a free-eating, population-based sample of men and women, irrespective of various potential confounders.

Keywords: Obesity; Overweight; Body mass index; Diet; Mediterranean; Epidemiology

Introduction

Obesity is currently considered a serious health problem because it has been associated with the occurrence of atherosclerotic disease and many other metabolic disorders [1–5]. Surveys in Europe and Pacific Asia have shown that rates of overweight and obesity have increased by 50% to 100% over the past two decades [4]. Moreover, the estimated number of annual deaths attributable to obesity in the United States is larger than 300 000 [1], and the prevalence of obesity in North America has increased significantly in men and women during the past two decades [2]. In addition, the number of overweight children has doubled in the past 20 y [3]. These trends raise concerns of an even greater preponderance of adult obesity in the future. The adopted sedentary lifestyle among populations may account, at least in part, for the excess rates in obesity in the developed world. However, although an extensive body of scientific evidence has related diet to incidence of cardiovascular diseases through effects on blood pressure, lipids, and lipoprotein levels [6–9], the role of nutritional habits in the occurrence of obesity has not been entirely understood and appreciated. One diet that seem to protect against the development and progression of atherosclerotic disease, metabolic disorders, and several types of cancer is the Mediterranean diet [6–9]. This dietary pattern is rich in cereals, fruits, vegetables, legumes and whole grains, fish, and low-

The ATTICA study is supported by research grants from the Hellenic Cardiological Society (HCS2002) and the Hellenic Atherosclerosis Society (HAS2003).

* Corresponding author. Tel.: +30210-960-3116; fax: +30210-960-0719.
E-mail address: d.b.panagiotakos@usa.net (D.B. Panagiotakos).

0899-9007/06/$ – see front matter
doi:10.1016/j.nut.2005.11.004

fat dairy products and high in monounsaturated fat intake, and the principal source of fat is olive oil [10–13]. The benefits of the Mediterranean diet on human health have been attributed to control of blood pressure levels, markers of systemic chronic inflammation, and platelet aggregation. However, data regarding the association between adoption of the Mediterranean diet and prevalence of obesity in the literature are sparse and conflicting.

In this work we evaluated whether greater adherence to the Mediterranean dietary pattern is associated with lower prevalence of obesity in a free-eating, population-based sample of Greek adults.

Materials and methods

Participants of the study

The ATTICA study was carried out in the province of Attica (including 78% urban and 22% rural areas), where Athens is a major metropolis. The sampling was random, multistage by city, and stratified by age and sex distributions in the province of Attica, as provided by the National Statistical Service (census of 2001). From May 2001 to December 2002, 4056 inhabitants from Attica were randomly selected to enroll in the study. Of these, 3042 agreed to participate (75% participation rate); 1514 of participants were men and 1528 were women. All participants were interviewed by trained personnel (cardiologists, general practitioners, dietitians, and nurses) who used a standard questionnaire. The questionnaire included questions about sociodemographic and behavioral characteristics, detailed medical history of cardiovascular risk factors, and dietary and lifestyle habits of the participants.

Dietary ascertainment

Evaluation of nutritional habits was based on a self-administered, semiquantitative, validated, food-frequency questionnaire [14]. In particular, we asked all participants to report daily or weekly intake of 156 foods that they consumed (as an average during the previous year). Regarding alcohol consumption we asked all participants about consumption of various alcoholic beverages (wine, retsina, ouzo, whisky, liqueurs, etc.). Then the consumption was quantified in wineglasses of 100 mL (one wineglass = 12 g of ethanol concentration). To evaluate the reliability of the reported consumption, we asked all participants to complete a short form (50 food groups) of the questionnaire 1 y after the initial evaluation (94% of participants responded to this re-evaluation). Using Kendall's τ-coefficient we assessed the concordance of the reports. We observed that fewer than 1% of participants showed considerable discordance between baseline and re-evaluated dietary habits ($\tau < 0.8$). These participants were excluded from the present analysis.

The Mediterranean dietary pattern has been described as a dietary pyramid [15] and consists of (1) daily consumption of non-refined cereals and products (whole grain bread, pasta, etc.), fruits (four to six servings per day), vegetables (two to three servings per day), olive oil (as the main added lipid), and non-fat or low-fat dairy products (one to two servings per day), (2) weekly consumption of fish, poultry, potatoes, olives, pulses, and nuts (four to six servings per week), and more rare eggs and sweets (one to three servings per week), and (3) monthly consumption of red meat and meat products (four to five servings per month). It is also characterized by moderate consumption of wine (one to two wineglasses per day), moderate consumption of fat, and a high ratio of monounsaturated to saturated fat (usually $\geq$2). According to the previous dietary pattern and the reported frequency consumption of these food groups, we developed a special diet score for each participant that assessed adherence to the Mediterranean diet (range 0–55). In particular, for consumption of items presumed to be close to this pattern (i.e., those suggested on daily basis or more than four servings per week), we assigned a score of 0 when a participant reported no consumption, a score of 1 with consumption one to four times per month, a score of 2 with consumption five to eight times, a score of 3 with consumption 9 to 12 times per month, a score of 4 with consumption 13 to 18 times per month, and a score of 5 for more than 18 times per month. In contrast, for consumption of foods presumed to differ from this diet (e.g., meat and meat products), we assigned the opposite scores (i.e., 0 when a participant reported almost daily consumption to 5 for rare or no consumption). Especially for alcohol, we assigned a score of 5 for consumption of fewer than three wineglasses per day, a score of 0 for consumption of more than seven wineglasses per day, and scores of 1 to 4 for consumption of more than three, four to five, six, and seven wineglasses per day. Higher values of this diet score indicates greater adherence to the Mediterranean diet, whereas lower values indicate adherence to the "Westernized" diet. We also calculated the tertiles of this score.

Sociodemographic and lifestyle variables

Participants' educational level (as a proxy of social status) was measured by years of school. Mean annual income during the previous 3 y was also recorded. Current smokers were defined as those who smoked at least one cigarette per day and former smokers were defined as those who had stopped smoking for at least 1 y. Occasional smokers (fewer than seven cigarettes per week) were recorded and combined with current smokers due to their small sample. The rest were defined as non-smokers. For a more detailed evaluation of smoking habits, we calculated the pack-years (cigarette packs per day multiplied by years of smoking). For evaluation of physical activity, we developed an index of weekly energy expenditure by using frequency (times per week), duration (minutes per time), and intensity (expended calories) of sports-related physical activity. In particular,