

**Original Research**

# Major Habitual Dietary Patterns Are Associated with Acute Myocardial Infarction and Cardiovascular Risk Markers in a Southern European Population

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**ABSTRACT**

**Background** Most dietary pattern analyses in southern Europe have relied on a priori food approaches using Mediterranean-style diet indexes. These methods may not reflect the current population's food consumption.

**Objective** To assess the association of a posteriori dietary patterns with acute myocardial infarction (AMI) and cardiovascular risk markers in the general adult population of Porto, Portugal.

**Design** A population-based case-control study was conducted. Information was collected by trained interviewers. Diet was assessed with a validated 82-item food frequency questionnaire.

**Participants/setting** Cases were patients consecutively hospitalized for an incident non-fatal AMI (n=820), and controls were individuals free of previous AMI selected from the hospitals' catchment area (n=2,196).

**Statistical analyses** Dietary patterns, representing mutually exclusive clusters of individuals, were identified by multivariate finite mixture models among controls. Odds ratios (OR) and their 95% confidence intervals (CIs) were

obtained from unconditional logistic regression, with adjustment for main confounders.

**Results** In comparison to women with a "healthy" dietary pattern, those with a "low fruit and vegetables" pattern and a "red meat and alcohol" (also characterized by lower intake of dairy products and vegetables) pattern showed a higher risk of AMI (OR 1.85, 95% CI 1.01 to 3.39 and OR 1.91, 95% CI 1.17 to 3.12, respectively). Female controls with the "red meat and alcohol" pattern also had a higher total to high-density lipoprotein cholesterol ratio. In comparison to men with a "healthy" pattern, those with the "red meat and alcohol" pattern, similar to the counterpart found in women, were more likely to experience an AMI (OR 1.98, 95% CI 1.35 to 2.92); male controls with this pattern had higher diastolic and systolic blood pressure, C-reactive protein, and uric acid levels.

**Conclusions** A dietary pattern with lower fruit and vegetable intakes in women, and a pattern characterized by higher consumption of red meat and alcohol (and lower of dairy products and vegetables) in both sexes, were associated with an increased risk of AMI and adverse cardiovascular risk profiles. These findings highlight the importance of sustained recommendations for fruit and vegetable intake and cautious guidance on consumption of alcoholic beverages, which clusters with less healthy dietary patterns of men and women.

*J Am Diet Assoc.* 2011;111:241-250.

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*Manuscript accepted: August 24, 2010.*

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*0002-8223/13\$36.00*

*doi: 10.1016/j.jada.2010.10.042*

**T**he examination of relationships between diet and coronary heart disease (CHD) has traditionally focused on the effect of single foods and nutrients but, due to the conceptual and methodological limitations of this approach, dietary patterns have attracted great interest (1,2).

The mainstream dietary pattern analyses have relied on a priori approaches; in southern Europe; these analyses have often used Mediterranean-style diet indexes (3,4). A main criticism of this approach is that it may not reflect the current population's food consumption. Moreover, a priori methods are based on the assumption of protective or deleterious health effects of major food components, but they do not acknowledge that clustering of food components could vary across populations, reflecting cultural traditions. For instance, moderate alcohol consumption is usually considered a healthy behavior (5-7), but whereas some studies have reported positive associ-

ations between alcohol and healthier foods (8,9), others have found the opposite (10,11). It suggests that the health effect of a single food can be confounded by population-specific dietary behaviors. These caveats make the case for using dietary patterns defined a posteriori.

Though several studies have assessed the association between a posteriori dietary patterns and cardiovascular disease (12-16), only sparse information is available for southern European populations. Portugal has a wide range of dietary exposures as well as a particularly high consumption of wine and fish (17,18). Its singular food habits, distinct from the Mediterranean-style diet followed by neighbor countries (19) and closer to the recently conceptualized Atlantic-style diet (20,21), could lead to unique food clusterings whose effect on coronary risk is unknown.

This study assessed the association of a posteriori dietary patterns with nonfatal acute myocardial infarction (AMI) and with some cardiovascular risk markers in the adult population of Porto, Portugal.

## METHODS

### Study Design and Participants

A population-based case-control study was carried out between 1999 and 2003 in Porto, an urban center located in northwest Portugal with almost 300,000 inhabitants. Cases were selected after consecutive admission to the Cardiology Department of the four hospitals that provide acute coronary care in Porto. Cases were included in the study if they had a first episode of AMI (22) and survived beyond the fourth day post-AMI. During the study period, 1,248 patients with a first AMI were identified. Out of these, we excluded 37 who died before the interview, 65 who were unable to collaborate, 3 who refused to participate, 138 with cognitive impairment as indicated by a score <24 in the Mini-Mental State Examination (23,24), and 164 with incomplete information. Further exclusions were made for 21 who changed diet in the year before interview.

Controls were individuals from the catchment area of the participating hospitals, with no previous clinical or silent infarction according to self-reported data or/and electrocardiographic evidence. Controls were selected from random digit dial of households, and then from simple random sampling of Porto permanent residents aged  $\geq 18$  years. Of note is that during the recruitment period, 97% of households had a telephone installed. Refusals were not substituted within the same household and the participation rate was 70% (25). Out of 2,485 participants initially selected, 103 (4.1%) were excluded due to previous clinical or silent AMI, 51 with cognitive impairment, 60 with incomplete information, and 75 who changed their food habits during the previous year. For the case-control analysis, the final sample included 820 cases (194 women and 626 men) and 2,196 controls (1,362 women and 834 men).

To examine the association between dietary patterns and cardiovascular risk markers, cross-sectional analyses were conducted among the controls only. Out of the 2,196 controls, we further excluded 328 individuals without information on at least one of the following outcomes: systolic and diastolic blood pressure, serum glucose, se-

rum total to high-density lipoprotein cholesterol ratio, and triglycerides. As a result, analyses with these variables were conducted with 1,868 persons. Lastly, for analyses concerning high-sensitivity C-reactive protein (hs-CRP), uric acid, and leukocyte count, a subsample of 925 participants was obtained, after exclusion of 1,209 individuals without measurement of one of the biomarkers under study, and 62 with hs-CRP above 10 mg/L, which suggests the presence of a clinically relevant inflammatory condition (26).

The Ethics Committees of the four participating hospitals approved the study protocol, and every participant gave written informed consent.

### Data Collection

AMI patients were interviewed during their in-hospital stay after clinical stabilization, usually between the fourth and eighth day after admission. Controls were invited to a face-to-face interview at the Department of Hygiene and Epidemiology of the University of Porto Medical School. Data on cases and controls were collected concurrently by the same set of trained interviewers, using the same questionnaire on sociodemographic, behavioral, and clinical characteristics.

Diet was collected with an 82-item semiquantitative food frequency questionnaire, previously validated against four 7-day food records (27,28). Each subject had to report the average frequency of consumption for each food item among nine categories, ranging from "never or less than once a month" to "six or more times a day"; subjects also had to choose the average portion consumed (lower, equal, or higher than the average portion size) and the seasonal variation of consumption. Food consumption was converted into total energy intake and nutrients using Food Processor Plus software (version 7.02, 1997, ESHA Research, Salem, OR), adapted to Portuguese foods and dishes.

Age and education were recorded as completed years of age and years of schooling. Tobacco consumption was registered as daily (at least one cigarette/day), occasional (less than one cigarette/day), former (quit for at least 6 months), and never smoking. For analyses, only two categories were considered: current smoking (daily and occasional smokers) and nonsmoking (never and former smokers). Physical activity referred to the regular practice (at least 30 minutes/week) of any leisure-time physical activity with energy expenditure higher than 2.5 metabolic equivalents per hour, including walking, running, and any sports activities, during the previous year. A family history of AMI was considered when at least one first-degree relative had had an AMI or a sudden death, regardless of age at occurrence.

Anthropometrics were performed with subjects in light clothing and barefoot under standard procedures. Body weight was measured to the nearest 0.1 kg using a digital scale (SECA, Columbia, SC), and height to the nearest centimeter with a wall stadiometer (SECA, Hamburg, Germany). Body mass index (BMI) was calculated as weight in kilograms divided by the squared height in meters. Waist circumference was ascertained midway between the lower limit of the rib cage and the iliac crest, and hip circumference on the maximum circumference over the femoral tro-

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