Abdominal obesity and inflammation predicts hypertension among prehypertensive men and women: the ATTICA Study

Abstract The aim of this work was to assess the 5-year incidence of hypertension and its predictors among prehypertensive adults. Under the context of the ATTICA Study, data from 1188 individuals, free of cardiovascular disease, but with defined high blood pressure levels (prehypertension) at baseline examination (during 2001–2002) were retrieved. In 2006, the 5-year follow-up of the study was performed, and 798 of the prehypertensive participants were allocated. In this work, incidence and determinants of developing hypertension were evaluated. The 5-year age-adjusted incidence of hypertension was 18.7% in men and 24.6% in women (P = 0.05); while almost one half of prehypertensive individuals at the age of 55–65 years developed hypertension, and approximately 6 out of 10 people over 65 years of age developed the disease. Multiple logistic regression analysis revealed that increased age (odds ratio [OR] per 1 year = 1.09, 95% confidence interval [CI] 1.07–1.12), male sex (OR = 0.40, 95% CI 0.21–0.68), high education status (OR per 1 year of school = 0.94, 95% CI 0.88–0.98), waist circumference (OR per 1 cm = 1.04, 95% CI 1.02–1.06) and C-reactive protein (OR per 1 mg/l = 1.12, 95% CI 1.05–1.20), were positively associated with the development of hypertension. Moreover, greater adherence to Mediterranean diet seems to protect only prehypertensive, with abdominal obesity patients prone to develop hypertension (OR = 0.94, 95% CI 0.90–0.98). Annual incidence of hypertension was roughly 4% in men and women. Older people, with low education, abdominal obesity, lower adherence to the Mediterranean diet, and increased inflammation, constitute a model of prehypertensive individuals that are prone to develop hypertension.

Key words Inflammation · Abdominal obesity · Hypertension · Incidence · Diet

Introduction

The level of arterial blood pressure has long been recognized as a major risk factor for several common cardiovascular diseases, including coronary heart disease, cerebrovascular disease and heart failure. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure suggested a new classification for borderline blood pressure levels, namely “prehypertension.” The new classification describes people with blood pressures between 120 and 139 mmHg systolic or 80–89 mmHg diastolic. This “new” category between normal blood pressure and established hypertension includes a population at high risk for developing hypertension and in which lifestyle modifications are needed. In our populations prehypertension seems to prevail more in men than in women (43% versus 35%).

Recently, the Trial of Preventing Hypertension (TROPHY) evaluated the efficacy of antihypertensive therapy in persons classified as “prehypertensive” and revealed a cumulative incidence of hypertension of 63% among untreated prehypertensives during the four years of follow-up. Data regarding the incidence of hypertension among prehypertensive people, as well as factors that associated with the development of the disease in people of the Mediterranean region, are lacking in the literature. Under the context of the ATTICA Study, the main hypothesis tested in this work was the 5-year incidence of hypertension and its determinants among prehypertensive, cardiovascular disease-free adults.
Materials and methods

Study design

The ATTICA epidemiological study is a health and nutrition survey that has been carried out in a province of the Attica region (including 78% urban and 22% rural areas), during 2001–2002. People with cardiovascular disease or people living in institutions were excluded from the sampling. According to the study's design, 4056 inhabitants from the above area were randomly selected to enroll in the study. Of them, 3042 agreed to participate; 1514 of the participants were men and 1528 were women. All participants were interviewed by trained personnel (cardiologists, dieticians and nurses) who used a standard questionnaire.

Baseline measurements

The baseline evaluation included: demographic characteristics (age, sex, mean annual income, and years of school as proxy of social status), detailed information regarding personal and family history of hypertension, hypercholesterolemia, and diabetes, dietary and other lifestyle habits, such as smoking and habitual/leisure time physical activity. In particular, the evaluation of nutritional habits was based on a validated semiquantitative food-frequency questionnaire. In particular, all participants were asked to report the average intake (per week or day) of several food items that they consumed (during the last 12 months). Alcohol consumption was measured in wineglasses (100ml) and quantified by ethanol intake (grams per drink). One wineglass was considered to have an equivalent of 12% ethanol concentration. To describe overall diet composite scores were used, which are necessary for the evaluation of epidemiological associations. Thus, a special Mediterranean diet score was used (range 0–55) that is based on the rationale of the Mediterranean dietary pyramid. Smokers were defined as those who were smoking at least one cigarette per day during the past year or had recently stopped smoking (within a year); the rest of the participants were defined as nonsmokers. For the ascertainment of physical activity status the International Physical Activity Questionnaire was used (IPAQ), as an index of weekly energy expenditure using frequency (times per week), duration (in minutes per time) and intensity of sports or other habits related to physical activity (in expended calories per time). Participants who did not report any physical activities were defined as physically inactive (sedentary lifestyle). Body mass index (BMI) was measured as weight (in kilograms) divided by standing height (in meters squared). Obesity was defined as BMI > 29.9kg/m². Waist (in cm) and hip (in cm) circumferences were also measured using standard procedures. Arterial blood pressure was measured at the end of the physical examination with subject in sitting position. All participants were at least 30 min at rest. Participants who had mean systolic/diastolic blood pressures within the range of 120–139/80–89mmHg and have never been told that they have high blood pressure levels were defined as prehypertensives as has recently been suggested by the American Heart Association. Hypercholesterolemia was defined as total cholesterol levels greater than 220mg/dl, or the use of lipid-lowering agents and diabetes mellitus as a fasting blood sugar >125mg/dl, or the use of antidiabetic medication. High-sensitivity C-reactive protein (as marker of low-grade systemic inflammation) was assayed by particle-enhanced immunonephelometry (N Latex, Dade-Behring Marburg GmbH, Marburg, Germany) with a range from 0.175 to 1100mg/dl. The intra-assay and interassay coefficient of variation was <5%.

Follow-up

From June to August 2006, the ATTICA Study investigators performed the 5-year follow-up on 2101 participants (941 of the 3042 [31%] participants were lost to follow-up). Of the participants that did not participate in the re-examination, 21% were not found because of missing or wrong addresses and telephone numbers, and 12% refused re-examination. No significant differences were observed between those who were lost to follow-up and the rest of the participants regarding sex (P = 0.89), age (P = 0.92), education level (P = 0.69), as well as presence of hypertension (P = 0.45), diabetes (P = 0.34), and hypercholesterolemia (P = 0.09). No differences were observed between those contacted by telephone and those participated in the face-to-face interviews, regarding age (45 ± 11 vs 45 ± 16 years, P = 0.77), sex (males: 55% vs 54%, P = 0.89) and place of residence (P = 0.98). Follow-up examination included detailed information from participants’ medical records, as retrieved by the study’s investigators. In some cases (15%) where individuals had no accurate records, a face-to-face interview was performed.

For testing the research hypothesis of this work, people who have been defined as having hypertension or were normotensive at baseline examination were excluded from the analysis. Therefore, 1188 individuals with defined prehypertension at baseline examination (in 2001) were the initial working sample of this work. Of them, 426 men and 356 women (i.e., n = 782) were found alive at the time of the follow-up, while 8 men and 8 women died due to cardiovascular disease (n = 9), cancer (n = 5), or because of other causes (67% participation rate in the follow-up). Thus, the remaining 782 prehypertensive individuals comprise the analytic sample of the present work.

The re-examination included information about: (a) vital status (death from any cause or due to cardiovascular disease), or development of coronary heart disease (including myocardial infarction, angina pectoris, other identified forms of ischemia (WHO-ICD coding 410–419.9, 427.2, 427.6), heart failure of different types, and chronic arrhythmias (WHO-ICD coding 400.0–409.9, 427.0–427.5, 427.9), or development of stroke (WHO-ICD coding 430–438), (b) development of hypertension was defined as systolic/diastolic blood pressure >140 and/or 90mmHg (average of three consecutive measurements), or use of special medication, hypercholesterolemia, and diabetes, among people who did not have these disorders at baseline, as well as