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Risk factors for prehypertension in the community: A prospective analysis from the Western New York Health Study

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Abstract *Background and Aim:* Prehypertension is an increasingly highly prevalent condition in the general population, and is associated with an increased risk for coronary heart disease and stroke. However, evidence from population-based studies of the risk factors for prehypertension is scant. We sought to examine the predictors of progression from normotension to prehypertension in a community-based population from Western New York.
Methods and Results: A longitudinal analysis, over 6 years of follow-up, among 569 men and women (mean age 51.8 years) who were free of prehypertension, hypertension, cardiovascular disease and diabetes at the baseline examination, in the Western New York Health Study (WNYHS). Incident prehypertension at follow-up was defined as systolic blood pressure of 120–139 mm Hg and/or diastolic blood pressure of 80–89 mm Hg.

The cumulative six year incidence of prehypertension was 33.5% (189/564). In bivariate analyses, there were several correlates of incident prehypertension, including age, BMI and waist circumference, impaired fasting glucose (IFG), uric acid, and baseline blood pressure levels. After multivariate adjustment, IFG at baseline [odds ratio (OR): 1.70, 95% CI: 1.07–2.69) and weight gain since age 25 (OR: 1.12, 1.04–1.21 per 10 lb increase)] were the strongest significant predictors of prehypertension at follow-up. Neither baseline waist circumference nor

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change in BMI were predictor variables in models when they were substituted for weight gain. *Conclusions:* Results from this study suggest early dysregulation of glucose metabolism and weight gain over the lifespan may represent important risk factors for prehypertension in the general population.

Introduction

Prehypertension, defined as the blood pressure range of 120—139 mm Hg systolic or 80 to 89 diastolic is present in approximately 70 million Americans [1,2]. This condition is a risk factor for coronary heart disease, frank hypertension, and stroke [3]. Current preventive approaches to prehypertension are not entirely effective in controlling this condition and many prehypertensive subjects will progress to have hypertension [4].

Prospective population-based studies of the risk factors for prehypertension or its sequels are scant [5—7]. For example, the Framingham Heart Study [5] reported a risk factor-adjusted hazard ratio for cardiovascular disease (CVD) of 2.5 for women and 1.6 for men with high normal blood pressure (systolic blood pressure of 130 to 130 mm Hg, diastolic pressure 80—89 mm Hg or both) relative to those with optimal blood pressure. The Strong Heart Study [6] showed that many prehypertensive persons would progress to have hypertension over four years and could be identified by echocardiographic findings at baseline as well as metabolic variables including diabetes. Data from the Women's Health Initiative [7] indicate that prehypertension is a common condition in postmenopausal women and is associated with an increased risk of all manifestations of CVD.

Prehypertension is often associated with the metabolic syndrome consisting in part of obesity, insulin resistance and elevated blood pressure and it is unclear whether prehypertension alone or the other related risk factors is more important in determining the optimal preventive strategy. We sought to examine the predictors of progression from normotension to prehypertension in a community-based population derived from Erie and Niagara Counties in Western New York. Precursors to prehypertension were examined over six years of follow-up in over 500 men and women who were initially free of prehypertension, hypertension, cardiovascular disease and diabetes in the Western New York Health Study (WNYHS). We hypothesized that metabolic and cardiovascular risk factors would predict incident prehypertension among normotensive middle-aged and older participants from the WNYHS.

Methods

Study population

Details of the WNYHS have been previously published [8—10]. Participants were originally enrolled as healthy subjects (i.e., without clinically evident cardiovascular disease) in the Western New York Health Study, an epidemiologic case—control investigation of patterns of alcohol intake and coronary heart disease in Erie and Niagara Counties, New York conducted from 1996 to 2001 (59.5% response rate). The cohort was selected from drivers' license lists and Health Care Finance Administration lists. Eligible participants for the follow-up examination were men and women aged 35—79 years selected from the baseline examination without known CVD or type 2 diabetes defined by a fasting glucose $>$125 mg/dl or receipt of oral hypoglycemic medication and who were capable of completing the study protocol ($n = 2652$). Exclusion criteria included: self report of any medical condition that would prohibit participation (e.g., all cancers except skin cancer, type 1 diabetes, physical or mental impairment, or inability to contact and determine eligibility). This left 2139 persons eligible for the follow-up visit in 2003—2004 of whom 1455 attended our clinic (68% response rate). The protocol was approved by the Buffalo Health Science Institutional Review Board and all participants provided written informed consent.

Incident prehypertension was assessed at the time of the follow-up clinic examination from 2003 to 2004 (follow-up of 5.9 $\pm$ 0.8 years). For the purpose of this report, we selected participants who were normotensive at baseline who also participated in the follow-up re-examination. Prehypertension at follow-up was defined according to the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC VII) guidelines systolic BP of 120—139 mm Hg and/or diastolic BP of 80—89 mm Hg [1]. Exclusion criteria included: type 2 diabetes mellitus at baseline, baseline use of antihypertensive medications or hypertension (defined as systolic $\geq$ 140 mm Hg, and/or diastolic BP $\geq$ 90 mm Hg) or hypertension at the follow-up examination. This left 564 eligible normotensive participants available for these analyses.

Clinical examination and classification of participants

At both the baseline and follow-up visits, participants underwent a clinical examination that included resting blood pressure. Three consecutive measurements of systolic and diastolic blood pressure (first and fifth Korotkoff sounds) were performed with an appropriately sized cuff using a Baum mercury sphygmomanometer (WA Baum Co) after the participant had been seated for 5 min. The mean of the second and third reading were used in the analyses. Questionnaires that were first administered at the baseline visit were re-administered at the follow-up visit. These assessed lifestyle and health habit information including: cigarette use, physical activity, alcohol use, general health