



Isolated Systolic Hypertension in Young and Middle-Aged Adults and 31-Year Risk for Cardiovascular Mortality

The Chicago Heart Association Detection Project in Industry Study

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ABSTRACT

BACKGROUND Isolated systolic hypertension (ISH), defined as systolic blood pressure (SBP) ≥ 140 mm Hg and diastolic blood pressure (DBP) < 90 mm Hg, in younger and middle-aged adults is increasing in prevalence.

OBJECTIVE The aim of this study was to assess the risk for cardiovascular disease (CVD) with ISH in younger and middle-aged adults.

METHODS CVD risks were explored in 15,868 men and 11,213 women 18 to 49 years of age (mean age 34 years) at baseline, 85% non-Hispanic white, free of coronary heart disease (CHD) and antihypertensive therapy, from the Chicago Heart Association Detection Project in Industry study. Participant classifications were as follows: 1) optimal-normal blood pressure (BP) (SBP < 130 mm Hg and DBP < 85 mm Hg); 2) high-normal BP (130 to 139/85 to 89 mm Hg); 3) ISH; 4) isolated diastolic hypertension (SBP < 140 mm Hg and DBP ≥ 90 mm Hg); and 5) systolic diastolic hypertension (SBP ≥ 140 mm Hg and DBP ≥ 90 mm Hg).

RESULTS During a 31-year average follow-up period (842,600 person-years), there were 1,728 deaths from CVD, 1,168 from CHD, and 223 from stroke. Cox proportional hazards models were adjusted for age, race, education, body mass index, current smoking, total cholesterol, and diabetes. In men, with optimal-normal BP as the reference stratum, hazard ratios for CVD and CHD mortality risk for those with ISH were 1.23 (95% confidence interval [CI]: 1.03 to 1.46) and 1.28 (95% CI: 1.04 to 1.58), respectively. ISH risks were similar to those with high-normal BP and less than those associated with isolated diastolic hypertension and systolic diastolic hypertension. In women with ISH, hazard ratios for CVD and CHD mortality risk were 1.55 (95% CI: 1.18 to 2.05) and 2.12 (95% CI: 1.49 to 3.01), respectively. ISH risks were higher than in those with high-normal BP or isolated diastolic hypertension and less than those associated with systolic diastolic hypertension.

CONCLUSIONS Over long-term follow-up, younger and middle-aged adults with ISH had higher relative risk for CVD and CHD mortality than those with optimal-normal BP. (J Am Coll Cardiol 2015;65:327-35) © 2015 by the American College of Cardiology Foundation.

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**ABBREVIATIONS
AND ACRONYMS****BMI** = body mass index**BP** = blood pressure**CHA** = Chicago Heart Association Detection Project in Industry**CHD** = coronary heart disease**CI** = confidence interval**CVD** = cardiovascular disease**DBP** = diastolic blood pressure**HR** = hazard ratio**ICD-8** = International Classification of Diseases-Eighth Revision**ICD-9** = International Classification of Diseases-Ninth Revision**IDH** = isolated diastolic hypertension**ISH** = isolated systolic hypertension**SBP** = systolic blood pressure**SDH** = systolic diastolic hypertension

Isolated systolic hypertension (ISH), defined as systolic blood pressure (SBP) ≥ 140 mm Hg and diastolic blood pressure (DBP) < 90 mm Hg, is highly prevalent in older adults but less so in younger and middle-aged adults (1-4). Data from the National Health and Nutrition Examination Survey indicate that among younger and middle-aged adults (< 40 years of age) in the United States, the overall prevalence of ISH between 1988 and 1994 of 0.7% more than doubled between 1999 and 2004 to 1.6% (2). From 1988 to 1994, of patients with untreated hypertension < 50 years of age in the National Health and Nutrition Examination Survey, 20% to 30% had ISH (1), which increased to 40% from 1999 to 2004 (2,4).

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The clinical consequences of ISH in younger and middle-aged adults remain uncertain (5). Whether ISH in younger adults is “pseudo” or “spurious” hypertension is still being debated (5-7). Data from a nested case-control study (insurance actuarial data) and

from United States and Swedish nationwide cohort investigations indicate that higher SBP and/or DBP is associated with higher risk for CVD mortality in younger adults (8-15). None of these studies, however, examined the risk by hypertension subtype: ISH, isolated diastolic hypertension (IDH), and systolic diastolic hypertension (SDH). Because the Chicago Heart Association Detection Project in Industry (CHA) study enrolled a large number of younger and middle-aged adults and their prospective follow-up encompasses more than 30 years (16,17), it provides a unique opportunity to investigate these issues.

Using the CHA study data, we assessed whether ISH in younger and middle-aged adults (18 to 49 years of age) is associated with higher risk for cardiovascular disease (CVD) mortality compared with normal blood pressure (BP).

METHODS

STUDY SAMPLE. Between 1967 and 1973, the CHA study recruited 39,441 participants from Chicago-area companies and organizations. Details of the study design and methods have been described (16-18). Trained staff members obtained a single casual supine BP measurement using a standard mercury sphygmomanometer. DBP was recorded as Korotkoff phase V. Heart rate was recorded by electrocardiography. Nonfasting serum total cholesterol levels were

measured using the Levine-Zak method. Diabetes was defined as clinically diagnosed by a personal physician or the use of antihyperglycemic medication (18,19). Questionnaires were used to collect information on demographics, smoking, medical history, and medication use. All participants gave written informed consent. The study protocol has received periodic institutional review board approval and, as described by the Health Insurance Portability and Accountability Act, the institutional review board granted a waiver before commencement of the present project.

For this study, we identified participants originally between 18 and 49 years of age with ascertained vital status during follow-up ($n = 28,238$). We excluded those who had pre-existing coronary heart disease (CHD), defined as electrocardiographic evidence of myocardial infarction ($n = 20$); those on antihypertensive drugs at baseline ($n = 599$); and 538 additional participants with missing or incomplete baseline BP data and/or covariates. As a result, 27,081 participants were eligible for inclusion.

OUTCOMES ASCERTAINMENT. Vital status was ascertained through 2003, with an average follow-up period of 31.1 ± 5.5 years (842,600 person-years). As previously reported (16,17), before 1979, follow-up was pursued by direct mail, telephone, contact with employer, and matching records with Social Security Administration files. From 1979 on, the National Death Index was used to identify deaths. Death certificates were obtained and coded by trained research staff members for multiple causes according to the International Classification of Diseases-Eighth Revision (ICD-8), and the International Classification of Diseases-Ninth Revision (ICD-9). Mortality from CVD was defined as ICD-8 and ICD-9 codes 400 to 445, CHD mortality was defined as ICD-8 and ICD-9 codes 410 to 414, and stroke mortality was defined as ICD-8 and ICD-9 codes 430 to 438.

BP CLASSIFICATION. Participants were stratified into 5 mutually exclusive BP categories: 1) optimal-normal BP (SBP < 130 mm Hg and DBP < 85 mm Hg); 2) high-normal BP (SBP 130 to 139 mm Hg and DBP 85 to 89 mm Hg, SBP 130 to 139 mm Hg and DBP < 85 mm Hg, or SBP < 130 mm Hg and DBP 85 to 89 mm Hg); 3) ISH (SBP ≥ 140 mm Hg and DBP < 90 mm Hg); 4) IDH (SBP < 140 mm Hg and DBP ≥ 90 mm Hg); and 5) SDH (SBP ≥ 140 mm Hg and DBP ≥ 90 mm Hg) (20). In a prior CHA report on the association of BP categories (i.e., optimal BP, normal BP, high-normal BP, and stages 1 to 3 hypertension) with 25-year CVD mortality in young adults (16), there was no difference in CVD mortality risk between optimal BP and normal BP.

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