# INCIDENCE AND PREDICTORS OF CORONARY HEART DISEASE AMONG OLDER AFRICAN AMERICANS—THE CARDIOVASCULAR HEALTH STUDY

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Although coronary heart disease (CHD) is the leading cause of death and morbidity in older African Americans, relatively little is known about the incidence and predictors of CHD in this population. This study was undertaken to determine the incidence and predictors of CHD in African-American men and women aged 65 years and older. The participants in this study included a total of 924 African-American men and women aged 65 years of age and older who participated in the Cardiovascular Health Study (CHS). The overall CHD incidence was 26.6 per 1000 person-years of risk. Rates were higher in men than women (35.3 vs. 21.6) and in those 75 years or older than in those less than 75 years (31.3 vs. 24.5). In multivariate analysis, factors associated with higher risk of incident disease were male gender [relative risk (RR) = 1.8, 95% confidence interval (CI) = 1.1, 2.7], diabetes mellitus (RR = 1.9, 95% CI = 1.2, 2.9), total cholesterol (RR for 40 mg/dL increment = 1.3, 95% CI = 1.0, 1.5), and low (i.e., <0.9) ankle-arm index (RR = 2.1, 95% CI = 1.3, 3.4) after adjusting for age. Within this cohort of older African Americans, male gender, diabetes mellitus, total cholesterol, and low ankle-arm index and were independently predictive of incident events. These results suggest that the ankle-arm index, a measure of advanced atherosclerosis, should be further evaluated for its efficacy in identifying older African Americans at risk for incident clinical events. (*J Natl Med Assoc.* 2001;93:423–429.)

**Key words:** coronary heart disease ♦ African Americans ♦ incidence ♦ elderly

Coronary heart disease (CHD) is the leading cause of death and morbidity in older African Americans.[1] However, little is known about either the

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Table 1. CHD Incidence Rates (Per 1000 Person-Years At Risk) Among Older

| | Women | | | | Men | |
|---|---|---|---|---|---|---|
| | *n* | PY | # Events | IR | *n* | PY |
| Age <75 years | 308 | 1483 | 34 | 22.9 (16.6, 29.3) | 199 | 888 |
| Age ≥75 years | 154 | 695 | 13 | 18.7 (6.5, 30.9) | 85 | 358 |
| Total | 462 | 2178 | 47 | 21.6 (17.4, 25.8) | 284 | 1245 |

*An incident CHD is defined as one of the following: myocardial infarction (MI) both fatal and non-fatal, angina

incidence of CHD or the factors associated with higher risk of incident events in this population. The Evans County Cardiovascular and Cerebrovascular Epidemiologic Study (Evans County, Georgia), conducted in the 1960s, examined new cases of CHD among those initially free of disease.[2] Among 65- to 74-year-old African Americans, the incidence of CHD [defined as fatal and nonfatal myocardial infarction (MI), angina pectoris (AP), chronic heart disease, and CHD mortality] during 87 months of follow-up in the Evans County Study was 52 per 1000 (63 and 45 per 1000, respectively, for males and females).[3]

Incidence estimates also are provided by studies using surveillance approaches to enumerate all cases, new and recurrent, of CHD. Hagstrom and colleagues[3] reported an annual incidence of acute CHD (defined as acute MI and sudden death) among 65- to 74-year-old African Americans of 7.2 per 1000 population (9.7 and 4.9 per 1000 for men and women, respectively). In a study conducted in Newark, New Jersey, the 1-year incidence of CHD (i.e., acute MI and out-of-hospital coronary-related death) among 70- to 79-year-old African Americans was 17.7 per 1000 (16.2 and 18.8 per 1000 among men and women, respectively).[4]

Comparison of rates across these studies is limited by the relatively small number of cases on which estimates were based, differing lengths of follow-up, and differences in the endpoints being monitored. In contrast, the African-American cohort of the Cardiovascular Health Study (CHS), a population-based, multicenter, longitudinal study investigating factors associated with the natural history of CHD and stroke in adults aged 65 years and older, is the largest of its kind. This offers a unique opportunity to examine CHD in older African Americans. This article reports on the incidence and predictors of CHD among community-dwelling, African-American men and women 65 years of age and older.

## METHODS

The Cardiovascular Health Study (CHS) is a population-based, longitudinal study of CHD and stroke in adults aged 65 years and older. A detailed description of the CHS has been published elsewhere.[5] Briefly, 5201 men and women were recruited between June 1989 and May 1990 from four communities: Forsyth County, North Carolina; Sacramento County, California; Washington County, Maryland; and Pittsburgh, Pennsylvania. Approximately 244 of the original cohort were African American.[6] Between 1992 and 1993, this cohort was augmented through the recruitment of an additional 687 older African Americans resulting in a total sample of 931.

Recruitment methods were similar for both enrollment cohorts. Eligible participants were sampled from Medicare eligibility lists in each area. Those eligible included all persons who were 65 years or older at the time of examination, were noninstitutionalized, were expected to remain in the area for the next three years, and were able to give informed consent and did not require a proxy respondent at baseline. Persons who were potentially eligible were excluded if they were wheelchair-bound in the home at baseline or were receiving hospice treatment, radiation therapy, or chemotherapy for cancer.

Data collection methods in the CHS have been described previously.[5,7,8] Briefly, the CHS baseline evaluation consisted of standard questionnaires assessing psychosocial factors (i.e., quality of life, social support, social networks, stressful life events, and personal habits), physical activity, physical functioning, depression, and dietary intake. A detailed medical history was also obtained along with data on prescription and nonprescription medication use. An extensive clinical examination was performed that included resting electrocardiogram (ECG), ul-

**African-American Participants of the CHS, By Gender and Age Group***

| Men | | Total | | | |
|---|---|---|---|---|---|
| # Events | IR | n | PY | # Events | IR |
| 24 | 27.0 (15.6, 38.5) | 507 | 2371 | 58 | 24.5 (20.4, 28.6) |
| 20 | 55.9 (14.9, 96.8) | 239 | 1053 | 33 | 33.3 (20.9, 41.8) |
| 44 | 35.3 (26.0, 44.7) | 746 | 3424 | 91 | 26.6 (23.6, 29.5) |

pectoris (AP) without MI, cardiovascular surgery (angioplasty, coronary artery bypass surgery) or mortality. *n* = number of participants; PY = person-years of follow-up; IR = incidence rate.

trasonography, anthropometry, a brief physical examination, fasting venipuncture, physical activity, resting blood pressure, and ankle-brachial blood pressures (for determination of ankle-arm index).

For these analyses, incident CHD is defined as one of the following: fatal or nonfatal MI, AP without MI, cardiovascular surgery (angioplasty, coronary artery bypass surgery), or CHD mortality in persons without a history of prevalent CHD at baseline.[9] Incident disease was determined using medical record documentation with local and central adjudication of all incident and fatal CHD events.[9] Prevalent disease at baseline was confirmed by hospital medical records, physician questionnaires, or clinical evidence (e.g., old MI on ECG, segmental wall-motion abnormality on echocardiography).[5] Continuous risk factors considered include age, systolic blood pressure, diastolic blood pressure, total cholesterol, low density lipoprotein (LDL) cholesterol, high density lipoprotein (HDL) cholesterol, fibrinogen, factor VIIc, total kilocalories of physical activity, total alcohol intake in grams per week, common carotid wall thickness, and internal carotid wall thickness. Categorical variables considered included gender, education (high school graduate or higher vs. not), income (greater than $25K vs. not), marital status (married vs. not), family history of MI, smoking status (former, current, never), history of hypertension (yes/no), history of diabetes by American Diabetes Association criteria (yes/no), obesity (greater than 120% of ideal vs. not), major ECG abnormality (presence of any one of the following: ventricular conduction defects, major Q-wave abnormalities, left ventricular hypertrophy, isolated ST-T wave abnormalities, atrial fibrillation or first-degree atrioventricular block), low ankle-arm index ($<0.9$), and intermittent claudication by Rose questionnaire.

## Statistical Analyses

Incidence rates were calculated per 1000 person-years at risk. Differences in incidence rates by groups were assessed with the log-rank test. Tests of association between demographics and other baseline characteristics with incident CHD were adjusted for age and gender. Adjusted percentages for dichotomous variables were obtained from logistic regression models while adjusted means and standard errors for continuous variables were obtained from analysis of variance. A forward stepwise regression procedure for the Cox proportional hazards model[10] identified independent predictors of incident CHD in 4 stages (*p*-values were 0.05 for entry into model and 0.10 for removal from the model). Age was forced into all models. In Stage I, demographic variables (i.e., gender, education, income, marital status) were allowed to compete for entry into the model. In Stage II, conventional risk factors (i.e., overweight, smoking, HDL, history of hypertension, history of diabetes, physical activity, alcohol, cholesterol, family history of MI, factor VIIc, fibrinogen, and systolic and diastolic blood pressure) were allowed to enter the model containing significant variables from the previous stage. In Stage III, measures of subclinical CHD (low ankle-arm index, Rose angina, common and internal carotid wall thickness, major ECG abnormalities) were allowed to compete for entry into the model containing significant variables from the previous stages. All variables that entered in Stages I through III were allowed to compete for entry into a final stepwise model. The final model identified factors associated with higher risk for incident CHD. All statistical analyses were performed

**Table 2. Association of Demographics and Other Population Characteristics with Incident CHD Among Older African Americans in the Cardiovascular Health Study***

| Characteristic | Incident CHD ($n$ = 90) | No Incident CHD ($n$ = 651) | Statistic ($p$-value) |
|---|---|---|---|
| Demographic Factors | | | |
| Age | 73.4 (SD = 0.6) | 72.7 (SE = 0.2) | 0.29 |
| Gender (% male) | 48 | 37 | 0.03 |
| Education (% ≥ HS)† | 57 | 56 | 0.84 |
| Income (% > $25K) | 16 | 20 | 0.44 |
| Married (% Yes) | 43 | 46 | 0.68 |
| Traditional Risk Factors | | | |
| Total cholesterol (mg/dL) | 219.8 (SE = 4.1) | 207.4 (SE = 1.5) | 0.01 |
| HDL cholesterol (mg/dL) | 59.5 (SE = 1.6) | 57.8 (SE = 0.6) | 0.32 |
| LDL cholesterol (mg/dL) | 138.6 (SE = 3.9) | 131.5 (SE = 1.4) | 0.09 |
| Systolic blood pressure (mmHg) | 143.2 (SE = 2.4) | 141.6 (SE = 0.9) | 0.52 |
| Diastolic blood pressure (mmHg) | 74.8 (SE = 1.2) | 75.4 (SE = 0.4) | 0.64 |
| Hypertension (%) | 74 | 64 | 0.06 |
| Smoking status (% ever smoked) | 61 | 51 | 0.12 |
| Diabetes (%) | 40 | 22 | <0.01 |
| Weight (% > 120% ideal) | 65 | 66 | 0.87 |
| Subclinical Disease Indicators | | | |
| Ankle-arm index (% ≤ 0.9) | 33 | 16 | <0.01 |
| Common carotid thickness (mm) | 1.1 (SE = 0.02) | 1.1 (SE = 0.01) | 0.30 |
| Internal carotid thickness (mm) | 1.5 (SE = 0.06) | 1.4 (SE = 0.02) | 0.04 |
| ECG LVM (gm)[4] | 163.1 (SE = 4.0) | 163.0 (SE = 1.5) | 0.98 |
| Major ECG abnormalities (%) | 45 | 33 | 0.03 |
| Coagulation Factors | | | |
| Factor VIIc (%) | 118.4 (SE = 2.7) | 111.9 (SE = 1.0) | 0.03 |
| Fibrinogen (mg/dl) | 354.3 (SE = 8.1) | 341.9 (SE = 3.0) | 0.15 |
| OTHER | | | |
| Rose IC (%)[5] | 3 | 0.4 | 0.01 |
| Self-rated health (% fair/poor) | 51 | 36 | 0.01 |
| Sibling history of MI | 25 | 22 | 0.58 |
| Alcohol (gm/week) | 0.7 (SE = 0.6) | 1.8 (SE = 0.2) | 0.09 |
| KCAL of physical activity | 971 (SE = 154) | 1089 (SE = 57) | 0.48 |

*Adjusted for age and gender. Significance of differences: $t$-test for continuous variables and chi-square for categorical variables.
†HS = high school; HDL = high density lipoprotein; LDL = low density lipoprotein; MI = myocardial infarction; KCAL = kilocalories.
‡Smoking status: never, former, current.
§Left ventricular mass by electrocardiography.
¶Intermittent claudication.

using Statistical Package for Social Sciences for Windows (SPSS, Inc., Chicago, IL).[11]

## RESULTS

Analyses in this report are based on 8 years of follow-up data (median = 4 years; maximum = 8 years). Of 924 African-American CHS participants, 746 were at risk for an incident event. There were 91 incident events (19 fatal and 72 nonfatal). Table 1 gives CHD incidence rates (per 1000 person-years at risk) in the cohort overall, and by gender and age category (<75 years vs. ≥75 years). Overall, CHD incidence was 26.6 per 1000 person-years of risk. Incidence was significantly greater in men than women (35.3 vs. 21.6, $p$-value = 0.02) and in those 75 years of age or older than those less than 75 years (31.3 vs. 24.5).

Table 2 presents the age- and gender-adjusted

**Table 3. Predictors of Incident CHD Among Older African Americans by Cox Proportional Hazards Regression**

| Risk Factor | Estimated Relative Risk | 95% CI | p-value |
|---|---|---|---|
| Stage I* | | | |
| Age (5 yr increments) | 1.15 | 0.95, 1.38 | 0.149 |
| Male gender | 1.71 | 1.11, 2.63 | 0.015 |
| Stage II† | | | |
| Age (5 yr increments) | 1.17 | 0.97, 1.42 | 0.107 |
| Male Gender | 1.91 | 1.23, 2.98 | 0.004 |
| Diabetes (Yes)‡ | 2.02 | 1.29, 3.15 | 0.002 |
| Total cholesterol§ | 1.34 | 1.09, 1.66 | 0.006 |
| Stage III¶ | | | |
| Age (5 year increments) | 1.09 | 0.89, 1.33 | 0.417 |
| Male Gender | 1.75 | 1.11, 2.74 | 0.015 |
| Diabetes (Yes) | 1.86 | 1.19, 2.91 | 0.007 |
| Total cholesterol§ | 1.25 | 1.01, 1.54 | 0.041 |
| Ankle-arm index (≤0.9) | 2.12 | 1.31, 3.44 | 0.002 |

*Age forced into all models. Then gender, education, income and marital status allowed to compete for entry into model.
†Traditional risk factors (overweight, smoking, HDL, total cholesterol, hypertension, diabetes, physical activity, alcohol, family history of MI, Factor VIIc, fibrinogen, systolic blood pressure, diastolic blood pressure) allowed to compete for entry into model from Stage I.
‡American Diabetic Association definition.
§In 1 standard deviation increment or 40 mg/dL.
¶Subclinical disease variables (Ankle-arm index, common and internal carotid wall thickness, major ECG abnormality), Rose angina allowed to compete for entry into model from Stage II.

comparisons of those with and without incident CHD on a number of demographic, physiologic, and behavioral characteristics. Incident events occurred more frequently in elderly African Americans who were male and who were significantly more likely to have a history of diabetes, higher levels of total cholesterol and factor VIIc, major ECG abnormalities, thicker internal carotid arteries, intermittent claudication by Rose questionnaire, and subclinical disease as measured by the ankle-arm index. Incident events also occurred more frequently in those who reported poor self-rated health. Other well-established risk factors for CHD (e.g., HDL cholesterol, LDL cholesterol, systolic blood pressure) did not differ significantly between the two groups.

The results of the stepwise Cox proportional hazard regression are presented in Table 3. Of the demographic variables, male gender (RR = 1.71, 95% CI = 1.11, 2.63) was the only independent predictor of incident events after adjusting for age. Among conventional risk factors allowed to compete for entry into the model in Stage II, history of diabetes mellitus (RR = 2.02, 95% CI = 1.29, 3.15), and total cholesterol (RR = 1.34 for a 40 mg/dL difference, 95% CI = 1.09, 1.66) were predictive of incident disease beyond age and gender. In Stage III, low (<0.9) ankle-arm index (RR = 2.19, 95% CI = 1.34, 3.58) was the only subclinical disease measure predictive of incident disease after accounting for age, male gender, and conventional risk factors. In the final stage, male gender (RR = 1.75, 95% CI = 1.11, 2.74), diabetes (RR = 1.86, 95% CI = 1.19, 2.91), low ankle-arm index (RR = 2.12, 95% CI = 1.31, 3.44), and total cholesterol (RR = 1.25, 95% CI = 1.01, .54) were independently associated with incident events after adjusting for age.

## DISCUSSION

In this cohort of older African Americans, approximately 26.6 incident events occurred for every 1000 person-years of follow-up. This rate is higher than that reported for the general United States population (11 per 1000 person-years for males and 6.4 per 1000 person-years for females) based on data from the Epidemiologic Follow-up Study of the first National Health and Nutrition Examination Survey in which incident CHD was defined as MI, angina, and other forms of chronic ischemic heart disease [International Classification of Diseases (ICD) codes 410 to 414].[12]

An important observation that emerges from this study is the finding that ankle-arm index, a measure of subclinical atherosclerosis, was predictive of incident disease in this cohort, independent of age, gender, history of diabetes, and total cholesterol. The relationship between measures of subclinical disease and CHD has been examined previously in predominantly white population samples. Low ankle-arm index (i.e., $\leq 0.9$) was a strong predictor of CHD mortality in both middle-aged[13,14] and older adults[13,15,16] independent of age, sex, and a number of conventional CHD risk factors. A composite measure of subclinical atherosclerosis (based on ankle-arm index, carotid artery stenosis, wall thickness, ECG and echocardiographic abnormalities, and positive responses to Rose angina and claudication questionnaires) was found to be strongly predictive of incident CHD events (fatal and nonfatal) among older adults[16] Our data provide evidence in support of these previous reports and extend these findings to older African Americans.

The literature is inconsistent regarding the relationship between total cholesterol and CHD. Studies conducted in older adults have variously reported total cholesterol to be independently predictive of CHD mortality with risk similar to that observed in younger populations,[17] predictive of CHD mortality with attenuated risk,[18–20] and unrelated to CHD morbidity and mortality.[21] Studies of CHD mortality among older African Americans have generally found total cholesterol to be unrelated to CHD mortality,[22,23] incident CHD,[24] or prevalent CHD.[25] In our study, a one standard deviation (i.e., 40 mg/dL) increase in total cholesterol was associated with a 25% increased risk of incident disease independent of other risk factors. The discrepancy between our study and previous studies may be related to the smaller, less geographically diverse samples of the latter, which potentially could have limited both the power and heterogeneity necessary to detect differences in CHD outcomes related to cholesterol level.

The present analyses were restricted to the total sample of African-American participants in the CHS. The baseline examination of the two cohorts 3 years apart might introduce important biases related to 1) change in methods of data collection over time and 2) change in the underlying population from which the samples were drawn over time. In the CHS, methods of quality assurance, data collection, and disease status ascertainment were similar for each cohort, thereby minimizing some of this potential bias. In addition, a comparison of the original and new cohorts found no consistent differences in CHD risk factor levels.[26]

As more African Americans reach older ages, it will become increasingly important to better understand the natural history of CHD in this population. Our results suggest that male gender, low ankle-arm index, history of diabetes, and total cholesterol are associated with increased risk for incident CHD in older African Americans. The absence of an association between incident disease and other conventional CHD risk factors, such as systolic blood pressure, and HDL and LDL cholesterol, as reported in this study, requires cautious interpretation and does not suggest that risk factor screening or risk reduction efforts in this population be abandoned. Continued surveillance of the CHS cohort will provide further opportunities to assess these relationships in older African Americans.

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