1   **Racial Differences in Fatal Out-of-hospital Coronary Heart Disease and the Role of Income in**

2   **the Atherosclerosis Risk in Communities Cohort Study (1987-2017)**

3   **Running Title:** Racial differences in fatal out-of-hospital coronary heart disease

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29

Abstract

Black individuals have higher incident fatal coronary heart disease (CHD) than White

counterparts. Racial differences in out-of-hospital fatal CHD could explain the excess risk in fatal

CHD among Black persons. We examined racial disparities in in- and out-of-hospital fatal CHD

among people with no previous history of CHD, and whether socioeconomic status might play a

role in this association. We used data from the Atherosclerosis Risk in Communities study,

including 4095 Black and 10884 White participants, followed between 1987-89 until 2017. Race

was self-reported. We examined racial differences in in- and out-of-hospital fatal CHD with

hierarchical proportional hazard models. We then examined the role of income in these

associations using Cox marginal structural models for a mediation analysis. The incidence of

out-of-hospital and in-hospital fatal CHD was 1.3 and 2.2 in Black participants, and 1.0 and 1.1

in White participants per 1,000 person-years, respectively. The sex- and age-adjusted hazard

ratios comparing out-of-hospital and in-hospital incident fatal CHD in Black versus White

participants were 1.65 (1.32-2.07) and 2.37 (1.96-2.86) respectively. The income-controlled

direct effects of race in Black vs. White participants attenuated to 1.33 (1.01-1.74) for fatal out-

of-hospital and to 2.03 (1.61-2.55) for fatal in-hospital CHD in Cox marginal structural models.

In conclusion, higher rates of fatal in-hospital CHD in Black participants vs. White counterparts

likely drive the overall racial differences in fatal CHD. Income largely explained racial differences

in both fatal out-of-hospital CHD and fatal in-hospital CHD.

Key words: racial disparities, out-of-hospital deaths, coronary heart disease

Introduction

While the incidence and mortality of coronary heart disease (CHD) have been declining over the past several decades in the United States[1-3], Black individuals continue to have higher prevalence of CHD, and higher hospitalization rates and mortality from CHD than White individuals[4-10]. However, these disparities do not seem to persist when considering non-fatal CHD events[8,11]. Studies from large population studies have reported no difference in total CHD incidence among Blacks versus White individuals[8,11]. However, in the same populations, Black men showed a higher incidence of fatal CHD and case-fatality than White men[8,11]. These findings could be driven by a higher rate of out-of-hospital CHD deaths in Black individuals, perhaps because of a lower access to healthcare, if a larger proportion of fatal CHD events occur before reaching the hospital in Black individuals compared with White counterparts. Existing studies of CHD mortality differences by race have rarely considered racial differences in fatal out-of-hospital CHD. Furthermore, most previous studies were conducted among Medicare beneficiaries ≥65 years of age, which could mask race-related disparities since Black individuals tend to develop CHD and die from it earlier in life than White individuals[8,12-19]. Also, income was highly associated with sudden cardiac death in previous studies perhaps through its relationship with healthcare access, health education, and lifestyle behaviors [20,21]. In the Atherosclerosis Risk in Communities (ARIC) study, we examined racial differences in the rates of out-of-hospital and in-hospital (post-admission) incidence of fatal CHD among US adults free of CHD at baseline. We explored the role of income in these associations in our models while we adjusted for cardiovascular risk factors.

Methods

The ARIC study is a prospective epidemiologic study conducted in 4 US communities (Washington County, MD; Forsyth County, NC; Jackson, MS; and selected Minneapolis suburbs, MN)[22]. Each ARIC field center randomly selected and recruited a cohort of approximately 4000 individuals aged 45-64 years from a defined community. Since very few Non-White and Non-Black participants participated in ARIC (n=48), we excluded them from the analysis. After excluding individuals who had prevalent CHD at baseline (n=766), our analysis included 14979 ARIC participants.

Participants received an extensive in-person evaluation, where sociodemographic and cardiovascular data were collected. Participants were reexamined in person every 3 years for the first 9 years (1990-92, 1993-95, 1996-98), with additional exams in 2011-13, 2016-17, and 2018-19. Also, participants were contacted by phone yearly (biannually since 2012) to update contact information and assess their health status. At visit 1 (baseline, 1987–1989), trained interviewers administered a questionnaire to collect data on demographic characteristics, medical history, and cardiovascular risk factors. Information on household income and years of education was also collected. Follow-up is ongoing in ARIC, however, in this analysis we ended the follow-up in 2017 since the adjudicated endpoint data for the Jackson site is currently available through 12/31/2017. Incident CHD events which occurred between the start of the data collection (1987-89) up to 12/31/2017 were included in the analysis. Procedures applied at all study centers were approved by each institutional review board, and informed consent was obtained from all participants.

95   Self-reported race at visit 1 was the exposure variable, which was classified as "Black

96   participants" and "White participants".

97   In ARIC, CHD events were ascertained by surveying discharge lists from local hospitals

98   and death certificates from state vital statistics and follow-up calls identifying hospitalizations

99   and deaths during the previous year. We followed the standard definitions of events in ARIC to

100   define a CHD event. A participant in the ARIC cohort was considered to have a CHD event if they

101   had a definite or probable acute myocardial infarction (AMI) or a fatal CHD during the follow-

102   up. The definition of AMI required the presence of at least one of the following: 1) evolving

103   diagnostic ECG pattern; (2) diagnostic ECG pattern and abnormal biomarkers; (3) cardiac pain

104   and abnormal biomarkers; (4) cardiac pain and equivocal biomarkers with evolving ST-segment/

105   T-wave pattern or diagnostic ECG pattern; or (5) abnormal biomarkers with evolving ST-

106   segment/T-wave pattern. Fatal out-of-hospital CHD included deaths of participants who died at

107   home or in other undefined places, or "deaths on arrival" to the hospital or deaths occurring in

108   nursing homes. Fatal in-hospital CHD included deaths that occurred in hospitals. In ARIC, fatal

109   out-of-hospital CHD events were ascertained and adjudicated after a special investigation.

110   Additional information was sought from the next of kin and other informants, certifying doctors

111   and family physicians, and coroners or medical examiners for out-of-hospital deaths. The next

112   of kin was contacted for an interview, and information was sought from physicians by sending

113   the Physician Questionnaire. Information on all out-of-hospital deaths was reviewed by 2

114   members of the expert committee of ARIC for event adjudication, in order to classify the event

115   as "definite fatal CHD" using established criteria. These criteria remained the same during the

116   follow-up. More information on the event classification is given in the ARIC Study surveillance

117   manual[22].

118   Income was included to our main models in 5 groups: < $16000, $16000 to $25000,

119    $25000 to $35000, $35000 to $50000, ≥ $50000. Cardiovascular risk factors included body mass

120   index (BMI), prevalent hypertension, prevalent diabetes, smoking status, and total cholesterol

121   levels measured at visit 1. BMI was calculated as weight (in kilograms) divided by the square of

122   height (meters) and was classified as "< 30.0" and "≥ 30.0". Prevalent hypertension was

123   defined as a systolic blood pressure of at least 140 mmHg or a diastolic blood pressure of at

124   least 90 mmHg or use of hypertension medication. Blood pressure was measured by a certified

125   technician using a random-zero sphygmomanometer after 5 minutes of rest and the average of

126   the last 2 of the 3 seated measurements was used. Prevalent diabetes was defined as a fasting

127   glucose level of at least 126 mg/dL, or a casual blood glucose level of at least ≥ 200 mg/dL, or a

128   self-reported diagnosis of diabetes by a physician or use of antidiabetic medications. Fasting

129   glucose levels were measured by the modified hexokinase/glucose-6 phosphate dehydrogenase

130   method. Fasting plasma total cholesterol concentration was assessed by enzymatic procedures

131   and was classified as "< 200 mg/dl" or "≥ 200 mg/dl". Smoking status was classified as

132   "current", "former" and "never" smoker.

133   First, we tabulated the distributions of baseline sociodemographic factors and

134   cardiovascular risk factors by race. Next, we computed incidence per 1000 person-years and 95

135   % confidence intervals (CI) for fatal, non-fatal, and total CHD by race. For fatal CHD, we

136   examined out-of-hospital and in-hospital CHD deaths separately.

137   We constructed age- and sex-adjusted Cox proportional hazard models (Model 1) to

138   compare fatal out-of-hospital and fatal in-hospital CHD, non-fatal CHD, and total incident CHD

139   between Black and White participants. While constructing Cox proportional hazard models for

140   fatal CHDs, we used a time to event analysis approach. In this analysis for fatal CHD, individuals

141   who had prior non-fatal CHD events during the entire follow-up were not censored but

142   individuals who died of other non-CHD causes were censored. In parallel to our main

143   hypothesis, that income, as a socioeconomic indicator, helps explain racial disparities in

144   outcomes and because differences in income could drive differences in cardiovascular risk

145   factors, income was considered a more proximal exposure than cardiovascular risk factors and

146   was included first in the second model (Model 2). We then added cardiovascular risk factors in

147   fully-adjusted Model 3 to examine the mitigation of the remaining excess risk in Black

148   participants vs. White participants. As a secondary analysis, we created models where

149   cardiovascular risk factors were included first in Model 2, without income, to compare the

150   results with the initial modelling approach.

151   We used logistic regression to examine racial differences in case-fatality among those

152   hospitalized. We tested multiplicative race and sex interactions using Cox proportional hazard

153   models adjusted for age. These models included in the interaction term 'sex*race' as well as

154   variables age, sex and race. Then, considering the results of the interaction testing, we

155   separately conducted a sex-stratified analysis. We also tested multiplicative race and income

156   interactions using the same approach. As a secondary analysis, we examined race differences

157   for the exact place of death (i.e., at home, or in undefined place) for out-of-hospital incident

158   CHD.

159   We then constructed Cox marginal structural models to examine the mediating role of

160   income using inverse probability weighting[23,24] . In our mediation analysis, we hypothesized

161   that income is a mediating factor on the pathway between race and the incident CHD

162   outcomes. Inverse probability weighting allowed us to avoid violation of a major mediation

163   analysis assumption,[25] which requires careful adjustment of mediator-outcome confounders

164   affected by (or associated with) the exposure[25]. As seen in the directed acyclic graph in **Figure**

165   **1,** since race, as the exposure, is an upstream variable, there could be a path (path 1) from race

166   to cardiovascular risk factors, which could also be confounders of the association between

167   income and incident CHD (through paths 2 and 5). Therefore, simply adjusting for all covariates

168   in the models could lead to biased results for mediation analysis. The use of methods such as

169   inverse probability weighting, which allows separating the effect of income from the effect of

170   other covariates, is recommended to get less biased estimates[24,26]. We estimated inverse

171   probability weights using logistic models where income was the outcome. We added

172   cardiovascular risk factors to these logistic models and derived stabilized inverse probability

173   weights to be included in our Cox marginal structural models. In sensitivity analyses, we used

174   different binary cut-points of income to examine whether our conclusions change or remain the

175   same. Missing data were < 5 % for income and other covariates. Individuals with missing

176   income or other covariates were excluded from the analysis. All analyses were conducted in

177   SAS version 9.4.

178   An institutional review board at each site approved the ARIC study, and study

179   participants provided written informed consent at all study centers. We also obtained approval

180   from the Emory University Institutional Review Board (IRB00111905).

Results

181   **Results**

182   The characteristics of the study population by race are described in **Table 1**. Among

183 participants, 43 % were men, and 27 % were Black. Black participants were slightly younger; the

184 mean (SD) age was 53.4 (5.8) for Black participants and 54.2(5.7) for White participants. There

185 were large differences in education and income by race. Among Black participants, 52.4 % had

186 an annual income of < $16000; that figure was 12.2 % among the White participants. Smoking

187 status and prevalence of hypercholesterolemia were similar by race, but Black individuals had a

188 higher BMI and a higher prevalence of hypertension and diabetes.

189   **Table 2** shows the association of race with incident fatal, non-fatal, and total CHD

190 events in the ARIC Cohort. The fatal CHD incidence was higher in Black participants (3.5 per

191 1000 person years, (95 % CI, 3.1-3.9) than in White participants (2.1, 95 % CI, 1.9-2.2).

192 Comparing Black to White participants, the hazard ratio of fatal incident CHD was 2.02 (1.75-

193 2.33) in age and sex-adjusted models and attenuated to 1.39 (1.17-1.64) after income was

194 included in Model 2. Racial differences in fatal CHD disappeared in Model 3 (HR, 1.01, 95 % CI,

195 0.84-1.21) after both income and cardiovascular risk factors were included. In contrast, the

196 non-fatal CHD incidence per 1000 person-years was similar by race; the age and sex-adjusted

197 hazard ratio comparing Black to White participants was 1.05 (0.93-1.18). Overall, the total

198 incident CHD rate was higher in Black versus White participants. In sex- and age- adjusted

199 models, the hazard ratio was 1.36 (95 % CI, 1.24-1.49) comparing Black versus White

200 participants. The hazard ratio attenuated to 1.06 (0.96-1.18) after income was included in the

201 model and further attenuated to 0.88 (0.79-0.99) in fully-adjusted multivariable Model 3.

202   Both fatal out-of-hospital and fatal in-hospital CHD were higher in Black vs. White

203   participants **(Figure 2).** The risk for fatal out-of-hospital CHD was higher in Black than White

204   participants in sex and age- adjusted models (HR, 1.65, 95 % CI, 1.32-2.07) **(Table 3)**. The

205   magnitude of the race difference was higher for fatal in-hospital CHD than for fatal out-of-

206   hospital CHD (HR, 2.37, 95 % CI, 1.96-2.86). However, after income was included in the models,

207   racial differences largely disappeared for fatal out-of-hospital CHD (HR:1.06, 95 % CI, 0.82-1.37),

208   whereas differences persisted for fatal in-hospital CHD (HR: 1.73, 95 % CI, 1.39-2.16). In fully-

209   adjusted multivariable models, the HRs attenuated to 0.77 (0.58-1.02) for fatal out-of-hospital

210   CHD and to 1.24 (0.98-1.58) for fatal in-hospital CHD **(Table 3).** Also, in fully adjusted models,

211   compared to those with income ≥ 50000, the participants in lower income groups had higher

212   risk for both fatal out-of-hospital and in-hospital CHD. The magnitude of hazard ratios was

213   particularly elevated for those in the lowest income groups (< $16000) for both fatal out-of-

214   hospital CHD (HR, 2.76, 95 % CI, 1.92-3.95) and for fatal in-hospital CHD (HR, 1.95, 95 % CI, 1.42-

215   2.67). Income was a predictor of both outcomes (**Supplementary Table 1).**

216   Among those hospitalized**,** the case-fatality for incident CHD was also elevated in Black

217   patients compared with White patients (HR, 1.82, 95 % CI, 1.42-2.32) **(Supplementary Table 2).**

218   There was a significant interaction between race and sex for non-fatal CHD (p: 0.003) and total

219   CHD (p: 0.042) but not for fatal CHD. The findings from the models which we created to test

220   interaction are presented in **Supplementary Tables 3-5.** The findings of the sex-stratified

221   analysis are presented in **Figure 3**. In sex-stratified analysis, among both men and women, the

222   racial difference in fatal out-of-hospital CHD was higher than the racial difference in fatal in-

223   hospital CHD (**Figure 3)**. There were no significant interactions between race and income.

224   In secondary analysis, the attenuation in the hazard ratios after including cardiovascular

225   factors (without income) to the models was similar to the attenuation in hazard ratios after

226   including income (without cardiovascular risk factors). These results suggest that income and

227   cardiovascular risk factors are interlinked and income is likely a proximal exposure leading to

228   higher levels of cardiovascular risk factors (**Supplementary Tables 6 and 7).**

229   In secondary analyses of out-of-hospital deaths, most Black and White participants died

230   in their homes, but Black individuals were more likely to die than White individuals whether the

231   death occurred at home (HR, 1.84, 95 % CI, 1.36-2.48) or in an undefined place (HR, 2.07, 95 %

232   CI, 1.26-3.39) (**Supplementary Table 8).**

233   In inverse probability weighted Cox marginal structural models, where income was

234   included as a mediator, the income-controlled direct effects of race in Black vs. White

235   participants was 0.96 (0.83-1.11) for incident non-fatal CHD and was 1.68 (1.41-2.00) for

236   incident fatal CHD. The racial disparities also attenuated for both fatal out-of-hospital CHD (HR:

237   1.33, 95 % CI, 1.01-1.74) and for fatal in-hospital CHD (HR: 2.03, 95 % CI, 1.61-2.55) **(Table 4)**.

238   Our conclusions remained similar when we regrouped income in the same models for a

239   sensitivity analysis **(Table 4)**.

240   **Discussion**

241   In this community-based cohort study, the incidence of both fatal out-of-hospital and

242   fatal in-hospital CHD was higher in Black versus White individuals. The racial disparity was

243   greatest for in-hospital fatal CHD and thus case-fatality of those hospitalized. The effect of

244   income in explaining racial disparities was similar for fatal out-of-hospital CHD and fatal in-

245   hospital CHD. These findings have implications for prevention and policy regarding access to

11

246 care and appropriateness of clinical care and prevention strategies for potentially under-served

247 groups such as the Black population.

248 We show that the lower income of Black individuals plays an important role in

249 explaining race differences in CHD death. In agreement with our results, income previously was

250 reported to be the main driver of racial differences in sudden cardiac arrest in other

251 investigations[20,21]. Furthermore, lower income has been associated with lower awareness of

252 CHD, including the alarming symptoms of an AMI[27]. Our findings extend this literature to out-

253 of-hospital death as a whole, and suggest a potential role for access to care, as a lower access

254 to health care due to limited income could cause delays in seeking care or even discourage care

255 altogether[28].

256 The higher rates of fatal incident CHD in our study parallel previous reports that the first

257 clinical presentation of CHD is more fatal among Black individuals compared with Whites[1,3,11].

258 One reason for the higher rate of fatal CHD in Black than in White individuals could be a higher

259 rate of sudden cardiac death among Black people. Sudden cardiac death was indeed almost

260 twice as high in Black than in White participants in previous analyses of the ARIC[20] and the

261 REGARDS studies[29]. However, we found an excess of mortality among Black individuals for both

262 out-of-hospital and in-hospital death, therefore it is unlikely that the higher rate of fatal CHD in

263 Black persons is simply a reflection of a higher rate of sudden cardiac death.

264 A second explanation for racial differences in incident fatal CHD could be due to

265 differences in the time between symptom onset and arrival to the hospital,[30] since significant

266 delays in seeking medical care could increase the possibility of death from CHD. Based on

267 previous studies, Black individuals tend to have longer prehospital delays[31,32] and are more

268 likely to be unaware of the symptoms of an incipient CHD event[27] compared with White

269 individuals. Also, previous studies suggest that Black patients with AMI receive lower in-hospital

270 quality of care with higher readmission rates than their White counterparts[33]. Additionally,

271 previous studies suggested that significant racial disparities exist in utilization and outcomes of

272 cardiac surgery[34,35] where Black individuals are disadvantaged compared to Whites. These

273 factors could lead to a higher incidence of in-hospital CHD and case-fatality in Black individuals

274 compared to White individuals as suggested by our findings in this study.

275   A third possible explanation is that Black individuals have a higher prevalence of major

276 CHD risk factors and lower rates of access to interventions aimed at controlling these risk

277 factors compared to White counterparts[36-38]. Previous literature reported higher in-hospital

278 mortality and lower secondary prevention uptake, such as revascularization procedures in Black

279 individuals compared to White individuals[12-19]. Furthermore, Black patients are reported to

280 have longer waiting times to treatment after hospitalization than White patients[39], resulting in

281 delays for the receipt of secondary prevention interventions which could contribute to higher

282 mortality[40]. The higher rates of fatal in-hospital CHD and of case-fatality in Black vs. White

283 individuals in our analysis are consistent with previous studies[8,41,42]. Race-related disparities in

284 fatal in-hospital CHD lost statistical significance after adjusting for cardiovascular risk factors,

285 suggesting that cardiovascular risk factors play a role to some extent in explaining outcome

286 differences by race.

287   Our study has several strengths, including the large sample size and the long duration of

288 follow-up in a community-based setting. Another strength was the use of self-reported race, as

289 suggested by recent guidelines for disparities research,[43,44] rather than inferring race from

290 other sources. We used rigorous methods for mediation analysis with marginal structural

291 models to help avoid potential biases. Furthermore, the ARIC study has active surveillance of

292 events through hospital records and adjudication by an expert committee, minimizing event

293 misclassification. For the adjudication of out-of-hospital incident CHD deaths, the ARIC study

294 incorporated multiple sources of information, including interviews with the next of kin and

295 physicians. However, a limitation is that all participants in the Jackson site were Black, and

296 participants in the Minnesota and Maryland sites were predominantly White; therefore, we

297 were not able to fully separate differences by race from differences by study site. Also, we

298 could only consider baseline socioeconomic and cardiovascular risk factors in our analysis and

299 we did not examine potential role of racial differences in treatments and procedures on the

300 study results. It is likely that other environmental, social, cultural and policy factors could play a

301 role in the excess CHD death among Black persons. Further studies are needed to investigate

302 how the geographical and contextual factors would impact the association of race and CHD

303 incidence.

304   In conclusion, based on our findings, Black individuals die from CHD at about twice the

305 rate of White individuals, and the excess in mortality is seen irrespective of where these events

306 occur in or out of the hospital. Income plays a pronounced role in this disparity for both in- and

307 out-of-hospital deaths, also suggesting a key role of healthcare access. These findings highlight

308 the need for better primary prevention interventions among Black people to prevent CHD

309 death. Our results also suggest the importance of targeting lack of healthcare coverage and

310 other potential barriers to access to care in order to decrease racial differences in CHD death

311 and foster health equity. Timely access to emergency care and effective preventive

312 interventions could decrease the racial disparities in fatal CHD events. Furthermore, equal

313 access to high quality of in-hospital care, and to advanced cardiology care, such as cardiac

314 surgery when needed, could prevent racial disparities in in-hospital fatal CHD and its case-

315 fatality.

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335 **Author contributions**

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338 **manuscript:** All authors **Supervision:** Vaccarino.

339 **Supplemental Materials**

340 Supplemental Tables 1-8

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Figure Legends

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491 **Figure 1.** Directed acyclic graph as a conceptual model demonstrating race and incident coronary heart

492 disease associations through income as the mediator and other covariates

493 Abbreviations: CVD: cardiovascular disease, BMI: body mass index, CHD: Coronary heart

494 disease, HT: Hypertension

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496 **Figure 2.** Incidence of non-fatal, fatal out-of-hospital and fatal in-hospital coronary heart

497 disease in Black and White participants in ARIC Cohort (1987-2017)

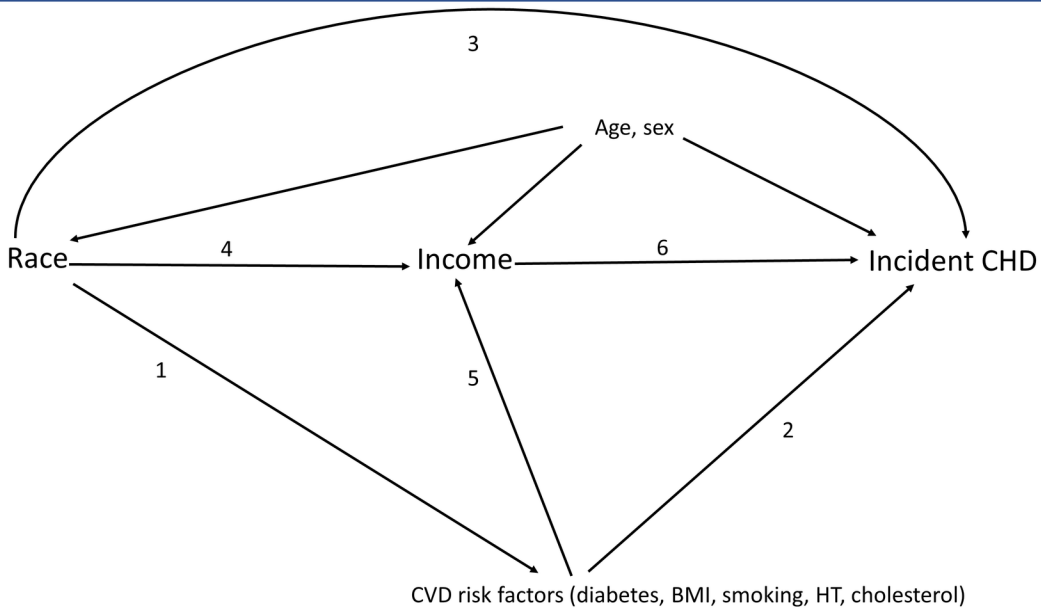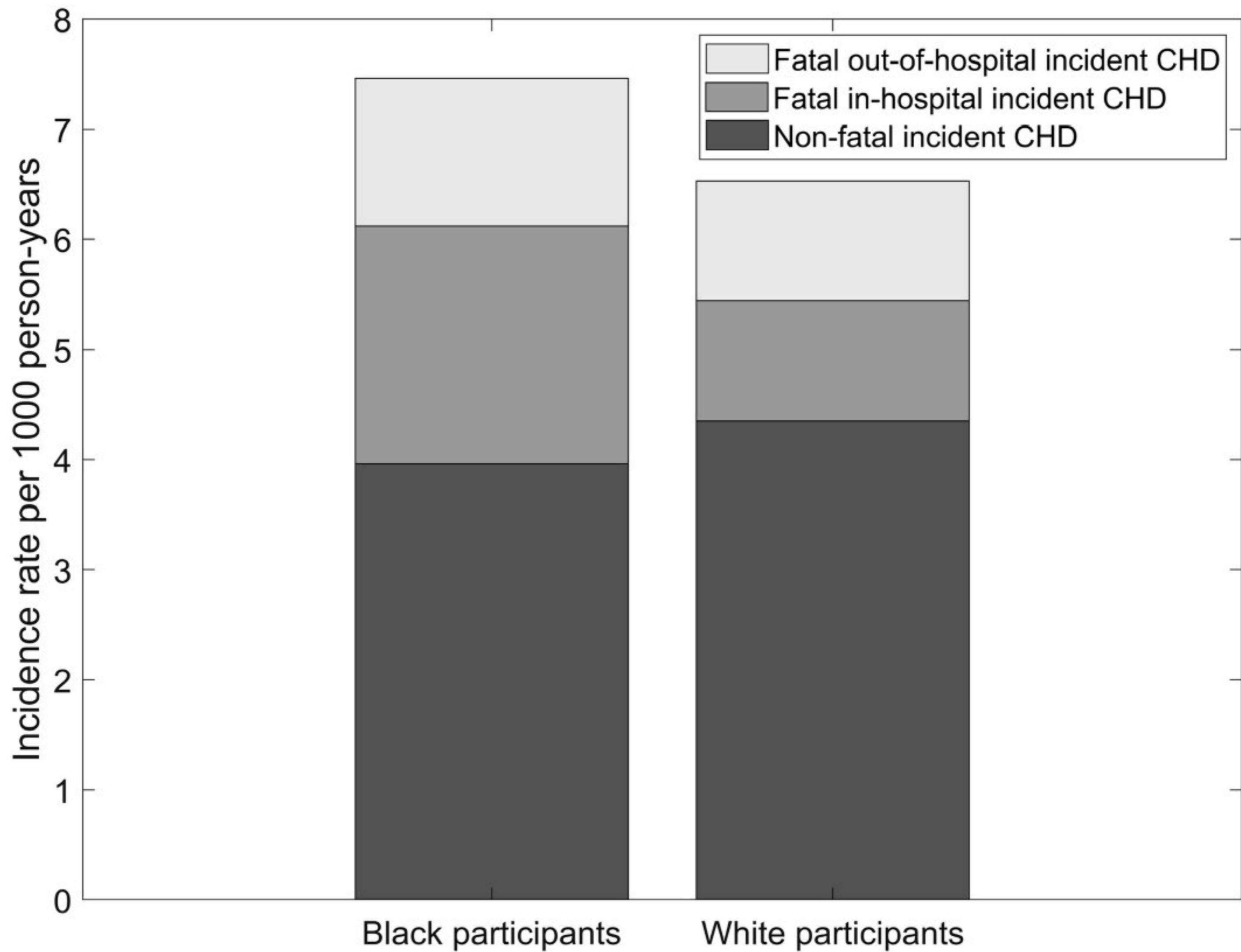498 Abbreviation: CHD: Coronary heart disease

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500 **Figure 3.** Results from sex-stratified analysis comparing racial differences in incident CHD outcomes

501 among men and women adjusted for age in ARIC Cohort (1987-2017)

502 Abbreviations: HR: Hazard Ratio, CHD: Coronary Heart disease

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Age, sex

Race

Income

Incident CHD

CVD risk factors (diabetes, BMI, smoking, HT, cholesterol)

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Black men vs White men

HR

Incident Nonfatal CHD | Incident out-of-hospital fatal CHD | Incident in-hospital fatal CHD | Incident total CHD
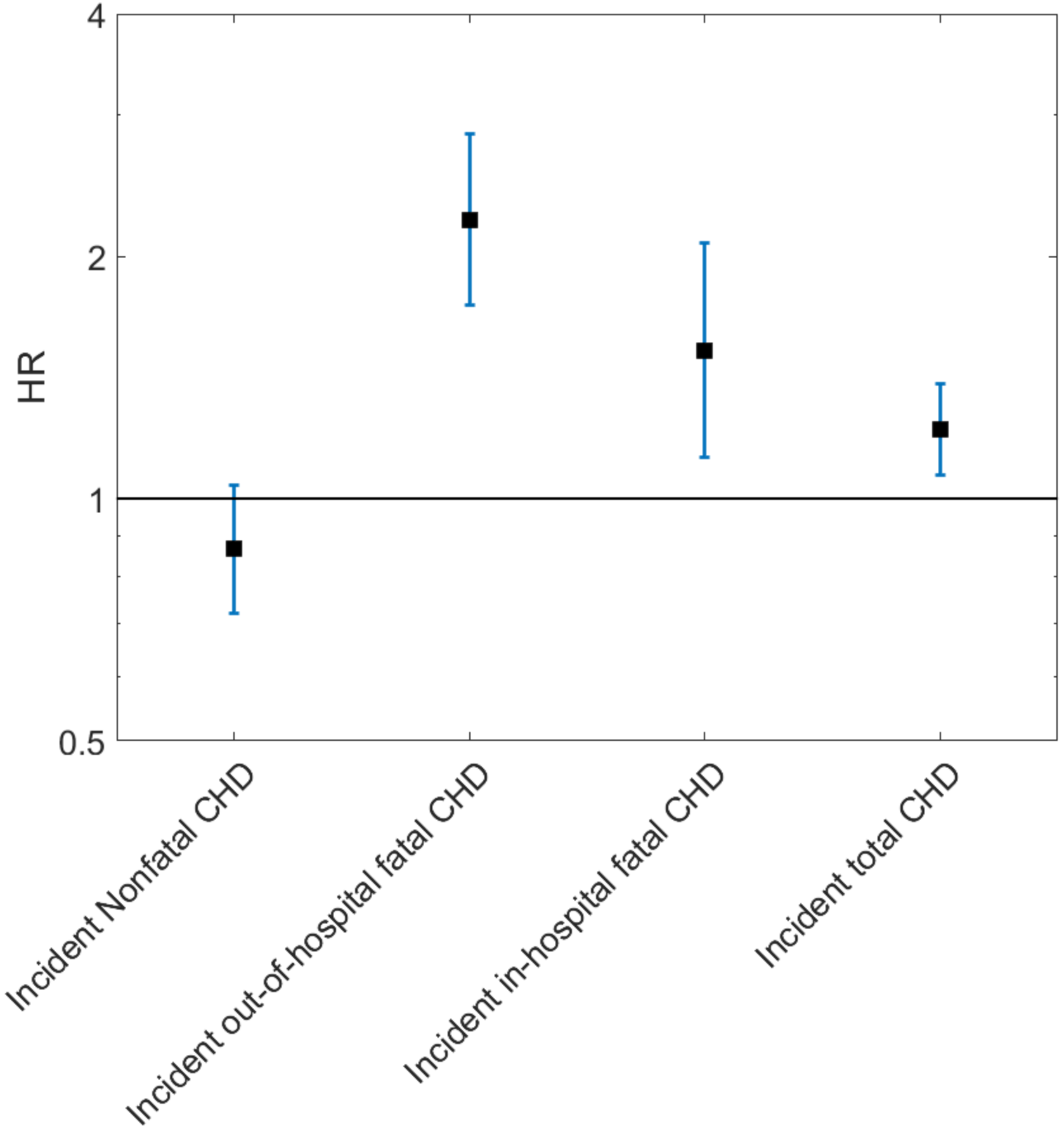
Black women vs White women

HR

Incident Nonfatal CHD | Incident out-of-hospital fatal CHD | Incident in-hospital fatal CHD | Incident total CHD

Table 1. Characteristics of Atherosclerosis Risk in Communities cohort study participants at baseline (1987-89) by race (n=14979).

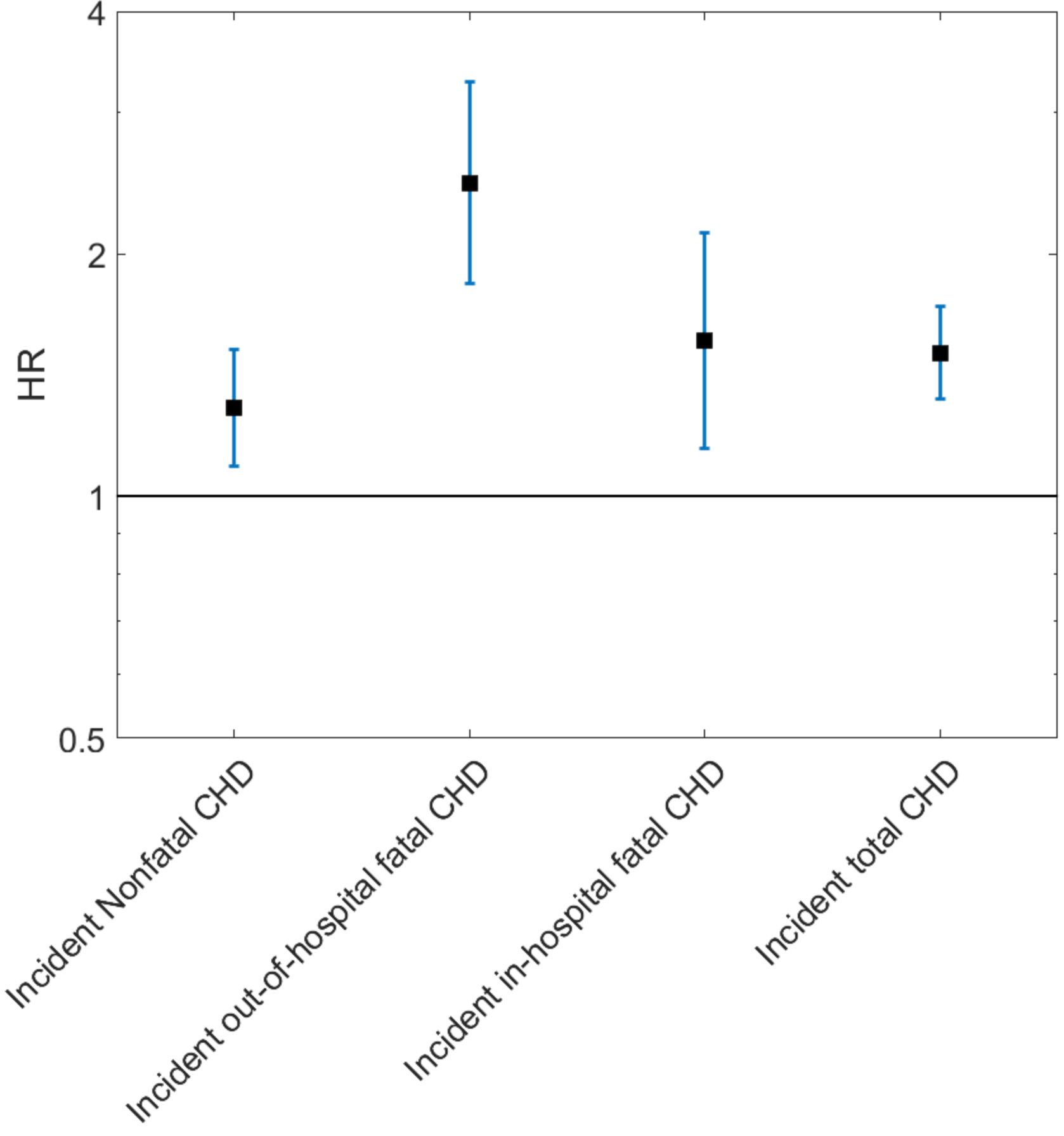|	Black participants[1] (n=4095)	White participants[1] (n=10884)
Age[2], mean (SD), y	53.4 (5.8)	54.2 (5.7)
Education, N (%)		
Grade school or less	805 (19.7 %)	580 (5.3 %)
High school, but no degree	884 (21.7 %)	1212 (11.1 %)
High school graduate	881 (21.6 %)	3975 (36.6 %)
Vocational school	278 (6.8 %)	980 (9.0 %)
College	708 (17.3 %)	3135 (28.8 %)
Graduate school or Professional school	527 (12.9 %)	989 (9.1 %)
Income (US $), N (%)		
< 16000	1931 (52.4 %)	1272 (12.2 %)
16000 to < 25000	666 (18.1 %)	1457 (14.0 %)
25000 to < 35000	466 (12.6 %)	2034 (19.5 %)
35000 to < 50000	360 (9.8 %)	2393 (23.0 %)
≥ 50000	262 (7.1 %)	3259 (31.3 %)
Smoking status N (%)		
Current	1212 (29.7 %)	2688 (24.7 %)
Former	951 (23.3 %)	3733 (34.3 %)
Never	1924 (47.1 %)	4455 (41.0 %)

Body Mass Index, N (%)		
< 30.0	2423 (59.4 %)	8434 (77.6 %)
≥ 30.0	1653 (40.6 %)	2439 (22.4 %)
Hypertension, N (%)	2252 (55.3 %)	2844 (26.2 %)
Diabetes, N (%)	753 (18.9 %)	922 (8.5 %)
Total Cholesterol, N (%)		
< 200 mg/dl	1559 (40.2 %)	4025 (37.1 %)
≥ 200 mg/dl	2322 (59.8 %)	6830 (62.9 %)

Abbreviations: SD: standard deviation

[1] All analyses were restricted to people with no previous history of coronary heart disease at baseline.

[2] Age is the age of the participant at baseline.

Table 2. Association of race with incident non-fatal, fatal and total coronary heart disease in the Atherosclerosis Risk in Communities cohort study (1987-2017) (n=14979)

	Black participants (n=4095)	White participants (n=10884)
Person-years	87327	249663
Incident fatal coronary heart disease		
Events	305	511
Incidence (95 % CI) per 1000 person-years	3.50 (3.11-3.90)	2.05 (1.88-2.23)
Model 1[1], HR (95% CI)	2.02 (1.75-2.33)	**ref**
Model 2[2], HR (95% CI)	1.39 (1.17-1.64)	**ref**
Model 3[3], HR (95% CI)	1.01 (0.84-1.21)	**ref**
Incident non-fatal coronary heart disease		
Events	347	1069
Incidence (95 % CI) per 1000 person-years	3.97 (3.57-44.1)	4.28 (4.03-4.54)
Model 1[1], HR (95% CI)	1.05 (0.93-1.18)	**ref**
Model 2[2], HR (95% CI)	0.89 (0.77-1.02)	**ref**
Model 3[3], HR (95% CI)	0.80 (0.69-0.93)	**ref**
Total incident coronary heart disease		
Events	652	1580
Incidence (95 % CI) per 1000 person-years	7.47 (6.91-8.06)	6.33 (6.02 -6.65)
Model 1[1], HR (95% CI)	1.36 (1.24-1.49)	**ref**
Model 2[2], HR (95% CI)	1.06 (0.96-1.18)	**ref**

Model 3[3], HR (95% CI)	0.88 (0.79-0.99)	**ref**

Abbreviations: HR: Hazard ratio, CI: Confidence interval

[1] Model 1 is Cox proportional hazard model, adjusted for age and sex.

[2] In Model 2, income is included in addition to Model 1. Income was included in five groups: < $16000, $16000 to $25000, $25000 to $35000, $35000 to $50000, ≥ $50000

[3] In Model 3, cardiovascular risk factors (smoking, BMI, hypertension, diabetes, total cholesterol) are additionally included to Model 2. All analyses were restricted to people with no previous history of coronary heart disease at baseline.

Table 3. Association of race with fatal out-of-hospital and in-hospital coronary heart disease in the Atherosclerosis Risk in Communities cohort study (1987-2017) (n=14979)

	Black participants (n=4095)	White participants (n=10884)
Person years	87327	249663
Fatal out-of-hospital incident coronary heart disease[1]		
Events	116	240
Incidence (95 % CI) per 1000 person-years	1.33 (1.10-1.59)	0.96 (0.85-1.09)
Model 1[2], HR (95% CI)	1.65 (1.32-2.07)	**ref**
Model 2[3], HR (95% CI)	1.06 (0.82-1.37)	**ref**
Model 3[4], HR (95% CI)	0.77(0.58-1.02)	**ref**
Fatal in-hospital incident coronary heart disease[5]		
Events	189	267
Incidence (95 % CI) per 1000 person-years	2.16 (1.87-2.49)	1.07 (0.95-1.20)
Model 1[2], HR (95% CI)	2.37 (1.96-2.86)	**ref**
Model 2[3], HR (95% CI)	1.73 (1.39-2.16)	**ref**
Model 3[4], HR (95% CI)	1.24 (0.98-1.58)	**ref**

Abbreviations: HR: Hazard ratio, CI: Confidence interval

[1] Fatal out-of-hospital coronary heart disease include deaths of participants who died at home, nursing homes, other undefined place or who were dead on arrival to hospital. All analyses were restricted to people with no previous history of coronary heart disease at baseline.

[2] Model 1 is Cox proportional hazard model, adjusted for age and sex.

[3] In Model 2, income is included in addition to Model 1. Income was included in five groups: < $16000, $16000 to $25000, $25000 to $35000, $35000 to $50000, > $50000

[4] In Model 3, cardiovascular risk factors (smoking, BMI, hypertension, diabetes, total cholesterol) are additionally included to Model 2. All analyses were restricted to people with no previous history of coronary heart disease.

[5] Fatal in-hospital coronary heart disease includes deaths which occurred in hospital

Table 4. Income-controlled direct effects of race on incident CHD in Atherosclerosis Risk in Communities cohort (1987-2017) (n=14979)

	Black participants (n=4095)	White participants (n=10884)
Incident fatal coronary heart disease		
HR[1] (95% CI)	1.68 (1.41-2.00)	ref
HR[2] (95% CI)	1.54 (1.27-1.86)	ref
HR[3] (95% CI)	1.49 (1.21-1.82)	ref
Incident non-fatal coronary heart disease		
HR[1] (95% CI)	0.96(0.83-1.11)	ref
HR[2] (95% CI)	0.93 (0.79-1.09)	ref
HR[3] (95% CI)	0.95 (0.81-1.12)	ref
Total incident coronary heart disease		
HR[1] (95% CI)	1.20 (1.07-1.34)	ref
HR[2] (95% CI)	1.13 (1.00-1.28)	ref
HR[3] (95% CI)	1.13 (1.00-1.28)	ref
Fatal out-of-hospital incident coronary heart disease[4]		
HR[1] (95% CI)	1.33 (1.01-1.74)	ref
HR[2] (95% CI)	1.17 (0.87-1.57)	ref
HR[3] (95% CI)	1.12 (0.84-1.49)	
Fatal in-hospital incident coronary heart disease[5]		

HR[1] (95% CI)	2.03 (1.61-2.55)	ref
HR[2] (95% CI)	1.93 (1.51-2.48)	ref
HR[3] (95% CI)	1.88 (1.43-2.47)	ref

Abbreviations: HR: Hazard ratio: CI: Confidence interval

[1] HR is estimated with a Cox marginal structural model where income (categorized as '< $35000 and '$35000 and above') is included as a mediator to the model. Inverse probability weighting method is applied. Other covariates include age, sex, and cardiovascular risk factors (smoking, BMI, hypertension, diabetes, total cholesterol). All analyses were restricted to people with no previous history of coronary heart disease at baseline.

[2] HR is estimated with the same Cox marginal structural model as above. Income is categorized as '< $25000' and '$25000 and above' for sensitivity analysis.

[3] HR is estimated with the same Cox marginal structural model as above. Income is categorized as '< $16000' and '$16000 and above' for sensitivity analysis.

[4] Fatal out-of-hospital coronary heart disease include deaths of participants who died at home, nursing homes, other undefined place or who were dead on arrival to hospital.

[5] Fatal in-hospital coronary heart disease include deaths which occurred in-hospital.