

# Life-Course Socioeconomic Position, Area Deprivation, and Coronary Heart Disease: Findings From the British Women's Heart and Health Study

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The idea that where one lives is important for one's health is not new.<sup>1</sup> However, there is debate regarding whether the characteristics of where people live (contextual effects) have an important influence on health independent of the characteristics of the people living in these areas (compositional effects).<sup>2,3</sup> The relevance of this issue is that if variations in health between areas can be entirely explained by the personal characteristics of the inhabitants of these areas, policymakers need act only on improving the circumstances of individuals. Conversely, the demonstration of independent area-level effects would emphasize the need to focus interventions on features of the areas where people live, not just on the individuals living there. This is important because the widening gap between the rich and the poor appears to be mirrored by a growing divergence of their residential environments, such that affluent people are increasingly living and interacting with other affluent people in affluent areas, whereas the poor increasingly live and interact with other poor people in more economically and socially deprived areas.<sup>4</sup>

The occurrence of coronary heart disease (CHD) varies geographically,<sup>5–7</sup> and CHD is strongly influenced by individual socioeconomic status or position (SEP).<sup>8,9</sup> Six studies have examined the effect of socioeconomic context on CHD by determining the effect of residential area deprivation, having adjusted for individual measures of SEP, and all 6 found moderate effects.<sup>10–15</sup> However, only 3 studies<sup>10,14,15</sup> adjusted for more than 1 individual measure of SEP. In such studies, it is likely that adjustment for only 1 or 2 indicators of an individual's SEP fails to capture the full complexity of their experience over the life course, leading to residual confounding by individual SEP rather than true contextual effects.<sup>3,16–19</sup> Among studies assessing the con-

**Objectives.** We sought to determine whether residential area deprivation, over and above the effect of life-course socioeconomic status or position (SEP), is associated with coronary heart disease.

**Methods.** We conducted a cross-sectional analysis of 4286 women aged 60 to 79 years from 457 British electoral wards.

**Results.** After adjustment for age and 10 indicators of individual life-course SEP, the odds of coronary heart disease was 27% greater among those living in wards with a deprivation score above the median compared with those living in a ward with a deprivation score equal to or below the median (odds ratio = 1.27; 95% confidence interval = 1.02, 1.57).

**Conclusions.** Adverse area-level socioeconomic characteristics, over and above individual life-course SEP, are associated with increased coronary heart disease. (*Am J Public Health.* 2005;95:XXX–XXX. doi: 10.2105/AJPH.2003.035592)

textual effects of SEP on all-cause mortality, the only study to adjust for individual SEP in childhood and adulthood found little remaining area-level effect,<sup>20</sup> suggesting that for all-cause mortality at least there may be no contextual effect over and above individual effects.<sup>3</sup> None of the studies assessing the association between socioeconomic context and CHD have adjusted for individual measures of SEP from across the life course.

The aims of this study were to assess the association between individual life-course SEP and adult residential area deprivation and to determine whether area socioeconomic deprivation, over and above the effect of individual life-course SEP, is associated with prevalent CHD in women.

## METHODS

### Study Participants

Data from the British Women's Heart and Health Study were used; full details of the selection of participants and measurements have been reported previously.<sup>21–23</sup> Women aged 60 to 79 years were randomly selected from general practitioner lists in 23 British towns. A total of 4286 women (60% of the

7166 invited) participated, and baseline data (self-completed questionnaire, research nurse interview, physical examination, and primary care medical record review) were collected between April 1999 and March 2001. Local ethics committee approvals were obtained.

### Outcome and Exposure Assessment

Prevalent CHD was defined as any participant with a primary care medical record of myocardial infarction (fulfilling World Health Organization diagnostic criteria<sup>24</sup>) or angina, or any participant who reported ever being diagnosed by a doctor with either of these conditions; 85% of cases were identified both in their medical records and by self-report of a physician diagnosis.<sup>23</sup> The geographic area used in this analysis was the electoral ward in which the women lived at the time of the baseline assessment. The postal code for each woman was used to locate her residence at the time of interview, and these postal codes were mapped to electoral wards for each woman. The mean population of wards in Britain is 5700, but they have a wide range (100–33 000); they cover, on average, an area of 16 km<sup>2</sup>. The Carstairs deprivation score (based on 1991 census data) was ob-

tained for all wards in Britain (England, Scotland, and Wales) from the census electronic files that are available to academic institutions ([http://census.ac.uk/cdu/Datasets/1991\\_Census\\_datasets/Area\\_Stats](http://census.ac.uk/cdu/Datasets/1991_Census_datasets/Area_Stats)). These scores were then mapped to their residential ward codes for each woman. The Carstairs deprivation score is based on 4 variables derived from census data: male unemployment, household overcrowding, car ownership, and the proportion of households in social classes IV (semi-skilled manual occupations) and V (unskilled manual occupations).<sup>25</sup> Weights applied to each of these 4 variables are determined by the proportion in the British population with each variable, and a *Z* score for the whole population is then calculated.<sup>25</sup> Thus, a ward score of 0 indicates that a ward has socioeconomic circumstances that are similar to the mean for the whole of Britain, a negative score indicates greater affluence compared with the average of Britain, and a positive score indicates greater disadvantage.

Details of the longest held occupation of the participant's father and husband and her own longest held occupation were requested in the self-completed questionnaire. Adult social class was derived from the longest held occupation of the participant's husband for married women and the participant's own longest held occupation for single women. Childhood social class was derived from the longest held occupation of the participant's father. Social class was categorized into 1 of 6 social classes (social class I [professional], II [intermediate], III<sub>nm</sub> [skilled non-manual], III<sub>m</sub> [skilled manual], IV [partially skilled manual], and V [unskilled manual occupations]).<sup>26</sup> Other indicators of childhood SEP were self-reported childhood household amenities (living in a house with a bathroom, living in a house with a hot water supply, and sharing a bedroom), family access to a car as a child, and age at leaving full-time education. Other indicators of adult SEP were housing status (social housing, private rented, owner-occupied, and other), car ownership, and pension arrangements (state only, state and occupational, state and personal, and other).

Full details of all anthropometric measures and measurements of lipids, blood pressure, insulin resistance (measured using the homeo-

stasis model assessment), diabetes status, and lung function have been previously reported.<sup>21,22</sup> Smoking was categorized as never, ex, and current smoker (including those who had given up smoking). Participants were asked to indicate their usual duration of activity in hours per week for several types of activities<sup>27</sup> and were categorized into 1 of 3 categories of either moderate or vigorous physical activity: less than 1 hour (inactive), 1 to 2 hours, or greater than 2 hours per week.

### Statistical Analysis

The Carstairs deprivation score was categorized into fifths. To illustrate the direction and shape of any associations between the Carstairs deprivation score and CHD and potential confounding and mediating variables, prevalences and means of these variables across the fifths of Carstairs scores were tabulated. Logistic and linear regression was used to estimate *P* values for linear trends across these categories.

Women in the study were randomly selected from 23 towns covering 457 electoral wards from a larger population of all wards in Britain. The data therefore form a natural hierarchy of individuals residing within electoral wards. Multilevel logistic regression was used to obtain estimates of the effects of area deprivation on CHD.<sup>28</sup> Because the main exposure of interest is an area-level measure, its effect cannot vary across the areas, and, therefore, multilevel models with varying intercepts but fixed exposure effects were used. To assess the association between area-level socioeconomic characteristics and CHD, a series of multilevel logistic regression models were fitted with area (ward) as the level 2 clusters and individual life-course socioeconomic indicators and potential mediating factors as level 1 covariates.

Homeostasis model assessment scores (insulin resistance) and triglyceride levels had positively skewed distributions, but logged values were normally distributed; geometric means were presented and logged values were used in the regression models. With these transformations, residuals were normally distributed in all models. All analyses were undertaken using Stata Version 8.0 (Stata Corp, College Station, Tex).

### Missing Data

Of the 4286 women, 536 did not provide occupational data for their fathers and 423 women did not provide occupational data for either themselves or their husbands. Although the participants were not specifically asked about unemployment, these women are likely to have been married to unemployed men and unemployed themselves (for those with missing adult data) and had fathers who were unemployed (for those with missing childhood data).<sup>21</sup> In the main analysis, a dummy variable for "unemployed" social class was included in the regression models for the women who did not provide occupation data for either their fathers or their partners. A sensitivity analysis was conducted in which these women were excluded from the analysis. These results did not differ substantively from the main analyses and have not been presented in this article. Small numbers of participants with missing data on other variables were included in the analyses. In the logistic regression models, all models contained only those women with complete data on all variables included in the models (*n* = 3626), so that any differences between parameter estimates from different models could not be attributable to different subgroups being included in different analyses. Differences in the proportions of women with CHD, mean age, and median ward level Carstairs scores between women with complete data and those without complete data on all variables included in these models were compared using  $\chi^2$ , Student's *t*, and Mann-Whitney *U* tests, respectively.

### RESULTS

Nonresponders were slightly older and more likely to have suffered a stroke or to have diabetes but did not differ from responders with respect to myocardial infarction, angina, or cancer prevalence.<sup>23</sup> The response proportion was similar across the 23 towns (*P* = .5 for effect of town on response) and across fifths of Carstairs deprivation score (*P* = .7 for effect of Carstairs deprivation score on response). Of the 4286 participants, 694 had CHD, yielding a prevalence of 16.2% (95% confidence interval [CI] = 15.1%, 17.3%). Across the 23 towns, the prevalence

of CHD varied from 9.4% (95% CI=5.8%, 14.1%) in Guildford in the south of England to 32.6% (95% CI=25.0%, 41.0%) in Merthyr Tydfil in Wales. In general, towns in the southeast of England had the lowest prevalences and those in Scotland and Wales had the highest prevalences. Study participants resided in 457 electoral wards. The wards in which the women lived were those in the middle of the distribution of all wards for Britain, with the mean population size of

wards in which study participants resided being 6889 (range, 1753–15 372). The number of women in the study residing in each of the 457 wards ranging from 1 to 112. Fifty-five (12%) of the wards contained just 1 woman from the study and 45 (10%) contained 20 or more participants. Ward-level Carstairs scores for study participants were positively skewed and ranged from –5.13 to 18.68 with a median of –0.11 (interquartile range=–2.22–2.34).

Table 1 shows the prevalence of CHD and other characteristics of the women across fifths of ward-level Carstairs scores. CHD prevalence increased with worsening ward-level deprivation. Although statistical tests did not provide evidence of a departure from a linear association across the distribution of Carstairs scores, examination of the prevalences by fifths suggested that there was a threshold effect, with prevalences in the 2 most deprived fifths being similar and those

**TABLE 1—Prevalence of Coronary Heart Disease and Prevalences or Means of Other Characteristics Across Ward Deprivation Score Quintiles**

	Prevalence or Mean (95% CI) (Range of Carstairs Score)					P
	1 (Most Affluent) (n=923) (–5.13 to –2.38)	2 (n=800) (–2.37 to –0.98)	3 (n=855) (–0.97 to 0.57)	4 (n=854) (0.58 to 2.69)	5 (Most Deprived) (n=854) (2.72 to 18.69)	
CHD, %	13.2 (11.1, 15.4)	12.0 (10.0, 14.5)	16.4 (14.1, 19.1)	20.2 (17.7, 23.1)	21.2 (18.6, 24.0)	.001
Adult manual social class, %	40.0 (36.8, 43.4)	39.0 (35.4, 42.6)	51.5 (48.0, 55.0)	62.1 (58.5, 65.5)	66.9 (63.4, 70.2)	<.001
Adult no car access, %	16.4 (14.1, 19.0)	19.7 (17.0, 22.6)	31.0 (27.9, 34.2)	35.0 (31.8, 38.4)	43.0 (39.6, 46.4)	<.001
Adult living in local authority housing, %	3.6 (2.6, 5.1)	5.6 (4.1, 7.4)	11.6 (9.6, 13.9)	21.2 (18.5, 24.2)	26.8 (23.9, 30.0)	<.001
State pension only, %	21.4 (18.8, 24.2)	22.9 (20.0, 26.0)	32.1 (29.0, 35.4)	40.0 (36.5, 43.3)	44.2 (40.8, 47.6)	<.001
Left full-time education before age 15 y, %	30.0 (27.1, 33.0)	25.1 (22.2, 28.2)	35.2 (32.0, 38.4)	36.7 (33.5, 40.0)	40.7 (37.5, 44.0)	<.001
Childhood, manual social class, %	70.0 (66.6, 73.0)	68.2 (64.6, 71.6)	76.8 (73.7, 79.7)	85.3 (82.5, 87.7)	83.6 (80.7, 86.1)	.003
Childhood, house with no bathroom, %	33.6 (30.6, 36.8)	30.8 (27.6, 34.2)	39.0 (35.8, 42.5)	44.9 (41.5, 48.4)	45.4 (41.9, 48.8)	.01
Childhood, house with no hot water, %	31.0 (28.1, 34.2)	27.4 (24.3, 30.7)	36.2 (33.0, 39.5)	40.1 (36.7, 43.5)	41.7 (38.3, 45.2)	<.001
Childhood, no family access to car, %	79.3 (76.6, 81.8)	76.6 (73.6, 79.4)	84.6 (82.0, 86.8)	88.2 (85.8, 90.2)	91.3 (89.3, 93.0)	<.001
Mean systolic blood pressure, mm Hg	146.6 (144.9, 148.2)	145.1 (143.3, 146.9)	147.7 (145.9, 149.5)	147.5 (145.7, 149.3)	148.9 (147.1, 150.6)	.02
Mean HDLc, mmol/L	1.72 (1.69, 1.75)	1.75 (1.71, 1.78)	1.63 (1.60, 1.66)	1.60 (1.57, 1.63)	1.57 (1.53, 1.60)	<.001
Mean TG, mmol/L <sup>a</sup>	1.61 (1.56, 1.66)	1.59 (1.54, 1.64)	1.67 (1.61, 1.72)	1.72 (1.66, 1.77)	1.79 (1.73, 1.84)	<.001
Diabetic, %	4.2 (3.1, 5.7)	5.3 (3.9, 7.0)	5.6 (4.3, 7.4)	4.8 (3.6, 6.4)	7.4 (5.8, 9.3)	.02
Insulin resistance (mean HOMA score) <sup>a</sup> in nondiabetics	1.50 (1.43, 1.57)	1.65 (1.57, 1.73)	1.67 (1.59, 1.75)	1.73 (1.65, 1.81)	1.80 (1.72, 1.89)	<.001
Mean BMI, kg/m <sup>2</sup>	27.1 (26.7, 27.4)	27.4 (27.0, 27.7)	27.6 (27.2, 27.9)	28.0 (27.6, 28.3)	28.2 (27.9, 28.6)	<.001
Underweight (BMI ≤20 kg/m <sup>2</sup> ), %	2.5 (1.6, 3.7)	2.3 (1.5, 3.7)	3.0 (2.0, 4.5)	2.7 (1.8, 4.1)	3.7 (2.5, 5.2)	.15
Obese (BMI >30 kg/m <sup>2</sup> ), %	24.4 (21.7, 27.2)	26.5 (23.6, 30.0)	33.3 (30.2, 36.5)	37.8 (34.6, 41.1)	38.9 (35.7, 42.3)	<.001
Mean WHR	0.815 (0.811, 0.820)	0.818 (0.813, 0.823)	0.817 (0.812, 0.821)	0.817 (0.812, 0.822)	0.830 (0.824, 0.834)	.001
Centrally obese (WHR >0.85), %	33.5 (30.6, 36.7)	34.1 (30.9, 37.5)	36.6 (33.4, 40.0)	35.7 (32.6, 39.0)	42.8 (39.5, 46.2)	<.001
Current smoker, %	8.1 (6.5, 10.1)	9.0 (7.2, 11.2)	11.5 (9.5, 13.8)	12.4 (10.3, 14.8)	17.1 (14.7, 19.8)	<.001
Ever smoker, %	39.4 (36.3, 42.6)	40.1 (36.8, 43.6)	45.1 (41.8, 48.5)	45.8 (42.4, 49.1)	52.1 (48.8, 55.5)	<.001
Inactive (<1 h/wk), %	17.4 (15.1, 20.0)	18.7 (16.2, 21.6)	19.5 (17.0, 22.4)	23.2 (20.5, 26.2)	21.0 (18.4, 23.9)	.006
Mean total height, mm	1595.8 (1591.8, 1599.8)	1595.3 (1591.0, 1600.0)	1587.5 (1583.2, 1591.8)	1578.6 (1574.4, 1582.9)	1580.6 (1576.3, 1584.9)	<.001
Mean leg length, mm	764.0 (761.3, 766.6)	762.6 (759.7, 765.5)	756.8 (753.9, 759.7)	751.5 (748.6, 754.4)	751.4 (748.6, 754.3)	<.001
Mean trunk length, mm	831.9 (829.5, 834.2)	832.7 (830.2, 835.3)	830.7 (828.2, 833.2)	826.9 (824.4, 829.5)	829.0 (826.5, 831.5)	.004
Mean FEV <sub>1</sub> , L	2.06 (2.03, 2.09)	2.05 (2.01, 2.09)	1.96 (1.92, 1.99)	1.94 (1.91, 1.98)	1.86 (1.82, 1.89)	<.001

Note. CHD = coronary heart disease; CI = confidence interval; HDLc = high density lipoprotein cholesterol; TG = triglycerides; BMI = body mass index; WHR = waist-to-hip ratio; HOMA = homeostasis model assessment (measure of insulin resistance); FEV<sub>1</sub> = forced expiratory volume in 1 s.

<sup>a</sup>Geometric means.

**TABLE 2—Association of Individual-Level Indicators of Socioeconomic Position From Across the Life Course With Area-Level Socioeconomic Characteristics of Adult Residence**

Indicators of childhood SEP	Odds Ratio (95% CI) for Living in Deprived Ward (Carstairs Score Above the Median)	
	Age-Adjusted	Age- and Adult SEP-Adjusted <sup>a</sup>
Manual childhood social class	2.14 (1.83, 2.51)	1.57 (1.32, 1.88)
No bathroom in childhood home	1.65 (1.46, 1.88)	1.35 (1.17, 1.57)
No hot water in childhood home	1.59 (1.39, 1.81)	1.31 (1.13, 1.53)
Shared bedroom as a child	1.92 (1.70, 2.17)	1.57 (1.29, 1.89)
No family access to a car as a child	2.21 (1.86, 2.62)	1.57 (1.29, 1.89)
Left full-time education before age 15 y	1.77 (1.54, 2.03)	1.30 (1.10, 1.53)
Indicators of adult SEP	Age-Adjusted	Age- and Childhood SEP-Adjusted <sup>b</sup>
Manual adult social class	2.43 (2.14, 2.77)	1.93 (1.67, 2.23)
No access to a car as an adult	2.64 (2.28, 3.05)	2.25 (1.91, 2.64)
Receiving state pension only	2.29 (1.99, 2.62)	1.91 (1.64, 2.23)
Living in public or state housing	5.46 (4.36, 6.83)	4.28 (3.35, 5.47)

Note. SEP = socioeconomic position; CI = confidence interval.

<sup>a</sup>Adjusted for individual-level adult SEP indicators: adult social class, adult car access, pension arrangements, and housing status.

<sup>b</sup>Adjusted for individual-level childhood SEP indicators: childhood social class, whether childhood home had a bathroom, whether childhood home had hot water, bedroom sharing as a child, family access to a car, and age at completing full-time education.

in the 2 most affluent fifths being similar. For this reason, the multilevel logistic regression models assessed the association of area deprivation categorized above and below the median score. All individual measures of SEP were positively associated with area deprivation. All other CHD risk factors increased with increasing area deprivation. Shorter women and those with both shorter legs and shorter trunk lengths (both biological markers of childhood growth patterns and therefore of dietary and other environmental exposures) were more likely to live in deprived areas. The age-adjusted odds ratio for living in an area with a Carstairs deprivation score above the median value for the whole sample was 0.78 (95% CI=0.73, 0.84) per 1-standard deviation (41.1 mm) increase in leg length and 0.88 (95% CI=0.81, 0.95) per 1-standard deviation (35.7 mm) increase in trunk length. With further adjustment for smoking, the association between trunk length and area deprivation attenuated to 0.92 (95% CI=0.83, 0.99); the association between leg length and area deprivation was not affected by additional adjustment for smoking. Table 2 shows the association between each individual-level measure of SEP and area deprivation. Indi-

vidual-level indicators of both childhood and adulthood SEP were independently (of each other) associated with area-level deprivation.

All further analyses were based on the 3626 (85% of study responders) women with complete data on any variable included in any of the multilevel logistic regression models. Compared with women without these data, women with complete data did not differ substantively in their mean age (68.9 vs 69.1 years,  $P=.50$ ), median ward-level Carstairs score ( $-0.22$  vs  $0.15$ ,  $P=.25$ ), and CHD prevalence (16.0% vs 18.5%,  $P=.68$ ). The intraclass correlation coefficient with age as the only explanatory variable in the CHD multilevel model was 0.07 ( $P<.001$ ), suggesting that 7% of the variation in age-adjusted CHD was attributable to area effects. This reduced to 0.05 with addition of area-level Carstairs score.

Table 3 shows the association between area deprivation and CHD, with adjustment for potential confounding and mediating factors. Area deprivation was positively associated with CHD. Adjustment for adult measures of SEP attenuated the association, and with additional adjustment for childhood measures, there was greater attenuation, although some association remained. After ad-

justment for age and all 10 indicators of individual life-course SEP, the odds of CHD (estimated from a multilevel model) were 27% greater among women living in areas with Carstairs deprivation scores above the median than women in areas with scores equal to or below the median (odds ratio=1.27, 95% CI=1.02, 1.57). Further adjustment for leg length, lifestyle, and physiological CHD risk factors attenuated the association to 1.17 (95% CI=0.93, 1.48). Standard quadrature checks for all of the multilevel models suggested that the estimates were reliable and not dependent on the choice of quadrature points (all relative differences  $<0.001$ ).

## DISCUSSION

### Main Findings

In this sample of postmenopausal British women, individual measures of SEP from across the life course were associated with area-level socioeconomic characteristics. The odds of prevalent CHD increased with worsening area deprivation. This association was independent of a wide range of individual life-course indicators of SEP, and these findings provide support for the suggestion that socioeconomic context, over and above the socioeconomic characteristics of individuals living in an area (compositional effects), is associated with CHD. This independent area-level effect was attenuated by adjustment for leg length, a biomarker of childhood exposures that affect linear growth and later adult disease,<sup>22,29,30</sup> and also by adjustment for adult lifestyle and physiological risk factors. These findings suggest that contextual socioeconomic effects on CHD are in part mediated by more proximal outcomes of childhood exposures and adult lifestyle and physiological risk factors. Area-level socioeconomic context may have a direct effect on lifestyle factors such as diet and physical inactivity in both childhood and adulthood because of a lack of neighborhood healthy food outlets, green spaces, and exercise facilities.<sup>2</sup> Smoking may be influenced by peer pressure or the neighborhood culture and the heavy promotion of cigarettes in deprived areas.<sup>31,32</sup> Physiological risk factors such as dyslipidemia, hypertension, and insulin resistance are influenced by these lifestyle factors.

**TABLE 3—Association Between Ward-Level Socioeconomic Circumstances and Prevalent Coronary Heart Disease, With Adjustment for Potential Confounding and Mediating Factors**

	Age-Adjusted OR (95% CI)	Age and Individual Measures of Adult SEP Only, Adjusted <sup>a</sup> OR (95% CI)	Age and Individual-Level SEP from Adult and Childhood, Adjusted <sup>b</sup> OR (95% CI)	Age, Individual Life-Course SEP, and Leg Length, Adjusted <sup>c</sup> OR (95% CI)	Age, Individual Life Course SEP, Leg-Length and Lifestyle Risk Factor, Adjusted <sup>d</sup> OR (95% CI)	Age, Individual Life Course SEP, Leg Length, Lifestyle and Physiological Risk Factor, Adjusted <sup>e</sup> OR (95% CI) <sup>f</sup>
Living in affluent ward (below or equal to median for Carstairs score)	1	1	1	1	1	1
Living in deprived ward (above median for Carstairs score)	1.57 (1.29, 1.91)	1.39 (1.14, 1.74)	1.27 (1.02, 1.57)	1.21 (0.97, 1.52)	1.18 (0.94, 1.49)	1.17 (0.93, 1.48)
<i>P</i>	<.001	<.001	.03	.09	.14	.17

Note. SEP = socioeconomic position; OR = odds ratio; CI = confidence interval.

<sup>a</sup>Adjusted for individual-level adult SEP indicators: adult social class, adult car access, pension arrangements, and housing status.

<sup>b</sup>Adjusted for individual-level adult and childhood SEP indicators: adult social class, adult car access, pension arrangements, housing status, childhood social class, whether childhood home had a bathroom, whether childhood home had hot water, bedroom sharing as a child, family access to a car, and age at completing full-time education.

<sup>c</sup>Adjusted for all indicators of SEP from across the life course as in footnote b and adult leg length.

<sup>d</sup>Adjusted for all indicators of SEP from across the life course as in footnote b and adult leg length and adult life-style risk factors: smoking, physical activity, and body mass index.

<sup>e</sup>Adjusted for all indicators of SEP from across the life course as in footnote b and adult leg length and adult life-style risk factors as in footnote d and physiological risk factors: systolic blood pressure, high-density lipoprotein cholesterol, triglyceride level, waist-to-hip ratio, and insulin resistance/diabetic status.

<sup>f</sup>Likelihood ratio test of null hypothesis that effect of an increase of one category (quintile) of Carstairs score = 0.

### Study Strengths and Limitations

The 60% response rate, although lower than anticipated, is consistent with other contemporary large epidemiological surveys, including the response proportion among women of a similar age for the Health Survey for England in which participants were visited in their own homes.<sup>33</sup> Responders were slightly younger and were less likely to have a medical record of either diabetes or stroke than nonresponders. The prevalence of CHD was similar among responders and nonresponders. The associations presented here would only be exaggerated by response bias if the direction of the associations were reversed in nonresponders or if associations were nonexistent or very weak in nonresponders. These possibilities seem unlikely. The measure of area-level socioeconomic characteristics used in this study was the Carstairs deprivation score. This is an established measure that has been used in several studies concerned with the association of area-level socioeconomic circumstances and health outcomes.<sup>11,13,25</sup> For assessing the impact of individual-level SEP, it has been suggested that a number of different measures should be used because each measurement may describe different aspects of SEP.<sup>34</sup> The same is

likely to be true of the assessment of area-level socioeconomic circumstances. Therefore, the Carstairs' score is useful because it combines information on a number of different aspects of socioeconomic circumstances (e.g., proportion of men who are unemployed in an area, proportion of households with overcrowding problems, proportion of households without access to a car, and proportion of adults in the area who belong to social class IV or V). However, Carstairs' scores provide little information about how socioeconomic context might impact health, and it has been argued that the investigation of contextual effects on health should go further than simply using derived census indicators and should examine the environments in which people live.<sup>2</sup>

A strength of this study is that it is the first to assess the effect of area SEP on CHD with adjustment for a large range of individual measures of SEP from across the life course. Childhood SEP was associated with adult area of residence deprivation, and adjustment for indicators of childhood SEP in addition to adult indicators resulted in greater attenuation of the area effects, thus supporting the suggestion that contextual effects should be determined by adjustment

for individual measures from across the life course.<sup>3</sup> We have relied on self-report of characteristics of individual life-course SEP, and there may be some misclassification or recall bias for these covariates.<sup>35</sup> Self-report of childhood socioeconomic circumstances in particular may be affected by reporting bias, although recall of the occupation of the head of the household and of educational attainment has been shown to be accurate among middle-aged adults.<sup>36,37</sup> It is unlikely that recall inaccuracy of SEP would be affected by CHD status, and, therefore, any misclassification would most likely be nondifferential. This would tend to dilute the effect of individual SEP and therefore in this study may exaggerate the main effect of interest—that of the association between area SEP, having taken individual SEP into account. The inclusion of 10 different measures of individual life-course SEP and the fact that previous studies have shown that self-report of some childhood circumstances is accurate<sup>36</sup> should mean that there would be less residual confounding attributable to individual SEP in this study than in previous studies. Because individual SEP is multifactorial, it is possible that some residual confounding by individual-level factors explains the remain-

ing associations of area deprivation with CHD. We have no measures of household income, which is an important indicator of individual-level SEP. However, within our 10 life-course measures, we have occupational social class on 2 occasions, car access on 2 occasions, housing status, pension arrangements, and childhood household amenities, all of which are strong predictors of having material resources.

This study is cross-sectional; therefore, 2 potential limitations are reverse causality and survival bias. Reverse causality would suggest that rather than the socioeconomic circumstances of the area in which one lives having an effect on CHD occurrence, the association found in this study is attributable to women with CHD migrating to poorer residential areas. A number of studies have shown that downward social mobility does not explain the association between SEP and health outcomes,<sup>9</sup> and our findings are consistent with those of 2 prospective studies of the contextual effect of area socioeconomic circumstances on CHD,<sup>13,14</sup> suggesting that reverse causality is unlikely to fully explain our results.

Survival bias would be important if large numbers of deaths caused by CHD occurred before the age of 70 years, the mean age of study participants. Mortality resulting from CHD among British women before the age of 70 years is uncommon. For example, in England and Wales in 1999, just 3826 women between the ages of 30 and 69 years died as a result of CHD, for a mortality rate of 2.0 per 100 000 and accounting for just 6% of the total of 59 363 deaths in women in that age group.<sup>38</sup> Furthermore, the consistency of findings here with those of prospective studies<sup>13,14</sup> suggests that survival bias is unlikely to fully explain our results.

## Implications

The widening gap between the rich and the poor appears to be mirrored by a growing divergence of the quality of their residential environments.<sup>4</sup> If both area and individual socioeconomic circumstances affect health outcomes such as CHD, this pattern of residency will contribute to further widening in health inequalities. Much health promotion work is directed toward individual lifestyle

risk factor change.<sup>39</sup> Our findings suggest that identifying and dealing with area environmental factors that are detrimental to health may also be important for improving health and reducing socioeconomic inequalities. The finding that the association between area socioeconomic circumstances and CHD is markedly attenuated by adjustment for established CHD risk factors does not indicate that the area association is confounded by CHD risk factors. Rather, area deprivation should be thought of as a potential fundamental and upstream cause of CHD, with established risk factors such as smoking, physical inactivity, and obesity as more downstream mediating causes.<sup>9</sup> The important policy question is, to what extent can risk factor profiles be improved by improving the characteristics of an area and how can such improvements be best achieved? To answer this question, future research should seek to identify the specific aspects (e.g., food outlets, green spaces, neighborhood culture) of deprived neighborhoods that are associated with adverse health outcomes. ■

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## Contributors

D.A. Lawlor, G. Davey Smith, and S. Ebrahim developed the study aim. S. Ebrahim and D.A. Lawlor manage data collection, storage, and cleaning for the British Women's Heart and Health Study. R. Patel maintains the study database and abstracted data for the deprivation scores. D.A. Lawlor undertook the analysis and coordinated writing of the article. All authors contributed to the final version.

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## Human Participant Protection

The British Women's Heart and Health Study has ethics approval from local ethics committees in each town of study participants.

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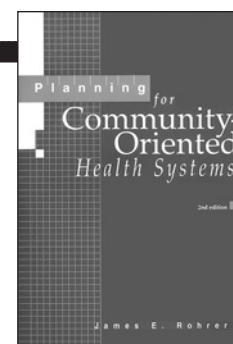
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