Area Characteristics and Individual-Level Socioeconomic Position Indicators in Three Population-Based Epidemiologic Studies

A.V. DIEZ ROUX, MD, PhD, C.I. KIEFE, MD, PhD, D.R. JACOBS, Jr, PhD, M. HAAN, MPH, DrPH, S. A. JACKSON, PhD, F.J. NIETO, MD, PhD, C.C. PATON, MSPH, AND R. SCHULZ, PhD

PURPOSE: There is growing interest in incorporating area indicators into epidemiologic analyses. Using data from the 1990 U.S. Census linked to individual-level data from three epidemiologic studies, we investigated how different area indicators are interrelated, how measures for different sized areas compare, and the relation between area and individual-level social position indicators.

METHODS: The interrelations between 13 area indicators of wealth/income, education, occupation, and other socioenvironmental characteristics were investigated using correlation coefficients and factor analyses. The extent to which block-group measures provide information distinct from census tract measures was investigated using intraclass correlation coefficients. Loglinear models were used to investigate associations between area and individual-level indicators.

RESULTS: Correlations between area measures were generally in the 0.5–0.8 range. In factor analyses, six indicators of income/wealth, education, and occupation loaded on one factor in most geographic sites. Correlations between block-group and census tract measures were high (correlation coefficients 0.85–0.96). Most of the variability in block-group indicators was between census tracts (intraclass correlation coefficients 0.72–0.92). Although individual-level and area indicators were associated, there was evidence of important heterogeneity in area of residence within individual-level income or education categories. The strength of the association between individual and area measures was similar in the three studies and in whites and blacks, but blacks were much more likely to live in more disadvantaged areas than whites.

CONCLUSIONS: Area measures of wealth/income, education, and occupation are moderately to highly correlated. Differences between using census tract or block-group measures in contextual investigations are likely to be relatively small. Area and individual-level indicators are far from perfectly correlated and provide complementary information on living circumstances. Differences in the residential environments of blacks and whites may need to be taken into account in interpreting race differences in epidemiologic studies.

Ann Epidemiol 2001;11:395–405. © 2001 Elsevier Science Inc. All rights reserved.

KEY WORDS: Socioeconomic Status, Social Class, Neighborhoods, Race, Ethnicity.

There has been growing interest in the use of area-level measures of socioeconomic characteristics in studies of social inequalities and health (1–3). Area-based measures have been used in ecological studies relating area characteristics to morbidity and mortality rates (4–7). Area-based measures have also been proposed as alternate indicators of socioeconomic position in studies of individuals when individual-level measures are unavailable (8,9). In addition, area measures have been increasingly studied as indicators of contextual area characteristics that may be related to health independent of individual level variables (9–23).

In the United States, health researchers using area-based indicators have often relied on existing sources such as the United States Census. Traditionally, the census areas most commonly employed in health research have been census tracts (13–15,18,24–28) or groups of census tracts (6,7,11,19,20,29–31). Block-groups (subdivisions of census tracts) have also been used (8,9,16). A variety of census variables have been used to characterize areas at both the...
The ARIC sample consisted of persons aged 45 to 64 years at baseline selected by probability sampling in Forsyth County, NC; Jackson, MS; the northwestern suburbs of Minneapolis, MN; and Washington County, MD (37). Three samples reflect the demographic composition of the communities (virtually all white in Washington County and suburbs of Minneapolis and 85% white in Forsyth County). The Jackson sample was entirely black. The addresses and socioeconomic data used in these analyses were obtained at baseline (1987–1989). The CHS sample consisted of persons aged 65 years or older at baseline selected from Medicare eligibility lists in Forsyth County, NC; Washington County, MD; Sacramento County, CA; and Pittsburgh, PA (38,39). Three of the four field centers recruited black and white participants. The Washington County sample was virtually all white. Because earlier addresses were not available, addresses and individual-level socioeconomic data used in these analyses correspond to the latest information available on file in early 1998 (4–8 years after baseline).

Study participants were asked to select their total combined family income from a list of categories and to report the highest grade or year of school completed. Income was categorized into six groups (under $12,000;12,000–15,999;16,000–24,999;25,000–34,999;35,000–49,999;50,000 or more). Education was categorized into three groups: incomplete high school, complete high school or GED but no college degree, and complete 4-year college. Occupation was not collected in a comparable fashion across studies.

Two census-defined areas were investigated: census tracts and block groups. Census tracts are subdivisions of a county with an average size of 4000 residents. When first delineated, they were designed to be homogeneous with respect to economic status and living conditions. In non-metropolitan areas, census tracts are replaced by block numbering areas (BNAs). Each census tract (or BNA) is subdivided into block-groups (average size 1000 individuals) (40,41). Study participants were geocoded to their area of residence by a commercial firm.

Information on census tracts and block-groups in the CARDIA, ARIC, and CHS sites was obtained from the 1990 census. Selected variables were chosen a priori from available census measures to reflect the constructs of area income and wealth, education, occupation and employment (42,43), and socioenvironmental characteristics related to area crowding, stability, and housing. The 13 variables investigated (for block-groups and census tracts) are listed in Table 1.

CARDIA, ARIC, and CHS sites included a total of 1910 census tracts and 5964 block-groups. Census tracts and block-groups were excluded if they had populations of less than 100 persons, had less than 30 housing units, or had 33% or more of their population living in group quar-
AEP Vol. 11, No. 6  
August 2001: 395–405  

Roux et al.

AREA AND INDIVIDUAL-LEVEL INDICATORS

This left 1772 census tracts and 5494 block groups within them for analysis.

Of the 3950 CARDIA participants attending the year 10 follow-up, 3531 matched to block-groups and census tracts that fulfilled the inclusion criteria (because nearly 50% of CARDIA participants no longer lived in the study sites at the year 10 follow-up, persons residing outside study sites were included as long as they matched to areas not meeting the exclusion criteria). Two participants were excluded, because they had no information on individual-level socioeconomic indicators, leaving 1797 whites and 1732 blacks for analysis. Of the 15,792 ARIC participants at baseline, 14,158 matched to nonexcluded census areas. Fifty participants were excluded, because they lacked information on socioeconomic indicators or belonged to race/ethnic groups other than black or white, leaving 10,229 whites and 3879 blacks for analysis. Of the 5888 CHS participants at baseline, 4553 matched to nonexcluded census areas. Twenty-nine participants were excluded, because they lacked information on socioeconomic indicators or belonged to race/ethnic groups other than black or white, leaving 3804 whites and 720 blacks for analysis.

**Statistical Methods**

**Interrelations between area indicators and comparison of census-tract and block-group measures.** Analyses of area measures were based on all census tracts and block-groups included in study sites, regardless of whether they included a sampled participant. After examination of correlations, factor analysis was used as an exploratory technique to identify subsets of variables that it would be meaningful to combine into a summary score (44). Variables with extremely skewed distributions (skewness > 1.5) (45) (median household income, median house value, unemployment, percentage below poverty, percentage of housing units boarded up, crowding, and percentage housing units occupied) were log transformed. Transformation of skewed variables increases consistency of the index over time or across geographic areas (46). Scree plot inspection of principal components was used to determine the number of fac-
tors to be extracted (47,48). Principal factor analysis with varimax orthogonal rotation was used for factor extraction (47,48). Analyses were performed for block-groups, and census tracts and were stratified by site.

Agreement between indicators for census tracts and block-groups was investigated by comparing measures for block-groups to measures for the census tract to which each block group belonged. Corresponding census tract measures were appended to each block-group. We examined Spearman’s correlation coefficients between measures at both levels and intraclass correlation coefficients (49) for multiple measures on a block-group (ICC BG), the multiple measures being the block-group specific measure and the corresponding census tract measure. The Spearman’s correlation measures the extent to which the ranking of block-groups based on block-group and census tract measures agree. The intraclass correlation coefficient (where “classes” are individual block groups) measures the extent to which there is absolute agreement between the block-group measure and the corresponding census tract measure. A value of ICC BG close to 1 signifies strong absolute agreement between the block-group measure and the census tract measure. Because block-groups are nested within census tracts, we also estimated the intraclass correlation coefficient for multiple block-groups within a census tract (ICC CT). Here the multiple measures are the measures on different block-groups within a census tract. This intraclass correlation coefficient (where “classes” are census tracts) is an estimate of the proportion of total variability in block-group indicators that is between census tracts (50). ICC CTs close to 1 imply that there is relatively little variability in block-groups measures within census tracts (i.e., strong agreement between measures for multiple block-groups within a census tract).

Relation between individual-level and area indicators.

The relation between individual-level and area indicators was investigated by examining the cross-classification of individual-level indicators and categories of area indicators. Loglinear models were used to obtain a summary measure of the strength of the association between individual-level indicators and area score category (51,52). The logarithm of the count in each cell of the individual social indicator-area quintile cross classification was modeled as a function of the individual-level indicator, area quintile, and their interaction. Individual-level indicators were included in the models as ordinal variables (1–6 for income, and 1–3 for education), and area quintiles were included as categorical variables. This allowed estimation of the odds ratio of being in each of the four lowest area quintiles (compared to the most advantaged quintile) per each unit decrease in individual-level income or educational category (e.g., the percentage increase in the odds of living in the lowest area quintile per one category decrease in individual-level income). The assumption of linearity of the log odds by categories of income or education was examined by fitting models with income or education as categorical variables and inspecting the regression coefficients for each category. Linearity was not found to be seriously violated. There was no evidence of gender differences in the association between individual and area indicators. However, gender, and its interactions with individual indicators and area category, were included to control for gender differences in the distribution of the socioeconomic indicators. Models were run separately by race/ethnicity and study.

To investigate differences in the likelihood of living in different types of areas by race/ethnicity, log linear models were also used to estimate the relative odds of being in each area category (compared to the most advantaged area category) in blacks versus whites within categories of income or education. The log of the count of the race*gender*area category cross classification was modeled as a function of race, gender, area category, and the gender*area and race*area interactions. These models allowed estimation of the relative odds of living in each area category (compared to the best-off category) in blacks versus whites within categories of individual-level income or education. Because there was no evidence of heterogeneity by income or education, associations between race and area category were also estimated for all income or educational categories combined (after adjusting for income or education). Results regarding associations between area and individual-level indicators were similar for census tracts and block groups, so only results for block-groups are reported.

RESULTS

Interrelations Between Census Indicators and Comparison of Census Tract and Block-Group Measures

Means and medians for the census indicators were similar for census tracts and block-groups (not shown), although the range (1st–99th percentiles) was slightly greater for block-groups. At the block-group level, wealth/income, education, and occupation variables tended to be fairly highly correlated (Spearman’s correlations (r): 0.5–0.8). However, percentage of housing units that were owner occupied was less strongly associated with education and occupation (most r < 0.4) and was weakly correlated with house value (r = 0.1). The stability indicator was generally weakly correlated with all variables (all r < 0.2) except percentage of owner occupied houses (r = 0.5). Correlations between socioeconomic indicators (housing units occupied, boarded up, and crowding), and all other indicators were in the intermediate range (0.3–0.6). Similar patterns were observed for census tracts; although, as expected, correlations
for census tracts were generally slightly stronger than those observed for block-groups (not shown).

Although results of factor analyses were not identical across sites, common patterns emerged. Scree plot examination revealed that the extraction of two components was appropriate in most cases. These two components accounted for 65–80% of the total variance in the 13 original variables across areas. In factor analyses, six variables related to wealth/income, education and occupation (log median household income, log median value of housing units, percentage of households receiving interest, dividend, or net rental income, percentage of adults with complete high school, percentage of adults with complete college, and percentage of persons in executive, managerial, or professional occupations) loaded strongly (loadings ≥ 0.6) on the first factor in most sites. The stability indicator and percentage owner-occupied houses generally loaded strongly (factor loadings ≥ 0.6) on the second factor. Similar patterns were documented for census tracts, although additional factors, such as percentage below poverty, crowding, percentage houses boarded up, and unemployment, often loaded on the first factor as well.

A summary score of area socioeconomic characteristics (reflecting patterns common across area sizes and sites), was constructed by summing Z-scores for the six variables that usually loaded together on the first or socioeconomic-position related factor, with an increasing index signifying increasing socioeconomic advantage. Z-scores were based on the mean and standard deviation of the variables for all sites combined. The internal consistency (Cronbach’s alpha) of the area score for the entire sample was 0.94 for census tracts and 0.92 for block-groups. Internal consistency was high (> 0.90) across all sites. Table 1 summarizes block-group characteristics by quintiles of block-group score. Similar patterns (not shown) were observed for categories based on census tract scores.

Overall, census tract and block-group measures tended to be highly correlated (Spearman’s correlation coefficients ≥ 0.85). Absolute agreement between block-group measures and the corresponding census tract measure were also high (all ICC BG ≥ 0.87) Eighty-six percent of the variation in block-group score was between census tracts (with ICC CT ranging from 0.71 to 0.92 for score components) (Table 2).

Relation Between Individual-Level and Area Indicators

Figure 1 shows the distribution of categories of block-group score (based on quintiles) within categories of individual-level income. The percentage of persons living in more disadvantaged block-groups tended to decrease as individual-level income increased. However, there was also evidence of heterogeneity in block-group score within categories of individual-level income. Blacks were much more likely than whites to live in disadvantaged areas, regardless of their income. Similar differences by race/ethnicity were present in men and women (data not shown). Similar patterns were observed for individual-level education categories.

Table 3 shows the relation between individual-level and area-level income measures (income is shown, because it can be similarly categorized at both levels). There is substantial variability in block-group income within categories of individual-level income. Table 3 also illustrates the degree of misclassification that would occur if block-group median income were used as a proxy for individual-level income (or vice versa). For example, over 90% of white ARIC participants with individual-level incomes below $16,000 lived in block groups where the median income was $16,000 or more. The degree of misclassification resulting from the use of area measures as proxies for individual-level measures would differ by race and income level.

Table 4 shows the odds ratios of being in each block-group quintile (vs. the top quintile or best-off category) per unit decrease in individual-level income. Very similar results were obtained for individual-level education (not shown). The strength of the association between block-group score and individual income or education was generally similar across studies and in both race ethnic groups.
FIGURE 1. Distribution of categories of block group score (based on quintiles) by individual-level income (U.S. $). Each bar shows how persons of a given individual-level income are distributed across the five quintiles of block-group. Shaded areas within bars correspond to neighborhood quintiles from lowest quintile (darkest) to highest quintile (lightest). For example, as individual-level income increases, the percentage of persons in the best-off neighborhood category (white in the bars) increases. Numbers across the top show the percentage of the total sample in each of the individual-level income categories.
For example, the odds ratio of living in the lowest block-group quintile (vs. the highest) associated with a unit decrease in income category ranged from 2.1 to 2.4 in whites and from 2.0 to 2.9 in blacks. Table 5 shows the odds ratios of living in each block-group quintile (as compared to the highest quintile) in blacks versus whites. The strength of these associations did not differ significantly across income strata, so only income-adjusted results are shown. Blacks were much more likely than whites to live in disadvantaged block-groups, even after adjustment for individual-level income. Black–white differences were most pronounced in ARIC and least pronounced (but still substantial) in CARDIA. Similar patterns were observed after adjustment for education (not shown).

**DISCUSSION**

In these samples, correlations between block-group measures of income/wealth, education, and occupation were generally in the 0.5–0.8 range. Slightly higher correlations were observed for census tract measures. Two factors, reflecting a socioeconomic dimension and a residential stability dimension, emerged in factor analyses of the 13 variables. We found generally high agreement between continuous block-group and census tract measures of the same construct, and most of the variability in block-group measures was between census tracts. Although area-based and individual-level socioeconomic position measures were associated, there was evidence of important heterogeneity in area of residence within individual-level income or education categories. Regardless of their income or education, blacks participating in the studies were much more likely to live in more disadvantaged areas than their white counterparts.

The emergence of a socioeconomic factor and a residential stability factor in factor analyses of area data is consistent with results reported by others in the United States (53–56). We combined the six area variables that loaded strongly on the first factor into a summary score of area socioeconomic environment. The need for (and components of) such a summary score depend on the objective being pursued (57–59). Our objective was to develop a summary of area socioeconomic characteristics that could be used in analyses of these data involving the construct of area socioeconomic environment. This type of summary may be useful when interest lies in the causal investigation of the contextual effect of area socioeconomic environment on health generally, when all potential indicators are correlated, and when there is no theoretical reason to choose
one indicator over another. However, the dependency of factor analytic results on the set of variables initially included and on correlations in a particular sample may limit the generalizability of our results. The development of a valid summary score that could be used in the United States as a whole (or in other samples) and with other specific purposes would require different analyses.

Although census tracts were originally delineated to be homogeneous in socioeconomic characteristics (60), it has been suggested that their use may obscure important variations within them (8,9,61,62). We found high agreement between block-group and census tract measures, and the variability in block-group measures within census tracts was small in relation to between tract variability. Although the actual empirical consequences of using census tract or block-group measures in the investigation of contextual effects can only be directly determined in studies relating these measures to health outcomes, our analyses suggest that differences in results using census tracts or blockgroups are likely to be relatively small. However, some variability in block-groups within census tracts remains. The extent to which block-groups provide information that is not captured by census tract measures may differ for different area characteristics or across larger contexts (e.g., cities, regions). Therefore, in some situations, and particularly if the size of the area whose characteristics are hypothesized to be related to the outcome is closer to block-groups than census tracts for theoretical reasons, the use of block-group measures still may be appropriate.

Previous methodological studies have focused on the validity of using area-based measures as proxies for individual-level indicators (63–65) and have compared the strengths of the associations of both types of indicators with health outcomes (8,9,63–67). We directly examined the relation between area and individual-level measures as indicators of two interrelated but different constructs. The presence of variability in individual-level indicators within areas is the source of the limitation inherent in using area measures as proxies for their individual-level analogues. On the other hand, the variability in characteristics of area of residence within categories of individual-level socioeconomic indicators suggests that area variables may provide information on living circumstances, which is not captured by individual-level data. Our results highlight the limitations of using measures at one level as proxies for measures at another level in causal epidemiologic investigations and suggest that it may often be analytically possible to separate out the contributions of measures at both levels to outcomes.

The strength of the association between individual and area measures (in relative terms; i.e., as quantified by the rel-

### TABLE 4. Odds ratios of being in each block-group quintile (compared to the most advantaged block-group quintile) per unit decrease in individual-level incomea

<table>
<thead>
<tr>
<th></th>
<th>Whites</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CARDIA</td>
<td>QV</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>QIV</td>
<td>1.5</td>
<td>1.4</td>
<td>1.7</td>
<td>1.6</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>QIII</td>
<td>1.6</td>
<td>1.6</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>QII</td>
<td>2.1</td>
<td>1.9</td>
<td>1.9</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>QI</td>
<td>2.1</td>
<td>1.7</td>
<td>1.7</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>ARIC</td>
<td>QV</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>QIV</td>
<td>1.4</td>
<td>1.4</td>
<td>1.4</td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>QIII</td>
<td>1.7</td>
<td>1.7</td>
<td>1.7</td>
<td>1.7</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>QII</td>
<td>2.1</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>QI</td>
<td>2.4</td>
<td>2.2</td>
<td>2.2</td>
<td>2.2</td>
<td>2.2</td>
</tr>
<tr>
<td>CHS</td>
<td>QV</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>QIV</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>QIII</td>
<td>1.6</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>QII</td>
<td>1.8</td>
<td>1.7</td>
<td>1.7</td>
<td>1.7</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>QI</td>
<td>2.2</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
</tr>
</tbody>
</table>

*The odds ratios shown correspond to the relative change in the odds of being in the corresponding block-group quintile (vs. the most advantaged quintile, quintile V) per unit decrease in individual-level income. For example, the odds ratio of 2.1 for QI in CARDIA whites implies that the odds of living in block-groups in the worst quintile (vs. quintile V) increased 2.1 times per each unit decrease in income category. CI: Confidence interval; QI-QV: first through fifth quintile of block-group score.

### TABLE 5. Odds ratios (95% confidence intervals) of being in each block-group quintile (compared to quintile V) in blacks vs. whites by studya

<table>
<thead>
<tr>
<th></th>
<th>Odds ratios</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>blacks vs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CARDIA</td>
<td>QV</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>QIV</td>
<td>2.6</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>QIII</td>
<td>4.8</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>QII</td>
<td>9.7</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>QI</td>
<td>26.5</td>
<td>17.6</td>
<td>17.6</td>
<td>17.6</td>
<td>17.6</td>
</tr>
<tr>
<td>ARIC</td>
<td>QV</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>QIV</td>
<td>5.2</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>QIII</td>
<td>4.2</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>QII</td>
<td>27.9</td>
<td>21.7</td>
<td>21.7</td>
<td>21.7</td>
<td>21.7</td>
</tr>
<tr>
<td></td>
<td>QI</td>
<td>129.0</td>
<td>98.1</td>
<td>98.1</td>
<td>98.1</td>
<td>98.1</td>
</tr>
<tr>
<td>CHS</td>
<td>QV</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>QIV</td>
<td>1.2</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>QIII</td>
<td>3.0</td>
<td>2.1</td>
<td>2.1</td>
<td>2.1</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td>QII</td>
<td>9.0</td>
<td>6.5</td>
<td>6.5</td>
<td>6.5</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td>QI</td>
<td>36.2</td>
<td>25.5</td>
<td>25.5</td>
<td>25.5</td>
<td>25.5</td>
</tr>
</tbody>
</table>

*The odds ratios correspond to the odds of living in each quintile (vs. the most advantaged quintile) in blacks vs. whites. For example, the odds ratio of 26.5 for QI in CARDIA participants means that the odds of living in QI (vs. V) was 26.5 times greater in blacks than in whites. Odds ratios are adjusted for individual-level income. QI-QV: first through fifth quintile of block-group score.
The increasing interest in examining contextual area effects on health and the reliance on standard datasets such as the U.S. Census to characterize areas highlights the need to examine empirically the relations between indicators available at different levels. Together with the theoretical model being tested and the specific question addressed, these descriptive analyses may inform the selection of variables and the interpretation of results obtained in contextual investigations. A distinct question, however, is the use of area indicators to monitor social inequalities in health generally (57–59,72,73). The implications for monitoring of using measures at different levels, different area-based indicators, and different sized-areas can only be addressed by directly examining the empirical associations of the different indicators with the outcomes of interest.

This work was supported by R29 HL59386 (Dr. Diez-Roux) from the National Heart, Lung, and Blood Institute. CHS was supported by contracts N01-HC-58079—N01-HC-58086 from the National Heart, Lung, and Blood Institute, and Georgetown Echo RC-HL 35129 JHU MRI RC-HL 15103. The ARIC Study was supported by Contracts N01-HC-55015, N01-HC-55016, N01-HC-55018, N01-HC-55019, N01-HC-55020, N01-HC-55021, N01-HC-55022 from the National Heart, Lung, and Blood Institute. The CARDIA Study was supported by Contracts N01-HC-48047, N01-HC-48048, N01-HC-48049, N01-HC-48050, and N01-HC-95095 from the National Heart, Lung, and Blood Institute. The authors thank the following: Sharon Merkin for assistance with the analyses; the CARDIA investigators and staff, and especially Dan Garside, Karen Virmig, Jerry Hamilton, Debbie Parker, Heather McGrath, and Rex Bombold for their assistance in geocoding the CARDIA data; the ARIC investigators and staff for their important contributions; and the following CHS investigators and staff: Forsyth County, NC: Bowman Gray School of Medicine of Wake Forest University: Gregory L. Burke, Sharon Jackson, Alan Elster, Curt D. Furberg, Gerardo Heiss, Dalane Kritman, Margie Lamb, David S. Lefkowitz, Mary F. Lyles, Cathy Nunn, Ward Riley, John Chen, Beverly Tucker; Forsyth County, NC: Wake Forest University, ECG Reading Center: Farida Rautaharju, Henri Rautaharju; Sacramento County, CA: University of California, Davis: William Bonekat, Charles Bernick, Michael Buonocore, Mary Haan, Calvin Hirsch, Lawrence Laslett, Marshall Lee, John Robbins, William Saeve, Richard White, Washington County, MD, The Johns Hopkins University: M. Jan Busby-Whitehead, Joyce Chabot, George W. Comstock, Abraham Dobs, Linda P. Fried, Joel G. Hill, Steven J. Kritter, Shinri Kumanyika, David Levine, Joao A. Lima, Neil R. Powe, Thomas R. Price, Jeff Williamson, Moyses Sisklo, Melvyn Tockman; MRI Reading Center, Washington County, MD, The Johns Hopkins University: Norman Beauchamp, R. Nick Bryan, Douglas Fellows, Melanie Hawkins, Patrice Holz, Naiyer Imam, Michael Kraut, Cynthia Quinn, Grace Lee, Carolyn C. Meltrar, Larry Schertz, Earl P. Steinberg, Scott Wells, Linda Wilkins, Nancy C. Yee; Allegheny County, PA, University of Pittsburgh: Diane G. Ives, Charles A. Jungreis, Laurie Nepper, Lewis H. Kuller, Elaine Meilahn, Peg Meyer, Roberta Moyer, Anne Newman, Richard Schulz, Vivienne E. Smith, Sidney K. Wolfson; Echocardiography Reading Center (Baseline), University of Pittsburgh; Hoda Anton-Culver; Julius M. Gardin, Margaret Knoll, Tom Kurosaki, Nathan Wong; Echocardiography Reading Center (Follow-Up), Geometric Medical Center: John Gottsdiener, Eva Haasner, Stephen Knaus, Judy Gay, Sue Lavigoa, Mary Ann Yohe, Retha Webb; Ultrasonic Reading Center, New England Medical Center, Boston: Daniel H. O'Leary, Joseph F. Polak, Laurie Funk; Central Blood Analysis Laboratory, University of Vermont: Elaine Cornell, Mary Cushman, Russell P. Tracy; Pulmonary Reading Center, University of Arizona-Tucson: Paul Enright; Coordinating Center, University of Washington, Seattle:
REFERENCES


