Subjective and Objective Neighborhood Characteristics and Adult Health

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ABSTRACT

This study examines objective and subjective assessments of neighborhood conditions, exploring the overlap between different sources of information on neighborhoods and the relative strength of their association with adult self-rated health. Data on perceived neighborhood quality from Wave IV (2001/2002) of the nationally representative Americans Changing Lives (ACL) panel study are merged with neighborhood-level census tract data to measure theoretically-derived subjective and objective neighborhood constructs. Structural equation models indicate that each of the subjective and objective constructs is related to health. However, perceived neighborhood quality is most strongly associated with health and mediates associations between health and the two objective constructs (neighborhood disadvantage and affluence). Additionally, individual characteristics play an important role in shaping the contribution of neighborhood conditions through selection and mediation. Our results highlight the separate contributions of both objective and perceived neighborhood quality on health, and the particularly strong contribution of perceived neighborhood quality.

The intense interest in the potential impact of neighborhood social environments on individual well-being has resulted in a rapidly growing literature that includes contributions from a variety of disciplines and fields such as child development (Duncan & Raudenbush, 1999; Sampson, Morenoff, & Gannon-Rowley 2002), medical sociology (Robert, 1999), and public health (MacIntyre, MacIver, & Sooman, 1993; Diez-Roux, 2001; Macintyre, Ellaway, & Cummins, 2002; 2002; Humpel, Owen, & Leslie, 2002). Collectively, this "neighborhood effects" literature has considered demographic composition, structural conditions, local culture, and social psychological aspects as some of the myriad ways in which neighborhood context may matter for health and well-being.

Researchers have utilized a variety of measures of neighborhood social environment that, with few exceptions, can generally be grouped into objective and subjective measures[1]. We refer to *objective measures* as those area-level indicators derived from aggregate sociodemographic characteristics of residents (e.g., median income) (Pickett & Pearl, 2001). *Subjective measures* refer to individual-level survey items that assess respondents' personal assessments of their neighborhood (e.g., perceived safety, presence of litter) (Humpel et al., 2002). Most studies to date have examined only one of these two types of measures at one time. Some studies have

[1] A few other types of measures have been used in the health literature. "Ecometric" measures (Raudenbush & Sampson 1999) rely upon survey items asked of a significant number of residents per neighborhood to create ecologic measures of social conditions (e.g., collective efficacy) (see Browning, Cagney, & Wen, 2003). Observational scales or inventories have also been used where researchers rate neighborhood conditions (e.g., see Caughy, O'Campo, & Patterson, 2001).

utilized both types of measures in relationship to overall health or mental health; however limitations of data and methodology (Elliot 2000; Steptoe & Feldman 2001; Stafford & Marmot 2003), as well as differences in substantive interests (Ross 2000; Ross et al. 2000), have meant that a number of unanswered questions remain. The present study aims to examine two important aspects of the relationship between neighborhoods and health that have not been adequately studied. First, we assess the relationship between objective and subjective measures of neighborhood conditions, and examine their relative strength in relation to self-rated health. Second, we consider the role of individual sociodemographic and socioeconomic factors in shaping the relationship between both objective and subjective neighborhood conditions and self-rated health.

BACKGROUND

Objective Characteristics

Studies examining "neighborhood effects" on individual health have considered many potential ways in which neighborhood context may "get under one's skin" to affect health. Research using objective characteristics of neighborhoods typically rely upon single- or multiple-item indexes of census measures of socioeconomic conditions measured at the level of the block group, census tract, postal code, or other administratively demarcated local area or district (Pickett & Pearl, 2001). While such variables have long been used in ecologic studies, the recent popularity of multilevel analytic methods has made the use of such variables commonplace in studying the potential health implications of neighborhood environments.

Most studies focus on, or at least include, some measure of socioeconomic *disadvantage*, using either single items, such as rates of neighborhood poverty or unemployment (Haan, Kaplan, & Camacho, 1987; Robert, 1998; Krieger et al., 2003) or composite indexes that combine a number of these measures (Ross & Mirowsky, 2001; Carpiano, 2007). In studying socioeconomic disadvantage, neighborhood *disadvantage* has been one of the most commonly examined neighborhood constructs. It has been measured via multiple item scales consisting of area census measures such as poverty rate, percentage of residents receiving public assistance, percentage of female-headed families, unemployment ratio, or percentage of African American residents (Xue, Levanthal, Brooks Gunn, and Earls, 2005; Sampson, Raudenbush, & Earls, 1997).

However, not all research has focused on area resource deficits *per se*. Some studies have also examined objective measures of neighborhood *affluence* (Massey, 1996) based on the general premise that exposure to higher proportions of socioeconomically advantaged neighbors may provide health-beneficial material and psychosocial resources (Wilson, 1987). Neighborhood *affluence* has been assessed in health and non-health research using single measures, such as the percentage of households with annual income above $30,000 (e.g., Brooks Gunn, Duncan, Klebanov, and Sealand, 1993; Browning, Cagney, & Wen, 2003), as well as multi-item scales comprised of such measures as percentages of families with incomes of $75,000 or greater, residents with a college degree, and individuals employed in professional or managerial positions (e.g., Sampson, Morenoff, & Earls, 1999; Beyers, Bates, Pettit, & Dodge, 2003).

Research shows that both neighborhood affluence and disadvantage may pose different implications for health and development outcomes. For example, Browning and colleagues found that neighborhood affluence—not disadvantage—was significantly associated with health (Browning, et al., 2003; Cagney & Browning 2005), whereas Krieger and colleagues (2003) suggest that percent poverty is the single measure with the strongest associations with a variety of health outcomes. These objective measures of neighborhood context allow for a summary assessment of the local area. However, they are usually based on census data, limiting the range of neighborhood domains they may assess. For this reason, they may not provide the best marker of what respondents living in the neighborhoods observe to be health promoting or damaging about where they live.

Subjective Characteristics

Research considering subjective neighborhood measures typically ask residents for their opinions about various aspects of their neighborhoods, such as safety, cleanliness, or pollution (Echeverria et al., 2004; Humpel et al., 2002). These data have benefits over "off the shelf" census indicators (Cummings et al., 2005) in that they are explicitly designed to assess aspects of the neighborhood relevant to health.

Similar to objective measures, subjective neighborhood measures have been examined individually and in composite scales. Studies have generally found good internal and test-retest reliability for scales describing neighborhood problems (e.g., disorder, violence, and safety), neighborhood participation and social cohesion, and health promoting aspects of the built environment (e.g., areas for walking and exercise, accessibility of healthy foods, and presence and quality of recreational facilities) (Echeverria et al., 2004; Ross & Mirowsky, 2001).

Overall, a major strength of subjective measures is that they allow insights regarding specific features of neighborhood environments that may be health promoting or health damaging for individuals. These features may be more proximal determinants of health. Conversely, a major weakness of these measures is that results may be at least partially attributable to same source bias. Same source bias occurs when some third, unobserved factor, like psychological disposition, influences both a respondent's reporting on his/her neighborhood and his/her health. Similar bias can influence the modeling of temporal causality when a respondent's health influences how he or she perceives and experiences the neighborhood environment, rather than vice versa. Analyses by Ellaway and Macintyre (1998) found that associations between subjective measures of neighborhood stressors and several physical health outcomes remained independent of mental health outcomes. More work is needed, however, that assesses *both* objective and subjective neighborhood characteristics, net of a variety of individual socioeconomic, demographic, and psychosocial characteristics.

Pathways

Data availability is a major determining factor in the type of neighborhood measures that will be used for a study, which is why there has been a reliance on census-based neighborhood measures (Cummins et al., 2006). To date, the few regional studies that have used both objective and subjective measures of neighborhood conditions have faced the limitations of small sample size when attempting to model the relationships between different dimensions of the neighborhood. For example, in studies of health considering the neighborhood influences of both affluence and deprivation as well as subjectively assessed neighborhood conditions, the power was inadequate to model all three relationships simultaneously (Elliot 2000; Steptoe & Feldman 2001). We extend this literature by using a large, nationally representative dataset in which a more statistically rigorous assessment can be conducted of the inter-relationships between neighborhood factors as well as the mediation and selection into these neighborhood conditions.

We consider the theoretical and conceptual issues relating particular measures with different pathways and explicitly model these pathways (Carpiano & Daley, 2006). By their nature, subjective assessments of the neighborhood environment most closely reflect individual appraisals of neighborhood conditions. They may operate through pathways such as stress and psychological well-being that are triggered by the hazards and perception of safety in one's environment (Ross & Mirowsky, 2001). In this capacity, they may capture aspects of the environment that objective measures do not measure. Similarly, objective measures may measure important structural aspects of the environment that the respondent does not or cannot perceive. For example, neighborhood disadvantage might shape access to local resources that consequently affect health (e.g., job leads, medical care, social services or safe places for recreation and exercise), even if people have overall positive appraisals about their neighborhood.

In addition, both the objective and subjective neighborhood measures are in part a reflection of the characteristics of the people living there. Sociodemographic factors such as race and ethnicity or social class often determine where people live through demand-side or "pull" factors (such as social networks that draw people with similar backgrounds to residential enclaves) and supply-side or "push" factors (such as racism in real estate markets that excludes people from living in certain neighborhoods). The presence of selection into or out of specific neighborhoods based on such individual characteristics influences the association between neighborhood characteristics and health when the individual factors determining this selection (e.g. race and ethnicity or social class) are themselves important for health. In this case, neighborhood influences are over-estimated without the presence of individual-level sociodemographic controls.

It is also possible, though, that such controls may lead to an under-estimation of neighborhood influences. Neighborhoods themselves may affect the socioeconomic characteristics of individuals that are in turn important for health. For example, people who live in a neighborhood with wealthier school districts and a more diverse job market have the opportunity to obtain a higher quality education and better job than people who live in a resource-poor neighborhood. These educational and occupational differences can translate into differences in health between people in resource-rich and resource-poor neighborhoods that originate in the neighborhood conditions, but which operate through individual characteristics.

Further complicating the dynamics between neighborhood characteristics, individual characteristics and health, are the potential pathways between objective and subjective neighborhood conditions. Objective neighborhood characteristics form part of the basis upon which subjective quality is assessed (e.g., Aneshensel & Sucoff, 1996), and subjective neighborhood assessments become the more proximal causes of stress and other psychosocial factors that affect health. In this sense, subjective characterizations of neighborhoods mediate the relationship between objective neighborhood conditions and health. To date, few studies have simultaneously evaluated objective and subjective neighborhood characteristics and their joint and separate associations with health outcomes. However, in one recent study, Wen and colleagues (2006) examined these questions using data from a sample of people ages 50-67 in Cook County, Illinois. They found that the association between objective measures of neighborhood socioeconomic status (SES) and self-rated health was substantially mediated by individual SES and demographic factors as well as perceptions of neighborhood quality. However, perceived neighborhood quality remained associated with self-rated health even after controlling for individual socioeconomic and demographic factors and for objective neighborhood SES.

In the present study, we examine the joint and separate associations between objective neighborhood conditions, subjective neighborhood quality, and self-rated health. The few previous studies that have examined both objective and subjective neighborhood conditions have examined the associations between these neighborhood conditions and health (as well as the mediation of objective by subjective neighborhood conditions) using indexes and multivariate regression (Steptoe & Feldman 2001; Stafford & Marmot 2003)[2]. While these models have in some cases addressed the biases associated with clustered observations on individuals from the same neighborhoods (Ross 2000; Ross, et al. 2000; Steptoe & Feldman 2001), they have not dealt with the problem of attenuated regression associations between the objective and subjective neighborhood indexes and health. This bias can occur in multivariate regression due to the required assumption that the covariates (which in this case are the neighborhood constructs) are measured without error. The combination of this potential bias with the small samples in several of these studies could lead to important underestimation of neighborhood effects

[2] Elliot (2000) uses a structural equation model; however as noted earlier, the study is unable to assess subjective and objective conditions simultaneously in the model due to small sample size. The perceived neighborhood measure is not included in the final model.

or mis-assessment of the extent of mediation of objective neighborhood conditions by perceived neighborhood quality and individual characteristics.

This study extends the work of Wen et al. (2006) by using a nationally representative sample with a wider age range. In addition, we examine the various roles of individual race and SES in contributing to the association between neighborhood objective and subjective conditions and individual health. In comparison with multiple regression modeling, structural equation modeling (SEM) allows a researcher to account for measurement error and thereby corrects for attenuation in regression analysis while simultaneously testing the assumptions associated with that attenuation correction. In addition, SEM offers direct tests for confounding and allows a researcher to directly model the relationships between neighborhood constructs. This study can thus provide more robust tests and more detailed information on the pathways between individual characteristics, neighborhood conditions, and health than have been conducted in previous research.

Study Questions and Hypotheses

Our study first examines whether objective measures of neighborhood affluence and disadvantage, as well as subjective assessments of neighborhood conditions, each contribute uniquely to a construct of neighborhood conditions. Then, we use these neighborhood constructs to address the remaining hypotheses.

Research Question 1: What is the relationship between health and both objective and subjective measures of neighborhood conditions?

Hypothesis 1: Both objective measures (affluence and disadvantage) and subjective assessments of neighborhood conditions will be associated with individual health.

Hypothesis 2: Subjective assessments of neighborhood conditions will be more strongly associated with health than objective measures of neighborhood conditions.

Hypothesis 3: The relationship between objective measures of neighborhood affluence and disadvantage and health will be partly mediated by subjective assessments of neighborhood conditions, but will retain some independent association with health

Research Question 2: To what extent is the association between neighborhood conditions and health influenced by individual characteristics?

Hypothesis 4: The relationship between neighborhood conditions and health will be explained only in part by selection, mediation and reverse-causal pathways attributable to individual characteristics.

Understanding how both objective and subjective neighborhood conditions are jointly and separately associated with health will contribute to the literature on the pathways between individual characteristics, neighborhood conditions, and health.

METHODS

Data

The data are from adults who participated in the fourth wave of the Americans' Changing Lives (ACL) study in 2001/2002. The first wave of the ACL study was a nationally representative, multistage area probability in-person survey with 3,617 noninstitutionalized adults ages 25 and older, living in the coterminous U.S. in 1986, with oversamples of both African Americans and people ages 60 and older (House et al., 2005). Sampling weights are not included in the analyses; however the variables used in the sampling strategy (age and race, described below) are included as important controls. The fourth wave of data was collected in 2001/2002, with a response rate of 83% of the original surviving respondents. We focus on the fourth wave because that is when the neighborhood perception measures were introduced. Addresses of respondents were geocoded and linked with tract-level data from the 2000 census. Because the sample is population representative, very few census tracts had multiple respondents[3]. Individual-level socioeconomic information comes from wave three (1994). Some of the interviews were conducted by proxy at wave IV, and we eliminated these 95 proxy respondents since it is unclear what effect the proxy responses would have on the subjective health and neighborhood quality measures. Our final analytic sample consists of 1509 of the 1692 respondents who were interviewed in the fourth wave. Forty-six respondents were omitted because they reported a race other than white or black, which is too small a sample to study well. Additionally, respondents were omitted who had missing data on census tract (11), perceived neighborhood quality or self-rated health (46), or important psychosocial and socioeconomic controls (80). Analyses (not shown) indicate that attrition was slightly higher for people who resided in lower SES neighborhoods at the first wave, which we address in the discussion section.

Measures

[3] No census tract had more than 12 respondents, only four census tracts had more than 10 respondents, and less than 16% of the sample had five or more respondents in the same census tract.

Table 1 provides descriptive information on all variables and Appendix A displays the correlation matrix for all variables in the latent variable analyses. The primary outcome of interest is self-rated health at wave four, coded on a five point scale ranging from poor to excellent health. This commonly used measure of health status has been extensively found to possess excellent predictive validity for mortality and a variety of functional health limitations (Idler et al., 2000).

In selecting objective measures of the neighborhood environment, we chose census variables that have been used extensively (and validated) in prior neighborhood effects research that constructed multi-item indices for neighborhood affluence (e.g., Sampson et al., 1999) and disadvantage (Sampson et al., 1997). Based on this literature, we expect neighborhood affluence to be measured by: percent of families with income over $75,000, percent of adults with college or greater education, and percent of the civilian labor force employed in a professional or managerial occupation. We expect neighborhood disadvantage to be measured by: percent living in poverty, percent living on public assistance, percent female headed households, percent unemployed, percent Black, and percent less than 18 years of age[4].

Perceived neighborhood quality is measured by a number of subjective measures of neighborhood conditions that clustered well in exploratory factor analysis (results not shown). These subjective measures include Likert-scaled respondent reports of: overall neighborhood satisfaction level (how satisfied a respondent is with his or her neighborhood), air quality, living environment (how a respondent rates the general upkeep of the neighborhood), and safety (whether the respondent feels this is a

[4] Because many of the neighborhood variables were right skewed we tested models in which we achieved more normally distributed data by using the square-root transformation. The findings were similar and we present the models with the original variables here.

neighborhood where he or she feels safe from personal attacks). We also included dichotomous indicators of perceived neighborhood problems with abandoned buildings and litter, as well as whether the respondent reported the presence of recreational facilities in the neighborhood.

Individual-level sociodemographic variables are measured in wave three (1994). These include dichotomous indicators for the respondent's race (black=1 versus white) and gender (female=1 versus male), and a continuous indicator for the respondent's age in 2000. The sociodemographic variables also include education −a continuous variable representing the respondent's highest year of schooling− and income −a continuous variable measuring the combined income of respondents and their spouses for the preceding year. Missing data for income were imputed using regression-based imputations by the researchers who collected and compiled the ACL data (see House, 2002). To assist in evaluating the possibility of same-source bias regarding the association between perceived measures of health and neighborhood conditions, we include a depression measure assessed via an eleven-item version of the extensively validated Center for Epidemiologic Studies Depression Scale (CES-D) (Radloff, 1977).

Analyses

Structural equation modeling (SEM) is particularly well suited to our research questions for several reasons. It allows us to address the measurement error associated with the theoretical neighborhood constructs, to measure these latent (or unobserved) neighborhood constructs with multiple observed indicators, and to correct for attenuation of parameter estimates caused by the measurement error in our assessment of the relationships between the latent constructs and health (Bollen, 1989). The ability to address measurement error is important because no dataset could include all of the numerous potential determinants of neighborhood affluence, disadvantage, and perceived neighborhood quality. Additionally, it allows us to explicitly model the indirect relationships between our latent and manifest (or observed) variables, as well as the intercorrelations between our latent constructs. Moreover, SEM allows us to model the neighborhood-health relationship while simultaneously addressing: a) selection into different neighborhoods based on individual characteristics, and b) confounding, mediation, and reverse-causal associations between health and neighborhood effects due to individual characteristics.

Our analytic approach involves two steps (Anderson & Gerbing, 1988). First, we establish a measurement model for the three unobserved latent constructs of neighborhood disadvantage, affluence, and perceived neighborhood quality. Based on the theoretical literature and exploratory factor analysis, we identify the most parsimonious measurement models for these three constructs. We conduct a confirmatory factor analysis of the neighborhood conditions, exploring the relationship between the three constructs (Figure 1). We include cross-loadings; these show the extent to which important indicators of each of the constructs load more or less strongly on the constructs that are, and are not, expected by theory. For example, we explore the extent to which poverty is more or less strongly associated with neighborhood advantage versus the expected construct neighborhood disadvantage.

The analyses are conducted using the sample of census tracts obtained from the individual-level data. Because few individuals were observed in the same census tract, we did not include multilevel adjustment for clustering at the individual level in these models or the subsequent structural equation models. In order to avoid bias associated with the inclusion of categorical indicators in the measurement models, we use variance adjusted weighted least squares models (WLSMV).

Second, to test our hypotheses, we estimate structural models for each of the following: 1) the association between each of the three neighborhood constructs and health modeled alone and then simultaneously with one of the remaining neighborhood constructs; 2) the association between all three neighborhood constructs and health, modeled simultaneously; 3) the association between each of the three latent constructs of neighborhood conditions and health, before and after controlling for individual characteristics; and 4) the association between all of the neighborhood constructs and health (modeled simultaneously) while controlling for individual characteristics.

We use several statistics to assess the evidence with respect to our research questions. To evaluate the fit of the structural equation models, we use multiple measures of goodness of fit (as suggested by Bollen, 1989). First, we report the WLSMV adjusted chi-square (χ^2) test and its associated probability value testing the statistical significance of the null hypothesis (e.g., that the model is able to explain the data, within sampling variation). In light of the documented problems with the χ^2 test (e.g. see Bollen 1989; Kline 2005), we rely on two other measures to assess goodness of fit that are appropriate for SEM with continuous and categorical variables. These are the comparative fit index (CFI) and the root mean square error of approximation (RMSEA). The CFI is typically thought to signal good model fit at a value of 0.9 or above (Hu & Bentler 1999; Kline 2005). The RMSEA indicates good model fit when no more than 0.05. In addition to the global fit measures, standardized parameter estimates allow us to consider the relative strength of paths in the measurement and structural components of the structural equation models. The statistical significance of each of these paths is assessed using probability values (p-values). In order to assess whether different paths are equivalent, we apply parameter constraints and then assess the statistical significance of the difference in model fit for the constrained and unconstrained models. This process is conducted using an adjusted chi-square difference text (Muthén 1998-2004). All models are estimated using Mplus Version 4.2 (Muthén 1998-2006).

RESULTS

Neighborhood Constructs

The confirmatory factor analyses for the neighborhood constructs developed in previous literature for neighborhood advantage and disadvantage, as well as the perceived neighborhood quality construct, are detailed in Figure 1. Standardized paths (indicated by single-headed arrows) between the observed variables (denoted by rectangles) and the latent constructs (denoted by ellipses). We also report the standardized correlations (indicated by double-headed arrows) between the three latent constructs.

Neighborhood affluence is strongly determined by the presence of high neighborhood occupational status, education, and income as indicated by the large, positive and statistically significant standardized paths (0.99, 0.95, and 0.84, respectively, all at $p \leq 0.001$). Neighborhood disadvantage is most strongly determined by the degree of unemployment, public assistance, female-headed households, poverty, and black residence in a census tract (0.87, 0.87, 0.84, and 0.80, respectively all at $p \leq 0.001$), and somewhat less strongly determined by the percent of the population under age 18 (0.43,

$p \leq 0.001$). The perceived neighborhood quality construct is significantly determined by respondents' assessments of each of the neighborhood conditions, though least so with assessment of the presence of recreational facilities.

There is some theoretically expected overlap in the measurement of the neighborhood conditions, such that some indicators of neighborhood affluence are also (negative) indicators of neighborhood disadvantage. Perceived neighborhood quality is correlated in the expected direction with neighborhood affluence (positively) and disadvantage (negatively), and in one case a subjective measure (recreation facilities) is more strongly related to an objective construct (0.24, $p \leq 0.001$) than the subjective construct (-0.19, $p \leq 0.001$).

The constructs are all inter-related; however, there is a qualitatively stronger relationship between the neighborhood disadvantage construct and the perceived neighborhood quality construct (-0.47, $p \leq 0.001$) than there is between neighborhood affluence and the perceived neighborhood quality construct (0.35, $p \leq 0.001$). The model fit statistics indicate acceptable (RMSEA=0.08) to good fit (CFI=0.92).

<u>Inter-relationships between self-rated health and neighborhood constructs</u>

Using each of the neighborhood constructs identified above, we explore our first research question about the relationships between health and both objective and subjective measures of neighborhood conditions. In the top two sections of Table 2 we present findings from three structural equation models (1-3) that consider the relationship between each neighborhood construct and self-rated health when the construct is considered alone. We then present models that consider the relationship between the subjective construct and health combined with neighborhood affluence (Models 4) and neighborhood disadvantage (Model 5). Our use of SEM for these pair-wise models, allows us to contrast the relative strength of objective and subjective constructs on health while simultaneously addressing the intercorrelation between the constructs.

The findings from Models 1, 2 and 3 support our first hypothesis that both objective and subjective measures of neighborhood context are associated with health. Our second hypothesis, about the relative strength of the three neighborhood constructs, is only partially supported by the remaining models. Consistent with this hypothesis, we find that one of the objective constructs, neighborhood disadvantage (the path for disadvantage: -0.17) is less strongly associated with health than the subjective construct (the path for perceived neighborhood: 0.20). However, contrary to expectations, the second objective construct, neighborhood affluence (path for neighborhood affluence: 0.20) is equally strongly associated with health as the subjective construct. We will further assess this finding in the subsequent models.

The findings from Models 4 and 5 provide some support for our third hypothesis regarding the presence of both direct and indirect relationships. The magnitude of the association between neighborhood affluence and health, as well as that between neighborhood disadvantage and health, are both reduced when the perceived neighborhood quality construct is included in the model. The association between neighborhood affluence and health is reduced by 35% (1- (0.13/0.20)) and the association between neighborhood disadvantage and health is reduced by over one half (1- (-0.08/-0.17)). The goodness of fit statistics indicate that with one exception (neighborhood disadvantage modeled alone) all of the models have good (CFI>0.9) to acceptable (RMSEA<0.1) fit.

In Figure 2 and Model 9 from Table 2, we depict the relationship between each of the neighborhood constructs and health, controlling for the relationship between all other neighborhood constructs and health and addressing the non-independent associations among them. The correlation of the neighborhood constructs depicted in Figure 2 (-0.53, -0.47, and 0.35) indicates this non-independence. Model 9 further supports our third hypothesis by showing that, in a fully mediated model with all of the neighborhood constructs, subjective neighborhood assessments have the strongest relationship with health (standardized path β=0.15, $p \leq 0.001$), followed closely by neighborhood affluence (β=0.12, $p \leq 0.001$).

It is important to note that we do not find that the magnitude of the standardized path between perceived neighborhood quality and health is statistically significantly different than the standardized path for neighborhood affluence (p=0.40)[5]. We do find, however, that the path for neighborhood affluence is not only larger in magnitude than the path for neighborhood disadvantage, but that the difference in the standardized coefficients is statistically significant (p=0.05)[6]. In addition, we find that the path between health and disadvantage is also statistically significantly different than that for perceived neighborhood quality (p=0.02)[7]. Our findings about the weaker role of neighborhood disadvantage relative to affluence and perceived neighborhood quality is further evidenced by the fact that in Model 9, neighborhood disadvantage is fully mediated (β=-0.02, p=0.34). These two findings strengthen the support for Hypothesis 2

[5] This finding is obtained using a parameter constraint. When we compare Model 9 with a constrained model (in which the standardized coefficient for health on affluence and the standardized coefficient for perceived neighborhood quality on health are constrained to be equal), the adjusted χ^2 difference test reflects that there is no statistically significant difference between these models (p=0.40).
[6] The difference in fit between the constrained model (in which the standardized path of affluence is constrained to be equal in magnitude but opposite in direction to that for disadvantage) and the unconstrained model in Model 9 are statistically significant (p=0.05).
[7] The finding is also obtained using a parameter constraint as detailed in Footnote 6.

about the expected stronger association between neighborhood affluence and health versus neighborhood disadvantage and health. Like the previous models in Table 2, the fully mediated model with simultaneous assessment of correlation between the neighborhood constructs has good (CFI>0.9) to acceptable (RMSEA<0.1) fit.

Selection and Mediation by Individual Characteristics

Next, we address our second research question about the pathways between individual characteristics, neighborhood conditions and health. Although only detailed longitudinal data would allow for a full understanding of the temporal relations between these variables, our analyses allow us to begin to unravel the potential roles of mediation, reverse-causality, and selection by individual demographic and socioeconomic characteristics. We examine these relationships with two different modeling approaches. Our initial consideration of these pathways is depicted on the bottom of Table 2, Models 6-7. Our final model addressing these issues is depicted in Figure 3.

In Table 2 Models 6-7, we show how controls for individual characteristics influence the basic relationships between the neighborhood constructs and health that were described earlier for Models 1-3. We use structural equation models to assess whether individual characteristics are simultaneously related to both health and the neighborhood characteristics. This allows us to assess the influence of potential selection into neighborhoods and mediation by the individual characteristics on the association between each of the neighborhood constructs and health. Because these models exhibit poor model fit (e.g. Models 6, 7, and 8 all have CFI <0.9 and only Model 8 has RMSEA <0.1), we will not discuss the results in detail. We note, however, that individual characteristics appear to have a large influence on the direct paths between each of the respective neighborhood constructs and health,

In Figure 3, we employ the same structural equation modeling strategies from above to assess the role of individual characteristics in both selecting individuals into neighborhood conditions and mediating the relationship between neighborhood conditions and health. This model is more complete than the previous models because we model all of the neighborhood constructs and individual characteristics simultaneously. We simultaneously regress health on both the individual characteristics and the neighborhood constructs (these paths are depicted in the figure). Additionally, we simultaneously regress each of the neighborhood constructs on individual characteristics. For visual clarity, we do not depict (with paths and arrows) the regression of each of the neighborhood constructs on the individual characteristics in Figure 3; rather we show the standardized coefficients for these paths in boxes next to each of the neighborhood constructs. The final model combines all of the strategies employed in the various models in Table 2.

We first report the findings from the regression of neighborhood constructs on individual characteristics. Race is the strongest correlate of neighborhood conditions. Blacks were much more likely to live in a neighborhood with disadvantage (0.57, $p \leq 0.001$), they were less likely to live in conditions of neighborhood affluence (-0.17, $p \leq 0.001$) and were less likely to describe their neighborhood as having good environmental conditions (-0.24, $p \leq 0.001$). Similarly, income and education were also strongly and positively associated neighborhood affluence (0.24, $p \leq 0.001$ and 0.24, $p \leq 0.001$, respectively). Income and education were slightly less strongly associated (but in the expected directions) with neighborhood disadvantage (-0.21, $p \leq 0.001$ and -0.10, $p \leq 0.001$, respectively) and perceived neighborhood quality (0.16, $p \leq 0.001$ and 0.08, $p \leq 0.010$, respectively). All of the socioedemographics, except gender, were significantly associated with perceived neighborhood quality.

We next report on the findings on mediation in Figure 3. As observed in Table 2 and Figure 2, neighborhood affluence and disadvantage are both mediated by perceived neighborhood quality. In contrast with the earlier findings, in Figure 3 we observe that, after modeling the association between individual characteristics and neighborhood conditions, neither neighborhood disadvantage nor affluence remains statistically significant. Furthermore, we find that it is the correlation of individual socioeconomic characteristics with neighborhood conditions (and their respective correlation with health) that most strongly influences the drop in the magnitude and statistical significance of the correlation between the objective measures and health. We observe that it is the inclusion of the controls for individual characteristics in Model 6 and in the final model in Figure 3 that most strongly influences the reduction in the magnitude and eliminates the statistical significance of neighborhood affluence on health. These findings, combined with the strong positive correlation between income and education and neighborhood affluence, suggest that the previously determined positive association between neighborhood affluence and health may be operating primarily through an individual's material and social resources.

In contrast with the above findings on the role of individual SES in shaping health through objective neighborhood conditions, we do not find strong evidence for mental health operating in a similar way through perceived neighborhood quality. Although depressive symptoms have a relatively large negative association with health (β=-0.20, $p \leq 0.001$), the model suggests that this aspect of mental health is not a strong mediator of the relationship between neighborhood conditions and health. It is not significantly associated with either of the objective neighborhood measures and it is only a moderate determinant of subjective assessment of neighborhood conditions.

DISCUSSION

This study examined objective and subjective assessments of neighborhood conditions, exploring the overlap between different sources of information on neighborhoods and the relative strength of their association with adult self-rated health. Although some research has examined both subjective and objective neighborhood conditions and health (Elliot 2000; Ross 2000; Ross et al. 2000; Steptoe & Feldman 2001; Stafford & Marmot 2003; Wen, Browning, and Cagney, 2003; Cagney et al., 2005), we extended the research on this topic by using a national data set, examining two distinct objective neighborhood constructs (neighborhood affluence and disadvantage), and using structural equation models to account for the interrelationships between neighborhood affluence and disadvantage as well as the interrelationships between these objective neighborhood assessments and the subjective neighborhood assessments. Moreover, our methods allowed us to better examine the selection, mediation, and confounding by individual characteristics like SES, gender, race, and age.

Consistent with our hypotheses and previous literature (Elliot 2000; Steptoe & Feldman 2001; Stafford & Marmot 2003; Wen, Browning, and Cagney, 2003; Cagney et al., 2005), we found that both objective and subjective measures of neighborhood conditions are related to health when considered individually. Also consistent with our hypotheses and previous literature (Stafford & Marmot 2003; Ross 2000; Ross et al. 2000), we found that subjective measures of the neighborhood mediate the association between objective neighborhood conditions and health. Our models also suggest that selection and mediation by individual characteristics play a role in explaining the association between neighborhood conditions and health. Indicators of resources and social position (e.g., race, income, and education) appear to explain more than demographics (e.g., gender and age) or mental health (e.g., depression). However, our findings support the hypothesis that the relationship between neighborhood conditions and health are explained only in part by selection, mediation, and reverse-causal pathways attributable to individual characteristics.

We found that neighborhood affluence is more strongly associated with health than neighborhood disadvantage when affluence and disadvantage are considered simultaneously. This finding provides national generalizability to previous studies on the role of neighborhood affluence versus disadvantage in the health of a local population (Wen, Browning, and Cagney, 2003; Cagney et al., 2005). Our finding on the importance of neighborhood affluence is an important contributions in itself because many studies focus only on neighborhood deprivation measures, and thus may omit potentially important dimensions of positive neighborhood context operating through objective measures. For example, as noted by Wen et al. (2003), higher prevalences of educated residents within neighborhoods may be indicating higher levels of human capital that, collectively, may encourage health-promoting behaviors and attitudes within the neighborhood. Furthermore, higher levels of neighborhood affluence may indicate higher levels of neighborhood social capital that residents may be able to use for pursuing individual and collective health-promoting/protective activities (Carpiano, 2007).

Additionally, as expected, all three of the neighborhood constructs are associated with each other and have overlapping associations with health. Subjective neighborhood assessments are stronger than objective neighborhood conditions in their associations with self-rated health, which is consistent with the research findings of Wen and colleagues (2006) in their sample of adults in Cook County. Because subjective neighborhood assessments and self-rated health are both self-reported by individuals, it is not surprising that they are strongly related to each other. However, controlling for CES-D and individual SES did not have much of an effect on the pathway between subjective neighborhood assessment and health. This lack of an effect reduces the likelihood that the relationship between subjective conditions and health is simply biased by a reverse-causal relationship where health and mental health influence neighborhood assessment or other confounding by third variables that affect both neighborhood assessment and individual health. Rather, it is more likely that subjective assessments of neighborhood are more strongly associated with health because they are more proximate determinants of health than are objective neighborhood conditions.

Our findings have important implications for how researchers measure neighborhood conditions. Because subjective neighborhood measures are more closely associated with health, research that uses only objective measures of neighborhood conditions may be limited by not measuring more proximate aspects of perceived conditions. On the other hand, research that only examines perceived neighborhood quality overlooks the objective neighborhood conditions that form a partial basis for perceived neighborhood quality. This is particularly elucidated by our demonstration of how closely race and neighborhood disadvantage are intertwined.

In our final model, we assessed the overlapping relationships between neighborhood constructs and their association with health, as well as the role of mediation and selection by individual characteristics. Our findings provide new insights into the role of specific socioeconomic and sociodemographic characteristics that provide pathways between neighborhood conditions and health. We find a dramatic association between race and neighborhood disadvantage that is nearly twice the magnitude of any other path in the model (path of 0.58 from Figure 3). This finding is not surprising given the extent of racial residential segregation in the U.S. (Iceland et al., 2002). However, our empirical demonstration of the importance of black race for inhibiting individual's selection out of, or persistent selection into, neighborhood disadvantage is a disturbing reminder that the negative relationship between neighborhood disadvantage and health is likely to perpetuate racial disparities in health in the US for years to come.

We also highlight the importance of both income and education in providing pathways between neighborhood conditions and health. In contrast with race, these achieved characteristics may not only select individuals into and out of different types of neighborhoods, but they also may provide pathways linking neighborhood disadvantage to health. The pathways between neighborhood SES, individual SES and health may thus have reciprocal, reinforcing cycles that contribute to cumulative disadvantage and cumulative advantage throughout the life course (O'Rand, 2002).

Our study has a number of limitations that point to directions for future research. First, although the use of structural equation modeling is a particular strength of our study, we recognize that a weakness of structural equation modeling is that several models can meet the same standards of goodness of fit. Therefore, we conducted additional sensitivity tests to explore whether alternative specifications of the models might provide a similar or even better fit (analyses not shown). The final models presented had the best goodness of fit statistics among all of the models that were shown and not shown. Where fit statistics suggested that the models were weak, we noted this in the text and highlighted how improvements in the models strengthened the model fit.

Second, we examined the relationship between neighborhood conditions and health at one point in time (except for our SES variables which were from a prior wave). It is likely that the reciprocal and reinforcing relationships described in this study between individual characteristics, neighborhood conditions, and individual health occur over an individual's life course. Future work needs to examine how individual and neighborhood SES contribute to health and vice versa, over the life course, for different racial and socioeconomic groups, and for different cohorts of people. These models will particularly strengthen our understanding of selection and mediation.

Third, our analyses were also limited by the number and types of measures of neighborhood characteristics available to us. For example, additional theoretical constructs, such as collective efficacy, could enhance our understanding of the subjective components of the neighborhood important for health. Moreover, objective neighborhood measures need to come from not only the census. Census variables are limited in the range of objective aspects of neighborhoods they capture, and the different boundaries that might be important to health beyond census-defined boundaries

(Raudenbush & Sampson 1999; Diez Roux, 2001; MacIntyre et al., 2002; Cummins et al. 2005).

Fourth, we know that those lost to follow-up by wave 4 of the ACL were slightly more likely to be from lower SES neighborhoods and less healthy at Wave 1. We also know that people in lower SES neighborhoods at W1 were more likely to die by Wave 4. This uneven loss to attrition and mortality likely resulted in an underestimate of the association between objective neighborhood advantage and disadvantage and health in our study. It might have also led to an underestimate of neighborhood disadvantage and health, in particular.

Finally, we explored self-rated health because of its strength as a summary indicator of social and physical well-being as well as longevity. It is possible that other health outcomes might be more closely related with the objective neighborhood measures considered here.

Clearly, research on neighborhoods and health needs to better demonstrate which specific pathways mediate the relationships for which people, in which circumstances. Improving our understanding of how objective and subjective measures of neighborhood environments overlap and interact, and how these neighborhood characteristics form and are formed by individual racial and socioeconomic dynamics, are necessary to provide us with a better understanding of how to improve health across people and places.

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Table 1. Descriptive Statistics, Americans' Changing Lives Study, Wave III (1994) and Wave IV (2001/2002) (n=1509)

Variable	Range		Mean	Standard Deviation
Wave IV				
Health				
Self-reported (1=very poor)	1	5	3.45	1.03
Affluence				
% income ≥ $75,000	0	0.91	0.25	0.18
% education >=12	0.01	0.86	0.22	0.16
% professional/managerial	0.04	0.79	0.31	0.13
Disadvantage				0.10
% Poverty	0	0.65	0.12	0.10
% Public Asst.	0	0.30	0.03	0.04
% Unemployed	0	0.35	0.06	0.05
% Population <18	0	0.48	0.27	0.05
% Black	0	0.99	0.18	0.28
% Female Head	0.07	0.85	0.27	0.14
Perceived Neighborhood Quality[a]				
Overall Satisfaction (1=low)	1	5	4.09	0.86
Air Quality (1=low)	1	5	4.18	0.86
Upkeep (1=low)	1	5	4.29	0.80
Safety (1=low)	1	4	3.47	0.77
Recreation (0=unavailable)	1	4	0.63	1.93
Abandon Build. (1=not present)	1	4	1.31	0.63
Litter (1=not present)	1	4	1.71	0.81
Wave III				
Mental Health				
CES-D (standardized)	-1.15	4.74	-0.26	0.92
Sociodemographic Characteristics				
Race (1=black)[a]	0	1	0.76	
Gender (1=female)[a]	0	1	0.37	
Age	39	97	60.5	14.3
Income	1374	500000	40557	37532
Education	0	17	13	3

[a]Note that these variables are modeled in the factor analyses and structural equation models as categorical indicators.

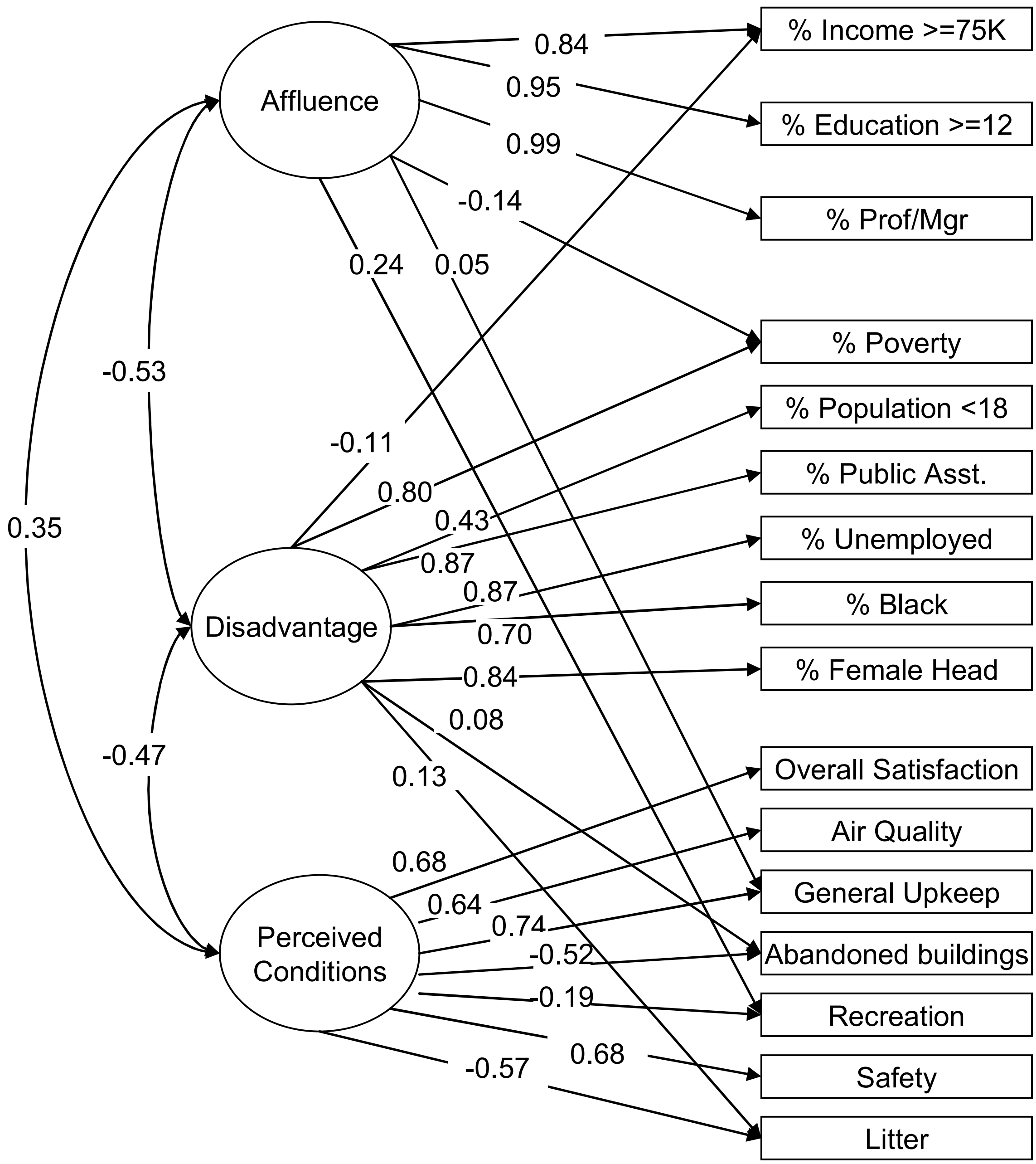
Table 2. Path Coefficients for Health (H) Regressed on Neighborhood Constructs: Affluence (A), Disadvantage (D), and Perceived Neighborhood Quality (P)[a]

Structural Component of SEMI[b]	Path for health on:	Standardized Path	Model Goodness of Fit Statistics		
			χ^2	CFI	RMSEA
1) H←A	A	0.20***	80.4***	0.95	0.08
2) H←D	D	-0.17***	470.4***	0.83	0.13
3) H←P	P	0.20***	128.9***	0.96	0.06
4) H←A, H←P, A⇔P	A	0.13***	273.6***	0.92	0.08
same as above	P	0.14***	same as above		
5) H←D, H←P, D⇔P	D	-0.08**	370.6***	0.92	0.07
same as above	P	0.16***	same as above		
6) H←A, H←**I, A← I**	A	0.03	2351.5***	0.77	0.14
7) H←D, H←**I,** D← **I**	D	0.00	5276.3***	0.56	0.22
8) H←P, H←**I,** P← **I**	P	0.09***	2359.1***	0.86	0.08
9) H←A, H←D, H←P, A⇔D, A⇔P, D⇔P	A	0.12***	378.5***	0.92	0.07
same as above	D	-0.02	same as above		
same as above	P	0.15***	same as above		

[a]Path coefficients and goodness of fit estimated using structural equation models.
[b]The measurement components for the constructs detailed here are depicted in Figure 1.
[c]These models also address the non-independence of the constructs by including the correlation between the constructs (signified here by the double arrowhead).
[d]The matrix **I** entails the following individual characteristics: race, gender, age, education, income, and CES-D. They are simultaneously associated with the neighborhood construct and health.

Abbreviations: CFI=comparative fit index; RMSEA=root mean squared error of approximation; Statistical significance is indicated as follows: * p≤0.050; ** p≤0.010; ***p≤0.001.

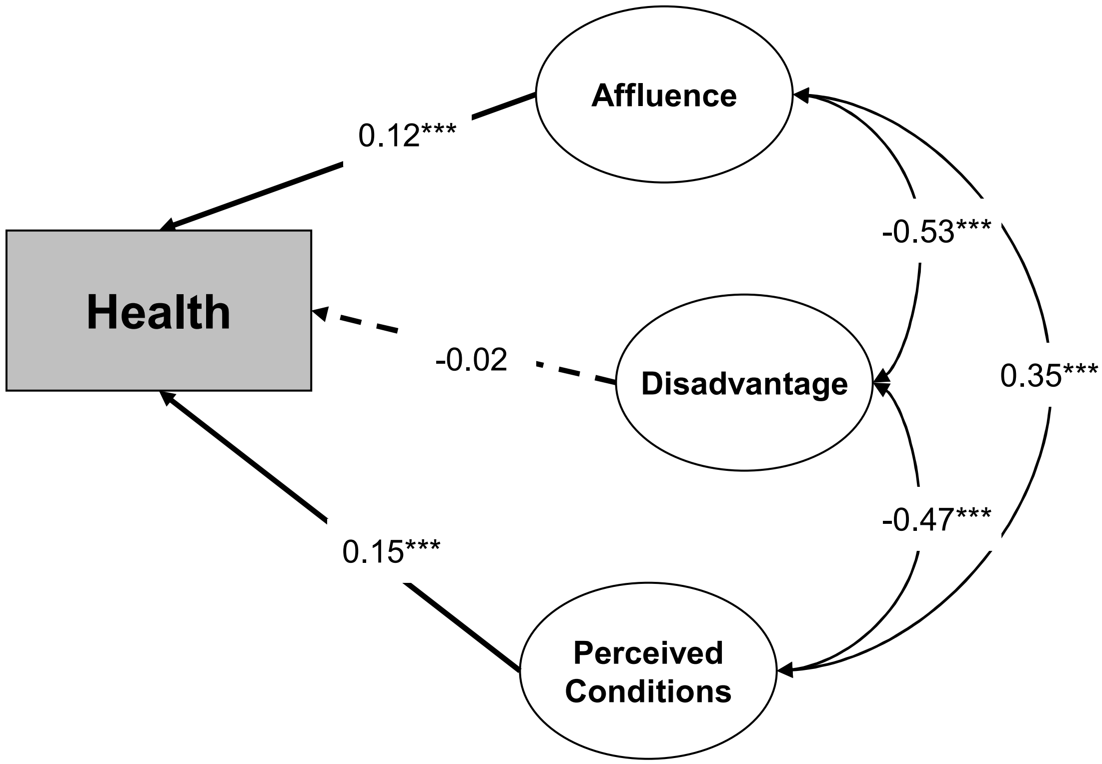
Figure 1. Measurement Model for Objective (Affluence and Disadvantage) and Perceived Neighborhood Conditions[a]



[a]Data on perceived neighborhood quality from the ACL Wave IV (2001/2002) and on objective conditions from matched, geocoded census data 2000.

Note: All paths are statistically significant at p≤0.05. Goodness of Fit Statistics: χ^2= 349.87***; CFI: 0.92; RMSEA:0.08.

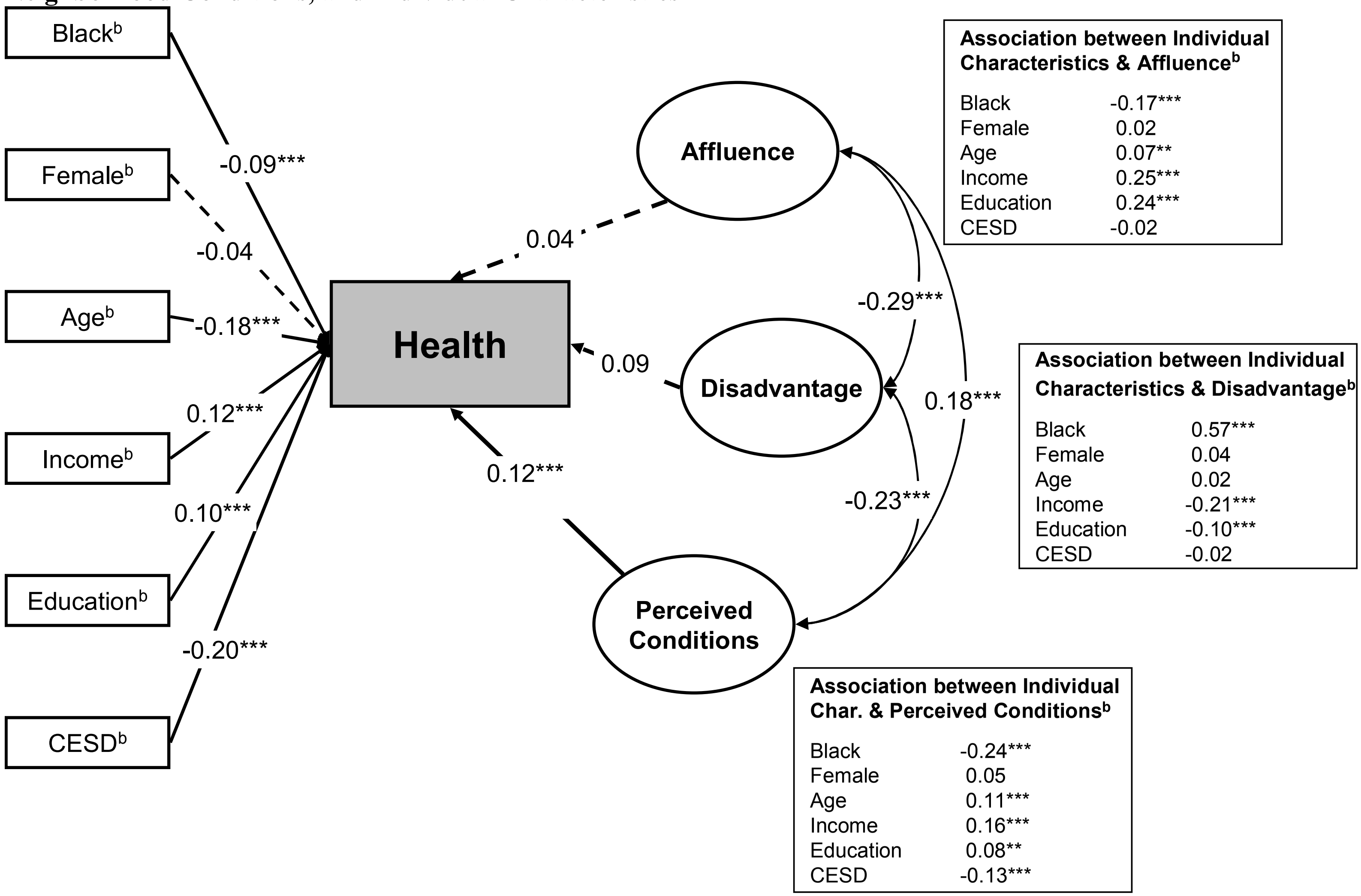
Figure 2. Relative Strength of the Associations between Health and Objective (Affluence and Disadvantage) and Perceived Neighborhood Conditions (Model 9)[a]



[a]See Table 2, Model 9 for model description and fit statistics; see Figure 1 for the variables included in the measurement of affluence, disadvantage, and perceived neighborhood conditions.

Note: Solid line indicates statistically significant path ($p \leq 0.05$), and dotted line indicates non-significant path ($p > 0.05$). Statistical significance is also indicated as follows: * $p \leq 0.050$; ** $p \leq 0.010$; ***$p \leq 0.001$.

Figure 3. Relative Strength of the Associations between Health, Objective (Affluence and Disadvantage) and Subjective Neighborhood Conditions, and Individual Characteristics[a,b]



[a]See Figure 1 for the variables included in the measurement of the neighborhood constructs.
[b]In addition to the direct association of each of the individual characteristics (Black, female, age, income, education, and CESD) on health, the indirect association of the characteristics, through the neighborhood conditions, are also modeled. The coefficients for each of these paths (that are not depicted in the figure) are included in the boxes by each construct.

Note: A solid line indicates statistically significant path ($p \leq 0.05$), and dotted line indicates non-significant path ($p > 0.05$). Z-statistics for paths are within parentheses. Statistical significance is also indicated as follows: * $p \leq 0.050$; ** $p \leq 0.010$; ***$p \leq 0.001$. Goodness of Fit Statistics: $\chi^2 = 796.15$***; CFI: 0.88; RMSEA:0.09.

Appendix A. Correlation Matrix of Neighborhood Variables and Self Rated Health

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(1) % Income ≥75 K	1.00																
(2) % Eduction ≥12	0.86	1.00															
(3) % Prof/Mgr	0.85	0.94	1.00														
(4) % Poverty	-0.63	-0.50	-0.55	1.00													
(5) % Public Asst.	-0.47	-0.45	-0.47	0.78	1.00												
(6) % Female Head	-0.44	-0.34	-0.39	0.75	0.71	1.00											
(7) % Unemployed	-0.49	-0.45	-0.48	0.78	0.76	0.72	1.00										
(8) % Pop. <18	-0.18	-0.32	-0.34	0.35	0.45	0.30	0.33	1.00									
(9) % Black	-0.32	-0.28	-0.32	0.57	0.54	0.83	0.57	0.32	1.00								
(10) % Home owner	0.02	-0.16	-0.06	-0.15	-0.07	-0.13	-0.05	-0.06	0.06	1.00							
(11) Overall Satis.	0.19	0.18	0.19	-0.21	-0.22	-0.25	-0.24	-0.13	-0.22	0.02	1.00						
(12) Air Quality	0.15	0.13	0.15	-0.26	-0.28	-0.34	-0.28	-0.08	-0.28	0.05	0.36	1.00					
(13) Upkeep	0.28	0.26	0.26	-0.30	-0.27	-0.29	-0.30	-0.12	-0.24	0.00	0.46	0.43	1.00				
(14) Safety	0.20	0.18	0.19	-0.29	-0.32	-0.35	-0.31	-0.13	-0.33	0.02	0.41	0.37	0.44	1.00			
(15) Recreation	0.14	0.17	0.16	-0.04	0.04	0.07	0.04	-0.03	0.03	-0.05	-0.04	-0.06	0.02	-0.01	1.00		
(16) Abandon Build.	-0.20	-0.20	-0.20	0.26	0.26	0.30	0.28	0.11	0.26	0.04	-0.22	-0.25	-0.28	-0.26	0.09	1.00	
(17) Litter	-0.27	-0.25	-0.24	0.28	0.27	0.28	0.26	0.12	0.23	0.02	-0.29	-0.27	-0.40	-0.31	-0.01	0.36	1.00
(18) Health	0.15	0.15	0.16	-0.14	-0.12	-0.12	-0.12	-0.07	-0.10	-0.01	0.08	0.11	0.14	0.17	0.08	-0.07	-0.08