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URBAN ADOLESCENTS' PERCEPTIONS OF THEIR NEIGHBORHOODS: AN EXAMINATION OF SPATIAL DEPENDENCE

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Spatial dependence exists when the variation between observations is dependent on spatial location. In the present study, geostatistical methods were used to examine spatial dependence in adolescents' perceptions of their neighborhoods: whether adolescents living in close proximity perceived their neighborhoods more similarly than adolescents living further apart. Participants included 343 adolescents (53% male; 91% African American) enrolled in sixth grade, residing in Baltimore City, with geocoded home addresses. These addresses were used in combination with a measure of perceived neighborhood disorder and disadvantage to compute variogram plots, a geostatistical technique used to evaluate spatial dependence. Results indicated that perceptions of youth residing in close geographic proximity were more similar than perceptions of youth residing further apart. Adjusting for census-level characteristics, but not individual and family characteristics, resulted in decreased variation among participants but did not eliminate the spatial dependence. Findings highlight the utility of geostatistical methods for social science research. © *2004 Wiley Periodicals, Inc.*

The work described in this article was supported by grants from the National Institute of Mental Health (RO1 MH577005) and the National Institute on Drug Abuse (RO1 DA11796). The authors also would like to thank the Baltimore City Public School System and the children and parents who participated in the Baltimore Prevention Program. We thank the Baltimore City Data Collaborative, an initiative of the Family League of Baltimore City, for its contribution of census level data on crime and family poverty; Frank Curriero for methodological assistance; Ann Klassen for critical editorial assistance; Tracy Dusablon for mapping assistance; and Jorielle Brown for content review.
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JOURNAL OF COMMUNITY PSYCHOLOGY, Vol. 32, No. 3, 277–293 (2004)
Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/jcop.20005

Ecological models stress the significance of the neighborhood context for understanding youth development (Bronfenbrenner, 1986; Jessor, 1992, 1993) and highlight two aspects of the neighborhood context as important for youth mental health outcomes: neighborhood structural characteristics and subjective experience or perception of the neighborhood environment (Aneshensel & Sucoff, 1996; Jessor, 1992; O'Neil, Parke, & McDowell, 2001). Although utilized less frequently than census-derived measures of neighborhood structural characteristics, subjective measures of the neighborhood context, such as perceptions of the neighborhood environment, have proven reliable and valid measures of the social environment (Aneshensel & Sucoff, 1996; Ewart & Suchday, 2002; Hadley-Ives, Stiffman, Elze, Johnson, & Dore, 2000). Moreover, perceptions of the neighborhood environment are particularly important to examine because these have been shown to mediate the relationship between objective neighborhood measures (e.g., census measures) and adolescent mental health outcomes (e.g., Stiffman, Hadley-Ives, Elze, Johnson, & Dore, 1999). In some studies examining associations between neighborhood context and adolescent mental health adjustment, perceived neighborhood context has shown greater predictive utility than objective measures (e.g., Hadley-Ives et al., 2000).

Subjective assessments of the neighborhood environment have included measures of perceived neighborhood safety and risk or danger (e.g., Aneshensel & Sucoff, 1996), perceived neighborhood cohesion (e.g., Aneshensel & Sucoff, 1996; Seidman et al., 1998), perceived neighborhood disorganization (e.g., Coulton, Korbin, & Su, 1996; Elliot et al., 1996; Hadley-Ives et al., 2000), and perceived neighborhood hassles (e.g., Seidman et al., 1998), each of which has demonstrated associations with adolescent adjustment. Adolescents' perceptions of neighborhood risk, such as gang activity and fighting, have been linked with alcohol, cigarette, and marijuana use (Scheier, Miller, Ifill-Williams, & Botvin, 2001), as well as symptoms of anxiety and depression, and oppositional defiant behavior and conduct problems (Aneshensel & Sucoff, 1996). In addition, neighborhood perceptions may be associated with cognitive styles and behaviors that place adolescents at risk for problem behavior. For example, Colder, Mott, Levy, and Flay (2000) found that perceived neighborhood danger was linked to positive beliefs about aggression, which were, in turn, associated with aggressive behavior. Griffin, Scheier, Botvin, Diaz, & Miller (1999) found that associations between perceived neighborhood risk and aggression were mediated by increased risk-taking behavior.

Perceptions of the neighborhood context also have been linked with educational outcomes. Perceived neighborhood deterioration relates negatively to intention to complete school and grade point average, and is positively associated with school suspensions among high school students (Williams, Davis, Cribbs, Saunders, & Williams, 2002). Similarly, perceived neighborhood disorganization has been found to be negatively associated with youth self-reported educational behavior among middle and high school students (Bowen, Bowen, & Ware, 2002). In contrast, positive perceptions of the neighborhood appear to protect against adolescent problem behaviors, such as early adolescent sexual activity (Lynch, 2001). Given these associations between perceived neighborhood context and adolescent adjustment, it is important to examine factors that influence adolescents' perceptions of their environments.

Several studies have identified correspondence between neighborhood structural characteristics and youth perceptions of the neighborhood. Aneshensel & Sucoff (1996) found that adolescents residing in neighborhoods characterized as low SES based on census measures perceived greater crime and violence, drug use and dealing, and

graffiti in their neighborhoods. Hadley-Ives and colleagues (2000) reported positive associations between adolescents' perceptions of neighborhood quality and census measures of neighborhood socioeconomic status (e.g., percent below poverty); additionally, perceived neighborhood quality discriminated high crime neighborhoods from neighborhoods with lower crime rates. Similarly, Herrenkohl, Hawkins, Abbott, Guo, and the Social Development Research Group (2002) found youth perceptions of neighborhood disadvantage and disorganization (e.g., crime, drug sales, gang activity) varied systematically at the census block group level. Specifically, these youth perceptions were significantly positively associated with a census-derived neighborhood disadvantage index and marginally associated with a census-derived neighborhood residential stability index. These findings suggest that youth perceptions of their neighborhoods correspond to census-level reports, and highlight particular aspects of census data that might be relevant for understanding youth perceptions of their environments. Moreover, associations between youth perceptions and census measures of the neighborhood context suggest that perceptions of the neighborhood context vary according to spatial location, with adolescents living in close proximity reporting similar perceptions of their neighborhoods.

Despite positive associations between adolescent perceptions and census-level reports of the neighborhood context, individuals living in the same environments may interpret their environments differently based on individual characteristics, family characteristics, or other aspects of the neighborhood environment; thus, in some cases, perceptions of adolescents living in close proximity may not necessarily be more similar than adolescents living further distances apart. Aneshensel and Sucoff (1996) found that adolescents' perceptions of neighborhood hazards varied according to the demographic characteristics of age, family structure, and ethnicity, independent of neighborhood type (e.g., impoverished, affluent) and length of residence in the neighborhood. Older adolescents and African American adolescents rated their neighborhoods as more threatening, and adolescents living with both natural parents reported greater perceived safety. Although other formal examinations of factors associated with differences in adolescents' perceptions of their neighborhood have not been conducted, the available literature suggests that gender, family socioeconomic status, and neighborhood characteristics (e.g., poverty, crime) also may influence adolescents' perceptions of their neighborhoods.

In general, males tend to have greater access and exposure to the neighborhood context (Furstenburg & Hughes, 1997), and report more witnessing and victimization by violence in the neighborhood (Fitzpatrick & Boldizar, 1993; O'Keefe, 1997; Weist, Acosta, & Youngstrom, 2001). Consequently, males may report more negative perceptions of the neighborhood than females. Family socioeconomic status also may have implications for adolescent exposure to and experiences in the neighborhood context. Because families with few economic resources tend to reside in poorer areas (e.g., environments characterized by multiple stressors and few resources), adolescents in these families may have more negative perceptions of their neighborhood environments than adolescents in families with more economic resources. Adolescent perceptions of the neighborhood also vary according to where youth live. Prior research examining whether youth perceptions of the neighborhood context vary geographically has examined correspondence between youth perceptions and characteristics of census tracts (e.g., Herrenkohl et al., 2002). This type of analysis provides some information about whether youth perceptions within census tracts are more similar than perceptions across tracts by examining the variance in perceptions

between tracts. An alternative and complementary method for examining whether youth perceptions of the neighborhood vary according to geographic location is to use geostatistical methods to assess spatial dependence.

Geostatistics is a branch of statistics that deals explicitly with spatial relationships among data, and has been extensively used in the environmental sciences to describe and predict the occurrence of natural phenomena. Unlike other statistical applications, geostatistics does not assume independence among observations. Instead, a primary assumption is that observations close together in geographic space are more similar than observations further apart. This type of dependence is called *spatial dependence* and is similar to the phenomenon in longitudinal research in which observations taken closer in time are assumed to be more similar than observations taken over greater spans of time. Spatial dependence suggests *spatial variation* among observations; specifically, that observations vary according to their geographic location. To test the amount of spatial variation among observations, geostatistical methods rely on geographic information systems (GIS), spatial information systems used to store, retrieve, manipulate, analyze, and map geographically referenced data (i.e., data linked to a geographic location such as x- and y-coordinates) to link individual data points with geographic information. Using the linked database, the amount of spatial variation among observations can be examined. A basis for most geostatistical analyses is to examine *spatial correlation*, the degree of correlation between two values separated by particular distances, using variogram modeling. A variogram is a graphical representation of the correlation between pairs of observations (i.e., data points) plotted against the distance of the pairs of observations. Thus, variograms display the degree of correlation between observations at various distances from each other, providing information about whether observations in close geographic space are more similar than observations further apart.

Recently, geostatistical methods have been applied in public health to examine issues such as health care accessibility and utilization, geographic patterns of disease outbreaks and mortality, and associations between environmental characteristics and health (e.g., Chen, Waters, & Green, 2002; Dangendorf, Herbst, Reintjes, & Kistemann, 2002; Parker & Campbell, 1998; Samet, Dominici, Curriero, Coursac, & Zeger, 2000), but have had limited application in social science domains. This is surprising because neighborhood research assumes that spatial location is an important dimension of study with implications for youth development and mental health adjustment. Neighborhood research assumes similarity among individuals residing in a particular neighborhood and differences between neighborhoods; thus, issues of spatial dependence are implicit in neighborhood research. Neighborhood research has employed multilevel or hierarchical modeling techniques and considered random effects models to account for the lack of independence between individuals or observations nested within neighborhoods. While it is possible to account for the clustering or grouping of individuals within neighborhoods using these methods, the grouping unit is typically a geographic region defined by administrative sources (e.g., census tracts). Geostatistical methods do not require this a priori spatial definition, but instead examine spatial point locations and formally examine whether the variance between observations in close geographic proximity is less than the variance between observations further apart. As a result, these methods do not rely solely on predefined boundaries that may not be consistent with residents' perceptions of neighborhood boundaries (Coulton, Korbin, Chan, & Su, 2001).

STUDY GOALS

The purpose of this investigation was to use geostatistical methods to explore whether urban adolescents' perceptions of their neighborhoods were spatially dependent. Given higher rates of maladjustment in disadvantaged and dangerous neighborhoods, and the assumption that these associations are mediated by negative perceptions of the environment, it has been assumed that perceptions of the environment are spatially dependent or vary according to respondents' location. However, this assumption has only been tested in relation to census-derived units (e.g., census tract) that may not match residents' perceptions of their neighborhood boundaries. Geostatistical methods may provide a more valid test of whether geographic location is important for adolescents' perceptions of their neighborhoods, and a formal examination of whether census tract level data is related to spatial dependence in adolescents' perceptions of their neighborhoods.

In the present study, variograms were used to assess spatial dependence in adolescents' perceptions of neighborhood because this method is suited to exploratory analyses. Correlation between youth perceptions and census-derived measures suggests that perceptions are spatially dependent. However, as noted above, neighborhood perceptions may vary according to individual, family, and neighborhood characteristics. Therefore, no specific hypothesis was made regarding spatial dependence in adolescents' perceptions of neighborhood and the variogram analyses were exploratory. Individual, family, and neighborhood characteristics were included in the analyses to examine: (a) their association with adolescent perceptions of neighborhood, and (b) whether they accounted for spatial dependence in perceptions, if dependence was present. Adolescents' race, gender, family socioeconomic status, and family structure were examined because each has been identified in prior research as relevant for adolescent perceptions and experiences in the neighborhood. Census-level variables indicating poverty, homicide rate, and rate of juvenile arrest also were examined to assess whether these neighborhood characteristics were associated with adolescent perceptions of their neighborhood.

METHODS

Data for this study were drawn from a longitudinal study conducted by the Baltimore Prevention Research Center at Johns Hopkins University. The original study population consisted of 799 children and families, representative of the entering first-grade students in nine Baltimore City public elementary schools. The children were recruited for participation in two school-based, randomized preventive intervention trials targeting early learning and aggression in first grade (Ialongo et al., 1999). The data were collected in accordance with the policies of the Johns Hopkins University Committee on Human Research.

Of the 799 children available for participation in the fall of first-grade assessments, approximately 73% ($N = 581$) completed a face-to-face interview, including the Neighborhood Environment Scale (NES; Elliott, Huizinga, & Ageton, 1985), at the sixth-grade follow-up assessment. Of these, 559 respondents (96%) had no missing data on the individual-level variables of interest. Written informed consent was obtained from parents and verbal assent from the youth. A face-to-face interview was used to gather data from the youth.

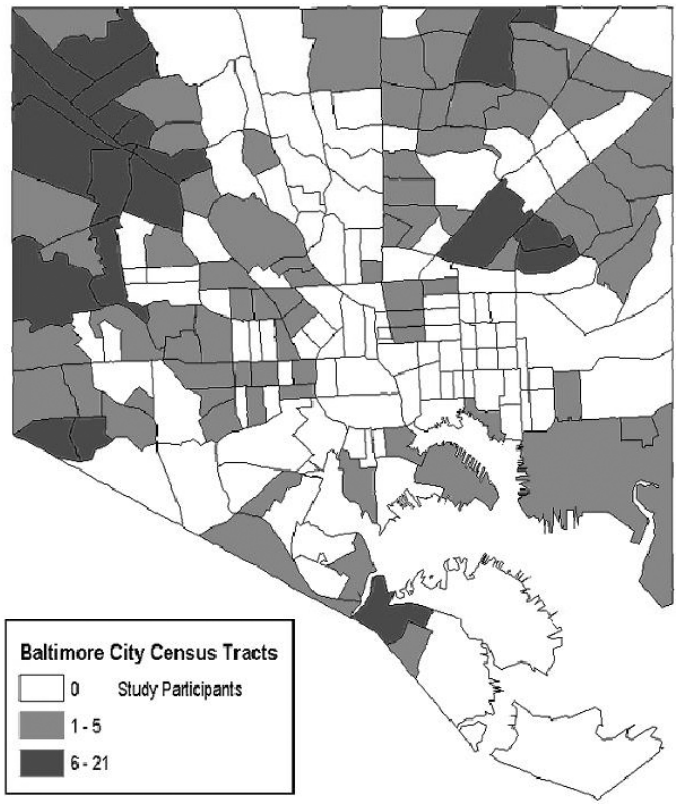

Figure 1. Baltimore City census tracts with study sample participants.

Participants

Using ArcView version 8.2 and address information provided by participants, latitude and longitude coordinates were obtained for each respondent. Address data were also used to determine the census tract for each respondent. Of the complete sample (N = 799), 78 (9.8%) did not provide a valid address for geocoding, 46 (5.7%) provided addresses outside the State of Maryland, and 675 (84.5%) provided valid Maryland addresses. Of the 675 respondents, 554 (82%) provided Baltimore City addresses; the remaining respondents lived outside of Baltimore City at the time of this assessment. The 343 youth (62%) with valid Baltimore City addresses[1] and complete data on the NES and the individual-level variables of interest were used as the study sample for this analysis. A map of the census tracts with youth from the study sample is presented in Figure 1. Figure 2 presents descriptive data about Baltimore City poverty and homicide rates from the year of the assessment.

The study sample consisted of 183 (53%) males and 160 (47%) females. Approximately 91% of the sample was African American (N = 314) and 9% was European

[1]Participants residing outside of Baltimore City were excluded because (a) authors were primarily interested in understanding the experience of adolescents residing in urban areas, and (b) examining distances between youth in Baltimore City and youth residing outside the city limit would provide estimates of distances between respondents that were not meaningful for interpretation.

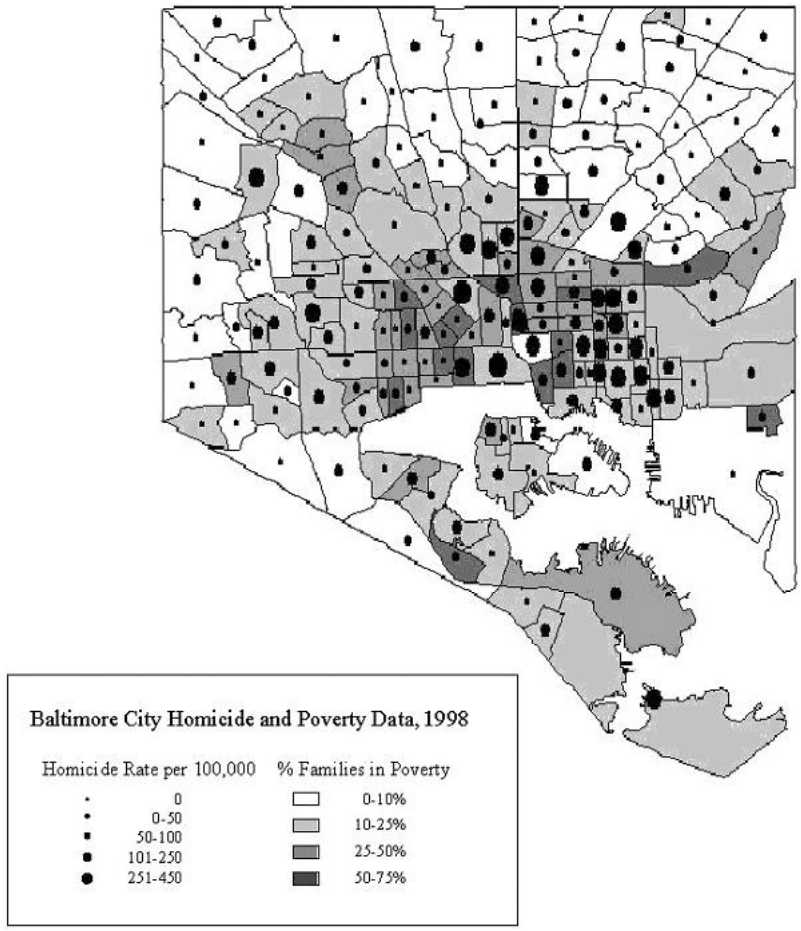

Figure 2. Baltimore City Homicide and Poverty Descriptive Data, 1998. (Data from Baltimore City Data Collaborative.)

American ($N = 29$). Subsidized school lunch was used as an indicator of the socioeconomic status of the sample, with 68% of the sample receiving free or reduced-cost lunches according to parent report. Youth resided in 96 of the 203 Baltimore City census tracts, with a range of 1 to 21 participants residing in the same tract. Chi-square analyses of statistical significance indicated that compared to the original sample ($N = 799$), the study sample ($N = 343$) had a higher percentage of African Americans, more students receiving free or reduced lunch, and more students with a married parent (See Table 1).

Measures

Perceptions of neighborhood disorder and disadvantage were assessed using 10 items from the 18-item Neighborhood Environment Scale (NES; Elliott et al., 1985). The NES is a self-report instrument originally made up of 18 true–false items used to assess exposure to deviant behavior in the neighborhood, including violent crime, drug use and sale, racism, and prejudice. The 10 items used in this study were chosen based on

Table 1. Characteristics of General Study Population and Sample for Analysis

	Total sample[a] *N = 799*		*Geocoded sample*[b] *N = 343*	
Male	435	(54.4)	183	(53.4)
African American	679	(85.0)	314	(91.5)
Free or reduced-fee lunch	367	(64.5)	234	(68.2)
Parent not married	228	(39.9)	125	(36.4)
NES Mean (*SD*)	18.10	(6.4)	18.94	(6.5)

Note. Data are presented as number (percentage) unless otherwise noted. NES = Neighborhood Environment Scale (Elliott, Ageton, & Huizinga, 1985).
[a]Original study sample. [b]Sample with geocoded Baltimore City addresses and no missing data on the NES.

an initial interest in modeling the effects of environment on the original study intervention and developmental outcomes of drug use and sale. The items specifically assess youth exposure to deviant behaviors in their neighborhood and feelings of safety and security (e.g., "There are plenty of safe places to walk or spend time outdoors in my neighborhood," "Every few weeks, some kid in my neighborhood gets beat-up or mugged"). Responses are coded using a 4-point Likert scale, ranging from *not at all true* to *very true*. Responses to the 10 statements were summed to create a scale ranging from 10 to 40, with lower scores representing better perceptions of the neighborhood. Reliability of the scale is good (Chronbach's alpha = 0.81). Table 2 presents the NES items and the distribution of study sample responses for each item.

Indicators of neighborhood disadvantage by census tract were obtained from the Baltimore City Data Collaborative, a joint venture of the Family League of Baltimore City, Baltimore Safe and Sound Campaign, and the Johns Hopkins Bloomberg School of Public Health. Data used in the present study were: juvenile arrest rate, calculated as number of arrests per 1000 youth ages 5 to 17; homicide rate, calculated as the number of homicides per 1000 population; and percentage of families in poverty. The percentage of families living in poverty was transformed into a categorical variable dichotomized at the median of 30%. The census tract level data, summarized in Table 3, were from 1998, the same year the youth survey was collected.

Analytic Strategy

Variogram plots were used to examine spatial dependence in the NES using R version 1.6.2 (Ihaka & Gentleman, 1996) and geoR, a geostatistical function developed by Ribeiro and Diggle (2000). The variogram is a standard graphical tool in the analysis of spatial data and can be used to assess the presence of spatial correlation within data (Diblasi & Bowman, 2001). The x-axis of a variogram indicates the geographical distance between study respondents. The y-axis represents the variance, specifically the squared difference between scores at each specific distance. Thus, variograms can be used to determine whether the scores of individuals who are closer to one another in geographic space are more similar (display less variation) than individuals who are farther apart spatially. A variogram that produces a line with a positive slope indicates that respondents who are closer in geographic space are more similar (have less

Table 2. Distribution of Study Sample Responses for Neighborhood Environment Scale

	Not at all true	*A little true*	*Sort of true*	*Very true*
There are plenty of safe places to walk or spend time outdoors in my neighborhood.[a]	47 (13.7)	66 (19.2)	79 (23.0)	151 (44.0)
Every few weeks, some kid in my neighborhood gets beat-up or mugged.	234 (68.2)	43 (12.5)	36 (10.5)	30 (8.8)
Every few weeks, some adult gets beat-up or mugged in my neighborhood.	266 (77.6)	37 (10.8)	25 (7.3)	15 (4.4)
I have seen people using or selling drugs in my neighborhood.	180 (52.5)	41 (12.0)	31 (9.0)	91 (26.5)
In the morning or later in the day, I often see drunk people on the street in my neighborhood.	182 (53.1)	58 (16.9)	45 (13.1)	58 (16.9)
Most adults in my neighborhood respect the law.[a]	17 (5.0)	51 (14.9)	61 (17.8)	214 (62.4)
I feel safe when I walk around my neighborhood by myself during the day.	46 (13.4)	58 (16.9)	63 (18.4)	176 (51.3)
People who live in my neighborhood often damage or steal each other's property.	243 (70.9)	42 (12.2)	28 (8.2)	30 (8.8)
I feel safe when I walk around my neighborhood by myself at night.[a]	169 (49.3)	52 (15.2)	57 (16.6)	65 (19.0)
In my neighborhood, the people with the most money are the drug dealers.	212 (61.8)	31 (9.0)	37 (10.8)	63 (18.4)

Note. Data are presented as number (percentage).
[a]Responses reverse coded for consistency with other items for overall scale score.

variation) than respondents who are farther apart in location. A variogram that produces a horizontal line indicates that the variance in the variable of interest has no association with the distance between the respondents.

Three variogram models were computed to explore the spatial dependence in neighborhood perceptions. The first model examined the spatial dependence of the NES scale score without adjusting for any of the individual-level or census tract-level covariates. This variogram, using unadjusted NES scores, served as the base model. Two additional variograms were computed to assess whether individual-level variables (i.e., gender, ethnicity, free lunch status, parent marital status) or census-level variables (i.e., homicide rate, juvenile arrest rate, percent families in poverty) accounted for spatial dependence in the NES. To examine whether the individual-level variables accounted for any spatial dependence in the NES scores, the NES was regressed on the individual-level variables. The residuals from this analysis were used to compute a

Table 3. 1998 Census Tract Characteristics for Study Sample

	Mean	*SD*	*Range*
Juvenile arrest rate per 1000 youth[a]	353.34	167.75	33.82–858.02
Homicide rate per 1000 population	0.37	0.48	0–1.65
% Families in poverty[b]	13.3	10.7	2.7–75.4

[a]Arrest rate for youth ages 5 to 17 years. [b]9.9% of the sample ($N = 34$) were located in a census tract with the percentage of families in poverty equal to or greater than 30%.

variogram. With these residual scores, the variance in NES attributable to the individual-variables was removed; therefore, using the residuals to compute the variogram allowed a test of the spatial dependence in the NES while controlling for individual-level variables. Similarly, the spatial dependence of the NES controlling for the census-level variables was computed by using the residuals from a regression in which the NES was regressed on juvenile arrest rate, homicide rate, and percentage of families in poverty. In each regression, intervention status at first grade was included as a control variable.

To determine whether the individual-level or census-level variables accounted for spatial dependence in the NES, the height and slope of the base variogram (computed using the unadjusted NES score) were compared to the variograms generated using the residual scores. A variogram with a lower height indicates that controlling for the covariates reduces the variance in the NES score. A variogram with a flatter slope indicates that controlling for the covariates decreases spatial dependence among the observations.

RESULTS

The majority of the respondents perceived their neighborhood as safe as measured by the NES (M = 18.94, SD = 6.50), with no differences by gender of respondent. Fifty-seven percent (N = 197) responded with a score in the lowest tertile, and 8% (N = 27) responded with a score in the highest tertile. These latter 27 respondents were distributed across 24 different census tracts dispersed throughout Baltimore city, suggesting no spatial clustering.

Regression Analyses

Regression analyses were performed to determine the association between the NES and (a) individual characteristics (gender, race, lunch status, parent marital status), and (b) census-level characteristics (juvenile arrest rate, homicide rate, and percent families in poverty). Results are presented in Table 4. None of the individual level

Table 4. Regression of NES on Individual Characteristics and Census Tract Characteristics

	B (se)	*95% CI*
Individual characteristics		
Gender	.52 (.72)	−0.88–1.93
Race	1.39 (1.29)	−1.14–3.93
Free lunch status	.87 (.78)	−0.66–1.41
Married parent	1.43 (.76)	−0.05–2.92
Census tract characteristics		
Juvenile arrest rate	.005 (.002)*	0.0002–.009
Homicide rate	1.015 (.74)	−0.43–2.46
% Families in poverty	2.035 (1.30)	−0.52–4.59

Note. N = 343. Individual level characteristics and census tract level characteristics examined in separate regression models.
*$p < .05$.

characteristics was statistically significant in relation to the NES, while only the juvenile arrest rate was statistically significant among the census-tract level variables. Despite the lack of association between the NES and the individual- and census-level variables using traditional regression techniques, these variables may still have an effect on the spatial distribution of the NES scores. Therefore, a series of variogram plots was computed.

Variogram Exploration of Spatial Dependence

Unadjusted NES scale scores were used to compute the first variogram (see Fig. 3). The x-axis represents the distance between respondents measured in meters and the y-axis represents the semivariance, the squared difference between the scale scores at each specific distance. The upward slope of the line indicates that there is spatial dependence in the NES; respondents who live closer to one another have more similar scale scores (less variation) than respondents who live farther apart.

To examine whether individual- and census-level variables accounted for spatial dependence in the NES scores, variograms were computed using NES scores adjusted for (a) individual-level variables, and (b) census-level variables. Figure 4a presents the unadjusted NES scale scores plotted in comparison to the NES scale scores adjusted for the individual respondent characteristics. The lack of difference in the height and slope of the plots indicates that adjusting for individual-level covariates did not reduce the amount of variance at each distance or account for the spatial dependence in the respondents' perceptions of their neighborhood. Figure 4b presents the unadjusted NES scale scores plotted in comparison to the scale scores adjusted for the census-level variables. After accounting for census-level variables, the level of variance at each distance decreased as indicated by the lower height of the plot of the adjusted NES score. However, the slope of the variogram with the NES adjusted for census-level

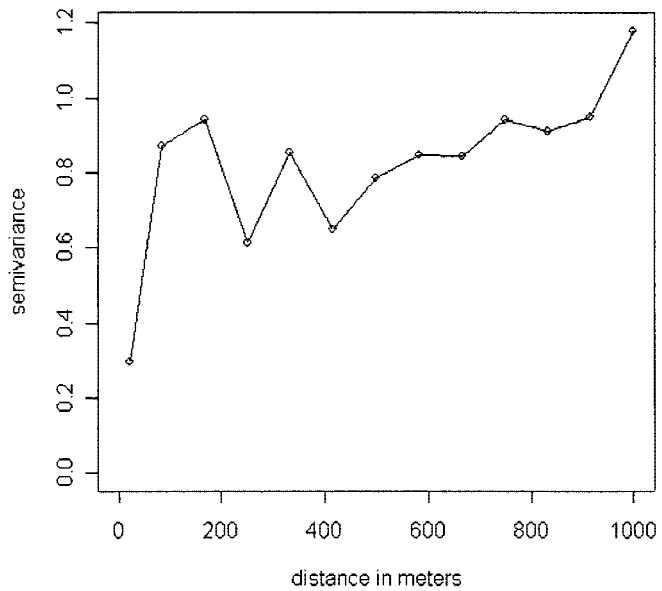

Figure 3. Variogram plot of Unadjusted Neighborhood Environment Scale (NES) scores.

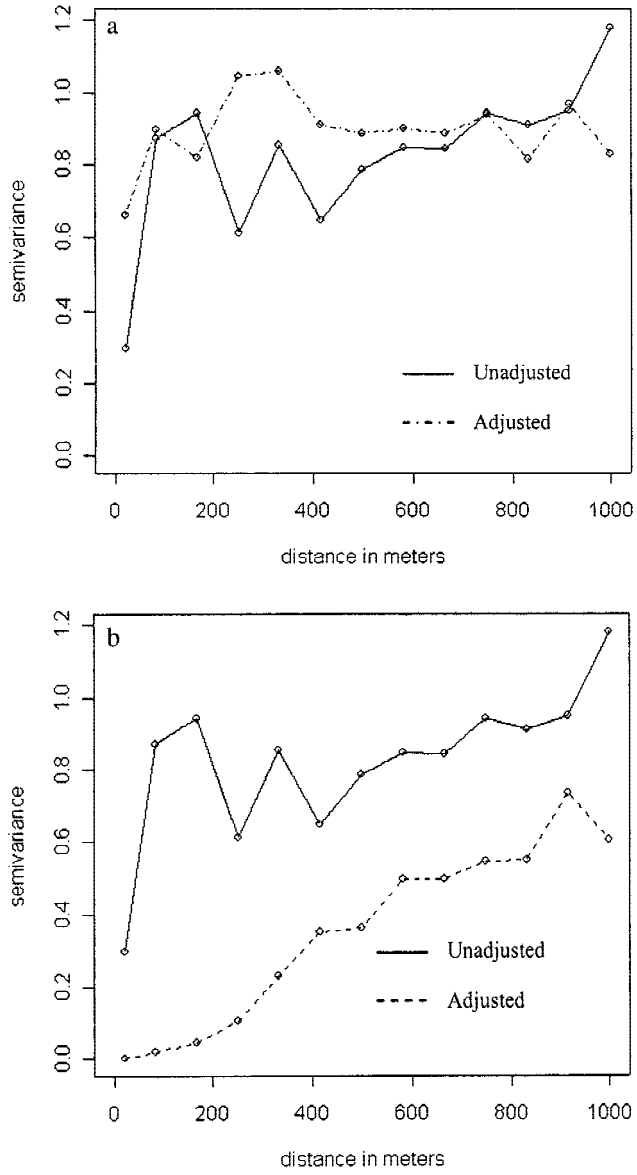

Figure 4. Variogram plot of Adjusted Neighborhood Environment Scale (NES) scores. (a) Adjusted for individual and family characteristics. (b) Adjusted for census-level variables.

variables was not different from the variogram with the unadjusted NES scores; thus, the spatial dependence of the NES scale score has not been explained by the census-level variables. Results of the variogram analysis stratified by gender yielded similar results for males and females.

DISCUSSION

We present a preliminary exploration of spatial dependence in urban adolescents' perceptions of disorder and disadvantage in their neighborhoods; this study is among

the first to use geostatistical methods in conjunction with assessments of the neighborhood context. Variogram analyses were performed to examine whether adolescents' perceptions of their neighborhoods were spatially dependent, specifically whether adolescents residing in close proximity to one another rated their neighborhoods more similarly than adolescents residing further distances apart. Results indicated that respondents living closer to one another perceived their neighborhoods similarly. The amount of variation in neighborhood perceptions was partially accounted for by census-tract level measures of crime and poverty, but not individual or family-level characteristics. Results are consistent with prior research documenting correspondence between perceived neighborhood characteristics and census-based measures of neighborhood (e.g., Herrenkohl et al., 2002), and suggest that adolescents' subjective experience of their neighborhood environment is based, in part, on structural characteristics of their neighborhoods. Although census-tract level measures indicated high crime in the adolescents' neighborhoods, the majority of adolescents in the present study did not perceive overall high levels of disorder and disadvantage within their neighborhoods. This divergence between adolescents' perceptions and objective census-level reports may reflect differences in adolescents' exposure to or participation in their neighborhoods of residence, or desensitization due to chronic exposure. The exception to this result is the percent who responded negatively to the question about feeling safe when walking in the neighborhood alone at night. Nearly half of the respondents responded that this statement was not at all true, possibly indicating that while they may not recognize or acknowledge the problems with drugs, alcohol, and other problems in their neighborhood, they do recognize that it is not a completely safe and secure place, particularly at night. Alternately, it is possible that this finding is an artifact of the self-report nature of the survey, with respondents indicating fewer problems than they actually experience. However, the lack of observable clustering among respondents who perceived high levels of disorder and disadvantage argues against any systematic bias in reporting.

Spatial Dependence in Neighborhood Perceptions

In the present study, adolescent perceptions of the neighborhood were spatially dependent. The variogram plot of the unadjusted neighborhood perception scores displayed a positive slope, indicating that adolescents living in close proximity rated their neighborhoods more similarly than adolescents who lived further distances apart. Accounting for individual- and family-level variables of gender, race, lunch status, and parent marital status did not reduce spatial dependence in neighborhood perceptions. These variables were selected because each may have relevance for adolescents' perceptions of their neighborhoods. For example, adolescent males and females may have different levels of access to the neighborhood, and consequently different experiences in and perceptions of the neighborhood. Race and family economic status are differentially distributed across neighborhoods and thus may help account for some of the spatial dependence in neighborhood perceptions. Parental marital status has been shown to influence parents' ability to monitor and supervise their children, with single parents having lower rates of parent monitoring (Chilcoat, Brelsau, & Anthony, 1996). Parent monitoring has been shown to be associated with adolescent involvement in drug use and other deviant behaviors (Chilcoat, Dishion, & Anthony, 1995; Chilcoat & Anthony, 1996) that may influence their perceptions of their neighborhoods.

Despite the relevance of these individual- and family-level variables, they were less important for how adolescents perceived their neighborhood than other factors.

When adolescent perceptions were adjusted for census-level measures of poverty and crime, the amount of spatial variation between adolescents' perceptions of their neighborhoods was reduced. Thus, reported crime and poverty have implications for how adolescents perceive their neighborhoods. This is consistent with prior research documenting associations between census-level reports of neighborhood and adolescent perceptions (e.g., Aneshensel & Sucoff, 1996; Hadley-Ives et al., 2000; Herrenkohl et al., 2002). Nonetheless, these area-level measures did not account for the spatial dependence in the perception measure. Prior research has relied solely on census-based boundaries to examine similarity in adolescents' perceptions of their neighborhoods. The results of this exploratory analysis suggest that neighborhood-level data should not be used without regard for how the neighborhood is perceived by the individuals living within its boundaries.

SUMMARY, LIMITATIONS, AND FUTURE RESEARCH

The primary strength of this study was the use of geostatistical methods to examine spatial dependence in adolescents' perceptions of their neighborhoods. Prior research documenting convergence between perceptions of neighborhood and census-level characteristics suggests that neighborhood perceptions overlap to some degree with census-level reports of neighborhoods. Although this prior research suggests that neighborhood perceptions might be spatially dependent or vary according to where respondents live, the present study is among the first to use geostatistical methods to specifically address this issue. An advantage of the statistical method used for this study is that spatial dependence was not restricted to an assessment of similarity within predefined boundaries such as census tracts. In fact, the spatial dependence observed in this study may reflect similarity of perceptions for adolescents within census tracts, or similarity of perceptions for adolescents who reside close together but in different census tracts. In future research, it will be important to formally examine this issue by exploring clustering of adolescents' perceptions of their neighborhoods and whether these clusters match census boundaries.

Results from the present study suggest additional directions for future research. This study relied on address information families provided to schools. The addresses provided may or may not be the primary residence of the respondent. Some youth may have multiple residences (Burton, 2001), or a relative's address may be given so that youth may enroll in a school of choice. The effect on neighborhood perceptions is unknown for youth who live concurrently in multiple locations and should be a subject for future research. An additional issue is the relative stability of residence. Individuals who have lived in a neighborhood for a longer period of time may perceive their neighborhoods differently than those who have lived there for shorter periods. In our sample, more than 70% of the respondents had lived in the same census tract for at least 2 years indicating that these adolescents had an adequate amount of time to rate their neighborhoods.

Although not assessed in this study, adolescent perceptions may additionally vary according to factors such as adolescents' level of participation in the neighborhood and parent monitoring of adolescents' time in the neighborhood. Inclusion of these variables in future research may provide additional insight into the source of adolescents' perceptions of their neighborhoods. This research is an important preliminary

step in understanding how the environment may affect adolescent adjustment. Next, it will be important to examine how perceptions of the neighborhood context influence adolescent development and whether the degree of convergence between perceptions and objective census-level reports of neighborhoods is associated with adolescent adjustment. Additionally, longitudinal examinations are necessary to assess stability and change in adolescents' perceptions and how these are associated with adolescent development.

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