Population density and youth antisocial behavior

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Theoretical models concerning how neighborhood contexts adversely influence juvenile antisocial behavior frequently focus on urban neighborhoods; however, previous studies comparing urban and rural areas on the prevalence of youth antisocial behavior have yielded mixed results. The current study uses longitudinal data on the offspring of a nationally representative sample of mothers (N = 4,886) in the US. There was no relation between density and mother-reported child conduct problems across ages 4–13 years, but youth living in areas of greater population density exhibited more youth self-reported delinquency across 10–17 years. Families often moved to counties with greater or lesser population density, but longitudinal analyses treating population density as a time-varying covariate did not support the hypothesis that living in densely populated counties influenced youth delinquency. Rather, the association between population density and delinquency appears to be due to unmeasured selection variables that differ between families who live in more or less densely populated counties. **Keywords:** Behavior problems, delinquency, demography, environmental influences, epidemiology.

At least since the publication of Shaw and McKay's (1942) seminal work, living conditions in dense urban environments have been viewed as fostering crime (Laub, 1983; Rutter, 1981). Accordingly, current research concerning 'neighborhood effects' on psychological development frequently assumes that the adverse neighborhoods in question are necessarily densely populated urban areas (Ingoldsby & Shaw, 2002). Nonetheless, theoretical models of how neighborhood factors influence psychological development rarely include mechanisms related to high population density, per se. Although densely populated urban areas are the implied backdrop for the neighborhood factors frequently implicated as detrimental to psychological development and adjustment, three key questions about the role of population density itself in the origins of antisocial behavior are unanswered.

Does a relation between population density and antisocial behavior exist?

The few studies comparing urban and rural areas have found discrepant results. Adolescents living in Oslo reported twice the rate of antisocial behaviors as adolescents living in less densely populated parts of Norway (Wichstrom, Skogen, & Oia, 1996). Similarly, Rutter, Cox, Tupling, Berger, and Yule (1975a) found higher rates of conduct disorder among children living near the London city center than among children on the less densely populated Isle of Wight. In contrast, neither the Ontario Child Health Study (OCHS; Offord et al., 1987) nor the Great Smoky Mountains Study (Costello et al., 1996) found urban–rural differences in the prevalence of child and adolescent conduct disorder.

Previous studies could have produced inconsistent results if the relation between population density and youth antisocial behavior is non-linear. For example, Wichstrom et al. (1996) found elevated rates of conduct problems only in heavily urbanized Oslo, whereas rates of conduct problems in all other areas of Norway (ranging from 'countryside' to 'large towns') were comparable. If the relation between population density and conduct problems is discontinuous, then differences in the density of the specific areas defined as 'urban' in various studies might create inconsistency in findings. Alternatively, the results of previous studies may have been influenced by other regional particularities. For example, Toronto, Canada, and Ashville, North Carolina, may not be typical urban areas in terms of the factors related to youth antisocial behaviors. In any case, the first question about the relation between youth antisocial behavior and population density to be answered is whether a linear or non-linear association actually exists. If so, it would be necessary to test the causal hypothesis that population density influences antisocial behavior.

Does the relation between population density and antisocial behavior extend across age?

Differences among previous studies also might reflect differences in the ages of the participants. Developmental theories suggest that antisocial

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behavior that begins during adolescence is more the result of social influences than antisocial behavior that begins during childhood (Moffitt, 1993; Patterson, DeBaryshe, & Ramsey, 1989; Patterson, Forgatch, Yoerger, & Stoolmiller, 1998). Consequently, it is possible that any risks conferred by urbanicity would be greatest during adolescence. On the other hand, Ingoldsby and Shaw (2002) proposed a developmental framework for the effects of neighborhood factors (the 'early starter' model), which specified that the adverse consequences of 'community disadvantage' begin as early as preschool and accumulate in the form of specific risks throughout middle childhood. Thus it remains unclear whether a relation between population density and antisocial behavior exists across both childhood and adolescence.

Is the relation between population density and antisocial behavior due to unmeasured confounds?

If youth antisocial behavior is correlated with population density, is it plausible to assume that environmental factors associated with population density are causal risk factors for antisocial behavior (Duncan, Connell, & Klebanov, 1997)? Or do more antisocial individuals (and their families of origin) tend to select more urban environments? For example, chronically antisocial adult men are more likely to reside in urban areas (Compton, Conway, Stinson, Colliver, & Grant, 2005). If antisocial men select urban residences because of the increased stimulation and opportunities for deviant behavior, their children would be exposed to higher genetic and environmental liabilities for antisocial behavior, but urbanicity per se may have no impact on their offspring's risk for antisocial behavior. Thus, the correlation between urbanicity and youth antisocial behavior could be the result of unmeasured confounds rather than causal effects of living in the urban environment. Consistent with this possibility, Rutter et al. (1975b) found that differences in conduct problem rates between inner London and the Isle of Wight were essentially eliminated after controlling for the higher rates of family adversity and poorer schools in London. In contrast, Wichstrom et al. (1996) found that the association between urbanity and conduct problems persisted even after controlling for numerous parent and family covariates, including occupational status, reliance on social aid, immigrant status, religious involvement, and parental involvement.

Additional evidence suggesting a possible causal effect of living in an urban area comes from the Gautreaux Project (Rosenbaum & Popkin, 1991). Low-income families residing in Chicago public housing were moved quasi-randomly to less densely populated communities following a court ruling against discriminatory public housing policies. Adolescents who moved to the suburbs were found to drop out of high school less often and attend college more often than comparable adolescents who remained in the city (Rosenbaum, Kulieke, & Rubinowitz, 1988). Thus, it is possible that the conditions found in less densely populated suburbs fostered adaptive development.

One approach to dealing with potential confounds is to include measured covariates as statistical controls. There is always the possibility, however, that unmeasured factors influenced selection into particular residential areas. A more powerful approach is to use a longitudinal design that follows youth as they move from areas of high population density to low population density and vice versa. If conditions inherent in high-density areas are causally related to youth antisocial behavior, then changes in residence in counties with varying population densities and changes in conduct problems should demonstrate within-person (time-varying) synchrony. In contrast, if the relation between urbanity and conduct problems is due to unmeasured confounds, then youth who move to a low-density county, but have been raised in the 'type' of family that tends to live in more densely populated counties, should demonstrate unchanging levels of conduct problems comparable to children who remain in densely populated counties.

The current study takes three steps to address these questions concerning the role of population density in the origins of youth antisocial behavior. First, we use data on the offspring of a nationally representative sample of women in the US from multiple geographical regions and a broad range of population densities. Second, we examine antisocial behavior problems separately in childhood and adolescence. Third, we use longitudinal analyses to test the causal hypothesis that the urban condition influences youth antisocial behavior.

Method

Mother-generation sample: The National Longitudinal Survey of Youth (NLSY79)

A sample of households was selected to be nationally representative in 1979 using a complex survey design, oversampling African American and Hispanic households. All 14–22-year-old male and female youth living in the households who were not in the military sample were eligible for participation. A total of 9,763 14–22-year-old male and female youth participated in the initial NLSY79 assessment. To date, 4,926 of the NLSY79 females (1,472 African American, 977 Hispanic, and 2,477 non-Hispanic European American and other groups) have given birth to children who have participated in assessments of offspring. The response rate for the initial NLSY79 assessment was 90%. Participants were re-interviewed annually 1979–1994 and biennially since then, with retention rates ≥ 90% during the first 16 waves and > 80% in subsequent waves.

Offspring-generation sample: children of the NLSY79 (CNLSY)

Biennial assessments of the biological children of NLSY79 women began in 1986 (Chase-Lansdale, Mott, Brooks-Gunn, & Phillips, 1991). In 1986, 95% of the offspring of NLSY79 mothers were assessed, with an average retention rate of approximately 90% through 2006. It is important to note that, although the mother-generation was representative of the US in 1979, the offspring-generation cannot be considered necessarily representative of the US in 2008. Mothers reported on their children's characteristics, including behavior problems and temperament, and the home environment. Beginning in 1988, offspring who were at least 10 years of age were asked about their delinquent behavior. The current analyses are based on mother-reported child conduct problems across ages 4–13 years and youth -reported delinquent behavior across 10–17 years.

Of the 11,192 offspring born to NLSY79 mothers, 9,440 offspring had at least one maternal report of childhood conduct problems. The number of times that mothers reported on their children's conduct problems over repeated assessments was 1 (12%), 2 (16%), 3 (14%), 4 (22%), or 5 or 6 (36%). Compared to mothers whose children were not in the age range to be rated on child conduct problems during the assessments, mothers of participating children had lower annual incomes ($31,851 vs. $37156), younger ages at first birth (22.2 years vs. 23.2 years), higher maternal delinquency scores ($z = -.005$ vs. $z = -.017$), lower cognitive ability scores (34.4 %-ile vs. 41.5%-ile), higher depression scores (9.60 vs. 9.86), and were less likely to be non-Hispanic white (50% vs. 69%). The mean level of risk characteristics may be higher in mothers reporting on their children because mothers at lower risk were more likely to delay childbearing and thus less likely to have children in the eligible age range.

Youth reports of their own delinquency were available for 6,638 offspring. The number of times that youth reported their own delinquency over repeated assessments was 1 (14%), 2 (19%), 3 (36%), or 4 or 5 (31%). Compared to mothers whose offspring were not in the correct age range at the time of the assessments to provide reports of their delinquency, mothers of participating youth had lower annual incomes ($29,227 vs. $38,391), younger ages at first birth (21.2 years vs. 24.0 years), higher maternal delinquency ($z = .003$ vs. $z = -.003$), lower cognitive ability (32.4%-ile vs. 40.2%-ile), higher depression (9.87 vs. 9.06), and were less likely to be non-Hispanic white (44% White vs. 65% White). All data on mothers and offspring was collected with informed consent. Again, this indicates that the sample is biased toward participants at greater demographic risk for delinquency, which must be controlled in statistical analyses.

Measures

Maternal characteristics. Maternal characteristics that could confound the relation between youth anti-social behavior and population density were included as measured covariates in the analyses. Sample statistics are summarized in Table 1. When they were

Table 1 Sample characteristics of CNLSY mothers

Maternal variables	N	M	SD	Min	Max
Age at first birth	4,765	22.36	5.05	11.67	43.44
Intellectual ability	4,659	35.61	27.29	1	99
Income	3,947	32,420	74,684	14	977,600
Maternal depression	3,778	9.62	8.95	0	53
Maternal delinquency	4,631	.00	1.46	−1.50	9.00

Note. The units of intellectual ability scores are percentiles; income is total family income in inflation-adjusted 1986 dollars when the mother was 30 years of age; maternal delinquency is the number of delinquent activities during the previous year regressed on mother's age when she completed the assessment in 1980.

15–22 years old, the NLSY79 women were asked about their engagement in 12 delinquent behaviors during the previous year using a version of the Self-reported Delinquency interview (SRD; Elliott & Huizinga, 1983). The SRD is reliable and valid and is the benchmark measure used in contemporary delinquency research (Loeber, Farrington, Stouthamer-Loeber, & Van Kammen, 1998; Moffitt, Caspi, Dickson, Silva, & Stanton, 1996).

Maternal depression was assessed in 1992 using the sum of item scores from the Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977). This 20-item questionnaire has been shown to discriminate between clinically depressed and non-depressed individuals and is highly correlated with other depression scales (see Radloff, 1977; Rose & Mirowsky, 1987). Cronbach's alpha for the CES-D is .89. Statistically controlling for maternal age at first birth also addressed a potentially problematic source of bias in the children of NSLY79 mothers (Turley, 2003): Until all childbearing by the NLSY79 cohort is completed, children with available data were born to somewhat younger mothers. Total family income when the mother was 30 years old was used as a measure of families' socioeconomic status. This reflected all income received in the household, including government support and food stamps, by the mother and her spouse, except that income from cohabiting unmarried partners was not included. In 1980, NLSY79 respondents completed the Armed Services Vocational Aptitude Battery (ASVAB), which measured knowledge and skill in 10 areas. A composite score derived from select sections of the battery (word knowledge, paragraph comprehension, math knowledge, and arithmetic reasoning) was used to construct a cognitive ability score. Raw scores were standardized and converted to a norm-based percentile.

Population density. Information on population density of the county of residence in each wave was obtained from the most recent US census at each wave: 7,985 children had non-missing data on county of residence at two or more different ages; 39.2% of these children ($N = 3098$) experienced changes in population density to a level that was in a different decile between the ages of 4 and 17. This allowed longitudinal tests of
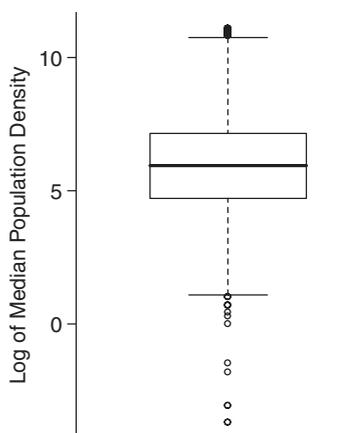
Figure 1 Boxplot of log-transformed population density (median of ages 4–13)

the effects of within-person variation on antisocial behavior. The distribution of population density had a long upper tail: 90% of counties were ≤ 3,156 people per square mile, but the maximum density was 64,922 people per square mile. Consequently, analyses used the log of population density (Figure 1).

Mother-reported conduct problems. When their children were 4–13 years of age, mothers rated them on the Behavior Problem Index (BPI). The BPI was created by selecting items from the Child Behavior Checklist (Achenbach, 1978) with the strongest correlations with CBCL factor scores (Peterson & Zill, 1986). In every assessment wave, mothers rated each item using a three-point scale: *Often True* [2], *Sometimes True* [1], and *Not* True [0]. BPI items were used to create three scales based on DSM-IV constructs; results from a confirmatory factor analysis of BPI items supported the scale (D'Onofrio et al., 2008). The 7 BPI items measuring conduct problems were: (a) cheats or lies, (b) breaks things on purpose or deliberately destroys his/her own or another's things, (c) disobedient at home, (d) disobedient at school, (e) has trouble getting along with teachers, (f) does not feel sorry after misbehaving, and (g) bullies other children. These items overlap substantially with those used in previous population-based longitudinal studies of conduct problems (e.g., Fergusson & Horwood, 2002; Moffitt et al., 1996). Symptom counts ranging from 0 to 14 (M = 2.24, variance = 5.01) were created by multiplying the mean of the non-missing dichotomized items by 7.

Youth-reported delinquency. In 1994, 1996, 1998, 2002, 2004, and 2006, the young adult (YA) assessment was completed by offspring who were 15 years or older. The self-completion portion included 7 items from the SRD (Elliott & Huizinga, 1983): (a) hurt someone bad enough to need bandages or a doctor; (b) lied to parent about something important; (c) took something from a store without paying for it; (d) intentionally damaged or destroyed property that didn't belong to you; (e) had to bring your parent(s) to school because of something you did wrong; (f) skipped a day of school without permission; and (g) ran away from home overnight. Beginning in 1988, offspring who were at least 10 years old but not yet 15 by the end of the

calendar year were administered the Child Self Administered Supplement (CSAS), which included the 7 SRD delinquency items, with staying out overnight without parental permission used as an age-appropriate alternative to running away from home. For budgetary reasons, delinquency items were not included in the YA in 2000. Delinquency items were not dropped from the CSAS in 2000 and were included in the present analyses.

Each of the 7 delinquency items was dichotomized as 'never' versus 'at least once or more', with the exception of 'staying out overnight,' which was dichotomized as 'never or once' versus 'more than once' to equate its prevalence of endorsement with running away from home. Symptom counts ranging from 0 to 7 (M = 1.37, variance = 2.22) were created by multiplying the mean of the non-missing dichotomized items by 7.

The 7 SRD delinquency items were included in the CNLSY because they assess high-prevalence acts that are highly correlated with more serious delinquent behaviors. We tested the criterion validity of the 7-item delinquency scale in the CNLSY using the criterion of at least one conviction for a nontrivial criminal offense (not including drug possession) during ages 14–19 years, controlling for sex, family income, maternal age at first birth, neighborhood social disorganization and crime, and race-ethnicity. Among youth with non-missing delinquency scores at both ages 14–15 and 16–17 years, 6.9% of females and 15.2% of males were convicted at least once. Using logistic regression, the odds of conviction were 1.78 (95% CI = 1.37–2.33), 1.94 (95% CI = 1.64–2.31), 2.14 (95% CI = 1.80–2.55), and 2.01 (95% CI = 1.70–2.38) times greater at each 1 standard deviation (SD) increase in youth-reported delinquency behavior at each successive year of age across 14–17 years, respectively. Interactions between delinquency scores and the youth's sex in the prediction of criminal conviction were never significant at $p < .10$. Thus, there was no evidence of sex differences in the criterion validity of the delinquency scale. Cronbach alphas for the delinquency scale across 14–17 years (including both the younger and older 14 year olds) were .60–.68, median = .66.

Data analysis

The between-persons association between population density and mother-reported child conduct problems (N = 9440 children) was assessed by taking the mean of all child conduct problems scores obtained during 4–13 years and computing the median of the population densities of all counties in which the youth resided in all assessments conducted during 4–13 years. The same method was used to assess the association between mean youth-reported delinquency (N = 6638 children) and median population density during 10–17 years. To test the causal hypothesis of an influence of population density on mother-reported conduct problems, controlling for all unmeasured between-family differences, we fit a series of generalized linear mixed effects models (GLMM; Gelman & Hill, 2006). GLMMs were specified to account for the non-normal distributions of both mother-reported conduct problems and youth-reported delinquent behaviors. A

number of covariates were included in the GLMMs (race-ethnicity, maternal age at first birth, household income, maternal delinquency, maternal depression, and maternal intellectual ability) to reduce sample bias and control for measured confounds. In addition, child sex was included as a statistical covariate, because of the higher rates of antisocial behavior problems evident among male children. Most importantly, the longitudinal GLMMs estimated the extent to which population density and conduct problems demonstrated a within-person association over time, an analysis that controls for unmeasured between-family differences. Thus, for offspring whose families lived in more than one county with different population densities over time, the models estimated the effect of moving to (or from) a county with a population density lower than the median population density of the counties in which the child's family resided over time, controlling for the average density of the counties in which the family lived over time. This longitudinal analysis of between- and within-cluster effects (Neuhaus & McCulloch, 2006) provides a test of the causal hypothesis that urbanicity influences children's conduct problems. All GLMMs were fit using the 'lme4' package (Bates, 2008) in the statistical software *R* (R Development Core Team, 2005). Antisocial behavior scores were modeled with an overdispersed Poisson distribution,[1] because the variances of mother-reported conduct problems and youth self-reported delinquency were greater than the means.

Results

Mother-reported conduct problems

The first analysis collapsed across measurement occasions to evaluate the 'between-person' relation between population density and mother-reported conduct problems. The left panel in Figure 2 illustrates the relation between the median population density of the counties in which the child resided between the ages 4 and 13 years and the mean conduct problems reported by the child's mother across 4 to 13 years. Children who tended to live in more urban areas were not, on average, reported to exhibit more childhood conduct problems than

children who tended to live in less densely populated counties.

As a preliminary step, we fit a GLMM model (not tabled) that characterized the change in mother-reported conduct problems across ages 4–13 years. This model included the fixed effects of age (centered at 4 years) and age-squared, and a random intercept for each child. The child-specific random intercept estimated the extent to which measurements for a single child over time were similar to each other. There was a significant negative linear effect of age ($B = -.076$; $SE = .005$) and a significant negative quadratic effect of age ($B = -.007$; $SE < .001$), indicating that childhood conduct problems initially decreased and then leveled off over time. The variance estimate for the child-specific intercept (.599) indicated that 36.3% of the variance in conduct problems was shared across assessments of the same child over time. The remaining 61.1% of the variance, then, was residual within children (.943).

Results for mother-reported conduct problems are shown in Table 2 for three increasingly complex longitudinal models. Model 1 included the child's race-ethnicity, sex, mother's history of delinquency, mother's depressive symptoms, total family income, mother's intellectual ability score, and the mother's age at first birth as measured covariates. Higher mother-reported conduct problems were predicted by male sex, African American and Hispanic race-ethnicity, younger maternal age at first birth, lower income, and maternal delinquency and depression. Maternal intellectual ability did not predict child conduct problems.

The longitudinal analysis in Model 2 included, in addition to the measured covariates, the log-transformed population density of the child's *current* county of residence at the time of each assessment of child conduct problems across ages 4–13 years. In Model 2, the coefficient for log-population density was not significantly different from zero ($B = -.006$, $SE = .005$), indicating that children currently living in higher-density counties did not exhibit systematically higher levels of conduct problems than children currently living in lower-density counties. We also estimated a number of interactions between log-population density and measured covariates, including child's age, race-ethnicity, and family income. None of the interactions were significantly different from zero (results not shown; available upon request).

Model 3 included both the *median* log-population density for all counties in which the child's family lived when the child was 4–13 years of age and the *difference* (deviation) between the child's current log-population density from the child's median log-population density. A positive deviation score indicated that the child was currently living in a county with greater density than the median of all of the counties in which the child lived across 4–13 years. Neither median lifetime population density ($B = -.013$;

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[1] An index of lack of fit to the Poission distribution is the dispersion parameter, which is calculated as the deviance for a model divided by the degrees of freedom. Values greater than 1 indicate overdispersion. An unconditional model that predicted antisocial behavior from an intercept term only estimated dispersion parameters of 2.20 for mother-reported conduct problems and 1.61 for youth self-reported delinquency. These estimates of overdispersion, however, may be due to the intercept-only model failing to take into account the dependence between multiple observations of the same child: Models that included both an intercept and a child-specific random effect yielded dispersion parameters of .983 for mother-reported conduct problems and .956 for youth self-reported delinquency, indicating that overdispersion may no longer be a problem with appropriate model specification. Nonetheless, the 'quasi-Poisson' procedure was used, which corrects for any possible lack of fit to the Poisson distribution.
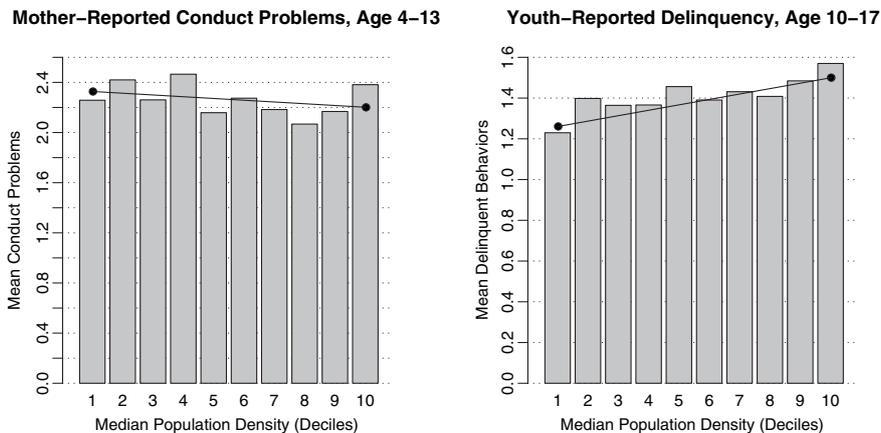
Mother–Reported Conduct Problems, Age 4–13   **Youth–Reported Delinquency, Age 10–17**

Figure 2 The mean of mother-reported child conduct problems across 4–13 years and the mean of youth-reported delinquent behaviors across 10–17 years by deciles of the median population density of the counties in which the youth resided over time

Table 2 Generalized linear models for mother-reported conduct problems

	Model 1	Model 2	Model 3
Statistical controls	B (SE)	B (SE)	B (SE)
Intercept	1.110 (.062)*	1.136 (.066)*	1.131 (.067)*
Age	−.081 (.005)*	−.081 (.005)*	−.081 (.005)*
Age-squared	.007 (.001)*	.007 (.001)*	.007 (.001)*
Female	−.276 (.020)*	−.276 (.020)*	−.273 (.020)*
Black	.210 (.027)*	.218 (.028)*	.209 (.029)*
Hispanic	.109 (.032)*	.113 (.032)*	.104 (.032)*
Maternal delinquency	.051 (.007)*	.051 (.007)*	.051 (.007)*
AFQT	−.0001 (.0005)	−.0001 (.0005)	−.0002 (.0005)*
Income	−.001 (.0002)*	−.001 (.0002)*	−.001 (.0002)*
Maternal depression	.022 (.001)*	.022 (.001)*	.022 (.001)*
Mother's age at first birth	−.026 (.003)*	−.026 (.003)*	−.027 (.003)*
Urban residency			
Current PD		−.006 (.005)	
Current PD Deviation			−.013 (.008)
Median PD			−.003 (.006)
Fit indices			
BIC	38733	38742	38751
Deviance (−2LL)*	38611	38610	38609

*$p < .05$

SE = .008) nor the deviation score (B = −.003; SE = .006) was significantly related to child conduct problems.

Youth-reported delinquency

The right panel in Figure 2 illustrates the relation between median population density (in deciles) and the mean of youth-reported delinquency scores during 10–17 years. In contrast to mother-reported conduct problems, youth who lived predominantly in more urban areas between the ages of 10 and 17 reported engaging in significantly more delinquent behaviors than youth who lived predominantly in more rural areas.

Results for the longitudinal GLMMs for youth-reported delinquency are shown in Table 3 (Models 5–8). As a preliminary step, we fit a model (not tabulated) that characterized the change in youth-reported

delinquency over 10–17 years. This longitudinal model included the fixed effects of age and age-squared. A youth-specific random intercept estimated the extent to which measurements for a single youth over time were similar to each other. There was a significant positive linear effect of age (B = .183; SE = .035) and a significant negative quadratic effect of age (B = −.005; SE = .001), indicating that youth-reported delinquency increased as the sample aged into adolescence, but leveled off in later adolescence. The variance estimate for the youth-specific intercept (.567) indicated that 34.3% of the variance in youth-reported delinquency was shared across assessments of the same youth over time. The remaining 65.7% of the variance was residual within youth (1.084).

The longitudinal analysis in Model 4 included the following measured covariates: the youth's race-ethnicity, sex, mother's history of delinquency, mother's current depressive symptoms, total family

Table 3 Generalized linear models for youth-reported delinquency

	Model 4	Model 5	Model 6
Statistical controls	*B (SE)*	*B (SE)*	*B (SE)*
Intercept	.506 (.089)*	.435 (.090)*	.427 (.091)*
Age	.122 (.014)*	.123 (.014)*	.123 (.013)*
Age-squared	−.010 (.002)*	−.010 (.002)*	−.010 (.002)*
Female	−.345 (.024)*	−.350 (.024)*	−.360 (.024)*
Black	.212 (.032)*	.192 (.033)*	.189 (.033)*
Hispanic	.221 (.040)*	.206 (.040)*	.205 (.040)*
Maternal delinquency	.069 (.008)*	.068 (.008)*	.068 (.008)*
AFQT	−.002 (.001)	−.002 (.001)	−.002 (.001)
Income	−.0005 (.0002)*	−.0005 (.0002)*	−.0004 (.0002)*
Maternal depression	.005 (.001)*	.005 (.001)*	.068 (.008)*
Mother's age at first birth	−.026 (.004)*	−.027 (.004)*	−.028 (.004)*
Urban residency			
Current PD		.018 (.007)*	
Current PD Deviation			.004 (.019)
Median PD			.020 (.008)
Fit Indices			
BIC	15746	15750	15759
Deviance (−2LL)*	15633	15628	15627

*$p < .05$

income, mother's intellectual ability score, and mo-ther's age at first birth. Higher youth-reported delinquency was predicted by male sex, African American and Hispanic race-ethnicity, lower mater-nal age at first birth, lower maternal intellectual ability scores, maternal delinquency, and maternal depression. Maternal income did not predict youth-reported delinquency in this joint model.

Model 5 included, in addition to the measured covariates, the log-transformed population density of the child's county of residence at each age when youth-reported delinquency was assessed. In con-trast to the corresponding model for mother-reported conduct problems, this effect was significantly dif-ferent than zero for youth-reported delinquency ($B = .018$, $SE = .007$). This indicated that youth who were currently living in higher-density counties reported engaging in significantly more delinquent behaviors than youth who were currently living in lower-density counties. It should be noted, however, that the BIC increased from Model 4 to Model 5, suggesting that a model *without* population density was a slightly more parsimonious representation of the data. Tested interactions between log-population density and child age, race-ethnicity, and family income were not significant (results not shown; available upon request).

Model 6 included both the median log population density of all counties in which the youth lived dur-ing 10–17 years and the *deviation* of the youth's current log-population density from the youth's own median log-population density. Median log-popula-tion density was significantly related to youth-reported delinquency ($B = .020$; $SE = .008$) even with the family-level measured covariates in the model, but the deviation score for current log-population density was not significant ($B = .004$; $SE = .019$). This suggests the hypothesis that the significant

relation between population density and self-re-ported delinquency is due to unmeasured differences between families rather than causal effects of factors associated with population density on delinquency.

Discussion

No association was found in the CNLSY sample between mother-reported child conduct problems during 4–13 years of age and county population density. This was true both for the *typical* (i.e., median) density of the county in which the child resided across 4–13 years of age, even when no measured demographic or family covariates were in the model, and for the *current* population density of the county during each assessment during 4–13 years. In contrast, youth who typically lived in higher-density counties during late childhood and adolescence (i.e., had higher median county popu-lation-density across 10–17 years) reported signifi-cantly more delinquent behaviors (but inclusion of population density did not improve the overall model fit, as indexed by the BIC). This finding is consistent with previous studies conducted in Norway (Wichstrom et al., 1996) and England (Rutter et al., 1975a), and are inconsistent with the findings of Offord et al. (1987) and Costello et al. (1996), which failed to find urban–rural differences in rates of child and adolescent conduct disorder in North America. This inconsistency could be due to the particular urban areas examined in those studies not being typical of high-density areas in the US, but it could reflect other differences in methods, such as differences in the measures of antisocial behavior or the age ranges of the participants.

The significantly higher level of youth-reported delinquency in higher- vs. lower-density counties

confirms the perception of a greater need for mental health and correctional services in more densely populated counties in the US and suggests that there is relatively greater need for effective preventive interventions in these areas. It is important, however, to go beyond documenting the correlation to attempting to understand the causal processes underlying it. Specifically, is there evidence to support the hypothesis that conditions inherent in living in densely populated areas foster the development of delinquency (Rutter, 1981; Laub, 1983)?

The results of longitudinal Model 6, which controlled for both measured and unmeasured differences between families who select more or less urban environments, indicated that changes in the population density of the county of residence over time was not significantly related to changes in the youth's report of delinquent behavior. Although there was substantial change in population density over time, this finding does not support the causal hypothesis that variations in population density at the county level influence risk for youth antisocial behavior. Rather, the present findings are more consistent with the interpretation that the observed association between the families' median (i.e., usual) population density and adolescent delinquency is the result of unmeasured differences between families that are confounded with the families' median population densities of their counties of residence. This result may not be surprising, given that population density is correlated with a matrix of other contextual risk factors, such as parental psychopathology, family structure, poverty, and weakened social ties to conventional others (Sampson, Morenoff, & Gannon-Rowley, 2002). Any of these contextual risks may persist beyond, or even be exacerbated by, a move to a less urban area. In order to fully understand the processes underlying the higher rates of self-reported delinquency in youth who typically reside in urban areas, it will be necessary for future research to measure multiple aspects of geographical and social context over multiple time points (Entwisle, 2007).

A potentially important limitation of the current study is that population density was measured at the county level, even though there may be considerable heterogeneity within a county with regard to population density and correlated risk variables. For example, some US counties contain both densely populated cities and less populated suburban areas. The aggregate population density for an entire county, therefore, may not fully characterize any one section. Measuring population density at the county level assures that participants are non-identifiable, uses a discrete geographical unit that is stable over time, and yields results that may be less influenced by narrow regional particularities. Nonetheless, it may be necessary for future research to measure population density and related contexts at a more proximal level.

A second limitation is that the measure of antisocial behavior in the current study based on the SRD included both aggressive behaviors (e.g., hurting someone badly enough to need a doctor) and rule-breaking behaviors (e.g., taking something from a store without paying for it). Unfortunately, there were not enough items of each antisocial behavior sub-type to conduct separate analyses. Previous behavioral genetics research has suggested that aggressive and rule-breaking antisocial behaviors may have somewhat different etiologies: Rule-breaking was significantly influenced by shared environmental factors (which would include population density, if living in an urban area affected siblings in the same way), whereas aggression was influenced more by additive genetic factors (Eley, Lichtenstein, & Moffitt, 2003; Tackett, Krueger, Iacono, & McGue, 2005). Thus, the results could have been different had we been able to consider the two forms of antisocial behavior separately.

Finally, a third limitation is that unmeasured time-varying factors, such as changes in family structure that are correlated with changes in population density, are not ruled out by the within-subject longitudinal analyses. It is possible, therefore, that factors such as changes in family structure could have canceled effects of changes in county population density.

The present findings do not, of course, preclude the possibility that other aspects of the physical and social environments in which families raise their children exert causal influences on risk for antisocial behavior in their children. It may be that aspects of smaller geographic units within counties influence risk for antisocial behavior, but that these influences are not evident in county-level analyses of population density. In particular, there is considerable evidence that variations in the social organization and crime in neighborhoods are correlated with antisocial behavior and adaptive youth development (Duncan, Connell, & Klebanov, 1997; Leventhal & Brooks-Gunn, 2000; Sampson, Raudenbush, & Earls, 1997). It will be very important to use data from the CNLSY and other informative samples to determine if such neighborhood factors causally influence antisocial behavior in youth.

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Key points

- Across the United States, mothers living in more densely populated counties did not report greater conduct problems across ages 4–13 years in their children.
- Youth living in counties with greater population density self-reported greater involvement in delinquent behavior across 10–17 years.
- When families moved from, or into, counties of greater population density, there were not statistically significant corresponding changes in either child conduct problems or youth-reported adolescent delinquency, which fails to support the causal hypothesis that processes associated with greater population density foster delinquency.
- The findings were consistent with the hypothesis that unmeasured selection factors that characterize families who tend to live in more or less densely populated counties are associated with greater delinquency.

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