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Neighborhood Disadvantage and Birth Weight: The Role of Perceived Danger and Substance Abuse

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In this analysis we connect structural neighborhood conditions to birth outcomes through their intermediate effects on mothers' perceptions of neighborhood danger and their tendency to abuse substances during pregnancy. We hypothesize that neighborhood poverty and racial/ethnic concentration combine to produce environments that mothers perceive as unsafe, thereby increasing the likelihood of negative coping behaviors (substance abuse). We expect these behaviors, in turn, to produce lower birth weights. Using data from the Fragile Families and Child Wellbeing Study, a survey of a cohort of children born between 1998 and 2000 and their mothers in large cities in the United States, we find little evidence to suggest that neighborhood circumstances have strong, direct effects on birth weight. Living in a neighborhood with more foreigners had a positive effect on birth weight. To the extent that neighborhood conditions influence birth weight, the effect mainly occurs through an association with perceived neighborhood danger and subsequent negative coping behaviors. Poverty and racial/ethnic concentration increase a mother's sense that her neighborhood is unsafe. The perception of an unsafe neighborhood, in turn, associates with a greater likelihood of smoking cigarettes and using illegal drugs, and these behaviors have strong and significant effects in reducing birth weight. However, demographic characteristics, rather than perceived danger or substance abuse, mediate the influence of neighborhood characteristics on birth weight.

Neighborhood characteristics have been linked to physical and mental health across the lifespan. A handful of studies implicate neighborhood violence or crime in outcomes such as self-rated health, chronic conditions such as coronary heart disease, and mental disorders like depression (Latkin and Curry 2003; Stockdale et al. 2007; Sundquist et al. 2006). In this research, we are particularly concerned with the influence of neighborhood conditions on birth weight. Only three studies have explored the link between neighborhood violence or crime and birth weight. Morenoff (2003) found that increases in the violent crime rate are associated with reductions in birth weight among mothers in Chicago, Illinois. Likewise, using a sample of mothers from Chicago, Collins, and David (1997) showed that whereas the risk of a low birth weight does not increase with violent crime rates, the risk of being born small for gestational age does increase among very low-income women. O'Campo et al. (1997) found that per capita crime had no direct effect on birth weight among babies born in Baltimore, Maryland, though maternal education was less protective when crime was higher. In a related study, Zapata et al. (1992) found that women who lived in neighborhoods in Chile experiencing more sociopolitical violence in the 1980s were more likely to experience a variety of pregnancy complications.

A larger body of evidence exists regarding the link between neighborhood socioeconomic status or the concentration of minorities and health, findings important to the study of violence given the association between

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these factors and neighborhood deterioration and crime (Massey and Denton 1993; Sampson, Raudenbush, and Earls 1997). In general, studies find modest, consistent neighborhood effects for both physical and mental health (Katz, Kling, and Liebman 2001; Leventhal and Brooks-Gunn 2003; for reviews of this research, see Pickett and Pearl 2001; Robert 1999). For birth weight, researchers have found associations with various indicators of neighborhood economic hardship in samples from North America and Western Europe (Buka et al. 2003; Collins et al. 2006; Fang, Madhavan, and Alderman 1999; Farley et al. 2006; Jarvelin et al. 1997; O'Campo et al. 1997; Pearl, Braveman, and Abrams 2001; Rauh, Andrews, and Garfinkel 2001; Roberts 1997; Sloggett and Joshi 1998), though the strength of the association varies with the group under study and the approach to measuring deprivation.

Relatively few studies have examined the link between racial or ethnic concentration in neighborhoods and birth weight in the United States. In all cases but one (Ellen 2000), controlling for individual characteristics and perceptions of the neighborhood have eliminated the apparent negative effects of minority concentration (Buka et al. 2003; Jaffee and Perloff 2003; Morenoff 2003; Roberts 1997). Additionally, only two studies have examined whether the geographic concentration of the foreign-born influences birth weight, which is surprising given the superior birth outcomes observed among immigrant women (David and Collins 1997; Fang, Madhavan, and Alderman 1999; Frisbie 1994). The findings of these two studies are inconsistent. Morenoff (2003) found that living in areas of Chicago with a high percentage of Mexicans had no influence on birth weight, whereas Gorman (1999) found that living in an area with a high percentage of foreign-born had a negative effect on the probability of a low birth weight for Mexican and white Americans. With the exception of Gorman (1999) and Sloggett and Joshi (1998), studies examining the effects of minority concentration or neighborhood deprivation on birth outcomes have been limited in geographic scope.

In this paper we use a novel source of data on a broader sample of cities to systematically study the connection between neighborhood conditions experienced by mothers during pregnancy and the weights of the newborns they ultimately deliver, controlling for individual and family characteristics. We develop measures of the degree to which minorities, immigrants, and poverty are concentrated spatially within an expectant mother's neighborhood and use these to predict the relative likelihood that she gives birth to a low weight baby. In addition to investigating the direct effect of these neighborhood circumstances on birth weight, we also investigate indirect effects through the intervening variables of perceived danger and substance abuse.

1. Implications of Birth Weight

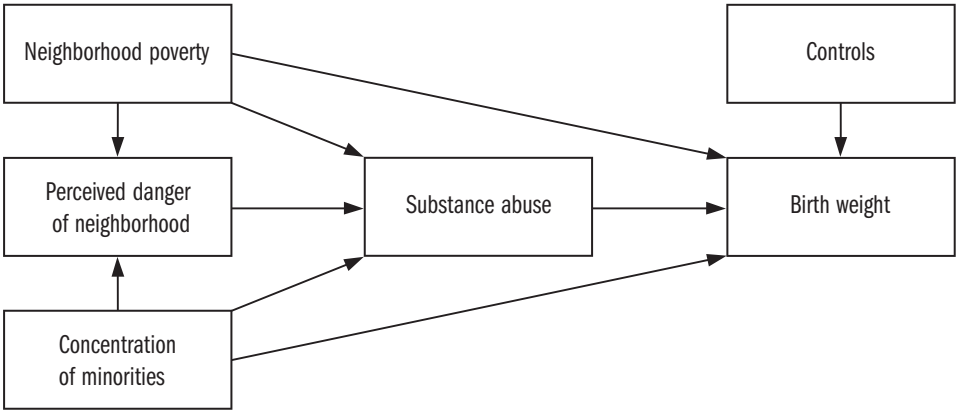
Birth weight is an important determinant of outcomes across the lifespan. In infancy, low birth weight (generally defined to be less than 2,500 grams) is a leading cause of mortality (Heron 2007; Hummer 1993). In childhood, low birth weight children experience diminished health, impaired cognitive ability, a higher rate of behavioral problems, and a greater likelihood of dropping out of school (Conley and Bennett 2000; Currie and Hyson 1999; McCormick and Brooks-Gunn 1992; Aylward et al. 1989). In adulthood similar differentials are observed, with low-birth-weight individuals experiencing higher rates of morbidity and mortality as well as diminished socioeconomic status (Barker 1995; Currie and Hyson 1999; Hack et al. 2002; Rich-Edwards et al. 2005).

2. Perceived Neighborhood Conditions and Birth Weight

Our model of the influence of neighborhood circumstances on birth weight is summarized in Fig. 1. We hypothesize that in addition to whatever direct effects they may have, neighborhood poverty and the concentration of minorities work indirectly to contribute to a greater prevalence of low weight births by increasing expectant mothers' perceptions of danger and leading them to abuse substances during pregnancy. In the United States, mothers living in high-poverty neighborhoods or among minorities are likely to experience elevated levels of crime, violence, and social disorder (Massey and Denton 1993).

Perceptions of neighborhood disorder, including individual evaluations of factors such as safety, decay of the physical environment, and crime, may serve as the mechanism by which objective characteristics of the environment influence health. In general, when individuals perceive higher levels of disorder in their communities, the risk

Figure 1: Contextual model of birth weight



for mental health problems such as anxiety, depression, powerlessness, and low self-esteem increases (Cutrona et al. 2000; Geis and Ross 1998; Ross and Jang 2000; Ross, Reynolds, and Geis 2000). For example, Aneshensel and Sucoff (1996) found that adolescents' perceptions of their neighborhoods as dangerous were associated with symptoms of mental health problems including depression, anxiety, conduct disorder, and oppositional defiant disorder. Similar associations exist with physical health (Feldman and Steptoe 2004; Franzini et al. 2005). For example, Ross and Mirowsky (2001) found that neighborhood disorder and fear mediated the influence of objective measures of neighborhood disadvantage on physical health including self-reported health, physical functioning, and chronic conditions.

To date, no large-scale study has explored the link between perceptions of neighborhood danger or safety and birth weight, though two have found a connection with other perceived neighborhood characteristics. Morenoff (2003) found perceived levels of reciprocated exchange and volunteering within neighborhoods – how often neighbors offered mutual support and participated in local voluntary associations – were associated with higher birth weights in a sample of mothers from Chicago. Likewise, Buka et al. (2003) found that levels of reported social cohesion, trust, and reciprocated exchange within Chicago neighborhoods also increased birth weights, though only for white mothers. Both studies relied on perceptions of neighborhood characteristics gathered from a sample of neighborhood residents rather than the perceptions of mothers themselves.

One smaller-scale study investigated whether aspects of perceived safety influence birth weight. In a case-controlled study of eighty black mothers, Collins et al. (1998) explored whether a mother's perception of neighborhood circumstances with respect to police protection, personal safety, friendliness, and other factors influenced the likelihood of experiencing a very low birth weight (defined as less than 1,500 grams). They concluded that unfavorable neighborhood ratings significantly increased the odds of having a very low-weight birth, controlling for individual substance abuse and other background factors. In the present study, we consider whether an expectant mother's perception of her neighborhood as unsafe affects the birth weight of the child that is ultimately delivered.

3. Neighborhoods, Substance Abuse, and Birth Outcomes

Both objective and perceived neighborhood conditions may also operate to affect birth outcomes by inducing expectant mothers to use or abuse cigarettes, drugs, and alcohol. There is strong evidence that cigarette use during pregnancy has large and very negative effects on birth weight (Buka et al. 2003; Noonan et al. 2007; Shiono et al. 1995; Visscher et al. 2003) and some evidence regarding the negative impact of drugs such as marijuana, cocaine, or heroin (Cosden, Peerson, and Elliott 1997; Kaestner and Joyce; Noonan et al. 2007; Visscher et al. 2003). Alcohol use, in general, has not been found to depress birth weights (Visscher et al. 2003).

A variety of neighborhood characteristics have been shown to increase substance abuse among both adolescents and

adults, net of individual characteristics. In terms of objective characteristics, many studies find that neighborhood deprivation and violence predict a greater propensity to smoke cigarettes (Duncan and Jones 1999; Fick and Thomas 1995; Ganz 2000), use illegal drugs (Boardman et al. 2001; Hoffmann 2002), and consume alcohol (Fauth, Leventhal, and Brooks-Gunn 2004; Ying-Chih et al. 2007), though the degree or presence of an association depends on how neighborhood deprivation is measured. Associations between minority concentration and substance use are less consistent. Depending on the study, living in an area of high minority or foreign concentration associates with increases in substance use (Cooper et al. 2007; Fuller et al. 2005), has no effect on substance use (Hoffmann 2002), or lowers rates of substance use (Kulis et al. 2007; Reardon, Brennan, and Buka 2002). In terms of neighborhood perceptions, studies have found links between social cohesion, safety, and disorder and the substances under study here, especially among adolescents (Duncan and Jones 1999; Ennett et al. 1997; Hill and Angel 2005; Miles 2006; Winstanley et al. 2008). However, findings are not universal (Byrnes et al. 2007).

Relatively few studies have examined whether neighborhood characteristics influence the prevalence of substance use during pregnancy, and all have focused on objective neighborhood characteristics. Finch, Vega and Kolody (2001) and Finch, Kolody and Vega (1999) report that a higher percentage of welfare-dependent households within a postal zip code is associated with an increase in the probability of substance abuse among pregnant women; but the size of the association depends on the substance under study, with welfare use in the zip code having significant effects on the use of tobacco, marijuana, and hard drugs but not alcohol or cocaine. Effects also differ for blacks and whites. Focusing on Latinas alone, Finch et al. (2000) found that living in a zip code with more families in poverty was associated with a small increase in the likelihood of using *any* drug (alcohol, tobacco, marijuana, cocaine, opiates, or amphetamines) but not with the use of individual drugs. Additionally, living in a community with a higher percentage of English speakers associated with increases in the use of a number of substances. Chasnoff, Landress, and Barrett (1990) found no effect of median income in the zip code of residence on substance use in a sample of pregnant women in one county of Florida. Finally, Ellen (2000) found that while the degree to which blacks and whites are isolated from one another had no influence on smoking or drinking for either group, black mothers were more likely to drink or smoke while pregnant when they were more residentially concentrated in inner cities.

4. Sample and Measures

Our data come from the Fragile Families and Child Wellbeing Study, a systematic survey of a birth cohort of parents and children over a five-year period, beginning at the birth of the child. The sample includes 4,898 births (with an over-sample of non-marital births) occurring between 1998 and 2000 in seventy-five hospitals in twenty cities in the United States with populations greater than two hundred thousand. Parents were interviewed at the child's birth and again when the child was roughly one year old, three years old, and five years old. The characteristics of the census tract occupied by mothers at the time of the child's birth were linked to core data for 4,725 (96.5 percent) of those initially interviewed. Tract characteristics were drawn from the 2000 U.S. Census.

For this investigation, we employ information from mothers' baseline interview. Analyses focus on 4,064 singleton births to mothers of all races and ethnicities who had complete data on all variables used in analyses, 85 percent of the baseline sample of single births. Mean values for variables used in the analysis are presented in Table 1.

Information on birth weight is coded in two ways. First, we use a continuous measure of birth weight in grams to maximize statistical power. On average, children weighed 3,227 grams at birth. Second, we classified newborns categorically as being of low weight if they weighed less than 2,500 grams at birth, the standard cutoff used to determine low birth weight status and widely recognized as a harbinger of health and well-being problems later in life. Based on this criterion, some 10 percent of all births were low weight, slightly more than the national average of 8.2 percent (Martin et al. 2007). This likely reflects the fact that our sample is particularly disadvantaged and includes a disproportionate number of black women; blacks have more low birth weight babies than other groups.

Table 1: Descriptive characteristics for the full sample

	Full sample
Birth outcomes	
Birth weight in grams	3,227.03 (617.30)
Low birth weight	10.04
Contextual variables	
Tract proportion black	.40 (.38)
Tract proportion Hispanic	.21 (.37)
Tract proportion foreign born	.14 (.16)
Tract proportion poor	.19 (.14)
Neighborhood safety rating	1.94 (.71)
Risk behaviors	
Any smoking	19.39
Any drinking	10.38
Any drug use	4.77
Individual controls	
Mother's demography	
Foreign born	15.06
Interviewed in Spanish	7.65
Age at Child's Birth	25.13 (6.01)
Married	24.09
Length of neighborhood residence in years	5.52 (7.53)
Mother's Education	
Less than high school	33.46
High school or GED	30.68
Some college or more	35.85
Annual Household Income	
Less than $10,000	22.17
$10,000–$24,999	23.23
$25,000 or More	38.71
Income Missing	15.90
Birth/pregnancy characteristics	
Male	52.95
First birth	38.53
Any prenatal care	97.91
Total number of subjects	4,064

For continuous variables, standard deviations are presented in parentheses. Otherwise, percentages are shown.

Our exogenous variables are census tract indicators of the proportion of families with incomes below the federal poverty line in 1999, the share of residents who are black, the share of residents who are Hispanic, and the share of residents who are foreign born, with all values ranging from 0 to 1.0. Together these measures objectively indicate a neighborhood's socioeconomic and demographic composition. In preliminary analyses, we explored whether these indicators had a nonlinear relationship with the outcomes under study and found no such pattern. On average, mothers lived in a census tract that was 40 percent black, 21 percent Hispanic, 14 percent foreign, and 19 percent poor.

We measure perceived danger of the neighborhood using a subjective evaluation provided by the mothers themselves. At the baseline interview, mothers were asked to respond to the question "How safe are the streets around your home at night?" using a Likert-type scale with four values: 1 (very safe), 2 (safe), 3 (unsafe), and 4 (very unsafe). The higher the value of the scale, therefore, the more dangerous the neighborhood is perceived to be. As indicated in Table 1, mothers generally perceived themselves to inhabit a relatively "safe" neighborhood, with a mean value of 1.94.

We hypothesize that perceived neighborhood danger affects birth outcomes by influencing a mother's propensity to use or abuse substances during pregnancy including cigarettes, alcohol, and illegal drugs (e.g. marijuana, crack, cocaine). Overall, 19.4 percent of mothers said they smoked while pregnant, 10.4 percent drank, and 4.8 percent used illegal drugs (see Noonan et al. 2006). In our multivariate analyses, we employ separate indicators for smoking, drinking, and drug use during pregnancy, comparing mothers who did and did not engage in each behavior. Preliminary analyses using ordinal indicators of substance use found that frequency of consumption did not matter in predicting outcomes of interest – what mattered was whether or not the mother used tobacco, alcohol, and drugs at all during pregnancy.

Final models also include a variety of controls for specific characteristics of households, mothers, and children. We measure mothers' self-reported race-ethnicity using dummy variables for whites, Mexicans, non-Mexican Hispanics, and a residual "other" category, leaving black mothers as the reference category. To control for variation in a mother's nativity, we employ an indicator for birthplace. Mothers

born outside the United States were coded as 1 (15 percent of the sample) and native-born mothers as 0.

Given the significant number of immigrants in our sample, we also attempt to address acculturation. All models include an indicator for language spoken. Mothers interviewed in Spanish were coded as 1 (8 percent of the sample) and those interviewed in English as 0. Interviews were not conducted in any other languages, and mothers who did not speak English or Spanish well enough for the interview were excluded from the sample (Reichman et al. 2001). Less than 5 percent of mothers were considered ineligible for the interview, for one or more of the following reasons: language, adoption, death of the father, or maternal or infant illness. Given that language alone may not capture the process of acculturation, preliminary analyses also controlled for mothers' responses to two questions on cultural attachment asked in follow-up interviews when the children were one year old. Mothers reported whether they agreed or disagreed with the statements that 1) I feel an attachment towards my ethnic heritage and 2) I participate in cultural practices of my own group, such as special food, music, or customs. Neither variable had any impact on key results and both were dropped from analyses to avoid the loss of 504 mothers from our sample who did not participate in the follow-up interview at age 1.

Because previous research has shown that a mother's age at birth has a non-linear relationship with birth weight, analyses include a continuous measure of mothers' age in years (25.1 years on average) as well as a squared term. To address a mother's length of exposure to neighborhood conditions as well as to control for any confounding effects of residential stability, all multivariate analyses control for years of residence in the census tract inhabited at the time of the baby's birth (5.5 years on average). Maternal education is measured using a series of dummy variables that differentiate mothers with less than a high school education (the reference group) from those who have a high school degree or have passed the General Educational Development (GED) tests ("High School or GED"), and those with some college or vocational training or holding a college degree ("Some College or More"), with approximately a third of mothers falling into each category. Family structure was measured using a dichotomous variable that equaled 1 if the child's mother and father were married at the time of the birth and 0 otherwise. Overall, 24 percent of mothers were married to the father of their child at the baseline interview.

Income is measured at the household level and uses mothers' reports of total before-tax income from all members of the sample household during the twelve months preceding the baseline interview. Households earning less than $10,000 served as the reference category and those earning $10,000–$24,999 and $25,000+ were indicated by dichotomous variables. Mothers who did not report their household income were coded as 1 to create an "income missing" variable. Results presented below do not differ when mothers who do not report household income are excluded from analyses. About half of all mothers reported household incomes below $25,000, 39 percent reported incomes above $25,000, and 16 percent did not report their incomes.

Models predicting birth weight included three characteristics of the birth itself. To capture the influence of birth order (Conley 2004), we include a variable defined as 1 if the child in question was the mother's first birth and 0 otherwise. Around 39 percent of births in the full sample were first births. We measured the child's gender using a dichotomous indicator that equals 1 if the birth was male and 0 if female. Male newborns weigh more, on average, than females. As one would expect given human reproductive biology, the sex ratio slightly favors male babies, 53 percent of the sample.

Finally we measured each mother's access to prenatal care with a dichotomous variable that equals 1 if she received prenatal care at any point during pregnancy and 0 otherwise. In preliminary analyses we experimented with separate indicators for prenatal care initiated in the first, second, or third trimester but found no difference in their effects on outcomes of interest. Almost 98 percent of mothers reported receiving prenatal care, perhaps reflecting the fact that large cities have "enabling resources" (Andersen 1995) such as a dense network of clinics or public transportation that make accessing care easy even among lower socioeconomic groups; such resources are not likely available in smaller cities or rural areas.

5. Methods

Our methodological approach involves estimating a series of multivariate equations corresponding to the various

paths depicted in Fig. 1. In Table 2, we estimate the effect of neighborhood poverty and minority concentration on perceptions of neighborhood danger using ordered logistic regression. In Table 3, we estimate the influence of objective and perceived neighborhood characteristics on cigarette, alcohol, and drug use. In the final two tables, we explore whether our key predictors – neighborhood characteristics and substance use – influence birth weight (Table 4) or the probability of a low birth weight (Table 5). We conducted supplementary tests to confirm whether mediation occurred in the expected manner, and those results are discussed below.

In all analyses, we adjust standard errors using Stata's cluster option to address the potential influence of neighborhood co-residence among mothers in the Fragile Families data. Though the vast majority of Fragile Families mothers live in a tract with no other respondents (37 percent), or just one (23 percent) or two other (15 percent) respondents, some 26 percent do inhabit tracts containing four or more respondents, thus opening up the potential for bias attributable to clustering. The data contain 2413 neighborhoods/clusters. Preliminary analyses employed hierarchical linear models to account for the nesting of individuals in neighborhoods. Individual level characteristics were entered into the model at level 1 while tract level characteristics were entered at level 2. Perhaps due to the large number of tracts that contained only one individual, models had trouble converging, often requiring thousands of iterations. Given this issue, we have chosen to present models conducted in Stata using the cluster option. In all cases except one (described below), key results are exactly the same in the two approaches.

6. Results

6.1. Neighborhood Conditions and Perceived Danger

As the estimates in Table 2 clearly reveal, mothers living in census tracts characterized by higher proportions of minorities and foreigners generally perceive their neighborhoods as less safe. Moreover, the introduction of extensive individual-level controls has little influence on the size of these neighborhood effects. If we take the exponent of the coefficient for the tract proportion black in model 2, for example, it appears that living in a neighborhood that is entirely black rather than a neighborhood with no blacks is associated with 490 percent increase in the odds of perceiving a higher level of danger [exp(1.79)=5.9]. Alter-

Table 2: Ordered logistic models showing the influence of census tract characteristics on mother's evaluation of level of neighborhood danger

	Model 1	Model 2
Contextual variables		
Tract proportion black	1.56 (.14)**	1.79 (.17)**
Tract proportion Hispanic	1.19 (.19)**	1.14 (.22)**
Tract proportion foreign born	1.23 (.23)**	1.15 (.26)**
Tract proportion poor	3.94 (.34)**	3.50 (.36)**
Individual controls		
Mother's demography		
Race		
White		.41 (.12)**
Mexican		.03 (.15)
Other Hispanic		.07 (.13)
Other		.26 (.19)
Foreign born		–.09 (.13)
Interviewed in Spanish		.72 (.17)**
Age at child's birth		.10 (.05)**
Square of age at child's birth		–.002 (.001)*
Married		–.27 (.09)**
Length of neighborhood residence in years		–.004 (.004)
Mother's Education		
High school or GED		–.22 (.08)**
Some college or more		–.36 (.09)**
Annual Household Income		
$10,000–$24,999		–.17 (.10)^
$25,000 or More		–.36 (.10)**
Income Missing		–.29 (.11)*
Cut point 1	.49 (.07)**	–3786.27
Cut point 2	3.70 (.10)**	4.69 (.63)**
Cut point 3	5.73 (.14)**	6.75 (.64)**
Log likelihood	–3786.27	–3732.04
Pseudo R^2	.10	.11
Model chi sq	738.75	837.92
Total number of subjects	4,064	4,064

** p<0.01; * p<0.05; ^ p<0.10 two tailed
Higher values indicate less safety. Coefficients are shown with standard errors in parentheses.

natively, compared with a neighborhood with no blacks, a neighborhood that is 40 percent black (the overall mean level) is associated with a 105 percent increase in the odds of perceiving a higher level of danger [exp(.40*1.79)=2.05]. Likewise, living in a neighborhood where the share of Hispanic residents is at the mean (21 percent) rather than in an area with no Hispanic residents associates with a 27 percent increase in the odds of perceiving a higher level of danger [exp(.21*1.14)=1.27]. Finally, living in a neighborhood with the mean share of foreign born residents (14 percent) rather than none at all predicts a 17 percent increase in the odds of greater perceived danger [exp(.14*1.15)=1.17].

Although these indicators of neighborhood racial-ethnic segregation are all quite significant statistically, the effect of concentrated poverty is even greater. Living in a tract with high poverty associates with a larger increase in the odds of perceiving a higher level of danger than living in a neighborhood with a high percentage of blacks, Hispanics, or foreigners. Mothers from neighborhoods where all residents live in poverty as opposed to none in poverty have odds almost thirty times greater of reporting that they feel unsafe. Likewise, for mothers living in neighborhoods at the mean level of family poverty (18.9 percent), the odds of reporting danger increase by 94 percent [exp(.19*3.5)=1.94] relative to mothers who live in a neighborhood lacking families in poverty.

A number of control variables also influence perceptions of neighborhood safety. Mothers who are white (rather than black) and those interviewed in Spanish perceive their neighborhoods as less safe. Increasing age at birth is associated with perceptions of greater danger in one's neighborhood up to age twenty-five, at which point the pattern reverses as older mothers begin to perceive greater safety. Married mothers and those with greater education and household incomes report greater safety.

6.2. Neighborhood Conditions and Substance Abuse

Table 3 presents coefficients from logistic regression models predicting whether or not mothers smoked, drank, and used drugs during pregnancy. For each behavior, Model 1 includes only tract characteristics, Model 2 adds perceived neighborhood danger, and Model 3 includes all control variables. Turning first to neighborhood racial and ethnic composition, Models 1 and 2 indicate that living in an area with a higher share of blacks, Hispanics, or foreigners is generally associated with a lower likelihood of substance abuse and that these effects shift only slightly once we include a mother's perception of neighborhood danger in the model. Likewise, living in an area with a greater percentage of Hispanics or foreigners is associated with a lower likelihood of drinking alcohol during pregnancy. Once we control for perceived neighborhood danger, living with a higher percentage of blacks is associated with drinking as well. Finally, living in an area with a larger percentage of blacks is associated with a marginal increase in drug use, but this effect goes to non-significance once we control for perceived danger. Turning to neighborhood socioeconomic composition, Models 1 and 2 indicate that living in a tract with a higher percentage of poor families is generally associated with a higher likelihood of smoking and taking drugs during pregnancy but that the effect disappears when perceived neighborhood danger is controlled. For all three outcomes, individual level controls entirely mediate the influence of tract characteristics except in one case: living among Hispanics continues to have a marginally significant, negative association with smoking.

Among neighborhood variables, perceived danger appears to be the key determinant of substance use. Greater perceived danger within neighborhoods is strongly and significantly associated with the odds of smoking, drinking, or doing drugs, and once perceived danger and other background characteristics are controlled, measures of neighborhood demographic composition generally fall to statistical insignificance. Considering the results of Model 3 for each behavior, we see that each point increase in perceived danger yields a 21 percent increase in the odds of smoking cigarettes, a 24 percent increase in the odds of drinking alcohol, and a 31 percent increase in the odds of using illegal drugs. Holding all other variables constant at their mean values, predictions indicate that the probability of smoking increased from 12 percent to 19 percent if mothers lived in very unsafe rather than very safe neighborhoods. For drinking, the probability increased from 7 percent in very safe neighborhoods to 13 percent in very unsafe neighborhoods, and for drug use the increase was from 2 percent to 4 percent.

Table 3: Logit models showing the effect of neighborhood context on smoking, alcohol use, and drug use during pregnancy

	Smoking			Alcohol			Drugs		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Contextual variables									
Tract proportion black	–.66** (.18)	–.81** (.18)	–.24 (.23)	–.54 (.21)	–.65** (.22)	–.27 (.28)	.53^ (.31)	.36 (.32)	–.14 (.40)
Tract proportion Hispanic	–1.22** (.25)	–1.34** (.25)	–.56^ (.31)	–1.01** (.31)	–1.09** (.31)	–.34 (.35)	–.60 (.52)	–.75 (.53)	–.76 (.62)
Tract proportion foreign born	–1.60** (.37)	–1.70** (.37)	.16 (.42)	–.91* (.45)	–.98* (.46)	–.37 (.54)	–.88 (.75)	–.98 (.76)	.29 (.88)
Tract proportion poor	1.96** (.40)	1.61** (.41)	.33 (.43)	.64 (.49)	.34 (.51)	.02 (.52)	1.35* (.60)	.98 (.63)	–.16 (.64)
Perceived neighborhood danger		.30** (.06)	.19** (.07)		23** (.07)	.22** (.08)		.34** (.12)	.27*(.12)
Individual controls									
Mother's demography									
Race									
White			1.28** (.16)			.57** (.18)			–.05 (.29)
Mexican			–.85** (.23)			–.35 (.26)			–.40 (.38)
Other Hispanic			–.20 (.20)			–.23 (.24)			–.76* (.36)
Other			.33 (.31)			–.92* (.45)			–.84 (.76)
Foreign born			–1.26** (.28)			–.22 (.25)			–1.65** (.59)
Interviewed in Spanish			–1.29** (.48)			–.68^(.36)			–1.73^ (1.04)
Age at child's birth			.23** (.06)			.31** (.08)			.24* (.10)
Square of age at child's birth			–.003** (.001)			–.004** (.001)			–.003 (.002)
Married			–1.38** (.17)			–.37* (.15)			–1.41** (.36)
Length of neighborhood residence in years						–.003 (.007)			–.004 (.009)
Mother's education									
High school or GED			–.78** (.11)			–.58** (.15)			–.80** (.18)
Some college or more			–1.32** (.14)			–.40* (.16)			–1.17** (.25)
Annual household Income									
$10,000–$24,999			–.25* (.12)			–.32* (.16)			–.30 (.20)
$25,000 or more			–.51** (.13)			–.42* (.16)			–.78** (.26)
Income missing			–.02 (.14)			.12 (.17)			.20 (.21)
Constant	–1.11** (.09)	–1.54** (.13)	–4.41** (.82)	–1.76** (.11)	–2.08** (.15)	–7.09**(1.07)	–3.32** (.18)	–3.82** (.25)	–6.36**(1.38)
Log likelihood	–1947.62	–1935.96	–1680.75	–1341.24	–1337.05	–1257.29	–757.56	–752.79	–675.70
Model chi sq	88.78	106.93	399.09	26.20	39.01	166.48	48.07	57.18	162.36
Pseudo R^2	.03	.03	.16	.01	.01	.07	.03	.03	.13
Total number of subjects	4,064	4,064	4,064	4,064	4,064	4,064	4,064	4,064	4,064

** p<0.01; * p<0.05; ^ p<0.10 two tailed

Coefficients are shown with standard errors in parentheses.

A supplementary set of analyses (not shown) indicates that individual level control variables, rather than perceived danger, mediate the influence of neighborhood racial and ethnic or socioeconomic composition on substance use. Though effects of control variables differ slightly depending on the substance under investigation, several consistent patterns emerge. White mothers are generally more likely than black mothers to smoke or drink during pregnancy, while mothers interviewed in Spanish and those who are foreign born are less likely to use substances. More educated mothers and those with higher incomes are less likely to smoke, drink, or use drugs. Married mothers are less likely than unmarried to smoke or use drugs but more likely to drink. Oddly, up until about the age of forty, the probability that a mother will use substances during pregnancy increases; beyond that age, the trend reverses.

6.3. Influences on Birth Weight

Table 4 presents results of OLS models that estimate the influence of neighborhood circumstances, perceived neighborhood danger, and substance use on birth weight. Model 1 includes only objective neighborhood characteristics; Model 2 adds in perceived danger; Model 3 adds in substance use; and Model 4 includes all other controls. Considering objective neighborhood characteristics, two factors consistently predict birth weight across all models. As can be seen, the tract black percentage generally has a negative association with birth weight, with the estimated size of the effect shifting from a highly significant 232 grams in Model 1 to a marginally significant 86 grams (14 percent of a standard deviation) in Model 4. In concrete terms, this shift implies that compared with an entirely non-black neighborhood, living in a neighborhood in which 40 percent of residents are black (the mean value) predicts a 34 gram decline in birth weight once all controls are included. However, in preliminary HLM models (not shown), this effect becomes non-significant. In contrast, the tract foreign percentage predicts greater birth weights, an effect that remains quite strong even after controlling for the influence of respondent nativity status and other background variables. Compared with a neighborhood where no residents are foreign-born, living in one where 14 percent are foreign-born (the mean value) predicts a 27 gram increase in birth weight.

Although the perceived danger of the neighborhood has a significant effect in Model 3, it is not significant in Model 2 and only marginally significant in Model 4, once background controls are added. Thus neighborhood danger itself does not seem to have a strong direct effect on birth weight. To the extent that perceived danger affects birth weight it seems to be through the intervening influence of substance use. Perceiving a neighborhood as unsafe associates with higher rates of substance abuse, which in turn associate with lower birth weights. Both Models 3 and 4 indicate that smoking and drug use during pregnancy have large and highly significant negative effects on birth weight. Consistent with previous research, Model 4 shows that women who reported smoking had babies who weighed 228 grams less at birth (37 percent of a standard deviation) whereas mothers who took illegal drugs had babies who weighed 171 grams less at birth (28 percent of a standard deviation), compared with mothers who did not smoke or use drugs, respectively.

After accounting for neighborhood factors and substance use, a number of individual controls also influence birth weight. As in the case of substance use models, supplementary analyses indicate that these individual controls mediate the influence of neighborhood factors on birth weight, rather than the key predictors under investigation here. Despite the rich set of effects included in the model, other groups continue to maintain a birth-weight advantage over blacks – 203 grams in the case of whites, 118 grams in the case of Mexicans, and 73 grams in the case of other Hispanics. Mothers interviewed in Spanish had babies who weighed 95 grams more at birth than those interviewed in English, consistent with the notion that foreign-born women have a birth-weight advantage over American-born women (Frisbie 1994; Frisbie and Song 2003). Mothers who were married, had a boy, and who received prenatal care had children with significantly greater birth weights. In contrast, first births tend to be somewhat lower in weight.

Table 5 concludes the analysis by showing coefficients from logistic regressions predicting whether or not the birth was classified as being of low weight. On the whole, effects are consistent with OLS models for birth weight in grams, though the patterns of significance change somewhat.

Table 4: OLS models exploring the effect of neighborhood context and risk behaviors on birth weight measured in grams

	Model 1	Model 2	Model 3	Model 4
Contextual variables				
Tract proportion black	–232.45 (41.25)**	–243.23 (41.99)**	–268.30 (40.61)**	–85.70 (50.52)^
Tract proportion Hispanic	–31.66 (52.45)	–39.89 (52.63)	–93.58 (51.03)^	–55.53 (59.91)
Tract proportion foreign born	208.03 (69.99)**	199.79 (70.42)**	143.20 (68.48)*	186.63 (76.51)*
Tract proportion poor	–80.85 (91.33)	–110.62 (92.92)	–36.48 (88.13)	17.15 (89.75)
Perceived neighborhood danger		23.33 (15.43)	37.56 (15.14)*	29.09 (14.95)^
Risk behaviors				
Smoking			–227.94 (26.54)**	–227.58 (27.50)**
Alcohol use			–1.20 (36.41)	–15.81 (35.91)
Drug use			–216.47 (52.87)**	–171.44 (51.28)**
Individual controls				
Mother's demography				
Race				
White				202.67 (36.46)**
Mexican				117.81 (39.37)**
Other Hispanic				73.35 (39.03)^
Other				10.49 (54.78)
Foreign born				2.00 (36.89)
Interviewed in Spanish				95.03 (46.33)*
Age at child's birth				22.77 (13.90)
Square of age at child's birth				–.46 (.25)^
Married				61.02 (26.56)*
Length of neighborhood residence in years				–.29 (1.23)
Mother's Education				
High school or GED				–38.43 (23.96)
Some college or more				–3.33 (28.17)
Annual Household Income				
$10,000–$24,999				–.08 (28.62)
$25,000 or More				21.08 (27.59)
Income Missing				–45.54 (31.86)
Birth/pregnancy characteristics				
Male				91.74 (18.28)**
First birth				–77.96 (21.73)**
Any prenatal care				142.20 (70.58)*
Constant	3314.53 (22.85)**	3282.05 (31.49)**	3324.00 (31.13)**	2738.32 (203.49)**
R^2	.03	.03	.06	.09
Total number of subjects	4,064	4,064	4,064	4,064

** p<0.01; * p<0.05; ^ p<0.10 two tailed

Standard errors are provided in parentheses.

Table 5: Logit models exploring the effect of neighborhood context and risk behaviors on the probability of having a low birth weight

	Model 1	Model 2	Model 3	Model 4
Contextual variables				
Tract proportion black	.76 (.21)**	.79 (.22)**	.89 (.21)**	.40 (.27)
Tract proportion Hispanic	–.10 (.33)	–.07 (.33)	.15 (.33)	.14 (.39)
Tract proportion foreign born	–1.13 (-.15)*	–1.11 (.48)*	–.89 (.47)^	–1.00 (.54)^
Tract proportion poor	–.15 (.46)	–.07 (.48)	–.32 (.47)	–.52 (.47)
Perceived neighborhood danger		–.07 (.09)	–.13 (.09)	–.11 (.09)
Risk behaviors				
Smoking			.76 (.13)**	.69 (.13)**
Alcohol use			.10 (.17)	.04 (.18)
Drug use			.68 (.20)**	.52 (.21)*
Individual controls				
Mother's demography				
Race				
White				–.45 (.20)*
Mexican				–.59 (.27)*
Other Hispanic				–.12 (.23)
Other				.00 (.32)
Foreign born				–.21 (.24)
Interviewed in Spanish				–.32 (.35)
Age at child's birth				–.03 (.07)
Square of age at child's birth				.001 (.001)
Married				–.39 (.19)*
Length of neighborhood residence in years				–.00 (.01)
Mother's Education				
High school or GED				.07 (.14)
Some college or more				–.07 (.17)
Annual Household Income				
$10,000–$24,999				.31 (.17)^
$25,000 or More				–.01 (.17)
Income Missing				.57 (.17)**
Birth/pregnancy characteristics				
Male				.28 (.13)*
First birth				–.18 (.11)^
Any prenatal care				–.63 (.27)*
Constant	–2.36 (.13)**	–2.27 (.18)**	–2.46 (.19)**	–1.61 (1.06)
Log likelihood	–1296.29	–1295.94	–1259.86	–1229.66
Model chi sq	55.06	57.51	135.63	195.35
Pseudo R^2	.02	.02	.05	.07
Total number of subjects	4,064	4,064	4,064	4,064

** p<0.01; * p<0.05; ^ p<0.10 two tailed
Coefficients are shown with standard errors in parentheses.

According to Model 4, we see that neither the socioeconomic nor the demographic composition of neighborhoods, nor perceived danger, have any real influence on the likelihood of a low weight birth once substance use and background controls are included in the equation. The percentage foreign-born does have a small and marginally significant effect in reducing the odds of a low weight birth, but apart from this one minor effect neighborhood circumstances seem not to matter except for how they influence substance use. Consistent with the OLS model for birth weight in grams, smoking cigarettes and using illegal drugs during pregnancy significantly raises the probability of having a low weight birth, increasing the odds by 99 percent and 68 percent, respectively. Likewise, white and Mexican mothers are less likely to give birth to low weight babies than black mothers, as are those who are married, received prenatal care, and were not delivering a first birth. Unlike the prior OLS model, however, missing data on household income is associated with a higher probability of having a low birth weight baby, suggesting that mothers who refuse to report or do not know their income tend to live in more disadvantaged households.

7. Discussion

In this analysis we sought to connect neighborhood conditions to birth outcomes both directly and through their intermediate effects on perceived danger and substance abuse. We hypothesized that neighborhood poverty and racial-ethnic concentration combine to produce environments perceived by mothers as dangerous, increasing the likelihood of negative coping behaviors such as substance abuse (see Fig. 1). Using data from the Fragile Families Study we found little evidence to suggest that neighborhood circumstances have strong direct effects on birth weight, except perhaps for a positive effect of living in a neighborhood with more foreigners and a slight negative effect of living in a neighborhood with more blacks. However, the latter effect is not robust in multilevel modeling.

To the extent that neighborhood conditions had any influence at all on birth outcomes they seemed to occur mainly indirectly – through their influence on perceived neighborhood danger and substance use. All four tract characteristics considered here – the proportion of residents who are black, the proportion who are Hispanic, the proportion who are foreign, and the proportion who are poor – were found to increase a mother's sense that her neighborhood was unsafe. The perception of a dangerous and unsafe neighborhood was, in turn, associated with a greater likelihood of smoking cigarettes and using illegal drugs, and these behaviors themselves had strong and significant effects in reducing birth weight. However, despite the strong relationship between the tract characteristics and perceived danger, it appears that individual level controls, rather than danger or substance use, mediate the influence of neighborhood characteristics on birth weight.

Given extensive evidence that neighborhood deprivation associates with birth weight (Buka et al. 2003; O'Campo et al. 1997), we were surprised to find that poverty had no direct effect in this investigation. Perhaps an alternative indicator of deprivation such as neighborhood unemployment or the prevalence of single-mother households would show a stronger association. Consistent with Gorman (1999), on the other hand, the concentration of the foreign-born has a positive association with birth weight (and a negative effect on the probability of a low birth weight) even after accounting for individual-level race, ethnicity, and nativity. By living in a community with many foreign born residents, one may acculturate to a set of practices that promote positive birth outcomes. Despite high rates of poverty, women of Mexican origin, for example, are relatively unlikely to have a low weight newborn (Frisbie 1994; Frisbie and Song 2003). This apparent advantage of women of Mexican origin dissipates with time spent in the United States and across immigrant generations (Guendelman and English 1995).

Why does perceived neighborhood danger associate with substance use? We expect that these behaviors are a response to the stress of living under deprived, chaotic, and even violent conditions. In the United States, mothers living in high-poverty neighborhoods or among minorities are likely to experience elevated levels of crime, violence, and social disorder (Massey and Denton 1993). As we saw here, these conditions elevate their sense of danger. Previous research indicates that perceiving one's neighborhoods as dangerous leads to higher levels of psychosocial stress (Hill and Angel 2005; Hill, Ross, and Angel 2005; Ross and Mirowsky 2001). That stress can then trigger an *allostatic*

response (i.e. mechanisms that are employed by the body to respond to stress) that is potentially harmful to health (Bremner 2002; Massey 2004).

The allostatic response is nature's way of maximizing an organism's resources to meet an immediate threat. Long-term physiological functions are temporarily sacrificed to put more energy into the bloodstream for evasive or aggressive action (McEwen and Lasley 2002). In the short run, the allostatic response is a healthy, adaptive mechanism; but its repeated triggering through chronic exposure to stressful events – as when someone is compelled by poverty and discrimination to live in a dangerous and threatening neighborhood – raises a person's *allostatic load* (i.e. cumulative strain on the body caused by stress) to unhealthy levels. When such exposure to stress-inducing conditions persists over time, it has powerful negative effects on a variety of bodily systems (Bremner 2002) and leads to negative coping behaviors like substance abuse, which provide temporary relief from stress. To address the role of psychosocial stress in the path from neighborhood circumstances to birth weight, future investigations should explicitly question mothers on different types of stress in their lives, including neighborhood-induced stress. To explicitly test the role of allostatic load, investigators would ideally use biomarkers such as cortisol readings from blood or saliva. These biomarkers are currently being collected in Wave IV of the U. S. Adolescent Health Survey, offering scholars new opportunities to assess the relative importance of this biosocial pathway.

The present investigation suffers from a number of limitations. First and foremost, our analyses employed a one-item measure of perceived danger, creating concerns for reliability. Though the measure showed significant relationships with both census tract characteristics and substance use in expected directions, a stronger measure may also highlight the expected relationship with birth weight. Such a finding would be consistent with previous investigations that have identified a relationship between perceived neighborhood characteristics and birth weight (Buka et al. 2003; Morenoff 2003). Future analyses should employ multi-faceted measures of neighborhood danger.

Second, our sample only included mothers from large cities. While the breadth of cities exceeds those used in most other studies of birth weight, it nonetheless means that our results are not necessarily generalizable to women in smaller cities or rural areas. Future analyses should aim to include women from these settings as well. Third, our data do not allow us to make causal claims. Mothers reported their substance use during pregnancy, perceived neighborhood danger, and the weights of their babies in the same interview. Perhaps mothers perceive their neighborhoods as dangerous because they abuse substances, rather than the other way around. Similarly, though we controlled for the length of mothers' residence in their current neighborhoods, we could not determine whether they were smoking, drinking, or using drugs prior to living in economically deprived, segregated, or dangerous neighborhoods.

Birth weight shapes a lifetime of outcomes. In this investigation, we showed that while neighborhood conditions have little direct effect on birth weight, they relate quite strongly to behaviors critical to a healthy birth. Mothers who saw their neighborhoods as dangerous or threatening – a likely scenario in violent, crime-ridden areas – smoked, drank, and used drugs more often than mothers who felt safer in their communities. In order to promote positive birth outcomes for women in dangerous settings, neighborhoods should strive to provide mothers alternatives to substance use for coping with their environments.

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