Published in final edited form as:
J Marriage Fam. 2017 April ; 79(2): 535–555. doi:10.1111/jomf.12355.

Family Structure, Residential Mobility, and Environmental Inequality

Liam Downey,
Department of Sociology, Ketchum 195, UCB 327, University of Colorado, Boulder, CO 80309

Kyle Crowder, and
Department of Sociology, 211 Savery Hall, Box 353340, University of Washington, Seattle, WA 98195-3340

Robert J. Kemp
State Demography Office, 1313 Sherman Street, Room 521, Denver, CO 80203

Abstract

This study combines micro-level data on families with children from the Panel Study of Income Dynamics with neighborhood-level industrial hazard data from the Environmental Protection Agency and neighborhood-level U.S. census data to examine both the association between family structure and residential proximity to neighborhood pollution and the micro-level, residential mobility processes that contribute to differential pollution proximity across family types. Results indicate the existence of significant family structure differences in household proximity to industrial pollution in U.S. metropolitan areas between 1990 and 1999, with single-mother and single-father families experiencing neighborhood pollution levels that are on average 46% and 26% greater, respectively, than those experienced by two-parent families. Moreover, the pollution gap between single-mother and two-parent families persists with controls for household and neighborhood socioeconomic, sociodemographic, and race/ethnic characteristics. Examination of underlying migration patterns reveals that single-mother, single-father, and two-parent families are equally likely to move in response to pollution. However, mobile single-parent families move into neighborhoods with significantly higher pollution levels than do mobile two-parent families. Thus, family structure differences in pollution proximity are maintained more by these destination neighborhood differences than by family structure variations in the likelihood of moving out of polluted neighborhoods.

Keywords

Inequality; child health; family health; health disparities; public health; singlehood

Over the past several decades, researchers have compiled an impressive body of evidence indicating not only that family structure plays a key role in shaping the life experiences and well-being of children *and* adults, but also that the consequences of family structure persist throughout the lifecourse (for reviews see Haveman and Wolfe 1995 and Sigle-Rushton and McLanahan 2004). Through its connection to economic resources, family-level processes, and neighborhood contexts, family status has been linked to children’s risk of experiencing psychological distress (Jablonska and Lindberg 2007), problem behavior (Hoffman 2006), poor school performance (Aughinbaugh et al. 2001), and income instability in adulthood (Lang and Zagorsky 2001). Similarly, single mothers are more likely than married parents to be exposed to neighborhood crime and social disorder which, in turn, are associated with elevated levels of strain, depression, and psychological distress (Ross 2000; Ryan et al. 2009), reduced access to monetary and housing assistance through kin and friendship networks (Turney and Harknett 2010), and diminished economic well-being (Harknett 2006; Henly et al. 2005).

Yet despite continued interest in understanding how family background affects the experiences and opportunities of children and adults, we still know relatively little about the link between family structure and the physical environment to which individuals and families are exposed. Most notably, there is currently almost no research on the link between family structure and residential proximity and exposure to environmental pollutants; and what research is available (Downey 2005a; Downey and Hawkins 2008) relies on cross-sectional, aggregate-level data rather than on longitudinal, household-level data that would allow researchers to directly examine family structure differences in pollution proximity and exposure, assess the extent to which associations between family structure and neighborhood pollution are attributable to family-level socioeconomic and demographic factors, and investigate the argument that differential patterns of residential mobility represent a key mechanism through which environmental inequality is produced and maintained (Downey 2005b; Hunter et al. 2003).

This gap in the literature is particularly troubling in light of evidence that residential mobility plays a key role in producing and maintaining environmental *racial* inequality (Crowder and Downey 2010; Downey 2006b) and that living near pollution sources such as highways, factories, and hazardous waste sites directly and negatively affects health (Evans and Kantrowitz 2002; Gee and Payne-Sturgess 2004), especially among children, for whom the negative health effects of pollution exposure are highly pronounced (Pastor et al. 2004), and among single-parent families, which research suggests are more susceptible than other families to the potentially damaging health effects of neighborhood pollution (Christopher 2005; Leininger and Ziol-Guest 2008; Mather 2010; McLanahan and Percheski 2008; Williams and Collins 1995; Williams and Mohammed 2009).

Given the potential health effects of, and variation in vulnerability to, pollution determining whether single-mother and single-father families are disproportionately burdened by environmental hazards and isolating the factors that shape the distribution of families with children across neighborhoods of varying environmental quality represents an important public health challenge for environmental inequality, neighborhood effects, and family researchers. To begin addressing this critical challenge, this article directly examines both the association between family structure and neighborhood air pollution and the micro-level, residential mobility processes that likely lead to differential neighborhood air quality (differential pollution proximity) across family types. To do this, we link neighborhood-level environmental hazard data derived from the *non-public version* of the Environmental Protection Agency's (EPA) Risk-Screening Environmental Indicators (RSEI) project with individual- and household-level data on families with children drawn from the nationally representative Panel Study of Income Dynamics (PSID) and neighborhood-level demographic data drawn from the decennial U.S. census. These data cover nearly every metropolitan area in the contiguous U.S. from 1990–1999, allowing us to (a) determine the extent to which single-mother, single-father, and two-parent families residing in U.S. metropolitan areas in the 1990s differed in terms of residential proximity to neighborhood air pollution; (b) assess individual-, family-, and neighborhood-level factors that might account for the association between family structure and neighborhood air pollution; and (c) examine the role that residential mobility plays in shaping the distribution of family types across neighborhoods of varying environmental quality, with residential mobility conceptualized as a two-stage process involving both the decision to move out of a neighborhood and the choice of a new destination neighborhood.

We restrict our attention to families with children because of the emphasis in the literature on the consequences of living in single-mother versus single-father and married-parent families and because of children's disproportionate vulnerability to pollution. It is important to note, however, that our unit of analysis is the family, not individual children. As a result, we do not directly examine children's proximity to neighborhood air pollution, but rather ask whether membership in a single-parent family is associated with living in a more polluted neighborhood.

As is the case with most environmental inequality research, we are unable to examine the role that the siting of environmentally hazardous facilities plays in producing environmental inequality. Nevertheless, prior research suggests that due to the high levels of residential mobility that exist in U.S. metropolitan areas, initial siting decisions may have less influence on patterns of proximity and exposure to environmental hazards than does residential mobility (Downey 2005b), which research shows plays a key role in producing environmental *racial* inequality (Crowder and Downey 2010).

Finally, we employ RSEI data from the 1990s because the non-public version of the RSEI provides the only annual estimates of neighborhood-level, toxicity-weighted, industrial air pollutant concentration levels for the contiguous U.S. and because we are unable to obtain more recent years of these non-public data. While it would be preferable to utilize more recent longitudinal environmental hazard data, few such datasets exist, the non-public RSEI provides by far the best estimates of residential proximity to industrial air pollutants available to researchers (see the Data and Methods section), and the children and adults included in this study are still living with any effects that living in polluted neighborhoods may have had on them.

Background and Theory

Environmental inequality researchers have studied the distribution of social groups around a variety of environmental hazards, including hazardous waste sites, manufacturing facilities, superfund sites, chemical accidents, and air pollutants (Brulle and Pellow 2006; Derezinski et al. 2003; Downey 2006a, b; Downey and Crowder 2011; Grant et al. 2010; Ringquist 2005). However, only two studies (Downey 2005a; Downey and Hawkins 2008) have examined family-based environmental inequality. Moreover, though these studies find a disproportionate concentration of single-mother families in more polluted tracts, an association that persists even after controlling for neighborhood racial composition, neighborhood socioeconomic status, and neighborhood housing quality, neither investigates the micro-level residential mobility processes that prior research (Crowder and Downey 2010; Hunter et al. 2003) suggests likely play a key role in creating and maintaining this family-based environmental inequality.

There are several reasons to expect that family structure will be strongly associated with neighborhood environmental quality and that this association will persist even after controlling for a variety of factors typically associated with residence in environmentally hazardous neighborhoods. Prior research demonstrates, for instance, that single-parent families experience discriminatory real estate practices related directly to their family status (independent of other characteristics: Lauster and Easterbrook 2011; South and Crowder 1998) that likely make it more difficult for them to move out of low quality neighborhoods and, in the event of a move, to attain residence in higher quality neighborhoods. In addition, the residential choices single-*mother* families make are uniquely shaped and limited by the fact that single-mother families are more likely than other families to rely on geographically-specific friend and kinship networks for material and non-material forms of support (Brewster and Padavic 2002; Harknett 2006; Henly et al. 2005). Since receiving certain critical forms of support (such as transportation, childcare, and emergency food) depends on living relatively close to friends and kin (Brewster and Padavic 2002), and because maintaining the social relationships through which aid is provided involve norms of reciprocity (Harknett 2006) that may be most easily met by people living in close geographic proximity to one another, reliance on geographically-specific friend and kinship networks may make it particularly difficult for single-mother families to escape polluted areas of cities even when they do move from one residence to another.

Specific transitions to single-parenthood, such as nonmarital childbirth, divorce, separation, widowhood, and the end of cohabitation, are also likely to play key roles in shaping family-based environmental inequality through their effect on residential mobility and attainment. Research shows, for instance, that these transitions each have unique consequences for families' ability to afford quality housing (Fomby and Sennot 2013; Saadeh et al. 2013), that they greatly increase the likelihood of multiple residential moves (Fomby and Sennot 2013; Saadeh et al. 2013), which research suggests has important independent consequences for cumulative pollution exposure (Bell and Belanger 2012; Pais et al. 2014), and that they have important implications for parents' ability to work and earn income outside the home (Avellar and Smock 2005; McKeever and Wolfinger 2011; Osborne et al. 2012), for family reliance on public housing and other forms of public assistance (South et al. 1998; McLanahan and Percheski 2008), and for family size and associated housing requirements (South et al. 1998), all of which are likely to affect where families live.

The fact that family structure is independently associated with residential attainment suggests that the association between family structure and neighborhood environmental quality will persist even after controlling for a variety of factors typically associated with residence in environmentally hazardous neighborhoods. This argument, which I call the *family structure thesis*, stands in sharp contrast to the *socioeconomic inequality*, *spatial assimilation*, and *place stratification theses* found in the environmental inequality and residential attainment literatures, which suggest that any association that exists between family structure and neighborhood environmental quality is simply the product of socioeconomic and race/ethnic differences between different family types.

The *socioeconomic inequality thesis* informing much of the research on environmental inequality suggests, for example, that because property values and rents tend to be relatively low in environmentally hazardous neighborhoods, such areas are more accessible to lower-income families and less attractive to higher income families (Downey 2005b). This argument parallels the residential attainment literature's more general *spatial assimilation thesis* which holds that residential differentiation by social class emerges as persons match their own socioeconomic status with that of their neighborhood such that individuals and families with greater socioeconomic resources are less likely to move into and more likely to move out of lower quality neighborhoods than are individuals and families with fewer socioeconomic resources (Alba et al. 1999).

Given the existence of sharp differences in socioeconomic resources across different types of families (Ellwood and Jencks 2002), these theoretical arguments hold important implications for the link between family structure and pollution proximity and exposure. In 2008, for example, median income stood at $72,743 for households headed by a married-parent couple, $43,571 for households headed by a single father, and $30,219 for households headed by a single mother (U.S. Census Bureau 2009). Single-mother households face similar disadvantages with regard to education. In 2007, about 14.8% of single mothers had earned at least a bachelor's degree compared to 34% of adults living in married-parent households and 16% of all single fathers (Kreider and Elliot 2009). Thus, the socioeconomic inequality thesis suggests that single-mother families will live in more polluted neighborhoods than do married-parent families because their relatively limited socioeconomic resources reduce their ability to move out of highly polluted neighborhoods and increase their likelihood of moving into such neighborhoods. This thesis further implies that, given their intermediate socioeconomic standing, the ability of single-father families to escape and avoid highly polluted neighborhoods will be greater than that of single-mother families but less than that of married-parent families. It also suggests that socioeconomic status is an important confounding factor affecting the relationship between family structure and neighborhood environmental quality and, as a result, that family structure differences in pollution proximity, exposure and mobility will be attenuated with controls for family financial resources and householder education.

Another key theoretical argument, the residential attainment literature's *place stratification thesis*, suggests that differences in the representation of racial and ethnic minorities among married-parent and single-parent families may also be an important factor explaining family structure differentials in pollution proximity, pollution exposure, and residential mobility patterns underlying proximity and exposure. The place stratification thesis holds that discriminatory actions by real estate agents (Yinger 1995), local governments (Shlay and Rossi 1981), and mortgage lenders (Ross and Yinger 2002) create barriers to residential attainment for minority homeseekers (Massey and Denton 1993) that produce sharp racial and ethnic differences in the ability to gain access to higher quality neighborhoods (Alba et al. 1999). Indeed, the available evidence suggests that even after controlling for family socioeconomic and sociodemographic resources, black householders are still less likely than other householders to gain access to more advantageous neighborhoods (Crowder and Downey 2010).

Since black householders are highly overrepresented among single-mother families, slightly overrepresented among single-father families, and highly underrepresented among married-parent families (U.S. Census Bureau 2009), the place stratification thesis thus suggests that family structure differences in pollution proximity and exposure and in mobility between neighborhoods of varying environmental quality are at least partially attributable to the effects of race. Specifically, the thesis suggests that single-mother and single-father families will be less likely to move out of and more likely to live in and move into polluted neighborhoods than are married-parent families largely because they are more likely to face discriminatory barriers to residential attainment based on their race, with the mobility differences between single-mother and married-parent families being more pronounced than they are for single-father and married parent families. Accordingly, controlling for the racial status of the household head should greatly weaken any statistically significant differences in pollution proximity, exposure, *and* mobility that exist between single-mother, single-father, and married-parent families.

Finally, the place stratification and socioeconomic inequality theses also suggest that family structure differences in mobility into and out of polluted neighborhoods may have less to do with the environmental characteristics of neighborhoods than with their non-environmental attributes (e.g. neighborhood racial composition). Indeed, these theoretical models both suggest that individual- and family-level characteristics shape environmental inequality by placing families in neighborhoods with socioeconomic and race/ethnic characteristics that (a) match the families' own characteristics, (b) differ systematically across family types and (c) are associated with neighborhood pollution levels. To the degree that this is true, it implies that if the micro-level predictions of the socioeconomic inequality and place stratification theses are supported, then inserting neighborhood-level predictors into our regression models along with our individual- and family-level controls should greatly attenuate any associations that previously existed between these micro-level controls and neighborhood pollution. In other words, if the micro-level control variables explain some of the association between family structure and neighborhood pollution, and if the neighborhood characteristic variables explain some of the association between neighborhood pollution and the micro-level controls, then it is likely that micro-level factors shape family-based environmental inequality in part by channeling single-mother, single-father, and married-parent families into neighborhoods with different non-environmental characteristics.

Data and Methods

Family-level data

We test the arguments set forth in the preceding sections using 1990–1999 data from the Panel Study of Income Dynamics linked to neighborhood-level sociodemographic data derived from the 1990 and 2000 decennial U.S. censuses and neighborhood-level environmental hazard data for 1990–1999 derived from the non-public version of the EPA's Risk Screening Environmental Indicators (RSEI) project. The PSID is a well-known longitudinal survey of U.S. residents and their families begun in 1968 with approximately 5,000 families (about 18,000 individuals). Members of panel families were interviewed annually between 1968 and 1997 and every two years thereafter. New families have been added to the panel as children and other members of original panel families form their own households.

For several reasons, the PSID is uniquely suited to examining environmental stratification and its underlying residential mobility patterns. First, PSID data are collected for a diverse national sample and contain rich information on a variety of individual- and household-level characteristics that are central to the study of residential attainment (we do not use PSID sample weights because no weights are assigned for a significant number of PSID householders and because PSID sample weights are primarily a function of independent variables included in our analyses). Second, the longitudinal nature of the PSID makes it possible to assess, prospectively, the effects of micro-level and contextual conditions on residential mobility. Third, and most importantly, the PSID's supplemental Geocode Match Files allow us to link the addresses of individual respondents at each interview to their corresponding census tract identifiers. These identifiers make it possible to trace the mobility of PSID respondents across neighborhoods between successive interviews. They also enable us to attach detailed socioeconomic, demographic, and environmental data about the neighborhoods occupied by PSID respondents at each interview (in order to maintain consistency across observation periods and to accurately detect residential changes in tract location, we use the PSID's year-2000 Geographic Match File codes for addresses at all interview years).

We use census tracts to represent neighborhoods for two reasons. First, they come the closest of any commonly available spatial entity to approximating the usual conception of a neighborhood (Hill 1992). Second, their use makes this study directly comparable to most prior aggregate-level environmental inequality research, which relies primarily on census tract data.

We take full advantage of the longitudinal nature of the PSID by segmenting the data for each PSID family into a series of family-period observations, with each observation referring to the two-year period between PSID interviews (the use of a two-year interval is necessitated by the adoption of a biennial interview schedule for the PSID after 1997). This strategy avoids the need to focus on proximity to pollution at any single point in time and allows us to examine multiple residential moves that may affect pollution proximity. It also allows us to incorporate information on new families formed during the study period and to examine residential conditions for families that take different structures at different points in time.

For our analyses, we select families with children under the age of 18 that were included in the PSID panel between 1990 and 1999 and resided in a census-defined Metropolitan Statistical Area (MSA) at the time of the interview (before restricting the data to families living in an MSA, 84% of the families with children lived in an MSA). We include observations beginning in 1990 and ending in 1999 because *these are the only years* for which we have access to the *non-public version* of the RSEI (see below), and we focus on metropolitan residents in order to enhance comparability with past environmental inequality research, most of which focuses on aggregate population patterns within metropolitan areas (Brulle and Pellow 2006). Focusing on metropolitan residents also allows us to calculate more precise environmental hazard estimates than would otherwise be possible because metropolitan area census tracts tend to be smaller than non-metropolitan area census tracts. Finally, we focus on families headed by individuals representing three racial/ethnic groups: Latinos, non-Latino whites, and non-Latino blacks. Families headed by other racial/ethnic groups were dropped from the study due to their very small sample sizes.

Given these restrictions, our analyses include data from 7,050 families, each of which contributes an average of just under 3.4 family-period observations to the sample, for a total of 23,903 observations. These observations are distributed across 276 of the 329 metropolitan areas in the contiguous U.S. (as defined in 2000). In a total of 15,849 of the observation periods, the family was headed by a married or unmarried couple. A single father headed the family in 1,336 of the observation periods and a single mother headed the family in 6,718 observation periods.

Neighborhood-Level Data

As previously noted, we merge our family-period PSID observations for the years 1990–1999 to tract-level measures of local industrial pollution derived from the EPA’s RSEI and to tract-level demographic data derived from the decennial U.S. census. The census data were obtained from the Neighborhood Change Database (NCDB) compiled by GeoLytics Corporation and the Urban Institute (GeoLytics 2005). These data utilize a consistent set of tract boundaries across decennial censuses, making it possible to employ linear interpolation to estimate values for tract-level control variables in non-census years.

The RSEI is derived from annual industrial air pollutant data provided by the EPA’s Toxics Release Inventory (TRI), the most comprehensive and detailed, publicly available, national record of industrial facility activity available to researchers. Facilities included in the TRI fall into one of seven industrial categories (manufacturing, metal mining, coal mining, electric generating facilities that combust coal or oil, chemical wholesale distributors, petroleum terminals, and bulk storage), employ the equivalent of ten or more full-time workers, and manufacture, process, or otherwise use any of a set of specified chemicals in specified quantities. Because the list of chemicals and industries included in the TRI has changed over time, we restrict our study to only those chemicals and industries (manufacturing) that have been included in the database since its inception (the EPA refers to these as core chemicals and industries).

The version of the RSEI that we rely on uses TRI air emissions data to estimate a 101-kilometer square pollution plume model (made up of one-kilometer square grid cells) for each TRI air pollutant released by each TRI facility in a calendar year. Incorporating factors such as wind speed, wind direction, air turbulence, smokestack height, exit gas velocities, and rate of chemical decay and deposition, the RSEI calculates a yearly, average air pollutant concentration value for each one-kilometer square grid cell in each plume model. Each grid cell value in each air pollutant model is then multiplied by the toxicity weight of the modeled air pollutant.

In the public release RSEI, pollution values derived from these grid cell estimates are linked to specific facilities, but the underlying grid cell data are unavailable to researchers, making it impossible to derive valid tract-level estimates from the public data. However, in the non-public version of the RSEI that we employ, the toxicity-weighted grid cell values for each air pollutant grid in the U.S. are summed together to create a toxicity-weighted air pollutant concentration grid for the entire nation (see EPA 2004 for technical details on the RSEI model). We are thus able to use these grid cell data to calculate toxicity-weighted industrial air pollutant concentration estimates for each census tract in the contiguous United States for each year from 1990 to 1999. To do this, we calculate (separately for each year) the proportion of each census tract covered by each grid cell that overlaps it, and then calculate the weighted average of each tract's overlapping grid cells, using the proportion overlap as our weighting variable. For example, if grid cells 1 and 2 cover 40% and 60% of tract A respectively, and if the toxicity-weighted concentration values of these grid cells are 10 and 20 respectively, then the toxicity-weighted concentration value of tract A equals [(10*.4) + (20*.6)].

We thus use the RSEI to estimate the relative air pollution risk of each census tract in the study area in relation to every other census tract in the study area. These risk estimates are not based on respondents' personal exposure to TRI air pollutants, and they only estimate neighborhood risk for one category of air pollutant. Nevertheless, industrial air pollutants are an important category of air pollutant that have been widely studied by environmental inequality researchers, and nationally representative, individual-level air pollutant *exposure* data do not exist. Moreover, the RSEI provides the only annually updated estimates of toxicity-weighted, industrial air pollutant concentration levels that are available to researchers for the entire contiguous U.S. (though as previously noted only the public version of these data – which cannot be linked to census tracts – are available to us after 1999). As such, these data provide the best estimate currently available to researchers of the relative industrial air pollutant risk of each census tract in the U.S., and have thus been used in several important environmental inequality studies (Ash and Fetter 2004; Author; Grant et al. 2010).

Dependent Variables

We test hypotheses related to three separate dependent variables. First, to assess the overall distribution of families with children across neighborhoods of varying environmental quality, we examine the *logged toxicity-weighted air pollutant concentration levels* (logged air pollutant levels) in the tracts occupied by PSID households at the beginning of each observation interval (time t), which provides us with a baseline description of family-based environmental inequality in metropolitan America between 1990 and 1999. We use the logged values of local pollution in all our analyses because the unlogged values are very positively skewed, with unlogged pollution values ranging from zero to 149,205 and 95% of the observations having pollution values less than 2,719 (to calculate the logged values of the pollution variable we first added a one to the unlogged values; more than 10% of our observations have pollution values equal to zero). Second, to model the residential mobility processes that likely shape family-based environmental inequality, we treat inter-neighborhood residential mobility as a two-stage process involving, first, the decision to move and, second, the choice of destination neighborhood (c.f., Massey et al. 1994). Accordingly, the second dependent variable in our analysis is a dichotomous variable indicating whether the respondent and her or his family *moved out of their census tract of origin* between PSID interviews (a value of "1" for those who moved during the mobility interval and "0" for those who remained in the same tract) and the third dependent variable is the *logged air pollutant level* in the *destination tracts* of mobile PSID households.

Explanatory Variables

As a key component of our effort to investigate how patterns of inter-tract mobility shape overall patterns of family-based environmental inequality, we examine the decision to move to a different tract as a function of the *logged air pollutant level*, as measured above, in each respondent's census tract at the beginning of the observation interval (time t). Family structure is operationalized as a set of dummy variables distinguishing between single-mother, single-father, and two-parent families, with two-parent families defined as married and unmarried couples with children (not all parents in the dataset are biological parents; however, we are unable to distinguish biological parents from non-biological parents, and as a result, it is possible that some of the households in our sample contain only non-biological parents). Single-mother and single-father families have only one parent in them.

We use two-parent families in our analysis rather than married-parent families because our data also do not allow us to distinguish between married couples and cohabiting couples. While it would be preferable to be able to distinguish between these two family types, in 1999 only 6% of children in the U.S. lived in cohabiting families and only 8.3% of two-parent families were headed by unmarried cohabiting couples (Acs and Nelson 2001), suggesting that most of the two-parent families in our sample are married-parent families. Moreover, the fact that cohabiting families with children tend to earn significantly less income and have significantly lower levels of education than do married-parent families (Manning and Brown 2006; Manning and Lichter 1996) means that our results likely underestimate the environmental disadvantage experienced by single-mother and single-father families relative to married-parent families (see our discussion of the socioeconomic inequality thesis in the Background and Theory section). Thus, our analysis likely provides a conservative estimate of family-based environmental inequality in U.S. metropolitan areas.

Our primary indicators of socioeconomic status – variables that are key to the assessment of the socioeconomic inequality thesis – are *education*, measured by years of school completed by the household head, and the family *income-to-need ratio*. This ratio is calculated by dividing the total taxable income of the household head and spouse/cohabiting-partner (if any) in the year preceding the observation period by the low-cost, food-need standard as defined by the Census Bureau for a family of the given size (when multiplied by 80, this ratio is equivalent to family income as a percentage of the federal poverty line). We use the income-to-need ratio rather than total taxable income because as the number of people in the family increases, so too do the economic resources needed to maintain the same standard of living. Thus, the ratio does a better job than income alone of measuring the resources available for attaining residence in less polluted and generally higher-quality areas.

The race/ethnicity of the household heads, crucial to our test of hypotheses drawn from the place stratification perspective, is indicated with a set of dummy variables differentiating between those reporting a Latino ethnicity (*Hispanic*=1), non-Latino household heads reporting white race (*White*=1), and non-Latino household heads reporting black or African-American race (*Black*=1). We also include controls for the percentage of residents in each census tract that are Latino and non-Latino black and for the average rent, average property value, and average income in each census tract (we use mean rather than median values on these latter three variables because median tract values are not available in the NCDB dataset due to the algorithm the NCDB uses to reapportion 1990 census tract data to 2000 tract boundaries).

We also control for a set of sociodemographic factors associated with residential mobility in prior research. These controls include the *total number of children* in the household at the beginning of the observation period, the *age* of the household head and, to capture the non-monotonic dependence of out-migration on age, *age-squared*. We indicate *home ownership* with a dummy variable scored 1 for those living in an owner-occupied housing unit at the beginning of the interval and 0 for non-owners; *household crowding* is measured by the number of family members per room; and *length of residence* is indicated with a dummy variable taking a value of 1 for those respondents who had lived in their current home for at least three years at the beginning of the mobility interval. We also include a dummy variable indicating whether the respondent lived in *public housing* at the beginning of the observation period. We do this because public housing is not distributed randomly across urban space and thus, may place low income families closer to or further from polluting facilities than would otherwise be the case.

In all models we control for the *year of observation*, measured as the number of years since the initial 1990 observation year, in order to account for temporal changes in mobility patterns and pollution levels. All the independent variables except householder race/ethnicity and family type are considered time-varying, and depending on the regression model, refer to conditions at either the beginning or end of the observation interval (time t or t+2).

Modeling Approach

To test our theoretical predictions, we fit a set of three-level random effects regression models for each of our dependent variables. In these regression models, person-period observations are nested within respondents and respondents are nested within metropolitan areas, with random intercepts specified at the respondent and metropolitan area levels (the logit models in Table 3 do not have residual variation around individual-level estimates; instead, this variance is set to (pi*pi)/3 or about 3.29 because y is assumed to follow a logistic distribution, which has a set variance equal to (s*s)*(pi*pi)/3 where s is a scaling factor that modifies the variance if y is a non-binary outcome).

We use random effects models rather than ordinary least squares (OLS) models because, on average, PSID respondents and metropolitan areas contribute 3.4 and 86.6 person-periods respectively to the analysis, violating the usual assumption of the stochastic independence of error terms underlying tests of statistical significance. We do not adjust for tract level clustering because there is a very low level of clustering of PSID respondents within census tracts, with many tracts having just one respondent and the average tract having fewer than two respondents.

In addition, because of data constraints we are unable to test specific predictions derived from each of the separate arguments that make up the *family structure thesis*. Nevertheless, this thesis does suggest that even after controlling for the socioeconomic and race/ethnic characteristics highlighted by environmental inequality and residential attainment researchers, single-mother and single-father families will still be more likely to move into, less likely to move out of, and more likely to live in polluted neighborhoods than are other families. It is this *family structure thesis* hypothesis that we test in our empirical analysis.

Finally, in tables 2 and 4, we insert the race/ethnicity variables into the regression equations separately from and before the socioeconomic variables. We do this for two reasons: first, to determine whether race/ethnicity and socioeconomic status each explain a portion of any observed family structure differences in pollution proximity and second, because inserting householder race/ethnic status into the regression models in Tables 2 and 4 has such a large effect on the size of the single-parent coefficients (and on the size and significance of the income and education coefficients) that we want to be sure that the effect of socioeconomic status on observed family structure differences in pollution proximity is at least partially independent of the effect of householder race/ethnicity.

As explained below, our modeling approach differs in Table 3 because there are no family structure differences in the effect of pollution on out-migration.

Results

We began our analysis by comparing the average pollution levels experienced by single-mother, single-father, and two-parent families at the beginning and end of the average observation interval. Using our entire sample for this comparison, the first two rows of Table 1 demonstrate that in the 1990s neighborhood pollution levels varied sharply by family type. Consistent with past aggregate-level research, single-mother families faced pollution levels at the beginning of the observation period (row 1) that were almost 46% higher than those experienced by two-parent families (955 vs. 655). Single-father families fell between these extremes with an average level of neighborhood pollution at time t (825) that was nearly 26% higher than that of two-parent families. For all three groups, levels of neighborhood pollution were lower at the end of the average observation period (row 2), a finding that parallels a general decline in reported TRI emissions over time. Nevertheless, at time t+2, single-mother and single-father families still experienced neighborhood pollution levels that were 36% and 32% greater, respectively, than those experienced by two-parent families. Moreover, these group contrasts, including those that existed between single mother and single-father families, were all statistically significant at times t and t+2.

Prevailing theoretical arguments suggest that these variations in neighborhood air pollution are at least partially attributable to family-structure differences in socioeconomic resources, race/ethnic status, and other household and neighborhood characteristics that shape residential attainment. Indeed, the descriptive statistics in Table 1 show that single-mother families, on average, had lower levels of income relative to needs than did other types of families and that both single mothers and single fathers lagged behind the heads of two-parent families in terms of education. Single-mother families were also least likely, and two-parent families most likely, to own their own home; and single-mother families were more likely than other families with children to live in publicly-funded housing. In comparison to both single-mother and single-father families, a higher share of two-parent families resided in their home for at least three years prior to the beginning of the average observation period, and two-parent families were least likely to move during the average observation period. Single-mother families were more likely than other families to be headed by a black householder and least likely to be headed by a Hispanic householder, and single-father families lived in neighborhoods with somewhat higher percentages of Latinos than did other families. Single father families were also more likely than two-parent families and less likely than single-mother families to live in neighborhoods with relatively high percentages of blacks and relatively low rents, property values, and incomes.

To assess the extent to which observed stratification in pollution proximity across family types was shaped by these differences in individual-, household-, and neighborhood-level characteristics, we estimated a series of three-level random effects regression models that predicted the logged toxicity-weighted air pollutant concentration levels in respondents' neighborhoods of residence at the beginning of the average observation interval.

The results of the random effects analyses are summarized in Table 2. Model 1 in Table 2 provides a baseline estimate of family structure differences in logged neighborhood pollution at the beginning of the average observation interval, controlling only for the year of observation. The positive coefficients for the family-structure indicators in this model confirm that in comparison to two-parent families, single-mother and single-father families tended to live in neighborhoods with relatively high levels of industrial air pollution. Indeed, after controlling for the year of observation, single-mother and single-father families still lived in neighborhoods with approximately 21.6% [exp(.196) = 1.216] and 5.4% [exp(.053)=1.054] higher pollution levels than did two-parent families, though the single father coefficient is only significant at the .10 significance level (p=.074). Unreported analyses further indicated that the difference in pollution proximity between single-mother and single-father families was also statistically significant in this model ($p<.001$) and in models 2–4 of the Table ($p<.05$ in all cases), but not in Model 5.

Providing a crucial test of the place stratification thesis, Model 2 of Table 2 includes controls for the race/ethnicity of the household head. As expected, black and Hispanic household status were both positively associated with neighborhood pollution levels, with African Americans and Hispanics living in neighborhoods with higher levels of pollution (74.5% and 56.9% higher respectively) than did their white counterparts even after controlling for family structure and year of observation. More important for our purposes was that controlling for the race/ethnicity of the household head attenuated a sizeable portion, though not all, of the family structure differences in neighborhood pollution observed in Model 1. Most notably, after including these controls, the coefficients for single mother and single father family status were reduced by about 37.2% (from .196 to .123) and 58.5% (from .053 to .022) respectively, with the single father coefficient becoming non-significant. Indicating that the pollution disadvantage experienced by single-parent families was at least partially attributable to their race/ethnic status, these findings are thus consistent with the place stratification thesis argument that residential attainment is, in part, a function of householders' race/ethnicity. Nevertheless, even after controlling for the race/ethnic status of the household head, single-mother families still tended to live in neighborhoods with relatively high levels of pollution.

Model 3 of Table 2 tests the argument, drawn from the socioeconomic inequality perspective, that the residual family structure differentials in neighborhood pollution found in Model 2 reflect the fact that single mother families were less likely than two-parent families to possess the socioeconomic resources needed to attain access to higher quality neighborhoods. Model 3 confirms much prior environmental inequality research by demonstrating that the household income-to-need ratio (hereafter referred to as income) was negatively associated with neighborhood pollution levels. Higher levels of family income relative to need thus appear to have been associated with residence in neighborhoods with lower concentrations of toxicity-weighted industrial air pollutants. More important for our purposes, this socioeconomic disparity in pollution proximity helped to explain some but not all of the family structure difference found in Model 2. Specifically, although the coefficient for single mother families declined by 7.3% (from .123 to .114) after controlling for family income and householder education, these families were still at a significant pollution disadvantage in comparison to two-parent families (when income and education were inserted into the regression equation before householder race/ethnicity, the single-mother and single-father coefficients declined in size by about 11.8% and 22.7% respectively).

The single-mother pollution disadvantage found in Model 3 persisted in Model 4, which includes controls for a set of sociodemographic and life-cycle factors associated with residential mobility in prior research. This pollution disadvantage also persisted in Model 5, which includes controls for neighborhood racial composition and neighborhood socioeconomic status (Model 5 has fewer observations than Models 1–4 because tract-level demographic data were not available for all PSID respondents; nevertheless, the results obtained when using the Model 5 sample to estimate the Model 4 coefficients are nearly identical to the Model 4 results presented in Table 2).

Focusing attention on Model 5, we see that holding a wide range of individual- and household-level characteristics constant, pollution proximity was negatively associated with average family income in the neighborhood and positively associated with the percentage of blacks and Hispanics in the neighborhood. In addition, including the neighborhood predictors in the model weakened the associations that existed between pollution proximity on the one hand and family income, homeownership, and black and Hispanic householder status on the other, with the homeownership and black householder coefficients declining in size by 17.8% (from .0985 to .081) and 72.2% (from .51 to .142) respectively and the family income and Hispanic status coefficients losing statistical significance. Including neighborhood-level predictors in the model also reduced the size of the single mother coefficient by 43.2% (from .095 to .054). Nevertheless, the association between neighborhood air pollution and single-mother family status remained statistically significant in Model 5, with the average single-mother family living in a neighborhood with a pollution level 5.5% higher [exp(.054) = 1.055] than that of the average two-parent family even after controlling for the individual-, household-, and neighborhood characteristics included in the Model.

Thus, Table 2 demonstrates that in the 1990s the pollution disparity between single-mother and two-parent families was relatively large (there was a 21.6% pollution gap between these groups in Model 1) and only partially explained by race/ethnic, socioeconomic, sociodemographic, and neighborhood differences between these groups. Table 2 also suggests that householder race/ethnicity and family socioeconomic status influenced family-based environmental inequality, at least in part, by channeling single mother families into low socioeconomic status neighborhoods and neighborhoods with disproportionately large African American and Latino populations.

These findings extend prior research on family-based environmental inequality, which has relied entirely on aggregate-level demographic data, but they provide no information on the role that residential mobility plays in shaping this inequality. Therefore, the remainder of our analysis focused on family structure differences in residential mobility that likely contributed to the substantial levels of environmental inequality revealed to this point.

One possibility, of course, is that this inequality emerges because single-mother and single-father families are less likely than two-parent families to leave neighborhoods with high levels of industrial pollution. To assess this possibility, Table 3 presents the results of a set of three-level random effects logistic regression models predicting the log-odds of moving to a different census tract between the beginning and end of the average observation period (time t to t+2). Because some families changed their status between the beginning and end of each two-year observation period (from single-parent to two-parent and vice versa), Table 3 only includes observations for which family status remained the same across the observation period.

The first model in Table 3 shows the effect of neighborhood pollution in the tract of origin on out-mobility for a pooled sample of all respondents, controlling only for the year of observation. The positive and significant logit coefficient for the logged pollution variable indicates that the likelihood of moving from the tract of origin increased with the level of neighborhood pollution. In order to determine whether the likelihood of moving in response to pollution varied across family types, Model 2 adds dummy variables for single-mother and single-father family status as well as product terms representing the interactions between neighborhood pollution and our indicators of family type. The single-mother and single-father family coefficients in Model 2 indicate that when neighborhood pollution was zero, single-parent families were more likely than two-parent families to move during the average observation period. However, the non-significant interaction term coefficients indicate that single-parent families were neither more nor less likely than two-parent families to move in response to higher levels of pollution.

Finally, Model 3 assesses the extent to which a similar pattern of mobility reactions to local pollution holds after controlling for other factors that significantly affect the likelihood of residential mobility. In this model, we included controls for all our mobility predictors because the results of unreported intermediate models were substantively identical to the results reported in Model 3 for our variables of interest. Most importantly, we see that controlling for these mobility predictors does not alter conclusions regarding family structure differences in the effect of neighborhood pollution on out-mobility. Table 3 thus shows that single-mother, single-father, and two-parent families were equally likely to move in response to pollution, suggesting that out-mobility patterns likely helped to maintain, rather than increase or decrease, pre-existing levels of family-based environmental inequality.

More central to the creation and maintenance of family-based environmental inequality were family structure differences in the destinations of those who did move. Table 4 presents the results of a series of three-level random effects regression models designed to examine the effects of family type and other explanatory variables on pollution proximity in the tracts to which mobile PSID householders relocated (though not shown here, results obtained using Heckman-corrected linear regression models were very similar to the results presented in Table 4 except that with Heckman selection the single-father coefficient was not statistically significant in any of the regression models). As in Table 3, Table 4 only includes observations for which family status remained the same at the beginning and end of the observation period.

The coefficients in the first model of Table 4 point to substantial gross differences in pollution proximity across the destination neighborhoods entered by mobile families of different types. Controlling for the year of observation and pollution levels in the origin tract, single-mother and single-father families entered neighborhoods with pollution proximity values 36.5% [exp(.311)] and 26.4% [exp(.234)] greater, respectively, than the destination neighborhood pollution values of two-parent families (the difference in destination neighborhood pollution levels between single-mother and single-father families was not statistically significant in any of the models reported in Table 4). Providing support for the place stratification thesis, Model 2 indicates that, conditional upon moving and controlling for family structure, origin neighborhood pollution and year of observation, black and Hispanic households tended to end up in neighborhoods with significantly higher levels of pollution than did mobile white households (47.7% higher in the case of black households and 28.5% higher in the case of Hispanic households). Controlling for these racial differences decreased the size of the still statistically significant single-mother and single-father family coefficients by 29.9% (from .311 to .218) and 22.2% (from .234 to .182) respectively, suggesting that the tendency for mobile single-parent households to enter neighborhoods with relatively high levels of pollution was partially attributable to the fact that single-parent families were more likely than two-parent families to be headed by an African American householder (single-mother families were only slightly less likely, and single-father families were only slightly more likely, than two-parent families to be headed by a Latino householder).

Consistent with the socioeconomic inequality thesis, Model 3 of Table 4 shows that 8.3% [(.218–.200)/.218)] of the single-mother pollution disadvantage and 6.0% [(.182–.171)/.182] of the single-father pollution disadvantage found in Model 2 reflected these families' relatively poor socioeconomic standing as compared to two-parent families (although neither of the socioeconomic variables were significantly associated with the dependent variable in Model 3, unreported results show that householder education was significantly and negatively associated with the dependent variable when inserted into the regression equation before the race/ethnic status variables). Yet even after controlling for respondent socioeconomic and race/ethnic status, the destination disadvantages experienced by single-mother and single-father families remained statistically significant.

The coefficients for single-mother and single-father family status also declined in size (by 10.5% and 19.9% respectively) with controls for family sociodemographic and life-cycle characteristics (Model 4), with the single-father coefficient losing statistical significance in Model 4. Nevertheless, even after we controlled for these sociodemographic and life-cycle characteristics, single-mother families still moved to more polluted neighborhoods than did two-parent families.

Finally, Model 5 includes a set of neighborhood-level income, housing, and race variables measured in the destination tracts of mobile PSID respondents. Consistent with the place stratification thesis, controlling for these neighborhood characteristics weakened the associations that existed between destination neighborhood pollution levels and householder race/ethnicity, with the coefficients for black and Hispanic householder status declining dramatically in size and losing statistical significance in Model 5 (neither family income nor householder education was statistically significant in Model 4). Nevertheless, the single mother coefficient, which declined in size by 8.4% with the addition of the neighborhood-level controls, remained statistically significant in Model 5, while the single-father coefficient actually increased in size by 11.7% and became marginally significant ($p=.084$) in this Model.

It is important to note, however, that the sample size was smaller in Model 5 than in Model 4, and that when the Model 5 sample was used to estimate the Model 4 coefficients, the single-mother and single-father coefficients for Model 4 were .189 ($p=.001$) and .155 ($p=.084$) respectively. Thus, when the sample used to estimate Models 4 and 5 was the same, adding the neighborhood-level controls decreased the size of the single-mother coefficient by 13.2% while having virtually no effect on the size or statistical significance of the single-father coefficient.

Model 5 thus suggests that family structure differences in destination neighborhood pollution levels were explained in part by the movement of single-mother and two-parent families into neighborhoods with different race/ethnic characteristics. More importantly, even after controlling for a wide range of theoretically important individual-, household-, and neighborhood-level factors, single-mother and single-father families still moved to neighborhoods with 17.8% [exp(.164)] and 16.5% [exp(.153)] higher industrial air pollution values, respectively, than did their mobile two-parent family counterparts.

Conclusion

Despite intense interest in examining the effects of family structure on children's and adult's life chances and well-being and evidence that suggests that single-mother families and children may be particularly vulnerable to the negative health effects of residential proximity and exposure to environmental hazards, relatively little research has examined the link between family structure and neighborhood environmental conditions. Thus, while a limited number of studies have shown that neighborhood pollution levels are positively associated with the percentage of single-mother families in the area (Downey 2005a; Downey and Hawkins 2008), this study is the first investigation of family-based environmental inequality to link individual- and household-level data from a nationally representative sample of householders to neighborhood-level measures of pollution. These unique data allow us to provide a clearer picture of the magnitude of family-based environmental inequality in U.S. metropolitan areas than has been possible in prior research and yield important insights into the previously unstudied residential mobility processes that shape this inequality.

Confirming the existence of significant family structure differences in household proximity to industrial air pollution in U.S. metropolitan areas between 1990 and 1999, these data show that at the beginning of the typical two-year observation period, single-mother families experienced neighborhood pollution levels that were on average 46% greater than those experienced by two-parent families and 16% greater than those faced by single-father families, with single-father families experiencing pollution levels that were 26% higher than those of two-parent families. Moreover, even after controlling for a wide variety of factors that shape residential attainment (Table 2), the neighborhood pollution gap between single-mother and two-parent families remained statistically significant at the beginning of the average observation period. Thus, among households sharing similar race/ethnic, socioeconomic, sociodemographic, and neighborhood characteristics, single-mother families still lived in neighborhoods with pollution proximity scores that were, on average, greater than those experienced by two-parent families. This was not true for single-father and two-parent families, for whom the neighborhood pollution gap at the beginning of the typical observation period was fully explained by race/ethnic, socioeconomic, sociodemographic, and neighborhood differences between them.

Our results further demonstrate that these family structure differences in pollution proximity were more the product of disparate mobility destinations (Table 4) than of family structure differences in the likelihood of leaving polluted areas (Table 3). Thus, while single-mother, single-father, and two-parent families were equally likely to leave polluted neighborhoods, single-mother and single-father families who moved entered significantly more polluted neighborhoods (36.5% and 26.4% more polluted respectively) than did mobile two-parent families.

Consistent with the socioeconomic inequality and place stratification theses, these mobility disparities, and the pollution disparities highlighted in Table 2, diminished in size with controls for family income, householder education, and householder race/ethnic status, indicating that family-based environmental inequality is shaped in important ways by family structure differences in these individual and household characteristics. Taken together, the in-mobility and Table 2 results further indicate that family socioeconomic and race/ethnic status shape family-based environmental inequality, at least in part, by channeling families into neighborhoods with income, housing, and race/ethnic characteristics similar to their own, thereby providing additional support for the socioeconomic inequality and place stratification theses.

Nevertheless, even after controlling for a wide range of theoretically important individual-, family-, and neighborhood-level characteristics, the single-mother coefficient remained statistically significant in the full model predicting neighborhood pollution at the beginning of the average mobility interval (Table 2, Model 5) and the full model predicting destination neighborhood pollution levels (Table 4, Model 5), with the single father coefficient attaining marginal significance in the latter model.

Thus, this study not only confirms that in the 1990s single-parent families lived in more highly polluted neighborhoods than did two-parent families, it also strongly suggests that this inequality was shaped in important ways by family structure differences in the experiences of movers which, in turn, were strongly but incompletely shaped by individual- and family-level race/ethnic, socioeconomic, and sociodemographic characteristics that vary across family types and channel families into neighborhoods with specific environmental and non-environmental attributes. Moreover, because the inequality uncovered in Tables 2 and 4 is only partially explained by our individual-, family-, and neighborhood-level socioeconomic, sociodemographic, and race/ethnic variables, this study also strongly suggests that factors unique to family structure, such as transitions to single-parenthood, family structure-based housing discrimination, and single-mother's reliance on geographically-specific friend and kinship networks, likely play an important role in producing and maintaining family-based environmental inequality.

Indeed, in a set of destination neighborhood regression models not presented here, we included a variable that indicates the logged distance that families moved between observation periods, allowing us to indirectly test the prediction that single-mother families' reliance on geographically-specific friend and kinship networks limits their ability to move far from friends and kin. In these models, which are otherwise identical to the models presented in Table 4, inserting the statistically significant 'distance moved' variable before any of the other control variables reduces the size of the single-mother coefficient to a greater degree than does separately inserting any of the other control variable except 'non-Hispanic black' (which has a similar effect on the size of the single-mother coefficient as does distance moved). Moreover, the size and statistical significance of the distance moved coefficient remains virtually unchanged with the subsequent insertion of all the race/ethnic, socioeconomic, sociodemographic, and neighborhood control variables, demonstrating that distance moved is not simply a function of these variables. We thus conclude that factors unique to family structure likely play an important role in producing and maintaining family-based environmental inequality.

Of course, this study represents only a first step in developing a full understanding of family-based environmental inequality and the micro-level mobility processes that help maintain and reinforce this inequality, leaving open a number of important issues for future investigation. For example, future research should examine racial and socioeconomic variations in the pollution-related mobility experiences of households of the same family type, which this and other studies suggest are likely to be quite large. In addition, if high quality, longitudinal, tract-level industrial air pollution data for the period since 1999 become publically available, researchers should determine whether the pattern of results uncovered here hold for more recent years. Investigators should also examine the role that factors unique to family structure, such as single-mother's reliance on geographically-specific friend and kinship networks, family structure-based housing discrimination, and specific transitions to single-parenthood, play in producing and maintaining family-based environmental inequality. Finally, researchers need to determine whether high levels of family-based environmental inequality are associated with family structure differences in health outcomes among both children and adults. Conducting such research will greatly extend our understanding of the micro-level determinants and effects of family-based environmental inequality, thereby shedding important light on this underappreciated and potentially critical consequence of family structure for individuals' life chances.

Acknowledgments

This research was supported by grants to the second author (R21 HD049610) and to both authors (R21 HD058708) from the National Institute of Child Health and Human Development (NICHD) and by a development grant to the first author from the NICHD-funded University of Colorado Population Center. We thank the anonymous reviewers for their helpful comments on earlier versions of the article.

References

Acs, G., Nelson, S. Honey, I'm home Changes in the living arrangements in the late 1990s Assessing the new federalism, policy brief b-38. Washington, DC: The Urban Institute; 2001.

Alba RD, Logan JR, Stults BJ, Marzan G, Zhang W. Immigrant groups in the suburbs: A reexamination of suburbanization and spatial assimilation. American Sociological Review. 1999; 64:446–460. DOI: 10.2307/2657495

Ash M, Fetter TR. Who lives on the wrong side of the environmental tracks? Evidence from the epa's risk-screening environmental indicators model. Social Science Quarterly. 2004; 85:441–462. DOI: 10.1111/j.0038-4941.2004.08502011.x

Aughinbaugh, A., Pierret, Charles P., Rothstein, Donna S. The impact of family structure and school quality on youth achievement in mathematics (mimeo). U. S. B. o. L. Statistics. , editor. Washington, DC: 2001.

Avellar S, Smock PJ. The economic consequences of the dissolution of cohabiting unions. Journal of Marriage and Family. 2005; 67:315–327. DOI: 10.1111/j.0022-2445.2005.00118.x

Bell ML, Belanger K. Review of research on residential mobility during pregnancy: Consequences for assessment of prenatal environmental exposures. Journal of Exposure Science and Environmental Epidemiology. 2012; 22:429–438. DOI: 10.1038/jes.2012.42 [PubMed: 22617723]

Brewster K, Padavic I. No more kin care?: Change in black mother's reliance on relatives for child care, 1977–94. Gender & Society. 2002; 16:546–563. DOI: 10.1177/0891243202016004008

Brulle RJ, Pellow DN. Environmental justice: Human health and environmental inequalities. Annual Review of Public Health. 2006; 27:3.1–3.22. DOI: 10.1146/annurev.publhealth.27.021405.102124

Bureau, U. S. C.. Current population survey, 2009 annual social and economic supplement. Washington, D.C: U.S. Government Printing Office; 2009. Accessed online at http://www.census.gov/cps/

Christopher K. A 'pauperization of motherhood'?: Single motherhood and women's poverty over time. Journal of Poverty. 2005; 9:1–23. DOI: 10.1300/J134v09n03_01

Crowder K, Downey L. Inter-neighborhood migration, race, and environmental hazards: Modeling microlevel processes of environmental inequality. The American Journal of Sociology. 2010; 115:1110–1149.

Derezinski DD, Lacy MG, Stretesky PB. Chemical accidents in the united states, 1990–1996. Social Science Quarterly. 2003; 84:122–143.

Downey L. Single-mother families and industrial pollution in metropolitan america. Sociological Spectrum. 2005a; 25:651–675. DOI: 10.1080/02732170500256633 [PubMed: 21874080]

Downey L. The unintended significance of race: Environmental racial inequality in detroit. Social Forces. 2005b; 83:305–341. DOI: 10.1353/sof.2005.0026

Downey L. Environmental racial inequality in Detroit. Social Forces. 2006a; 85:771–796. DOI: 10.1353/sof.2007.0003

Downey L. Using geographc information systems to reconceptualize spatial relationships and ecological context. American Journal of Sociology. 2006b; 112:567–612.

Downey, L., Crowder, K. Using distance decay techniques and household-level data to explore regional variation in environmental inequality. In: Maantay, J., McLafferty, S., editors. Geospatial analysis of environmental health. New York: Springer; 2011. p. 373-395.

Downey L, Hawkins B. Single-mother families and air pollution: A national study. Social Science Quarterly. 2008; 89:523–536. DOI: 10.1111/j.1540-6237.2008.00545.x [PubMed: 19347054]

EPA. Epa’s risk screening environmental indicators (rsei) chronic human health methodology: Rsei version 2.1. Washington, D.C.: The Environmental Protection Agency; 2004.

Evans GW, Kantrowitz E. Socioeconomic status and health: The potential role of environmental risk exposure. Annual Review of Public Health. 2002; 23:303–331. DOI: 10.1146/annurev.publhealth.23.112001.112349

Fomby P, Sennott C. Family instability and mobility: The consequences for adolescents’ problem behavior. Social Science Research. 2013; 42:181–206. DOI: 10.1016/j.ssresearch.2012.08.016

Gee GC, Payne-Sturges DC. Environmental health disparities: A framework integrating psychosocial and environmental concepts. Environmental Health Perspectives. 2004; 112:1645–1653. DOI: 10.1289/ehp.7074 [PubMed: 15579407]

Grant D, Trautner MN, Downey L, Thiebaud L. Bringing the polluters back in: Environmental inequality and the organization of chemical production. The American Sociological Review. 2010; 75:479–504. DOI: 10.1177/0003122410374822 [PubMed: 21921966]

Harknett K. The relationship between private safety nets and economic outcomes among single mothers. Journal of Marriage and Family. 2006; 68:172–191. DOI: 10.1111/j.1741-3737.2006.00250.x

Haveman R, Wolfe B. The determinants of childrenís attainments: A review of methods and findings. Journal of Economic Literature. 1995; 33:1829–1878.

Henly J, Danziger S, Offer S. The contribution of social support to the material well-being of low-income families. Journal of Marriage and Family. 2005; 67:122–140. DOI: 10.1111/j.0022-2445.2005.00010.x

Hill, MS. The panel study of income dynamics: A user’s guide. Newbury Park, CA: Sage; 1992.

Hoffman JP. Family structure, community context, and adolescent problem behaviors. Journal of Youth and Adolescence. 2006; 35:867–880. DOI: 10.1007/s10964-006-9078-x

Hunter LM, White MJ, Little JS, Sutton J. Environmental hazards, migration, and race. Population and Environment. 2003; 25:23–39.

Jablonska B, Lindberg L. Risk behaviours, victimisation and mental distress among adolescents in different family structures. Social Psychiatry and Psychiatric Epidemiology. 2007; 42:656–663. DOI: 10.1007/s00127-007-0210-3 [PubMed: 17522746]

Kreider, RM., Elliot, DB. Current population reports. Washington, DC: U.S. Census Bureau; 2009. America’s families and living arrangements: 2007. Pub no. P20-561

Lang K, Zagorsky JL. Does growing up with a parent absent really hurt? Journal of Human Resources. 2001; 36:253–273. DOI: 10.2307/3069659

Lauster N, Easterbrook A. No room for new families? A field experiment measuring rental discrimination against same-sex couples and single parents. Social Problems. 2011; 58:389–409. DOI: 10.1525/sp.2011.58.3.389

Leininger LJ, Ziol-Guest KM. Reexamining the effects of family structure on children's access to care: The single-father family. Health Services Research. 2008; 43:117–133. DOI: 10.1111/j.1475-6773.2007.00758.x [PubMed: 18211521]

Manning W, Brown S. Children's economic well-being in married and cohabiting parent families. Journal of Marriage and Family. 2006; 68:345–362.

Manning W, Lichter D. Parental cohabitation and children's economic well-being. Journal of Marriage and Family. 1996; 58:998–1010. DOI: 10.2307/353986

Massey, DS., Denton, NA. American apartheid: Segregation and the making of the underclass. Cambridge, MA: Harvard University Press; 1993.

Massey DS, Gross AB, Shibuya K. Migration, segregation, and the geographic concentration of poverty. American Sociological Review. 1994; 59:425–445. DOI: 10.2307/2095942

Mather, M. US Children in single-mother families. Washington, DC: Population Reference Bureau; 2010.

McKeever M, Wolfinger NH. Thanks for nothing: Income and labor force participation for never-married mothers since 1982. Social Science Research. 2011; 40:63–76. DOI: 10.1016/j.ssresearch.2010.06.008

McLanahan S, Percheski C. Family structure and the reproduction of inequalities. Annual Review of Sociology. 2008; 34:257–276. DOI: 10.1146/annurev.soc.34.040507.134549

Osborne C, Berger LM, Magnuson K. Family structure transitions and changes in maternal resources and well-being. Demography. 2012; 49:23–47. DOI: 10.1007/s13524-011-0080-x [PubMed: 22215507]

Pais J, Crowder K, Downey L. Unequal trajectories: Racial and class differences in residential exposure to industrial hazard. Social Forces. 2014; 92:1189–1215. DOI: 10.1093/sf/sot099

Pastor M, Sadd JL, Morello-Frosch R. Reading, writing, and toxics: Children's health, academic performance, and environmental justice in los angeles. Environment and Planning C Government and Policy. 2004; 22

Pellow D, Brehm H. An environmental sociology for the twenty-first century. Annual Review of Sociology. 2013; 39:229–250. DOI: 10.1146/annurev-soc-071312-145558

Ringquist, E. Environmental justice: Normative concerns and empirical evidence. In: Vig, NJ., Kraft, ME., editors. Environmental policy: New directions for the 21st century. Washington D.C.: CQ Press; 2000. p. 232-256.

Ringquist EJ. Assessing evidence of environmental inequities: A meta-analysis. Journal of Policy Analysis and Management. 2005; 24:223–247. DOI: 10.1002/pam.20088

Ross, SL., Yinger, J. The color of credit: Mortgage discrimination, research methodology, and fair-lending enforcement. Cambridge: The MIT Press; 2002.

Ryan R, Kalil A, Leininger L. Low-income mothers' private safety nets and children's socioemotional well-being. Journal of Marriage and Family. 2009; 71:278–297. DOI: 10.1111/j.1741-3737.2008.00599.x

Saadeh FB, Clark MA, Rogers ML, Linkletter CD, Phipps MG, Padbury JF, Vivier PM. Pregnant and moving: Understanding residential mobility during pregnancy and in the first year of life using a prospective birth cohort. Maternal and Child Health Journal. 2013; 17:330–343. DOI: 10.1007/s10995-012-0978-y [PubMed: 22415811]

Shlay AB, Rossi PH. Keeping up the neighborhood: Estimating net effects of zoning. American Sociological Review. 1981; 46:703–719. DOI: 10.2307/2095075

Sigle-Rushton, W., McLanahan, S. Father absence and child wellbeing: A critical review. In: Moynihan, D.Rainwater, L., Smeeding, T., editors. The future of the family. New York: Russell Sage; 2004. p. 116-155.

Smith CL. Economic deprivation and environmental inequality in postindustrial detroit: A comparison of landfill and superfund site locations. Organization & Environment. 2007; 20:25–43. DOI: 10.1177/1086026607300245

South SJ, Crowder KD. Avenues and barriers to residential mobility among single mothers. Journal of Marriage and the Family. 1998; 60:866–877. DOI: 10.2307/353630

South SJ, Crowder KD, Trent K. Children's residential mobility and neighborhood environment following parental divorce and remarriage. Social Forces. 1998; 77:667–693.

Williams DR, Collins C. Us socioeconomic and racial differences in health: Patterns and explanations. Annual Review of Sociology. 1995; 21:349–386. DOI: 10.1146/annurev.so.21.080195.002025

Williams DR, Mohammed S. Discrimination and racial disparities in health: Evidence and needed research. Journal of Behavioral Medicine. 2009; 32:20–47. DOI: 10.1007/s10865-008-9185-0 [PubMed: 19030981]

Yinger, J. Closed doors, opportunities lost: The continuing costs of housing discrimination. New York: Russell Sage Foundation; 1995.

Table 1

Descriptive Statistics for Variables in Regression Models by Family Type: PSID Householders 1990–1999*

	Single Mother Families		Single Father Families		Two Parent Families		Pooled Sample	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Dependent Variables								
Unlogged Air Pollution Values in origin tract	955.00	3749.14	824.56	2733.85	654.91	2798.38	748.73	3094.81
Unlogged Air Pollution Values in destination tract	775.52	2734.24	753.87	3563.56	572.27	3368.13	639.04	3216.75
Changed Tracts, time t to t+2 (1=yes)	0.37	0.48	0.52	0.50	0.24	0.43	0.29	0.46
Independent Variables								
Individual and Family Level								
Income-to-Need Ratio	1.35	1.29	2.20	1.95	3.25	3.04	2.65	2.74
Education	12.15	2.49	12.20	2.63	13.33	3.10	12.93	2.97
Age	35.86	11.39	33.40	14.00	38.32	9.06	37.35	10.20
Number of Children	2.04	1.18	1.71	0.98	2.01	1.02	2.00	1.07
Homeowner (1=yes)	0.27	0.44	0.49	0.50	0.66	0.47	0.54	0.50
Persons per Room	0.78	0.45	0.83	0.49	0.76	0.37	0.77	0.40
In Same House 3+ Years (1=yes)	0.40	0.49	0.40	0.49	0.53	0.50	0.49	0.50
In Public Housing (1=yes)	0.18	0.39	0.07	0.26	0.04	0.19	0.08	0.27
Non-Hispanic Black	0.65	0.48	0.44	0.50	0.28	0.45	0.39	0.49
Hispanic	0.19	0.39	0.24	0.42	0.21	0.40	0.20	0.40
Logged distance moved (if moved tracts from time t to t+2)	1.93	1.40	2.20	1.57	2.55	1.90	0.67	1.40
Tract Level								
% Non-Hispanic Black	46.54	37.68	29.88	34.82	20.05	29.63	28.04	34.46
% Latino	15.04	24.22	17.15	26.69	15.59	25.46	15.53	25.20
Avg. Rent (in 1000s)	0.48	0.16	0.53	0.21	0.58	0.22	0.55	0.21
Avg. Property Value (in 1000s)	88.57	63.16	104.15	70.86	118.99	82.91	10.97	7.84
Avg. Family Income (in 1000s)	36.96	16.24	42.55	18.97	49.55	25.12	4.56	2.33
Year of Observation	6.56	2.78	6.57	2.79	6.37	2.75	6.44	2.76
N of person-periods	6718		1336		15849		23903	

*Except where otherwise noted, all variables in the table are measured at the beginning of the observation interval.

Table 2

Random Effects Coefficients for Regression of Logged Air Pollution Concentration in Census Tract of Origin: PSID Householders 1990–1999

Independent Variables	Model 1		Model 2		Model 3		Model 4		Model 5	
Individual and Family Level										
Single Mother	0.196 (0.022)	***	0.123 (0.022)	***	0.114 (0.022)	***	0.095 (0.022)	***	0.054 (0.022)	*
Single Father	0.053 (0.030)	+	0.022 (0.030)		0.017 (0.030)		0.008 (0.030)		−0.003 (0.030)	
Two Parent	*Reference*		*Reference*		*Reference*		*Reference*		*Reference*	
Non-Hispanic Black			0.557 (0.033)	***	0.537 (0.033)	***	0.510 (0.034)	***	0.142 (0.038)	***
Hispanic			0.451 (0.038)	***	0.425 (0.039)	***	0.409 (0.039)	***	0.008 (0.043)	
Non-Hispanic White			*Reference*		*Reference*		*Reference*		*Reference*	
Income-to-Need Ratio					−0.008 (0.003)	**	−0.006 (0.003)	*	0.001 (0.003)	
Education					−0.005 (0.003)		−0.003 (0.003)		0.004 (0.003)	
Age							−0.007 (0.005)		−0.005 (0.005)	
Age Squared							0.0001 (0.000)		0.0001 (0.000)	
Number of Children							−0.0016 (0.008)		−0.0082 (0.008)	
Homeowner (1=yes)							−0.0985 (0.018)	***	−0.0810 (0.018)	***
In Public Housing (1=yes)							0.0135 (0.025)		−0.0349 (0.026)	
Persons per Room							−0.0056 (0.018)		−0.0201 (0.018)	
In Same House 3+ Years (1=yes)							0.0127 (0.012)		−0.0029 (0.012)	
Tract Level										
% Non-Hispanic Black									0.007 (0.000)	***
% Latino									0.011 (0.001)	***

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Avg. Rent (in 10000s)					0.192 (0.788)
Avg. Property Value (in 10000s)					−0.004 (0.003)
Avg. Family Income (in 10000s)					−0.029 ** (0.010)
Year of Observation	−0.107 *** (0.002)	−0.106 *** (0.002)	−0.105 *** (0.002)	−0.104 *** (0.002)	−0.097 *** (0.003)
Constant	5.349 *** (0.110)	5.165 *** (0.111)	5.257 *** (0.119)	5.423 *** (0.151)	5.379 *** (0.153)
Random Effects Parameters					
MSA Intercept Std. Dev.	1.732	1.743	1.743	1.745	1.768
Family Intercept Std. Dev.	0.887	0.863	0.862	0.860	0.834
Residual Std. Dev.	0.658	0.657	0.657	0.657	0.654
X^2	2777.300 ***	3126.020 ***	3138.590 ***	3178.833 ***	3820.768 ***
N observations	23903	23903	23903	23903	23525
N families	7050	7050	7050	7050	6968

† p < .10,

* p < .05,

** p<.01,

*** p<.001

Table 3

Random Effects Logistic Coefficients for Regression of Residential Mobility Out of Census Tract of Origin: PSID Householders 1990–1999

Independent Variables	Model 1		Model 2		Model 3	
Logged Air Pollutant Concentration at time t	0.1129 (0.0214)	***	0.0840 (0.0249)	**	0.0296 (0.0240)	
Family Type						
Single Mother			1.0888 (0.2075)	***	0.3051 (0.2002)	
Single Father			1.8714 (0.4081)	***	1.1585 (0.4044)	**
Two Parent			*reference*		*reference*	
Interactions						
Pollution × Single Mother			−0.0061 (0.0370)		0.0002 (0.0355)	
Pollution × Single Father			−0.0169 (0.0736)		−0.0199 (0.0730)	
Individual and Family Level						
Non-Hispanic Black					−0.0181 (0.1074)	
Hispanic					−0.3811 (0.1252)	**
Non-Hispanic White					*reference*	
Income-to-Need Ratio					0.0315 (0.0120)	**
Education					0.0458 (0.0114)	***
Age					−0.2134 (0.0158)	***
Age-squared					0.0017 (0.0002)	***
Number of Children					−0.0944 (0.0293)	**
Homeowner (1=yes)					−2.0455 (0.0731)	***
In Public Housing (1=yes)					−0.5023 (0.0934)	***
Persons per Room					0.4284 (0.0727)	***

Independent Variables	Model 1		Model 2		Model 3	
In Same House 3+ Years (1=yes)					0.3907 (0.0572)	***
Tract Level						
% Non-Hispanic Black					−0.0029 (0.0015)	*
% Latino					−0.0012 (0.0021)	
Avg Rent (in 1000s)					0.7236 (0.2517)	**
Avg Property Value (in 1000s)					−0.0018 (0.0008)	*
Avg Family Income (in 1000s)					−0.0032 (0.0031)	
Year of Observation	0.0017 (0.0090)		−0.0031 (0.0089)		0.0464 (0.0102)	***
Constant	−1.9429 (0.1474)	***	−2.1229 (0.1595)	***	3.6695 (0.3831)	***
Random Effects Parameters						
MSA Intercept Std. Dev.	0.491		0.477		0.386	
Family Intercept Std. Dev.	2.064		1.947		1.618	
X^2	29.39	***	314.82	***	1609.85	***
N observations	21168		21168		20822	
N families	6694		6694		6596	

† $p < .10$,

* $p < .05$,

** $p<.01$,

*** $p<.001$

Table 4

Random Effects Coefficients for Regression of Destination Tract Pollution for Movers: PSID Householders 1990–1999

Independent Variables	Model 1		Model 2		Model 3		Model 4		Model 5	
Logged Air Pollutant Concentration in Origin Neighborhood (time t)	0.224 (0.016)	***	0.210 (0.016)	***	0.209 (0.016)	***	0.208 (0.016)	***	0.206 (0.016)	***
Individual and Family Level										
Single Mother	0.311 (0.050)	***	0.218 (0.052)	***	0.200 (0.053)	***	0.179 (0.054)	**	0.164 (0.054)	**
Single Father	0.234 (0.086)	**	0.182 (0.086)	*	0.171 (0.086)	*	0.137 (0.089)		0.153 (0.089)	+
Two Parent			*reference*		*reference*		*reference*		*reference*	
Non-Hispanic Black			0.390 (0.065)	***	0.365 (0.067)	***	0.357 (0.068)	***	0.114 (0.075)	
Hispanic			0.251 (0.076)	**	0.221 (0.078)	**	0.221 (0.079)	**	0.086 (0.085)	
Non-Hispanic White			*reference*		*reference*		*reference*		*reference*	
Income-to-Need Ratio					−0.012 (0.011)		−0.010 (0.011)		0.008 (0.012)	
Education					−0.007 (0.009)		−0.006 (0.009)		0.003 (0.009)	
Age							−0.008 (0.011)		−0.004 (0.011)	
Age Squared							0.000 (0.000)		−0.0001 (0.0001)	
Number of Children							−0.020 (0.019)		−0.028 (0.019)	
Homeowner (1=yes)							−0.056 (0.049)		−0.036 (0.049)	
In Public Housing (1=yes)							0.003 (0.057)		−0.005 (0.057)	
Tract Level										
% Non-Hispanic Black									0.006 (0.001)	***
% Latino									0.005 (0.001)	***
Avg. Rent (in 1000s)									−0.584 (0.164)	***

Independent Variables	Model 1		Model 2		Model 3		Model 4		Model 5	
Avg. Property Value (in 1000s)									−0.002 (0.001)	**
Avg. Family Income (in 1000s)									0.004 (0.002)	*
Year of Observation	−0.073 (0.008)	***	−0.074 (0.009)	***	−0.073 (0.009)	***	−0.071 (0.009)	***	−0.064 (0.009)	***
Constant	3.848 (0.130)	***	3.800 (0.132)	***	3.943 (0.176)	***	4.201 (0.267)	***	4.196 (0.272)	***
Random Effects Parameters										
MSA Intercept Std. Dev.	1.032		1.056		1.058		1.061		1.053	
Family Intercept Std. Dev.	0.939		0.933		0.932		0.932		0.925	
Residual Std. Dev.	0.855		0.852		0.852		0.851		0.836	
X^2	400.770	***	436.420	***	439.120	***	446.820	***	566.570	***
N observations	4874		4874		4874		4874		4782	
N families	2841		2841		2841		2841		2801	

†p < .10,

*p < .05,

**p<.01,

***p<.001