



Downward Neighborhood Poverty Mobility during Childhood Is Associated with Child Asthma: Evidence from the Geographic Research on Wellbeing (GROW) Survey

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Abstract Causal evidence regarding neighborhood effects on health remains tenuous. Given that children have little agency in deciding where they live and spend proportionally more of their lives in neighborhoods than adults, their exposure to neighborhood conditions could make their health particularly sensitive to neighborhood effects. In this paper, we examine the relationship between exposure to poor neighborhoods from birth to ages 4–10 and childhood asthma. We used data from

the 2003–2007 California Maternal Infant and Health Assessment (MIHA) and the 2012–2013 Geographic Research on Wellbeing (GROW) survey ($N = 2619$ mother/child dyads) to fit relative risks of asthma for children who experience different types of neighborhood poverty mobility using Poisson regression controlling for individual-level demographic and socioeconomic characteristics, and neighborhood satisfaction. Our results demonstrate that [1] living in a poor

What is already known on this subject?

- Neighborhood socioeconomic disadvantages are linked with children's health, after adjusting for individual-level socioeconomic factors.
- However, most research examined neighborhood-child health associations only with cross-sectional data.

What does this study add?

- Moving from a non-poor to a poor neighborhood and living in a poor neighborhood at baseline and follow-up were each associated with higher risk of asthma compared with children not living in a poor neighborhood at baseline and follow-up.

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neighborhood at baseline and follow-up and [2] moving into a poor neighborhood were each associated with higher risk of asthma, compared with children not living in a poor neighborhood at either time. Exposure to impoverished neighborhoods and downward neighborhood poverty mobility matters for children's health, particularly for asthma. Public health practitioners and policymakers need to address downward neighborhood economic mobility, in addition to downward family economic mobility, in order to improve children's health.

Keywords Asthma · Neighborhood effects · Longitudinal

Introduction

In the public health literature, it is often taken for granted that neighborhoods affect health via several plausible pathways, including resources (such as availability of healthy food), physical attributes (such as pollutants), social characteristics (such as stress, poverty level, or racial composition of a neighborhood), and other factors [1–3]. Compared with adults, children may be particularly sensitive to the effects of neighborhood poverty on health due to the greater proportion of their time spent in their neighborhoods, as well as having comparably less agency to choose their neighborhoods. Although most children are residentially stable, many are not and move to a different neighborhood during childhood, which results in higher or lower neighborhood poverty exposure relative to residentially stable children. Therefore, omitting mobility over a child's life course could result in measurement error for neighborhood exposure measures. Using a life course epidemiology perspective, we examine how exposure to neighborhoods during childhood is related to the development of asthma [4]. As such, we do not test specific mechanisms that lead from neighborhoods to the development of asthma, but rather conceptualize neighborhood effects as being the confluence of social and biological factors interactively influencing health outcomes.

Children may be particularly susceptible to exposure to neighborhood conditions, especially neighborhood poverty, for the development of asthma. Asthma is a serious medical condition affecting millions of American children where the airways are inflamed with elevated mucus, making it difficult to breathe [5]. In

addition to genetic factors, asthma can also be caused by respiratory infections, allergies, and environmental conditions such as indoor and outdoor air quality [6–9]. Infections, allergies, and indoor and outdoor air quality can all be conditioned by neighborhood socioeconomic status. For instance, neighborhoods can exacerbate asthma symptoms as previous research has shown that upticks in pollution lead to oxidative injury to airways leading to greater inflammation which leads to difficulty breathing and ultimately more asthma-related hospitalizations [10–12]. In general, poorer neighborhoods generally have higher concentrations of pollution than more advantaged neighborhoods. Indoor air quality is also associated with a higher prevalence of asthma. Indoor smoking, indoor allergens, and type of housing are all possible pathways through which neighborhoods, and in particular high-poverty neighborhoods, affect childhood asthma [13–15]. In addition to physical pathways to childhood health, family stresses, such stress about neighborhood conditions or mother's depression, are also associated with increased rates of childhood asthma [16, 17]. Overall, there are many pathways that neighborhoods can physically, such as indoor and outdoor air quality, or socially, such as family stress, affect childhood asthma, and all are related to neighborhood poverty.

A greater understanding of the neighborhood determinants of asthma is critically important to stemming a serious problem for millions of American children, children who are disproportionate of color [5, 18]. Childhood asthma is also costly in terms of medications, emergency room visits, and hospitalizations [19]; limits school attendance and physical activity; and can result in death if uncontrolled [20, 21]. In 2012, asthma prevalence among black children ages 5–14 years (26%) was nearly twice that of white (14%) children, reproducing racial inequality in health [22].

Given the serious lifelong implications of asthma and the potential contextual determinants, previous research has sought to link neighborhood characteristics to asthma among children (for an overview see DePriest and Butz) [18]. Prior neighborhood-effect studies have linked neighborhood socioeconomic disadvantage with childhood asthma [23, 24], even after adjusting for individual-level risk factors, including socioeconomic characteristics. Additionally, because populations of color disproportionately live in socioeconomically disadvantaged neighborhoods compared with white populations [25–28], evidence suggests that neighborhood

effects contribute to racial/ethnic disparities in asthma [29, 30]. However, other work has found that the relationship between contextual factors and asthma among children was explained by individual-level controls [31]. Additionally, poor neighborhoods are associated with less neighborhood satisfaction which may additionally be a risk for stress pathways to health [32].

One potential reason for these discrepant results may be differences in measures of exposure to neighborhood characteristics as previous research on neighborhood effects on asthma has mostly examined cross-sectional associations, which in addition to limiting causal inferences, may also misrepresent exposure to neighborhoods and their attendant risk factors. The importance of precisely measuring exposure to neighborhoods has been shown for other health outcomes such as sleep among children and risk of obesity among adolescents likely because living in neighborhoods increases the cumulative risks for health conditions [33–35]. Americans move between different types of neighborhoods, and it is important to consider exposure to neighborhood environments over time. Indeed, the association between neighborhood conditions and health is likely considerably greater for a child who has spent their whole life in an impoverished neighborhood compared to a child who just moved to a poor neighborhood. Moving to an impoverished neighborhood may also elevate the risk of asthma. This study thus examines the relationship between neighborhood poverty exposure and mobility and asthma. While we do not test specific pathways between neighborhoods and asthma, our analysis examines the association between exposure to high-poverty neighborhoods and poor health. We hypothesize that the relationship between neighborhood poverty exposure and asthma will be sensitive to exposure to poverty, given known contextual determinants of asthma.

Methods

Data

We used data from the California Maternal Infant and Health Assessment (hereafter: MIHA) and the California Geographic Research on Wellbeing (hereafter: GROW) study. MIHA is an annual statewide-representative survey of roughly 3500 women who have recently given birth and were able to be located through the birth certificate of their child, with annual response

rates exceeding 70%. MIHA was stratified according to region, maternal education, and maternal race/ethnicity, oversampling African American women [36, 37]. GROW (2012–2013) is a follow-up survey of the 2003–2007 MIHA sample, designed to examine the effects of neighborhood environments on child and maternal health. MIHA respondents were eligible for the GROW survey if they had agreed to be re-contacted for a future survey and lived in one of six highly urbanized counties (Alameda, Los Angeles, Orange, Sacramento, San Diego, and Santa Clara) at the time of the MIHA survey ($n = 9256$, or over half of all MIHA respondents). Of the 9256 eligible mothers, 4026 mothers were re-contactable, resulting in the “active” sample. In total, 3016 mothers participated in GROW (response rate = 74.9% among the active sample). GROW is representative of its target population [38]. MIHA and GROW are both linked to 2000 decennial census data and the 2005–2009 American Community Survey based on residential addresses to obtain census tract-level neighborhood poverty indicators prior to the time of each survey. The analytic sample included 2619 mother-child pairs after excluding mothers who did not live with the index child ($n = 41$); and had missing data on asthma ($n = 69$), neighborhood poverty rates at the two time points ($n = 5$), child race/ethnicity ($n = 18$), maternal marital status ($n = 13$), maternal education level ($n = 6$), family income at either time point ($n = 231$), and neighborhood perception ($n = 10$). We also excluded American Indian or Alaska Native children because of the number ($n = 4$). This research was approved by the Institutional Review Boards at the University of Texas at Austin, the University of California, San Francisco, and the California Department of Public Health. Further details on the GROW survey and methodology are published elsewhere [38].

Measures

Dependent Variables We examined childhood asthma using an indicator reported by the Mother: childhood asthma. Mothers were asked: “Did a doctor, nurse or other health care worker ever tell you that this child had any of the following health problems?” Childhood asthma was determined if the mother indicated “yes” for asthma.

Key Independent Variable We operationalized “neighborhood poverty mobility” with a typology of

neighborhood exposure based on the census tract corresponding to the mothers' address during the MIHA survey (soon after the child was born) and the census tract of the mothers' address during the GROW survey (when the child was between 4 and 10 years old). We categorized neighborhood mobility into four categories based on whether the census tract had at least 20% poverty at the two time points: (1) not in a poor neighborhood at both times; (2) in a poor neighborhood at both times; (3) in a poor neighborhood at MIHA and not in a poor neighborhood at GROW (i.e., upward mobility); and (4) not in a poor neighborhood at MIHA and in a poor neighborhood at GROW (i.e., downward mobility). The cutoff of 20% in a census tract was based on the U.S. Census definition of high-poverty areas [39]. The poverty level data came from the 2000–2005 and 2005–2009 American Community Surveys for the MIHA and GROW respectively (see Margerison-Zilko 2015 and Sheehan 2018) [2, 33].

Other Independent Variables In our multivariate analyses, we controlled for individual-level demographic and socioeconomic characteristics: child age, sex (boy, girl), and race/ethnicity (Asian/Pacific Islander, non-Hispanic black, Latino/a, non-Hispanic white, and more than one race), mother's marital status (married/cohabiting, separated/divorced/widowed, single/never married), mother's education (less than high school, high school/GED, some college, college graduate or more), mother's neighborhood satisfaction, and family poverty mobility (based on family poverty to income ratio: never in poverty, always in poverty, not in poverty in MIHA but became poor in GROW, in poverty in MIHA but became non-poor in GROW). Neighborhood satisfaction comes from the question on what best describes how respondents feel about their neighborhood and is coded as negative if a mother responds "I do not like my neighborhood and would move if I could." vs. "I like my neighborhood and I would like to stay here if I can" or "I would like to live in a better place, but it is OK for now." Family income was measured during both MIHA and GROW surveys, while other control variables were measured during the GROW survey.

Analytical Strategy

We first descriptively documented individual and neighborhood characteristics overall as well as the prevalence of asthma for each characteristic. Next, we examined

characteristics of each neighborhood poverty mobility category. We then analyzed the association between neighborhood poverty mobility and child asthma using a series of Poisson regressions estimated with the %SURVEYGENMOD macro in SAS [40], to estimate risks of asthma among children, accounting for possible confounding effects of individual-level variables. We used Poisson regression to estimate relative risks because odds ratios from logistic regression models may overestimate the relative risk for outcomes that are not rare [41]. In the first set of models, we examined the extent to which each independent variable was associated with each dependent variable one at a time (i.e., separate bivariate models). The second model examined whether neighborhood poverty mobility, controlling for children's demographic factors, was associated with each dependent variable, the third model included mothers' socioeconomic factors, and the final model included neighborhood satisfaction. There was little clustering of respondents within tracts of residence, which precluded formal multilevel modeling in this study.

To evaluate the robustness of our findings, we conducted two sensitivity analyses. First, we estimated logistic regression models using the PROC SURVEYLOGISTIC procedure. Reassuringly, the substantive results were similar compared to logistic models (see Appendix Table 5). Second, we fit inverse probability of treatment weighted (IPTW) Poisson regression models to account for possible bias of treatment selection attributable to measured confounders and to better understand treatment effects on the outcomes of interest [42]. The goal of inverse probability of treatment weighting is to balance (or standardize) two or more treatment groups based on a set of observed confounders, thereby making the groups comparable in their distributions on these confounders and thus eliminating the association between confounders and treatment (i.e., neighborhood poverty mobility). The inverse probability of treatment weighting analysis consists of four steps: (1) the propensity score, or probability that each respondent experiences a particular type of neighborhood poverty mobility, was estimated conditional on a set of measured confounders that include the following: child's race/ethnicity, mother's age, mother's marital status, mother's education level, and family income measured in MIHA; (2) inverse probability of treatment weights (IPTW) was constructed using the inverse of the propensity score specific to the type of neighborhood

poverty mobility experienced by each respondent; (3) model weights were constructed by multiplying the IPTW and survey weights to account for both the complex survey design and the aforementioned measured confounders of treatment; and (4) inverse probability-weighted Poisson regression models were estimated to assess relative risks of child asthma associated with neighborhood poverty mobility after controlling for child age and sex, family poverty mobility, and negative neighborhood perception measured in GROW. All models were weighted to be representative and were conducted using SAS 9.4.

Results

Descriptive results are presented in Table 1. The majority of children in the sample lived in the same type of neighborhood at both time points. Nearly two-thirds (64.5%) of children lived in a non-poor neighborhood both times while 18% lived in a poor neighborhood both times. Twelve percent of children moved from a poor to a non-poor neighborhood between the two surveys, while 6% moved from a non-poor to a poor neighborhood between the two surveys. More than half of the sample were boys, and Latino/as were the largest racial/ethnic group. The majority of mothers were married or cohabiting with a partner, and about a third were college graduates. More than half of families were not in poverty both times, while nearly 30% were in poverty both times or became poor.

The prevalence of child asthma was 13.2%. Prevalence of asthma in our sample was higher than estimates in the Behavioral Risk Factor Surveillance Survey for similarly aged children in 2008 (8.0%) [43], perhaps because the GROW sample was derived from urban counties where prevalence rates might be expected to be higher. Outcome prevalence was highest among children who moved into a poor neighborhood, followed by those in a poor neighborhood both times, those moving out of a poor neighborhood, and lowest among those not in a poor neighborhood both times.

Table 2 presents individual-level characteristics by neighborhood poverty mobility. Non-Hispanic white and Asian/Pacific Islander children were overrepresented among those who lived in non-poor neighborhoods both times, while Latino/a and non-Hispanic black children were disproportionately represented in other types of neighborhood poverty mobility. In neighborhoods that

were poor both times, the proportions of children whose mothers were college graduates or whose families were not in poverty were disproportionately low compared to other types of neighborhood poverty mobility. Table 3 shows the results of the Poisson regression models for child asthma. The results from the final model were robust to the other model specifications, suggesting that the neighborhood effects are independent of demographic and individual-level socioeconomic characteristics. In the final model, children who lived in poor neighborhoods both times were more likely (RR = 1.38, 95% CI = 1.01–1.88) to have asthma than were children living in non-poor neighborhoods both times. Children who moved into poor neighborhoods between the surveys were also more likely to have asthma (RR = 1.57, 95% CI = 1.06–2.32) than those in non-poor neighborhoods both times. Boys (RR = 1.54, 95% CI = 1.32–1.92), Asian/Pacific Islander children (RR = 1.67, 95% CI = 1.10–2.51), and non-Hispanic black children (RR = 2.64, 95% CI = 1.82–3.83) were more likely to have asthma than girls or non-Hispanic white children. Additionally, children of mothers who reported wanting to move out of their neighborhoods were more likely to have asthma (RR = 1.34, 95% CI = 0.97–1.85).

The findings from our sensitivity analysis using the IPTW Poisson regression are shown in Table 4. Children who moved into a poor neighborhood were more likely to have asthma than those in a non-poor neighborhood both times. However, children in a poor neighborhood both times did not have higher RR of having asthma than those in a non-poor neighborhood both times.

Discussion

Early childhood is a critical period that can shape subsequent life course health [4]. While previous research has connected neighborhood features, such as neighborhood poverty, safety, and indoor and outdoor air quality to the likelihood and prevalence of asthma, less research has operationalized neighborhood poverty *exposure* and its relationship to asthma. Among children aged 4–10 living in urban areas of California and consistent with our hypotheses, we found that both (1) moving into a poor neighborhood and (2) long-term exposure to high-poverty neighborhoods were associated with higher risk of asthma compared with not living in a poor neighborhood at all. The former finding was supported in the Inverse Probability Treatment Weighted (IPTW)

Table 1 Descriptive statistics of individual- and neighborhood-level characteristics, Geographic Research on Wellbeing (GROW) study, CA, USA, 2012–2013, $N = 2619$

Characteristics	<i>N</i>	Weighted (%)	Prevalence of asthma (%)
Total sample			13.2
Neighborhood poverty mobility			
Non-poor both times	1788	64.5	11.8
Poor both times	396	17.8	16.7
Moved into a poor neighborhood	158	6.2	19.5
Moved out of a poor neighborhood	277	11.5	12.2
Child age			
4–5 years	653	23.4	12.4
6–7 years	1,045	37.6	12.0
8–10 years	921	39.1	14.8
Child sex			
Boy	1370	52.3	15.8
Girl	1249	47.7	10.3
Child race/ethnicity			
Asian/Pacific Islander	191	11.0	15.4
Black, non-Hispanic	235	5.2	29.8
Latino/a	1235	54.7	12.5
White, non-Hispanic	753	21.9	9.9
More than one race	205	7.2	13.4
Mother's marital status			
Married or cohabiting	2193	84.2	12.9
Separated/divorced/widowed	187	6.9	12.7
Single/never married	239	8.9	16.7
Mother's education			
Less than high school	400	19.0	12.5
High school/GED	459	21.6	11.7
Some college	634	23.3	16.5
College graduate or more	1126	36.2	12.3
Family income			
Non-poor both times	1712	58.4	13.0
Poor both times	454	21.2	13.3
Became poor	185	7.9	15.7
Became non-poor	268	12.6	12.2
Mother neighborhood dissatisfaction	225	9.2	18.6

Note. Family income and neighborhood mobility were measured at the time of both the MIHA and GROW surveys, and other variables were measured at the time of the GROW survey

regression analyses that account for selection into treatment based on observable covariates.

While previous research has linked neighborhood poverty level to asthma among children, we build on this research in some important ways. First, by using multiple waves of geolocated data, we were able to

show that children who *consistently* live in impoverished neighborhoods have a higher risk of asthma than those who lived in low-poverty neighborhoods at either period measured, and this association withstands important controls such as race/ethnicity and household socioeconomic status and a doubly robust

Table 2 Individual-level characteristics by neighborhood poverty mobility, Geographic Research on Wellbeing (GROW) study, CA, USA, 2012–2013, $N = 2619$

Characteristics	Neighborhood poverty mobility			
	Non-poor both times	Poor both times	Moved into a poor neighborhood	Moved out of a poor neighborhood
Child age (%)				
4–5 years	23.6	24.6	19.9	21.9
6–7 years	38.7	36.8	35.7	33.1
8–10 years	37.7	38.6	44.4	45.0
Child sex (%)				
Boy	51.6	50.4	57.1	57.1
Girl	48.5	49.6	42.9	42.9
Child race/ethnicity (%)				
Asian/Pacific Islander	14.7	1.7	5.6	7.3
Black, non-Hispanic	3.0	10.1	9.4	7.2
Latino/a	41.9	84.0	69.5	73.2
White, non-Hispanic	30.7	1.7	10.8	9.7
More than one race	9.6	2.5	4.6	2.6
Mother's marital status (%)				
Married or cohabiting	87.7	73.7	81.5	82.2
Separated/divorced/widowed	6.5	8.0	7.6	6.6
Single/never married	5.7	18.3	11.0	11.3
Mother's education (%)				
Less than high school	11.3	38.4	22.8	30.0
High school/GED	16.5	32.0	33.1	27.8
Some college	23.7	22.4	21.3	23.7
College graduate or more	48.6	7.3	22.8	18.5
Family income (%)				
Non-poor both times	73.1	22.8	40.8	40.4
Poor both times	10.9	47.9	28.7	33.5
Became poor	6.2	12.7	12.9	7.9
Became non-poor	10.0	16.7	17.6	18.2
Mother neighborhood dissatisfaction	5.1	19.4	19.8	10.7

Note. Family income and neighborhood mobility were measured at the time of both the MIHA and GROW surveys, and other variables were measured at the time of the GROW survey

IPTW model. These results are consistent with previous research that show the importance of exposure to neighborhood poverty health outcomes among children and experimental studies such as Moving to Opportunity that stress the negative effects of living in neighborhood poverty for health [44, 45]. In addition, we show that children who are downwardly mobile—those who move into an impoverished neighborhood—have a significantly higher risk of asthma than those who

remained in an advantaged neighborhood. This is a novel finding as we are unaware of other research that has shown that neighborhood downward mobility is related to an increased risk of asthma. While the randomized experimental study Moving to Opportunity showed the positive effects of upward mobility, our study shows the negative effect of downward mobility. Whether this is due to socioeconomic characteristics of the family, stress that may accompany the move,

Table 3 Relative risks from weighted Poisson regression models assessing associations between neighborhood poverty mobility and asthma among children, Geographic Research on Wellbeing (GROW) study, CA, USA, 2012–2013, $N = 2619$

Characteristic	Bivariate models		Demographic model		Socioeconomic model		Final model	
	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
Neighborhood poverty mobility								
Non-poor both times	1.00		1.00		1.00		1.00	
Poor both times	1.41*	1.08–1.85	1.31 ⁺	0.98–1.76	1.38*	1.01–1.88	1.33 ⁺	0.98–1.83
Moved into a poor neighborhood	1.65**	1.14–2.39	1.52*	1.05–2.21	1.57*	1.06–2.32	1.51**	1.03–2.23
Moved out of a poor neighborhood	1.04	0.73–1.46	0.96	0.66–1.39	0.98	0.68–1.42	0.98	0.68–1.42
Child age	1.05	0.98–1.12	1.04	0.96–1.13	1.04	0.96–1.11	1.04	0.97–1.11
Child sex								
Boy	1.53***	1.22–1.92	1.53***	1.22–1.91	1.53***	1.23–1.91	1.54***	1.23–1.92
Girl	1.00		1.00		1.00		1.00	
Child race								
Asian/Pacific Islander	1.56*	1.03–2.34	1.58*	1.05–2.39	1.63*	1.08–2.46	1.64*	1.09–2.47
Black, non-Hispanic	3.02***	2.18–4.18	2.64***	1.85–3.75	2.64***	1.82–3.83	2.63***	1.82–3.82
Latino/a	1.27	0.96–1.67	1.16	0.87–1.56	1.26	0.88–1.79	1.24	0.88–1.76
White, non-Hispanic	1.00		1.00		1.00		1.00	
More than one race	1.36	0.85–2.17	1.30	0.83–2.04	1.30	0.83–2.04	1.29	0.81–2.05
Mother's marital status								
Married or cohabiting	1.00				1.00		1.00	
Separated/divorced/widowed	0.99	0.63–1.53			0.90	0.57–1.41	0.88	0.56–1.38
Single/never married	1.29	0.94–1.78			0.96	0.68–1.37	0.95	0.67–1.34
Mother's education								
Less than high school	1.01	0.73–1.41			0.96	0.65–1.43	0.95	0.63–1.41
High school/GED	0.95	0.69–1.31			0.89	0.60–1.32	0.90	0.61–1.33
Some college	1.34*	1.03–1.73			1.24	0.93–1.65	1.23	0.92–1.64
College graduate or more	1.00				1.00		1.00	
Family poverty								
Non-poor both times	1.00				1.00		1.00	
Poor both times	1.02	0.77–1.35			0.91	0.65–1.28	0.90	0.64–1.26
Became poor	1.21	0.82–1.78			1.09	0.71–1.68	1.06	0.69–1.64
Became non-poor	0.93	0.66–1.32			0.84	0.57–1.25	0.84	0.58–1.24
Mother neighborhood dissatisfaction	1.47*	1.08–2.00					1.34 ⁺	0.97–1.85

RR, relative risk; CI, confidence interval

⁺ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note. Family income and neighborhood mobility were measured at the time of both the MIHA and GROW surveys, and other variables were measured at the time of the GROW survey

environmental characteristics unique to disadvantaged neighborhoods, or other characteristics, is an important avenue for future research.

There are limitations as well, primarily with the measurement of the dependent variables. These variables were self-reported by mothers and were based on recall of a health worker's opinion/diagnosis. Children without

healthcare access, therefore, have less opportunity for this. Evidence from claims data compared to self-reported asthma health utilization suggests that self-reports of asthma are generally reliable [46]. Previous research has consistently shown that there is less access to quality healthcare in impoverished neighborhoods, and this healthcare is critical for provider opinion/diagnosis.

Table 4 Inverse Probability-Weighted Regression Adjustment (IPWRA), Geographic Research on Wellbeing (GROW) study, CA, USA, 2012–2013, $N = 2619$

Items	(1) Unbalanced model relative risk (95% CI)	(2) IPWRA relative risk (95% CI)
A. Child asthma		
Neighborhood mobility		
Non-poor both times	1.00	1.00
Poor both times	1.38* (1.01–1.88)	1.15 (0.69–1.90)
Moved into a poor neighborhood	1.57* (1.06–2.32)	1.85* (1.15–2.99)
Moved out of a poor neighborhood	0.99 (0.68–1.44)	1.10 (0.73–1.64)

* $p < .05$

This likely suggests that our results are conservative. Only 3% of our sample is less than 5 years old, and asthma in school-aged children is easier to identify [47]. In addition, we do not have information on the age of children at the time their mothers were told their child has asthma nor whether they moved multiple times between MIHA and GROW, which may be especially relevant for those families moving into or out of neighborhood poverty. We also note that there may be substantial variation in how neighborhoods affect pathways to asthma over the 4–10 age range that we analyze. However, the additional analysis did not show significant variation in neighborhood effects by age (analysis available upon request). Finally, our model did not test mediators implicated in the theoretical literature such as environmental conditions, indoor air quality, and family stress. It is also worth noting that in addition to movement between tracts, children can experience neighborhood poverty mobility from their neighborhood changing poverty level over time rather than moving. About 1/3 of the children who live in neighborhoods with different poverty levels between surveys are in neighborhoods that underwent change rather than a result of childhood residential mobility. Twenty-five percent of children who “move” into high-poverty neighborhoods and 32% of children who “move” out of high-poverty neighborhoods are actually in the same neighborhood, but the level of poverty changes over time. However, supplemental analysis (available upon request) interacting neighborhood mobility and moving was not significant.

We find evidence that moving to a more impoverished neighborhood seems to matter for children’s health, particularly for asthma. Moving from a non-poor to a poor neighborhood may be a signal that a family is experiencing economic instability or some other stressful event such as a job loss. MIHA was collected just before the

Great Recession, and GROW was collected several years afterward. Poor families and those living in poor neighborhoods were the most vulnerable to the effects of the Recession [48] and experienced the highest rates of unemployment and foreclosure [49, 50]. Downward neighborhood economic mobility, in addition to downward individual/household economic mobility, is another dimension that public health practitioners and policymakers need to address in order to improve children’s health. Nearly a quarter of children in GROW were living in a poor neighborhood at the time of the survey (18% in poor neighborhoods both times plus 6% who moved into one). Given the literature on the negative consequences for children of growing up in a poor neighborhood, this fact should be a high priority for policymakers and public health officials. Additionally, our results show that children who moved to more advantaged neighborhoods have similar health outcomes to children who never live in high-poverty neighborhoods, suggesting avenues for intervention. A large proportion of children are also living in families with incomes below the poverty level (30% at the time of GROW), presenting particularly challenging circumstances if those families are also living in poor neighborhoods, given the high cost of living in California.

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Compliance with Ethical Standards

Disclaimer The American Cancer Society had no role in the design, analysis, or writing of this article.

Patient Consent Obtained.

Ethics Approval This research was approved by the Institutional Review Boards at the University of Texas at Austin, the University of California, San Francisco, and the California Department of Public Health.

Appendix

Table 5 Sensitivity analyses using PROC SURVEYLOGISTIC, Geographic Research on Wellbeing (GROW) study, CA, USA, 2012–2013, $N = 2619$

Characteristic	DV = Asthma	
	OR	95% CI
Neighborhood poverty mobility		
Non-poor both times	1.00	
Poor both times	1.47*	1.01–2.14
Moved into a poor neighborhood	1.72*	1.06–2.82
Moved out of a poor neighborhood	0.99	0.64–1.53
Child age	1.05	0.97–1.14
Child sex		
Boy	1.66***	1.28–2.14
Girl	1.00	
Child race/ethnicity		
Asian/Pacific Islander	1.80*	1.11–2.91
Black, non-Hispanic	3.40***	2.13–5.42
Latino/a	1.31	0.88–1.95
White, non-Hispanic	1.00	
More than one race	1.36	0.80–2.31
Mother's marital status		
Married or cohabiting	1.00	
Separated/divorced/widowed	0.86	0.51–1.46
Single never married	0.95	0.61–1.46

Table 5 (continued)

Characteristic	DV = Asthma	
	OR	95% CI
Mother's education		
Less than high school	0.97	0.601–1.55
High school/GED	0.89	0.56–1.41
Some college	1.30	0.92–1.84
College graduate or more	1.00	
Family poverty		
Non-poor both times	1.00	
Poor both times	0.89	0.60–1.34
Became poor	1.11	0.66–1.88
Became non-poor	0.82	0.52–1.30
Mother would move	1.07	0.93–1.23

OR, odds ratio; CI, confidence interval

*** $p < 0.001$

Note. Family income and neighborhood mobility were measured at the time of both the MIHA and GROW surveys, and other variables were measured at the time of the GROW survey

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