Neighborhood Socioeconomic Change over Time and Young Children's Obesity

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Numerous studies in the last ten years have investigated correlates of obesity among young children. Increasing attention is paid to the influence of neighborhood environments – social and physical —on a variety of young children's health outcomes. This work identifies resource-based and community-based mechanisms that make difficult the maintenance of healthy weights for young children in socioeconomically depressed areas, and shows consistently higher rates of obesity in more deprived areas. None of this work, however, has explored whether *changes* in the characteristics of neighborhoods over time is related to children's risk of obesity. Utilizing restricted geo-coded data from the Early Childhood Longitudinal Study (Kindergarten) (N=17,180), we utilize multilevel logistic regression models to show that neighborhood change measures on their own have little association with obesity for children. However, we uncover evidence of a 'poverty paradox' whereby poor young children in neighborhoods which have improved in overall socioeconomic status since 1990 are at higher risk of obesity, as are wealthier children in neighborhoods which have declined in overall socioeconomic status since 1990. Our findings suggest that not everyone's health benefits from improvements in the socioeconomic status of neighborhoods, despite long-standing work showing the relationship with neighborhood poverty to a host of negative outcomes for children. Our work also shows the importance of considering neighborhood context not just at one point in time, but rather considering neighborhoods as dynamic agents whose direction of change might influence residents' wellbeing.

Introduction

Young children's increasing overweight and obesity in the United States has received considerable scholarly attention over the past decade. Despite a recent stabilizing in the upward obesity trend for children and adolescents in the U.S., child overweight remains a significant public health issue, with 31.7% of children ages 2-19 overweight or obese (Ogden et al., 2010), and significant and increasing disparities by socioeconomic status (SES) (Singh et al., 2010a) and race/ethnicity (Kimbro et al.,2007; Whitaker & Orzol, 2006). In addition to research documenting the increase in overweight and obesity for children, a large amount of current medical research aims to develop and evaluate interventions for preventing and reducing children's overweight (for a recent review, see Hesketh & Campbell, 2010). In this paper, we argue that structural conditions in children's neighborhoods influence obesity above and beyond individual- and family-level factors – and this means that policies need to take structure into account, particularly when targeted at lower-socioeconomic status children living in neighborhoods with multiple structural barriers to good health. Using a unique restricted, geocoded dataset (the Early Childhood Longitudinal Study, Kindergarten wave, 2010-2011 data) we take advantage of information on children, and their neighborhoods over a twenty-year period (1990-2010), to test whether changes in the overall socioeconomic status of neighborhoods over time influences child obesity.

The most recent estimates of overweight among young children in the United States indicate that 21.2% of children ages 2-5 are overweight (>=85th percentile on the CDC's sex-specific BMI-for-age growth charts), and 35.5% of children ages 6-11 are overweight. Considering children at or above the 95th percentile, 10.4% of young children ages 2-5 are obese, and 19.6% of children ages 6-11 are obese (Ogden et al., 2010). Although rates of overweight and obesity are high overall for U.S. children, large racial/ethnic differences exist, particularly between minority children and Non-Hispanic white children. Among Hispanic children, 27.7% of children ages 2-5 are overweight, as are fully 42.6% ages 6-11; contrasted with 17.4% of Non-Hispanic white children ages 2-5, and 34.5% ages 6-11; and 26.0% of black children ages 2-5, and 37.6% ages 6-11 (Ogden et al., 2010). In terms of racial/ethnic differences in obesity (at or above the 95^{th} percentile), differences are considerably smaller - 9.1% of non-Hispanic white children ages 2-5 are obese, compared to 8.7% of black children and 14.2% of Hispanic children.

Multiple hypotheses for racial and ethnic disparities in young children's overweight status have been proposed (Yancey & Kumanyika, 2007) and research findings have centered largely on group differences in socioeconomic status (SES) (Whitaker & Orzol, 2006; Singh et al., 2008), cultural differences between groups (Contento et al.,2003), and differences in parenting surrounding diet and physical activity (Rhee, 2008). Although many of these studies account for a wide range of proximate factors known to be associated with obesity, to our knowledge, none has been able to completely account for these disparities in child obesity by SES. Scholars interested in the determinants of young children's weight status have recently focused on neighborhood environments as catalysts for healthy and unhealthy trajectories in weight, raising the question of whether differing neighborhood contexts might drive SES disparities in child obesity.

Neighborhoods and Child Obesity

Beginning in the late 1990s, researchers found links between area deprivation measures and children's weight status (Jansen & Hazebroek-Kampschreur, 1997; Booth et al., 1999; Kinra et al., 2000), although methodological considerations limited the conclusions that could be drawn from these studies. More recent work with new methods also finds links between area measures and child obesity, although the factors predicting obesity may vary by SES of the neighborhood (Edwards et al., 2010). Three recent studies documented a link between neighborhood SES and obesity in school-aged children (Grow et al., 2010; Singh et al., 2010b; Kimbro and Denney 2013). Grow et al. (2010) find, using a wide array of Census measures at the tract level in King County, WA, that for insured children aged 6-18, less social advantage is associated with higher rates of obesity. Utilizing nationally-representative data but subjective, parent-reported neighborhood information, Singh et al. (2010b) find that overweight and obesity is higher among children aged 10-17 in neighborhoods that parents rate as unsafe or as having poor conditions. Finally, Kimbro and Denney (2013) find evidence that Census measures such as neighborhood poverty and neighborhood levels of education are associated with child obesity, after accounting for a host of individual and family factors.

Explanations for the influence of neighborhood environments on child health outcomes generally center on two main theoretical frames, both of which capitalize on the inherent social inequality in neighborhoods in the United States – first, that neighborhoods enjoy differential levels of resources, which impact children through accumulating advantages or disadvantages; and second, that neighborhoods are comprised of different types of residents with different social norms, which impact the behaviors and opportunities of residents, including children (Shonkoff & Phillips, 2000; Jencks & Mayer, 1990).   The theories are complementary, as it is likely that children’s neighborhood experiences are influenced both by the structural advantages or disadvantages (e.g. resources) in their neighborhoods as well as by the demographic composition and social characteristics of local residents. Although there is debate about whether neighborhoods may be more influential for older children and adolescents, even very young children interact with a variety of social institutions in neighborhood environments and in fact likely spend more of their time at home experiencing their neighborhood environment (Shonkoff & Phillips, 2000; Klebanov et al., 1997). Our interest lies in developing these theories to ascertain whether *changes* in neighborhood resources and the aggregate social characteristics of residents over time might be linked to child obesity. In other words, we know that static neighborhood characteristics (e.g. percent of residents in poverty at a given Census year) are associated with child outcomes including obesity, but we argue that it is also possible that the shape of neighborhood characteristics over time might also play an important role.

Explanations for the relationship between neighborhood socioeconomic status and child obesity focus on aspects of the physical or built environment (neighborhood resources) as well as the social environment (collective socialization). In terms of the built environment, higher SES neighborhoods generally have higher-quality green space and parks, better lighting, fewer fast food establishments, and better access to recreational facilities, which encourages physical activity for children (Carroll-Scott et al., 2013). Higher-SES neighborhoods also may have denser social ties less crime, and higher perceptions of neighborhood safety, which also improves children's physical activity (Carroll-Scott et al., 2013; Datar et al., 2013).

The Dynamics of Neighborhood Change

While static neighborhood characteristics have been associated with a variety of child development outcomes, most current models of neighborhood effects on children fail to take into account the dynamic ways that neighborhoods can change over time. Although scholars have long been interested in the dynamics of neighborhood change, methodological difficulties have limited this kind of work, such as insufficient samples within neighborhoods, imprecise theoretical models, and geographic narrowness—such as studying only one city. These issues, as well as the fact that there are not many good datasets available with which to assess the impact of neighborhoods on children's outcomes, mean that we have very little information to date on how neighborhood change over time might impact children.

A recent study examined whether a focus on residential mobility from neighborhood to neighborhood matters when considering the impact on child wellbeing (Jackson and Mare, 2007), and concluded that it generally does not because children do not move to radically different neighborhoods in terms of SES. Even if mobility does not bring analytic leverage when studying children, the long-term trends in neighborhoods might. One could hypothesize that neighborhoods in a period of long-term decline could intensify in their effects on child health and wellbeing over time – and consequently, neighborhoods in a period of improvement might provide an additional boost to child development. Neighborhoods in decline tend to lose affluent residents; while those on the upswing gain affluent residents. This influx of affluent, potentially more-educated residents could have an impact on children's health or social behaviors, according to a collective socialization model. Similarly, neighborhoods in decline may lose important resources like grocery stores or libraries, which would have a negative impact on child wellbeing, according to an institutional resources model. It is also necessary to distinguish between change that occurs over time in one neighborhood – and changes in surrounding neighborhoods that may impact the relative experiences in that neighborhood (Bursik and Grasmick 1992; Crowder and South 2008). For example, the first kind of change would refer to an increasing proportion of residents in poverty; but the second kind of change would be if, relative to other nearby neighborhoods, a neighborhood experienced a significant change in poverty which would either increase or decrease its difference from the other neighborhoods. The first type of change is absolute; the second, relative.

As described above, many factors involved in how neighborhoods affect child outcomes such as institutional resources, relationships, and norms have been studied extensively (Leventhal and Brooks-Gunn, 2001), but tend to observe effects at one point in time. This approach can be limiting since neighborhoods are always changing and families often do not stay in one neighborhood for the entire period of one's childhood. In fact, neighborhoods change due to action by residents, macro-structural changes, and public policy initiatives, and many American children live in several different neighborhoods throughout childhood which in turn may influence the way neighborhoods affect child well-being (Pebley and Sastry, 2003; Sastry, Ghosh-Dastidar, Adams, and Pebley, 2006). By treating neighborhoods as static, researchers could be missing unmeasured characteristics associated with neighborhoods that might truly account for the neighborhood effects being observed (Leventhal and Brooks-Gunn, 2000). As Leventhal and Brooks-Gunn (2001) suggest, it is possible that despite research revealing that neighborhood affluence has consistent associations with children's and adolescents' achievement-related outcomes this pattern of findings could change once studied over time. Furthermore, tracking changes in neighborhood over time could help uncover the extent to which neighborhood characteristics affect children's outcomes.

Although studies have acknowledged the potential importance of neighborhood change in relation to child well-being, research is limited with regards to its direct examination (Sastry et al., 2006). There are two ways in which children experience residential change over time (Jackson and Mare, 2007; Leventhal and Brooks-Gunn, 2001). The first is through residential mobility, or the process by which families move from one neighborhood to another, and the second is through internal neighborhood processes such as urban redevelopment and gentrification. Jackson and Mare (2007) present a rare case in which both movement between neighborhoods and change in characteristics of neighborhoods over time have been studied (2007). Using the Los Angeles Family and Neighborhood Survey (LA FANS) and the Child Development Supplement (CDS) of the Panel Study of Income Dynamics (PSID), the authors found that residential mobility plays a significant role in children's exposure to neighborhood poverty throughout childhood. At the same time, their results suggest that neighborhood change does not contribute substantially to the variation in neighborhood poverty, although the LA FANS study tracks change over a relatively short period of time.

Residential mobility studies have varied in the ways they have been conducted. Some involve retrospective residential histories such as LA FANS and PSID-CDS have been used, while others have used experimental designs such as housing mobility programs (e.g. the Gautreaux Project and the Moving to Opportunity (MTO) Program) (Leventhal and Brooks-Gunn 2003; Leventhal and Brooks-Gunn 2000; Timberlake, 2007). Timberlake (2007) used the former approach, using the PSID to observe changing neighborhood characteristics for residentially non-mobile children and differences in destination versus origin neighborhood SES for residentially mobile children. He found that non-mobile white children on average experience greater improvement in neighborhood SES than black and Latino children. Non-mobile white children experience positive average yearly change on all measures of neighborhood SES; in contrast, non-mobile children from all 5 non-white groups experienced lower levels of improvement or even negative change in neighborhood SES. Another study focused on adults, using MTO data, found modest but important improvements in weight status and diabetes risk when low-income mothers with children moved from a high-poverty neighborhood to a lower-poverty neighborhood (Ludwig et al., 2011).

Neighborhoods can also change via internal neighborhood processes such as action by residents, macro-structural changes, and public policy initiatives including urban redevelopment and gentrification. A qualitative study on Early Head Start (EHS) – a program which planned to renovate and later dismantled several Pittsburgh public housing communities – found that such programs may be detrimental to the residents (McAllister, Thomas, Wilson, and Green 2009). Families who had been relocated to another community or who stayed behind in nearby neighborhoods discussed the negative impacts on child development and the experience of root shock or the fundamental disruption in a family's emotional ecosystem, demonstrating the negative impact of neighborhood change. In addition, a review of the literature on gentrification and urban children's well-being has found interesting results regarding the effects of this form of neighborhood change (Formoso, Weber, and Adkins 2010). They find that affluent neighbors may be better able to secure high-quality services for neighborhood children and that income mixing in schools has resulted in gains in achievement for children from low-income families, but has also shown that an influx of affluent neighbors reduces the number and quality of institutional resources available to poor children. Formoso et al. (2010) comment that residential stability is positively related to local friendship networks, community social organization, intergenerational closure, reciprocated exchange, and the informal social control of children; therefore, gentrification could disrupt some of these networks. Another study that followed socioeconomic characteristics of neighborhoods over time is the Grigsby-Toussaint et al. (2010) study. Data from the U.S. Census (1970-2000) was used to categorize neighborhoods as stable diversity, emerging low income, emerging high income, desertification, and emerging bipolarity, and along with data from the Chicago Childhood Diabetes registry, was used to study whether patterns in socioeconomic characteristics in Chicago over time are associated with neighborhood distribution of youth diabetes risk. Children living in neighborhoods of entrenched poverty (desertification neighborhoods) were more likely to develop Type-2 diabetes.

It is also possible that whether or not neighborhood socioeconomic change (an improvement or a decline) is associated with child outcomes depends on the child's family socioeconomic status as well. In other words, family SES may moderate the impact of a change in neighborhood SES. A poor child in an improving neighborhood may be crowded out of institutional resources (Formoso et al. 2010) such as parks, playgrounds, or more expensive grocery stores. Conversely, family SES may impact whether a child in a declining neighborhood may be kept indoors out of fear of crime or victimization. Thus, in this paper we seek to test not only how neighborhood socioeconomic change is associated with child obesity, but also how family-level SES may moderate the impact of changes in neighborhoods over time.

Hypotheses

The existing research suggests that the structural and social characteristics of children's neighborhoods exert an impact on their risk of obesity, but to our knowledge, no study has yet investigated whether neighborhood socioeconomic change is associated with child obesity. A first set of hypotheses addresses if and in what ways neighborhood change matters for child obesity risk after accounting for more proximate individual level factors: (H1) children living in neighborhoods which have experienced an increase in neighborhood poverty, a decrease in median income, and an increased in concentrated disadvantage since 1990 will exhibit a higher risk of obesity. Next, (H2 and H3) ask whether the influence of neighborhood socioeconomic change on child obesity differs based on family SES. Here, we develop two contrasting hypotheses. First, H2 states that there will be additive effects, such that for a child in a poor family, living in a declining neighborhood will present additional risk; and conversely, for a child in a non-poor family, living in an improving neighborhood will present additional benefit in terms of the risk of obesity. Finally, H3 states that the effects will be paradoxical; such that a decline in neighborhood socioeconomic status increases the risk of obesity for a non-poor child most; and conversely, that an improvement in neighborhood socioeconomic status would increase the risk of obesity for a poor child most.

Data and Methods

This study uses restricted, geo-coded data from the spring kindergarten wave of the Early Childhood Longitudinal Study-Kindergarten Class of 2010-2011 (ECLS-K), which is a nationally-representative sample of U.S. children who were in kindergarten in 2010-2011. Currently data is available only for the fall and spring Kindergarten waves. For this paper, we utilize data from the fall wave if the child had valid height and weight data, or the spring wave if the height and weight data were available in the spring wave but not the fall wave. In the analysis, we control for the wave in which the child's height and weight data are drawn. A total of 17,180 children had at least one valid height and weight measurement and a valid 2010 Census tract. To assess neighborhood change, we utilized the Neighborhood Change Database (NCDB) which allows us to standardize Census tracts over time. Using 2010 Census tract boundaries, we assess socioeconomic measures in 1990, 2000, and 2010 and link them to the ECLS-K data.

Variables

Our outcome measure, whether a child is obese, is based on the CDC's gender-specific weight-for-age guidelines, and children were weighed and measured by trained ECLS-K interviewers. Children at or above the 95th percentile according to the CDC's guidelines are classified as obese. We focus on obesity rather than overweight because it reflects a more severe health status for children and is related more strongly to health problems in adolescence and adulthood than child overweight (Dietz 1998).

Individual-level variables include the child's race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, non-Hispanic Asian, and non-Hispanic other), whether one or both parents were born outside the U.S., child's age in months, the child's gender (1=male), the mother's age, whether the child was breastfed, whether the households receives food stamps (1=yes), whether the child receives free or reduced lunch at school, the number of siblings in the household, family structure (two-parent family, single-mother family, and other family type), and region of residence. All of these characteristics have been linked to child obesity in prior studies (e.g. Singh et al., 2008).

To measure family SES, we utilize the composite measure provided by the ECLS, which incorporates household income, both parents' occupational prestige, and both parents' education (this measure incorporates the custodial parent's data if only one parent is present in the household). Each component is standardized, and the resulting z-scores are added and divided by the number of components to yield an overall standardized measure of SES. In other words, a value of 1 indicates a family is one standard deviation higher in SES than the mean.

Neighborhood-level variables come in two forms. First, we include the 2010 (static) version of the variable. Second, using the neighborhood change database we are able to include measures that capture increasing or decreasing patterns of disadvantage over a 20-year period (1990-2010) and over a 10-year period (2000-2010). We include both individual measures of neighborhood disadvantage—percent poverty in the neighborhood and median income in the neighborhood—as well as an index of concentrated disadvantage for the neighborhood. The concentrated disadvantage index is created based on the first dimension of a principal components factor analysis on the percent of adults in the census tract living below the poverty line, the percent of households receiving public assistance, the percent of adult residents who are unemployed, and the percent of female-headed households with children.

Missing Data

Approximately 16% of children remaining in our analytic sample are missing data on one or more measures of interest. Children missing data were more often non-Hispanic black or Hispanic, poorer, lived with single mothers, and were more likely to have foreign-born parents. Given the evidence that our missing data are not missing completely at random and may be conditioned by other observed covariates, standard procedures such as listwise deletion would be inappropriate (Allison 2002). Instead, we use multiple imputation procedures in Stata (Royston 2005) to estimate values for our multivariate analyses. During imputation, a diverse set of predictors estimate five sets of probable values for each missing value. The resulting five data sets include a random component based on draws from the posterior predictive distribution of the missing data under a posited Bayesian model and provide unbiased estimates of variance (Allison 2002). Models estimated without imputation provide results very similar to the imputation results (available upon request).

Estimation

To test the effects of neighborhood conditions on odds of child obesity we estimate multi-level logistic regression models (Guo and Zhao 2000; Rabe-Hesketh and Skrondal 2008) within Stata software (StataCorp 2012). The models treat level-1 children as nested within level-2 census tracts.

All models utilize maximum likelihood estimation with adaptive quadrature (Rabe-Hesketh and Skrondal 2008), adjusting for clustering by neighborhood, different sample sizes for level-1 and level-2 units, heteroscedastic error terms, and varying numbers of cases within level-2 units – all problems that otherwise downwardly bias estimated standard errors (Raudenbush and Bryk 2002). First, in a logistic regression model at level-1, the logged odds of obesity for child *i* in neighborhood *j* (Y_{ij}) is a function of family socioeconomic status (SES_{ij}) and k control variables (X_{kij}):

$$\ln [\text{Prob}(Y = 1) / \text{Prob}(Y = 0)] = \beta_{0j} + \beta_{1j} * SES_{ij} + \sum\beta_{kj} * X_{kij} \qquad (1)$$

With all predictors centered at their means, β_{0j} represents the logged odds of obesity, β_{1j} the effect of family SES, and β_{kj} the effect of the specified controls on the logged odds of obesity for each neighborhood *j*.

We evaluate the relevance of neighborhood-level factors by entering them one at a time (and a level-2 error component u_j) along with the level-1 predictors. Equation 2 represents the logged odds of obesity, allowing the odds to vary across neighborhoods, and includes family SES, k control variables, and a neighborhood-level indicator (for example, concentrated disadvantage (CD_j)) as a level-2 explanatory variable:

$$\ln [\text{Prob}(Y = 1) / \text{Prob}(Y = 0)] = \beta_{0j} + \beta_{1j} * SES_{ij} + \sum\beta_{kj} * X_{kij} + \beta_{2j} * CD_j + u_j \qquad (2)$$

Finally, we specify cross-level interactions. A set of level-2 equations treats the level-1 random effects as outcomes and treat neighborhoods rather than children as the units of analysis.

With neighborhood measures (C_{mj}) for concentrated disadvantage, poverty, median income, and changes from 1990 to 2010 and from 2000 to 2010 as predictors of the β coefficients, the level-2 equations are as follows:

$$\beta_{0j} = \gamma_{00} + \Sigma\ \gamma_{0m} * C_{mj} + u_{0j}\ , \quad (3a)$$

$$\beta_{1j} = \gamma_{10} + \Sigma\ \gamma_{1m} * C_{mj} + u_{1j}\ , \quad (3b)$$

$$\beta_{kj} = \gamma_{k0} \quad (3c)$$

The γ_{0m} and γ_{1m} coefficients represent the effects of the aggregate variables on the neighborhood-specific level of child obesity and the effect of family SES on child obesity. The model treats the intercept (β_{0j}) and the family SES effect (β_{1j}) as random and the effects of the control variables as fixed. The error terms (u_j, u_{0j}, u_{1j}) are assumed to be multivariate normally distributed, each with a mean of 0 and nonzero variances and covariances. We report all regression results as odds ratios (OR).

Results

Table 1 presents descriptive statistics for the full sample, and by the child's obesity status. From the full sample, 8% of children are classified as obese (greater than 95^{th} percentile). The sample is approximately half Non-Hispanic White, 13% Non-Hispanic Black, 24% Hispanic, 4% Asian, and 6% "Other" race/ethnicity (largely multiracial children). Fully 37% of the children have at least one foreign-born parent, 68% live in two-biological parent households (married or cohabiting), and 23% live with a single mother. About 30% of the sample currently receives SNAP, and 63% of the children were ever breastfed. In terms of how obese and healthy weight children differ across individual-level characteristics, obese children are less likely to be male, more likely to be Black or Hispanic, more likely to have a foreign-born parent, have lower composite SES, and less likely to have two biological parents in the household. Obese children are also more likely to live with a single mother, to receive SNAP, and less likely to have been breastfed. Turning to the neighborhood characteristics, obese children on average live in neighborhoods with higher levels of poverty, a slightly smaller increase in median income between 2000-2010, lower median income in 2010, a smaller increase in median income between 1990-2010, and a higher degree of concentrated disadvantage.

Table 2 provides information on the impact of both individual- and neighborhood-level predictors absent any cross-level interactions. At the individual-level, Model 1 and the subsequent models show that many previously established relationships are present. Black and Hispanic children, relative to whites, have higher odds of obesity, as do older children and children with a foreign born parent. The odds of obesity decline as number of siblings increases and children who were breastfed have lower odds of obesity at kindergarten. Perhaps most important, family SES exerts a powerful and negative association with the odds of child obesity. That is, a one standard deviation increase in SES is associated with a 25% reduction in the odds of child obesity.

Models 2 through 7 add one neighborhood-level covariate at a time and show that many of the individual-level associations are robust to the inclusion of these covariates. Outside of median income, neither the static or changing levels of the neighborhood covariates show significant relationships with child obesity after accounting for important individual-level covariates. For median income, however, there is a significant negative association. For higher median income neighborhoods in 2010, the odds of child obesity decline.

(Table 2 about here)

Table 3 presents results addressing whether family SES moderates the impact of neighborhood characteristics on child obesity. The results in Table 3 suggest that exploring changing neighborhood conditions and their associations with child obesity are worth considering beyond the direct impacts of neighborhood change. In other words, we see some evidence in Table 3 that the influence of neighborhood SES change on child obesity differs by family SES. For example, Model 2 shows that the impact of an increase in neighborhood poverty between 1990-2010 is higher for children at higher levels of SES. In other words, children in higher-SES families who live in neighborhoods which are "declining" in terms of the percent of residents in poverty are at heightened risk of obesity. The same is not true for children in lower-SES families, for whom the highest risk of obesity occurs when neighborhood are "improving" in terms of the percent of residents in poverty.

The same pattern is exhibited across the models for median income changes and changes in concentrated disadvantage. Focusing on Model 4, neighborhoods that experienced marked improvements in median income from 1990 to 2010 associated with declines in child obesity for children living in households with mean or better levels of SES. However, for children in lower SES families, improving neighborhood median income associated with an increase in the odds of obesity. A similar but less pronounced pattern is observed for change in concentrated disadvantage from 1990 to 2010. Figures 1 and 2 show these trends. Again, as neighborhoods improved on the concentrated disadvantage index, children in mean or better SES families experienced declines in the odds of obesity while children in lower SES families experienced increases in the odds of obesity.

(Table 3, Figure 1, Figure 2 about here)

Discussion (In progress!)

As more research demonstrates the small but significant impacts on child obesity from neighborhood characteristics (Kimbro and Denney 2013; Grow et al., 2010; Singh et al., 2010b), and a growing consensus is developing which de-emphasizes individual-level interventions, understanding of how and why these contextual factors are related to obesity is important. Virtually all studies of neighborhood characteristics and obesity (and the vast majority of those focused on neighborhoods and health more generally) focus on neighborhood characteristics in a cross-sectional, static framework. Studies which follow residents from one neighborhood to another generally find small improvements in health behaviors and outcomes when residents move to lower-poverty neighborhoods (e.g., Ludwig et al., 2011). Our interest is in how changes in *neighborhoods themselves* over time might be associated with child obesity. In other words, are neighborhoods which are improving or declining better contexts for children's health? And finally, does family SES determine whether these changing contexts are positive or negative for children's health?

Our findings are counterintuitive. Although we hypothesized that changes in neighborhood characteristics alone would impact child obesity, we do not find much evidence of this. Median income in 2010 was the only predictor which mattered above and beyond individual- and family-level characteristics in the non-interacted models. The fact that percent of neighborhood residents in poverty in 2010 is not a significant predictor of child obesity is puzzling, given the small but significant impact of neighborhood poverty found in prior studies using different national data (e.g., Kimbro and Denney 2013). It is conceivable that this data, which was collected after the depths of the Great Recession, does not show an association with neighborhood poverty and child obesity because poverty levels overall rose during this period.

We do, however, find strong support for our hypothesis that family SES would moderate the impact of neighborhood change on child obesity – specifically, our hypothesis that family and neighborhood SES would have opposite associations with child obesity. For all three neighborhood SES change measures, percent of residents in poverty, median income, and concentrated disadvantage, we find that lower-SES children's risk of obesity increases in neighborhoods which are "declining," and that conversely, higher-SES children's risk of obesity increases as neighborhoods "improve." Explanations for this finding are beyond the scope of our study, but it seems reasonable to conclude that changes in institutional resources and in collective socialization or norms would occur as neighborhoods shift in SES characteristics over time. These changes could result in feelings of alienation for residents whose family SES does not match the direction of the changes in the neighborhood. Evidence that improvements in institutional resources related to healthy living are not shared equally among residents lends support to this hypothesis (Formoso et al. 2010). Finally, it is important to note that our measures are entirely objective, Census measures of neighborhood change – when what may really matter for residents' outcomes are their own perceptions of that change (Hwang and Sampson 2014), which may or may not match with Census data.

The paper is not without limitations. Although we are utilizing three decades of Census data to assess neighborhood change, the study is still cross-sectional in our outcome. We do not know how long the children's families have resided in each neighborhood, or how much time the children and their families spend there. We do not know about other contexts they may experience which may also impact obesity risk. We also are not able to tap into why we might see this counterintuitive result of a paradoxical relationship between family SES and changes in neighborhood SES. However, we believe that given the consistency with which we find this paradoxical relationship across models and measures, our findings are worth pursuing further.

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Table 1: Descriptive Statistics for the Full Sample and by Weight Change in Kinder, ECLS-K 2011

	Full Sample	Healthy Weight	Obese (8%)	
	N = 17,180	N = 15,760	N = 1,420	
	Mean or %	Mean or %	Mean or %	
Child's age in mos	74.53	74.53	74.65	
Child is male	0.52	0.53	0.50	*
Child's race/ethnicity				
Non-Hispanic White	0.53	0.57	0.44	***
Non-Hispanic Black	0.13	0.13	0.16	*
Hispanic	0.24	0.21	0.31	***
Asian	0.04	0.04	0.03	**
other race/ethnicity	0.06	0.05	0.07	**
Nativity				
One or both parents foreign-born	0.37	0.35	0.41	***
Socioeconomic Status				
Composite SES (standardized)	-0.08	-0.01	-0.27	***
Family structure				
Two bio parents in hhold	0.68	0.70	0.63	***
Single mother	0.23	0.21	0.28	***
Other family type	0.09	0.09	0.10	
Number of siblings in hhold	1.55	1.58	1.46	**
Family receives SNAP	0.30	0.28	0.35	***
Child was breastfed	0.63	0.65	0.56	***
Region of the U.S.				
Northeast	0.15	0.15	0.15	
Midwest	0.23	0.24	0.21	+
South	0.39	0.38	0.43	**
West	0.23	0.24	0.20	*
Neighborhood Measures				
Change in % Pov, 2000-2010	0.08	0.08	0.08	
% Pov, 2010	0.14	0.14	0.17	***
Change in % Pov, 1990-2010	0.09	0.09	0.09	
Change in median income, 2000-2010	0.26	0.26	0.25	*
Median income, 2010 ($10K)	6.64	6.72	5.87	***
Change in median income, 1990-2010	3.49	0.80	0.74	***
Change in condis, 2000-2010	-0.39	-0.39	-0.45	
Concentrated Disadvantage (std)	0.00	-0.02	0.19	***
Change in condis, 1990-2010	-0.50	-0.49	-0.58	

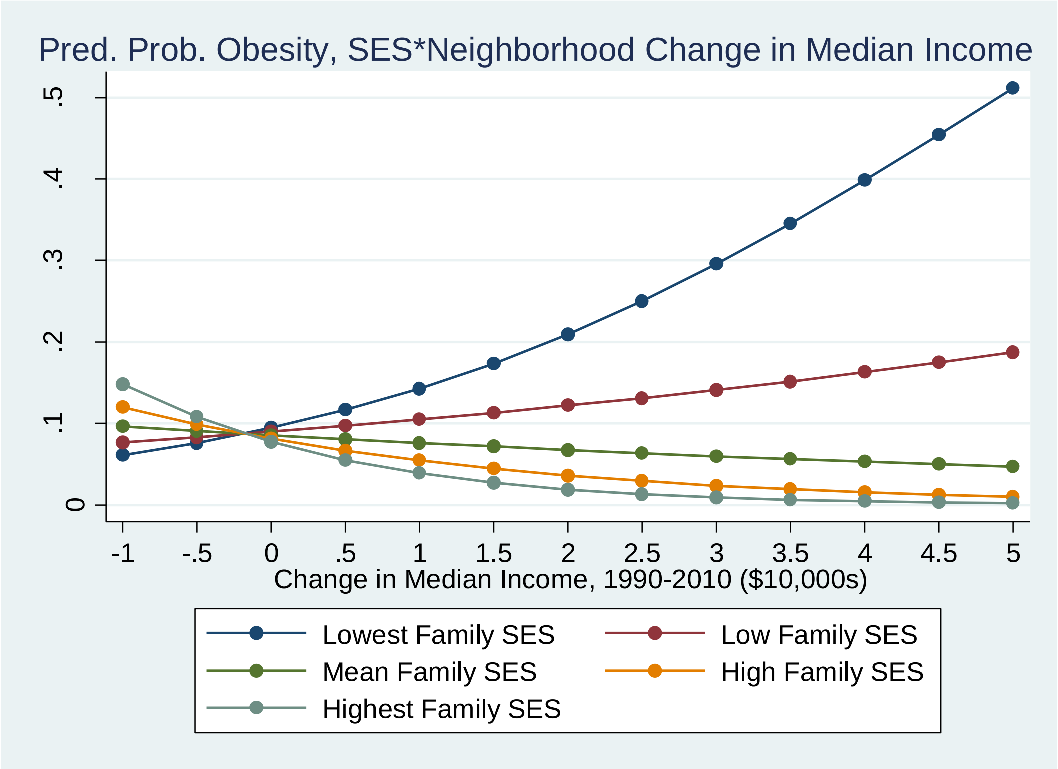
Note: Statistical tests are for differences from healthy weight children. All sample sizes rounded to the nearest 10.

+ p<10; * p<.05; ** p<.01; *** p<.001

Table 2: Logistic Regressions Predicting Child Obesity														
	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7	
	OR		OR		OR		OR		OR		OR		OR	
Child race/ethnicity														
(White)														
Black	1.29	**	1.29	**	1.29	**	1.24	*	1.24	*	1.28	*	1.29	*
Hispanic	1.83	***	1.83	***	1.83	***	1.79	***	1.78	***	1.83	***	1.83	***
Asian	0.89		0.89		0.89		0.92		0.92		0.89		0.89	
Other	1.75	***	1.75	***	1.74	***	1.75	***	1.74	***	1.74	***	1.75	***
Child is male	0.91	+	0.90	+	0.90	+	0.91	+	0.91	+	0.91	+	0.90	+
Age in months	1.02	***	1.02	***	1.02	***	1.02	***	1.02	***	1.02	***	1.02	***
Parent(s) foreign-born	1.18	*	1.18	*	1.18	*	1.17	*	1.17	*	1.18	*	1.18	*
Family Structure														
(2 bio parents)														
Single parent	1.14	+	1.14	+	1.14	+	1.13		1.13		1.14	+	1.14	+
Other family structure	0.96		0.96		0.96		0.95		0.95		0.96		0.96	
Number of siblings	0.91	**	0.91	**	0.91	**	0.91	**	0.91	**	0.91	**	0.91	**
Child was breastfed	0.78	***	0.78	***	0.78	***	0.79	***	0.79	***	0.78	***	0.78	***
Family receives SNAP	0.92		0.92		0.92		0.90		0.90		0.92		0.92	
Child free/reduced lunch	1.15	+	1.15	+	1.15	+	1.13		1.13		1.15	+	1.15	+
Region														
(Northeast)														
Midwest	0.91		0.91		0.91		0.89		0.88		0.92		0.91	
South	1.10		1.11		1.10		1.07		1.07		1.11		1.10	
West	0.84	+	0.84	+	0.84	+	0.83	*	0.83	+	0.84	+	0.84	+
BMI from fall only	0.91		0.91		0.91		0.91		0.89		0.91		0.91	
SES (composite)	0.75	***	0.75	***	0.75	***	0.78	***	0.78	***	0.76	***	0.76	***
Neighborhood Measures														
Population Density (ln)	1.00		1.00		1.01		1.00		1.00		1.00		1.00	
Change in % Pov, 2000-2010			0.90											
% Pov, 2010			1.02		1.08									
Change in % Pov, 1990-2010					0.75									
Change in median income, 2000-2010							1.11							
Median income, 2010							0.96	**	0.96	**				
Change in median income, 1990-2010									1.00					
Change in condis, 2000-2010											1.04			
Concentrated Disadvantage											1.01		1.00	
Change in condis, 1990-2010													1.01	
_cons	0.016	***	0.016	***	0.015	***	0.021	***	0.022	***	0.016	***	0.016	***
+ p<10; * p<.05; ** p<.01; *** p<.001														

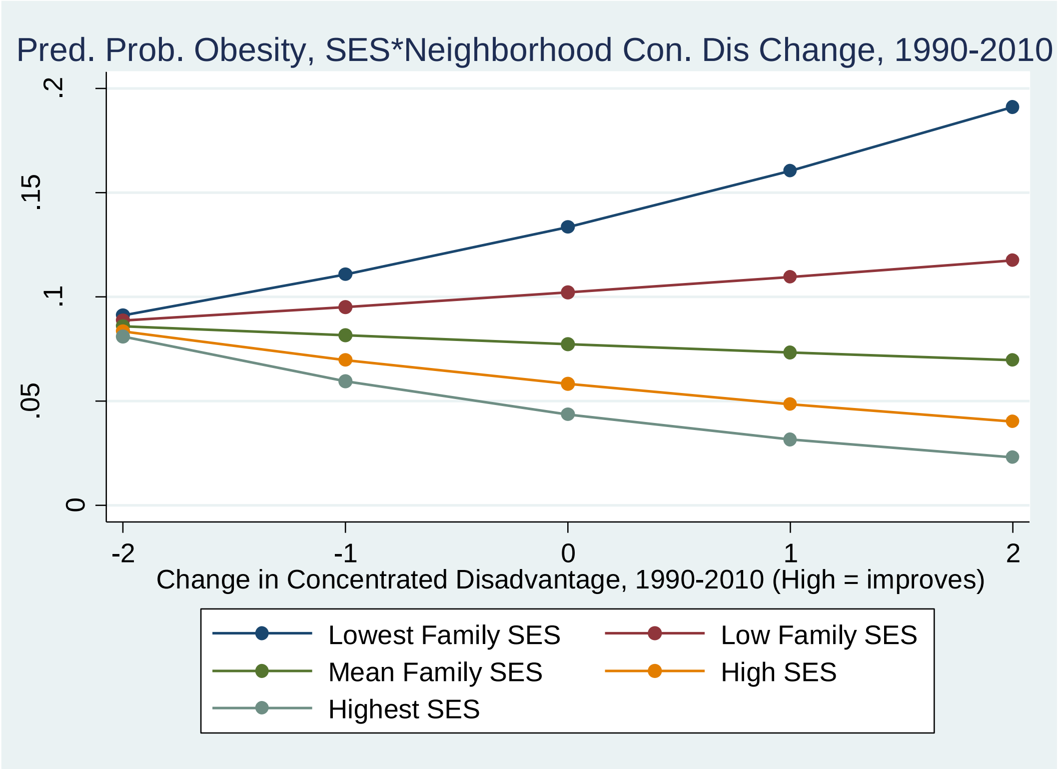
Table 3: Family SES and Neighborhood SES Interactions												
	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	OR		OR		OR		OR		OR		OR	
Child race/ethnicity												
(White)	1.00		1.00		1.00		1.00		1.00		1.00	
Black	1.29	**	1.29	**	1.24	*	1.23	*	1.28	*	1.29	*
Hispanic	1.84	***	1.83	***	1.79	***	1.79	***	1.83	***	1.83	***
Asian	0.90		0.89		0.92		0.91		0.89		0.89	
Other	1.75	***	1.74	***	1.74	***	1.73	***	1.74	***	1.74	***
Child is male	0.90	+	0.91	+	0.91	+	0.91	+	0.91	+	0.90	+
Age in months	1.02	***	1.02	***	1.02	***	1.02	***	1.02	***	1.02	***
Parent(s) foreign-born	1.18	*	1.18	*	1.17	*	1.16	*	1.18	*	1.18	*
Family Structure												
(2 bio parents)	1.00		1.00		1.00		1.00		1.00		1.00	
Single parent	1.14	+	1.14		1.13		1.13		1.14	+	1.14	+
Other family structure	0.96		0.96		0.95		0.94		0.96		0.96	
Number of siblings	0.91	**	0.91	**	0.91	**	0.91	**	0.91	**	0.91	**
Child was breastfed	0.78	***	0.78	***	0.79	***	0.79	***	0.78	***	0.78	***
Family receives SNAP	0.92		0.92		0.90		0.91		0.92		0.92	
Child free/reduced lunch	1.15	+	1.15	+	1.12		1.12		1.15	+	1.15	+
Region												
(Northeast)	1.00		1.00		1.00		1.00		1.00		1.00	
Midwest	0.91		0.91		0.89		0.88		0.92		0.91	
South	1.10		1.10		1.07		1.07		1.11		1.10	
West	0.84	+	0.84	+	0.83	*	0.84	+	0.84	+	0.84	+
BMI from fall only	0.91		0.91		0.91		0.89		0.91		0.91	
SES (composite)	0.74	***	0.73	***	0.82	**	0.97		0.76	***	0.76	***
Neighborhood Measures												
Population Density (ln)	1.00		1.01		1.00		1.00		1.00		1.00	
Change in % Pov, 2000-2010	1.57											
SES # Change, 2000-2010	2.86	+										
% Pov, 2010	1.00		1.05									
Change in % Pov, 1990-2010			1.60									
SES # Change, 1990-2010			4.12	**								
Change in median income, 2000-2010					1.03							
SES # Change, 2000-2010					0.82							
Median income, 2010					0.96	**	0.97	*				
Change in median income, 1990-2010							0.87					
SES # Change, 1990-2010							0.72	**				
Change in condis, 2000-2010									1.03			
SES # Change, 2000-2010									0.98			
Concentrated Disadvantage									1.01		1.00	
Change in condis, 1990-2010											0.94	
SES # Change, 1990-2010											0.87	*
_cons	0.015	***	0.015	***	0.022	***	0.024	***	0.016	***	0.016	***
+ p<10; * p<.05; ** p<.01; *** p<.001												

Figure 1



Pred. Prob. Obesity, SES*Neighborhood Change in Median Income
0
.1
.2
.3
.4
.5
-1
-.5
0
.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Change in Median Income, 1990-2010 ($10,000s)
Lowest Family SES
Low Family SES
Mean Family SES
High Family SES
Highest Family SES

Figure 2



Pred. Prob. Obesity, SES*Neighborhood Con. Dis Change, 1990-2010
0
.05
.1
.15
.2
-2
-1
0
1
2
Change in Concentrated Disadvantage, 1990-2010 (High = improves)
Lowest Family SES
Low Family SES
Mean Family SES
High SES
Highest SES