Health & Place 44 (2017) 86–93

Contents lists available at ScienceDirect

Health & Place

journal homepage: www.elsevier.com/locate/healthplace

Does neighborhood social and environmental context impact race/ethnic disparities in childhood asthma?

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ARTICLE INFO

Keywords:
Childhood asthma
Neighborhoods
Race/ethnicity
Environment
Disparities

ABSTRACT

Utilizing over 140,000 geocoded medical records for a diverse sample of children ages 2–12 living in Houston, Texas, we examine whether a comprehensive set of neighborhood social and environmental characteristics explain racial and ethnic disparities in childhood asthma. Adjusting for all individual risk factors, as well as neighborhood concentrated disadvantage, particulate matter, ozone concentration, and race/ethnic composition, reduced but did not fully attenuate the higher odds of asthma diagnosis among black (OR=2.59, 95% CI=2.39, 2.80), Hispanic (OR=1.22, 95% CI=1.14, 1.32) and Asian (OR=1.18, 95% CI=1.04, 1.33) children relative to whites.

1. Introduction

Asthma, a leading chronic condition among children in the U.S., varies substantially across racial/ethnic groups. In 2012, 22% of non-Hispanic black children carried a diagnosis of asthma compared to 14% of Hispanic and 12% of non-Hispanic white children (Bloom et al., 2013). Research suggests that disparities in asthma prevalence between black and white children have increased in the last decade (Akinbami et al., 2014). The causes of asthma, which include a range of individual- and contextual-level risk factors, are complex (Gold and Wright, 2005). While it remains unclear why large disparities in childhood asthma persist, recent attention is focusing beyond individual level factors to the role of neighborhood context (Wilhelm et al., 2009; Williams et al., 2009; Rosenbaum, 2008).

Neighborhood factors contribute to pediatric asthma by exposing children to health risks and resources in the physical and social environment, which become biologically "embodied" and reflected in the social patterning of asthma prevalence (Kreiger, 2001: 673). Asthma prevalence is higher in low-income, urban communities (Williams et al., 2009; Bhan et al., 2015), and black and Hispanic children disproportionately live in disadvantaged and racially segregated areas, which are contextual characteristics associated with a host of negative health risks and outcomes (Williams and Collins, 2001; Williams et al., 2009; Lichter, 2013). Black and Hispanic children are therefore exposed to ecologically distinct physical and social environments that may contribute to the uneven distribution of asthma prevalence.

The purpose of this study is to examine whether racial and ethnic disparities persist in asthma prevalence after accounting for children's differential exposure to health risks at the individual and neighborhood-level. Specifically, we draw from an ecological framework to examine whether three aspects of neighborhood context account, at least partially, for racial/ethnic disparities in childhood asthma: outdoor air pollution (including particulate matter and ozone levels), socioeconomic status (SES), and race/ethnic residential composition.

1.1. Physical and social neighborhood contributors to asthma disparities

Outdoor air pollution is an aspect of the physical environment associated with increased asthma prevalence in a community, especially among young children who have developing lungs and immature metabolic pathways (Guarnieri and Balmes, 2014). Ozone and fine particulate matter less than 2.5 micrograms (μm) in aerodynamic diameter ($PM_{2.5}$) are pollutants commonly linked to worse asthma symptoms and to a lesser degree, asthma onset, though findings are not always consistent (Guarnieri and Balmes, 2014). For example, Akinbami et al. (2010) find that children (ages 3–17 years) who are

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http://dx.doi.org/10.1016/j.healthplace.2017.01.006
Received 23 February 2016; Received in revised form 20 November 2016; Accepted 9 January 2017
Available online 20 February 2017
1353-8292/

chronically exposed to high levels of ozone and particulate matter at the county-level are more likely to suffer from asthma, and among children living in L.A., high ozone exposure is associated with worse asthma morbidity even after accounting for household and neighborhood-level risk factors (Wilhelm et al., 2009). Nishimura et al. (2013), however, find no association between early life exposure to $PM_{2.5}$ and subsequent asthma onset among Latino and black children from five geographic regions in the U.S. and Puerto Rico. Beyond these inconsistencies, it is less clear whether disproportionate exposure to outdoor air pollution accounts, at least in part, for higher rates of asthma prevalence among black and Hispanic children. Higher levels of air pollution are generally found in lower-income, non-white communities (Gold and Wright, 2005; Ash and Fetter, 2004), and evidence suggests that children in low-income neighborhoods experience increased incidence of asthma diagnosis when ambient air pollution levels rise (Wendt et al., 2014). Several studies, however, find persistent racial disparities in asthma even after controlling for air pollution, suggesting that air pollutants are one of many asthma risk factors unevenly experienced by minorities (e.g. Rosenbaum, 2008; Astell-Burt et al., 2013).

Higher rates of asthma prevalence in low SES neighborhoods may also indicate differential health risks in the social environment. Neighborhood disadvantage, which exposes residents to a host of daily and chronic stressors, is characterized by a web of health risks including poverty, substandard housing and building infrastructure, unemployment, the erosion of social capital, and exposure to high levels of violence and crime (Williams et al., 2009; Gold and Wright, 2005). In turn, stress is associated with increased asthma severity (and possibly asthma onset) among children, particularly in early life (Chen et al., 2006; Gold and Wright, 2005). For instance, exposure to community violence has been linked to worse asthma morbidity among children and increased vulnerability to negative respiratory health effects of air pollution (Wright, 2011; Williams et al., 2009). Neighborhood disadvantage may also influence behavioral risk factors if residents adopt coping strategies (e.g. smoking) that threaten children's respiratory health (Gold and Wright, 2005).

Racial residential composition is another aspect of the social environment that may contribute to racial disparities in childhood asthma. There are well-established race/ethnic disparities in housing and neighborhood conditions, which are not fully attributable to group differences in SES (Rosenbaum, 2008; Friedman and Rosenbaum, 2004). Specifically, black and Hispanic households are exposed to higher levels of substandard housing conditions (e.g. chipping paint, pest infestation, lower quality housing stock and inadequate heating), which are risk factors associated with asthma prevalence and increased asthma morbidity (Rosenbaum, 2008; Krieger and Higgins, 2002). Racial residential composition is also a powerful predictor of neighborhood quality and access to community resources (Logan, 2013; Massey and Denton, 1993). For instance, Logan (2013) finds that on average, affluent black and Hispanic households are exposed to higher levels of neighborhood poverty than *poor* white households. While racial residential segregation is typically linked to poor health outcomes (Williams and Collins, 2001), some evidence suggests that after accounting for area-level socioeconomic disadvantage, a protective effect of racial/ethnic density emerges, whereby race/ethnic minorities are healthier when they live in neighborhoods with a higher concentration of members from their own race/ethnic group (Bécares et al., 2012; Astell-Burt et al., 2013). The protective effects of racial/ethnic density, or co-ethnic composition, are theoretically attributed to the buffering effects of bolstered social cohesion, a strong sense of community, mutual social support and diminished exposure to racial discrimination and low-status stigma (Bécares et al., 2012; White and Borrell, 2011). In a review of 57 studies examining the (physical) health effects of ethnic density among adults, Bécares et al. (2012) conclude that higher levels of residential co-ethnic composition are often detrimental for U.S. blacks, though generally protective for U.S. Hispanics. Overall, the protective or harmful effect of ethnic density varied by physical health outcome and respondent race/ethnicity (Bécares et al., 2012). Taken together, racial residential composition, regardless of SES, influences children's exposure to health risks and resources, and as such, is an important component for understanding the racial patterning of asthma prevalence among children who reside in neighborhoods of various race/ethnic compositions.

Despite this potential importance of racial residential composition, we know very little about how neighborhood racial composition is associated with childhood asthma. Among the few studies that account for racial composition, researchers typically examine how the presence of a single race/ethnic group (e.g. percent black) influences asthma outcomes (equally) for all children (e.g. Holt et al., 2013; Rosenbaum, 2008; Wilhelm et al., 2009; Cagney et al., 2007). For instance, Holt et al. (2013) find no association between asthma diagnosis by age five and percent non-Hispanic black residents, while Rosenbaum (2008) finds no association between the percent of white residents and asthma prevalence among a racially and ethnically diverse sample of New York households. None of these studies, however, assess the effect of race/ethnic composition (i.e. race/ethnic density) for each race/ethnic group (e.g. percent Hispanic for Hispanic respondents) or whether the effect of co-ethnic composition differs by respondent race/ethnicity. In several U.S. metropolitan areas, including Houston, large-scale immigration from Latin American and Asian countries is creating a context of changing residential patterns. Neighborhoods of race/ethnic diversity are emerging but also coexisting alongside neighborhoods characterized by more traditional patterns of segregation (e.g. black-white) and white flight (Logan and Zhang, 2010; Logan, 2013). To reflect the diversifying landscape of the U.S. and to fill existing gaps, we utilize an indicator of racial composition – percent co-ethnic (also referred to hereafter as co-ethnic composition) – to assess how racial disparities in asthma prevalence are associated with various arrangements of racial/ethnic density for black, white, Hispanic and Asian respondents. To our knowledge, this is the first study to examine the effects of percent co-ethnic for childhood asthma *and* to test whether these effects differ based on a child's race/ethnic status.

Racial disparities in childhood asthma therefore must be understood as resulting from multiple, concurrent health risks at the individual and neighborhood level (Williams et al., 2009). To capture asthma risk across multiple contextual levels, we link electronic medical records from over 200,000 children (ages 2–12) living in the Houston metropolitan region with census and historical ambient air quality data to create a detailed portrait of children's physical and social environment. The Houston metropolitan area, as the most racially and ethnically diverse large metropolitan area in the U.S. (Emerson et al., 2012), is an ideal location for examining how racial differences in childhood asthma are related to neighborhood contexts that diverge from the traditional black-white color line (Logan, 2013). The current study has two primary goals. First, we establish how asthma prevalence differs among non-Hispanic black (black), Hispanic, Asian and non-Hispanic white (white) children in a large, ethnically diverse sample. Second, holding individual-level characteristics constant, we examine whether accounting for differential exposure to health risks in the neighborhood environment – including outdoor air pollution, concentrated disadvantage and racial residential composition – explains race/ethnic disparities in childhood asthma. Few studies have explored the role of neighborhood context in contributing to racial disparities in pediatric asthma, and to our knowledge, none of these studies include comprehensive measures of both the physical (e.g. outdoor air pollution) and social environments (e.g. neighborhood SES *and* racial/ethnic residential composition) (e.g. Rosenbaum, 2008; Holt et al., 2013; Pearlman et al., 2006).

2. Data and methods

Data for our project come from multiple sources. Health records