Assessing Disparities in Asthma among Children across Neighborhoods of a Large Metropolitan Area: The Child Opportunity Index

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While poor and vulnerable populations often contribute significantly less to environmental problems, they are significantly more likely to suffer from adverse economic and health effects caused by environmental problems. Poor children, who are often children of color, are particularly vulnerable to environmental health disparities. The purpose of this paper is to describe the application of the Childhood Opportunity Index, to assess asthma disparities among children in a SW Florida metropolitan area and discuss its implications for strengthening public health policy. Used in conjunction with 2017 Florida Environmental Public Health Tracking data of children's asthma related emergency room visits, results based on application of this measure revealed that children who live within high child opportunity tracts generally experienced fewer asthma-related emergency room visits than did children who live within low child opportunity tracts. As the racial and ethnic composition of large metropolitan areas in the United States continues to increase, more research should focus on these dynamics and their influence on healthy development of children. The Child Opportunity Index is a useful tool in identifying communities that face educational, environmental and economic disadvantages, and further analysis based on this index may help to inform policies and promote more equitable health outcomes.
Keywords: asthma, health disparities, race.

Introduction

A great deal of attention has been devoted to examining the negative economic and health effects caused by environmental hazards. While poor and vulnerable populations often contribute significantly less to environmental problems, they are significantly more likely to suffer from adverse economic and health effects caused by environmental problems. To address the unfair distribution of environmental hazards, the environmental justice movement emerged in the 1990s as an international initiative to foster environmental justice through "legal transformations aimed at curbing abuses of power that result in the poor and vulnerable suffering disproportionate impacts of pollution and lacking equal opportunity to access and benefit from natural resources" (United Nations Development Programme, 2014, p. 6). According to the U.S. Environmental Protection Agency (EPA, 2018), environmental justice is "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations and policies." (para. 2)

While environmental justice has been part of the social fabric since the late 1990s, in recent years a new conversation has emerged on children's environmental justice (Gaffron & Niemeier, 2015; Sampson, 2012). Poor children, who are often children of color, are particularly vulnerable to environmental health disparities. From an ecological perspective, children's development is not only influenced by their immediate environment, but also by their larger neighborhood and school environments (Institute for Child, Youth and Family Policy, 2018; Paquette & Ryan, 2001). For example, asthma and other chronic diseases have been linked to homes and schools' proximity to toxic waste release sites and busy, highly traveled roads. Child neighborhood opportunity is defined as "the context of neighborhood-based opportunities that influence children's health and development" (Institute for Child, Youth and Family Policy, 2018). In 2015, the diversitydatakids.org project, in collaboration with the Kirwan Institute for the Study of Race and Ethnicity, developed the Child Opportunity Index (COI), a publicly available index comprised of educational, health and environmental, and social and economic domains within the largest 100 metropolitan areas in the United States (Beck et al., 2015). Each neighborhood is assessed relative to the "geography of opportunity in its metropolitan area" (Institute for Child, Youth and Family Policy, 2018). The purpose of this paper is to describe the application of the Childhood Opportunity Index as a tool to assess asthma disparities among children in a SW Florida metropolitan area and discuss its implications for strengthening public health policy.

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The Burden of Asthma

According to the U.S. Centers for Disease Control and Prevention (CDC), asthma is a chronic disorder of the airways that affects more than 20 million adults and nearly 7 million children in the U.S., an increase by 15% since 2000 (CDC, 2018.; Sampson, 2012). Asthma is characterized by inflammation of the lungs accompanied by a tightening in the chest, shortness of breath, coughing and wheezing (Asthma and Allergy Foundation of America, 2005). Asthma has no known causes, but attacks are generally induced by allergens, infections, tobacco smoke, and air pollutants (CDC,2018; EPA, 2015). There is also no known cure for asthma, but it can be managed through healthy behaviors and medications (CDC, 2013; Mayo Clinic, 2018; National Center for Complementary and Integrative Health, 2013). Despite this, asthma still causes two million emergency room visits, 14 million doctors' visits, and 439,000 hospitals stays each year (Asthma and Allergy Foundation of America, 2018a; EPA, 2016a). Furthermore, between 2008 and 2013, the economic cost of asthma was nearly $82 billion (Henriques, 2018; Nurmagambetov, Kuwahara, & Garbe; 2018), of which the majority of the cost was associated with hospital stays, missed work and missed school days, and in 2013 alone, children aged 5-17 missed more than 13.8 million school days (Asthma and Allergy Foundation of America, 2018b).

Environmental Factors of Asthma

Near-roadway air pollution (NRP), including particulate matter (PM), such as carbon monoxide, nitrous oxides, ozone, benzene and brake and tire debris contaminate both outdoor and indoor air and increase the risk of developing asthma (Brandt et al., 2014; EPA, 2015; Gasana et al., 2012; Hopkins, 2017). As more families move further away from the city center, travel distance and time to work and schools relies more heavily on motorized transportation via personal cars or school buses (EPA, 2015; Gaffron & Niemeier, 2015). Newer vehicles must meet federal clean engine requirements, but there are no regulations for older vehicles. For example, more than 60% of operating diesel-fueled trucks were built prior to the implementation of these clean-engine regulations and may emit 63 times more particulate matter than newer vehicles (Hopkins, 2017). Furthermore, while there are standards for monitoring particles as small as one-thirtieth, the width of a single hair strand, no such monitoring exists for ultrafine particles (Hopkins, 2017).

Poor air quality is not limited to outdoor air pollution concentrations. Poor indoor air is also problematic, as many homes in older neighborhoods suffer from mold, vermin, and chemicals from cleaning products (EPA, 2016b; Sampson, 2012; U.S. Department of Housing and Urban Development, 2016). Furthermore, traffic related pollutants find their way inside homes, schools and other buildings. As much as 29% of indoor air pollution concentration can be linked to outside sources, making near-road air pollution a significant contributor to poor indoor air quality (Gaffron & Niemeier, 2015). Elevated particulate matter concentrations in homes and schools are further exacerbated by poor ventilation and filtration, open doors and windows, insufficient cleaning practices, and high occupancy levels (EPA, 2015).

Although near-road air pollution is linked to asthma attacks in children, children with asthma are more likely to ride in cars or school buses to get to school and less likely to engage in outdoor activity (Foty et al., 2013). Children who live in inner cities are also less likely to spend time outdoors due to disparate exposure to toxic substances and violence (Cardwell, Elliott, & Chrighton, 2014; Sampson, 2012; Teixeira & Zuberi, 2016; Yinusa-Nyahkoon, Cohn, Cortes & Bokhour, 2010). There is growing evidence, however, that outdoor air may have more restorative qualities than indoor air, thus having a positive effect on children's overall health (Hartig, Mitchell, de Vries, & Frumkin, 2014; Sampson, 2012). Furthermore, engaging in active transportation, such as walking or riding bicycles, may significantly reduce the number of vehicles on the road that may lead to a reduction in near-road air pollution (EPA, 2015).

Impact of Asthma on Children

According to the most recent asthma prevalence data compiled by the CDC, 9.6% of children aged 5-11, and 10.1% of adolescents report that they currently have asthma as opposed to 8.3% of adults (CDC, 2018). Children are more susceptible to asthma than adults for several reasons. First, children have less-developed respiratory systems and their bodies are not able to excrete toxins as rapidly as adults (EPA, 2015; Sampson, 2012). Furthermore, children spend more time outside, are generally more active, and breathe more rapidly than adults (EPA, 2015; Gasana et al., 2012). Asthma also disproportionately impacts minority children, affecting 1 in 6 African American children (Asthma and Allergy Foundation of America, 2005; Gaffron & Niemeier, 2015; Mohai et al., 2015). African American and Puerto Rican children have the most negative asthma outcomes, some of which can be attributed to disparate access to health care which often means that these children are more likely to receive treatment through emergency room visits than through regular, preventive care (Asthma and Allergy Foundation of America, 2005). Children from these cultural

groups are also three times more likely to die from asthma complications than white children (Asthma and Allergy Foundation of America, 2005; McClurg, 2016; U.S. Department of Health and Human Services, 2016). Not surprisingly, homes and schools with the highest concentrations of outdoor and indoor air pollution are more likely to be inhabited by poor minority children (Cohen 2010; Gaffron & Niemeier, 2015; Hopkins, 2017; Mohai et al., 2015).

The state of Florida is unique in that it is home to some communities that are both the most affluent and economically disadvantaged in the United States. Florida also has a large percentage of African American and Hispanic residents. In 2011, Florida had the 10th lowest adolescent asthma rate at 21.7% (Institute for Child, Youth and Family Policy, 2018). This overall rate is lower than the national adolescent asthma rate of 23%. Looking at rates by race, however, reveals some variation. For example, Florida ranks sixth lowest asthma rates for white adolescents (19.7%) and fifth lowest asthma rates for African American adolescents (22%). For Hispanic adolescents, however, Florida has the 15th lowest asthma rates (24.5%).

Florida is also home to sixteen of the largest metropolitan areas in the U.S. (Institute for Child, Youth and Family Policy, 2018). As one of these areas which varies greatly in terms of poverty and wealth, the Cape Coral-Fort Myers metropolitan area, with a population of 123,564 children, ranked 98th most populous metro area for children in the U.S. Located on Florida's southwest coast bordering the Gulf of Mexico, communities within the Cape Coral-Fort Myers metropolitan area include Boca Grande, an island community off the coast of Cape Coral, identified in a May 2018 CNBC report as the most expensive ZIP code in Florida (Carter, 2018). This metropolitan area also includes the Estero community, identified as the 15th most expensive ZIP code for renters in the state (Logan, 2017). Yet, the Cape Coral-Fort Myers metropolitan area contains communities where severe residential and school segregation and high poverty persists. The Hispanic-white dissimilarity index, a measure of segregation, for Cape Coral-Fort Myers is 35.7 and the black-white dissimilarity index is 59.4 (Institute for Child, Youth and Family Policy, 2018). This means that nearly 36% of Hispanic students and 59% of black students would need to move to another neighborhood to achieve more equitable distribution across all neighborhoods. Furthermore, a study by Acevedo et al. (2014) also identified Cape Coral as the third worst metropolitan area for white, non-Hispanic children with 19.6% living in very low-opportunity neighborhoods. These factors make the Cape Coral-Fort Myers metropolitan area an interesting case study to describe the utility of the Child Opportunity Index to examine asthma disparities among across neighborhoods.

Methodology

Descriptive analyses were used to assess disparities across neighborhoods in the Cape Coral-Fort Myers metropolitan through the following research questions:

1. How do asthma-related emergency room visits vary by ZIP code?
2. Does Childhood Opportunity influence asthma-related emergency room visits?
3. How can the Childhood Opportunity Index be used to assess disparities across neighborhoods?

The Florida Department of Health provides public data on asthma-related emergency room visits in 2017 through the Environmental Public Health Tracking System. These data were analyzed using the Child Opportunity Index (COI), which is used to establish a measure of relative neighborhood opportunity across metropolitan areas. The COI measure and the Florida Environmental Public Health Tracking System data are described below.

Child Opportunity Index

The Child Opportunity Index (COI), a measure of relative "geography of opportunity" across all neighborhoods in a metropolitan area, was developed through collaboration between the diversitydatakids.org project and the Kirwan Institute for the Study of Race and Ethnicity (Institute for Child, Youth and Family Policy, 2018). The diversitydatakids.org project is based at the Institute for Child, Youth and Family Policy at the Heller School for Social Policy and Management at Brandeis University and funded by the Robert Wood Johnson Foundation and the W.K. Kellogg Foundation. The COI is a composite score calculated from the average sub-index scores of three defined opportunity domains: Educational Opportunity, Health and Environmental Opportunity, and Social and Economic Opportunity (Institute for Child, Youth and Family Policy, 2018). The three domains combine 19 separate component indicators (see Table 1) that are related to child development.

Table 1.
19 Indicators of Child Opportunity Index by Defined Opportunity Domain

Type of Opportunity	Indicator
Educational	Adult educational attainment
	Student (school) poverty rate
	4th grade reading proficiency rate
	4th grade math proficiency rate
	Early childhood education neighborhood participation
	High school graduation rate
	Proximity to high quality early childhood education centers
	Proximity to early childhood education centers of any type
Health & Environmental	
	Retail healthy food index
	Proximity to toxic waste release sites
	Volume of nearly toxic release
	Proximity to parks and open spaces
	Housing vacancy rates
	Proximity to health care facilities
Social & Economic	Neighborhood foreclosure rate
	Poverty rate
	Unemployment rate
	Public assistance rate
	Proximity to employment

Source: diversitydatakids.org

Child Opportunity Index categories (Very Low, Low, Moderate, High, Very High) are determined by sorting all census tracts within a metro area into quintiles based on their opportunity index scores (Institute for Child, Youth and Family Policy, 2018). To offer a visualization of the geographic distribution of the Child Opportunity Index categories, a Child Opportunity Map, an interactive map that can be generated for each of the largest 100 metropolitan areas in the U.S., is generated to show relative neighborhood opportunities for children of specific racial and ethnic groups in the metropolitan area (Institute for Child, Youth and Family Policy, 2018).

Florida Environmental Public Health Tracking System

For the purpose of this study, 2017 age-adjusted data for asthma-related emergency room visits among children (up to age 18) living across 27 ZIP codes in the Cape Coral-Fort Myers metropolitan area are used. These data are compiled through the Florida Environmental Public Health Tracking System, in collaboration with the U.S. Centers for Disease Control and Prevention (CDC). This surveillance system tracks several health conditions, including asthma, and provides publicly accessible data so that physicians, researchers, and citizens can identify and compare health statistics within or across states.

Analysis

Descriptive information of the overall sample consists of frequency distributions of adolescent asthma-related emergency room visits by ZIP code and Child Opportunity Index category. A Child Opportunity Map is generated by diversitydatakids.org for the Cape Coral-Fort Myers metropolitan area to provide a visualization of the geographic distribution of opportunities for children. A more detailed map was generated using ArcGIS, a geographic information system. ArcGIS online offers free map exploration and can be used for compilation of geographic information, creating maps, and spatial reasoning. The Child Opportunity Map will then be explored to determine whether the Child Opportunity Index can be used to provide a more detailed description and illustration of asthma disparities as quantified by the asthma-related ER visits. A more in-depth demographic analysis of select ZIP codes with high and low asthma-related ER visits will demonstrate the utility of the Child Opportunity Index to provide a deeper understanding of neighborhood disparities.

Results

In 2017, the Florida Environmental Public Health Tracking System recorded 1,070 asthma related emergency room visits for children (up to age 18) from 27 different ZIP codes in the Cape Coral-Fort Myers metropolitan area. Of those, 328 were White, 316 were African American, and 426 were Hispanic (Florida Department of Health, 2018). A Child Opportunity Map, generated by diversitydatakids.org was then used to spatially identify each ZIP code and categorize the Overall Child Opportunity. The results showing asthma-related emergency room visits by neighborhoods (ZIP codes) in the Cape Coral-Fort Myers metropolitan area are presented in Table 2.

The ZIP codes fall within all of the Child Opportunity categories: six ZIP codes fall within the high opportunity tract, three ZIP codes fall within high opportunity tract, six ZIP codes fall within moderate opportunity tract, five ZIP codes fall within low opportunity tract, and seven ZIP codes fall within very low opportunity tract. Two communities, Boca Grande (ZIP code 33921) and Captiva (ZIP code 33924) had no asthma-related ER visits and fall within the very high and high child opportunity tracts, respectively. Two communities in Estero, ZIP codes 33967 and 33928, also fall within the very high child opportunity tract, and had low numbers of asthma-related ER visits. On the other end of the spectrum, the Fort Myers-Dunbar community (ZIP code 33916) is located within the very low child opportunity tract and had the most asthma-related ER visits of any community in the metro area.

Table 2.
Asthma-Related Emergency Room Visits by ZIP Code

Zip Code	Asthma Emergency Room Visits (N)	Neighborhood	Overall Child Opportunity
33907	45	Villas	Very high
33924	0	Captiva	High
33971	72	Lehigh Acres/Buckingham	Very low
33972	20	Lehigh Acres	Low
33991	28	Cape Coral/Matlacha	Moderate
33973	66	Lehigh Acres	Low
33974	39	Lehigh Acres	Very low
33976	55	Lehigh Acres	Very low
33990	44	Cape Coral	Moderate
33967	30	Estero/San Carlos Park	Very high
33913	16	Gateway/Lehigh Acres	Moderate
33914	26	Cape Coral	Moderate
33916	149	Fort Myers/Dunbar	Very low
33917	24	North Fort Myers/Suncoast Estates	Low
33901	47	Fort Myers	Very low
33919	32	Cypress Lake/McGregor	Very high
33921	0	Boca Grande	Very high
33905	73	Buckingham/Tice	Very low
33903	31	Cape Coral/North Fort Myers	Low
33904	31	Cape Coral	Very high
33908	31	Harlem Heights/Iona	High
33909	42	Cape Coral	Moderate
33928	12	Estero/Bonita Springs	Very high
33936	40	Lehigh Acres	Low
33966	14	Fort Myers	High
33993	39	Cape Coral/Matlacha	Very low
34135	37	Bonita Springs	Moderate

Source: Florida Environmental Public Health Tracking System

The Child Opportunity Map generated by diversitydatakids.org provides a visualization of the spatial distribution of overall child opportunities in the Cape Coral-Fort Myers metropolitan area (see Figure 1). Child opportunity categories have been color-coded from pale yellow, representing the very low child opportunity tract, to dark maroon, which represents the very high child opportunity tract. As can be seen from the map, island communities and those along the westernmost coast are more likely to fall within moderate to very high child opportunity tracts. Communities that fall within low to very low child opportunity tracts are more likely

to be situated within the interior of the metro area. A closer analysis of select communities describes more detailed demographic information to provide context for the opportunities and barriers that children that live within those communities may encounter.
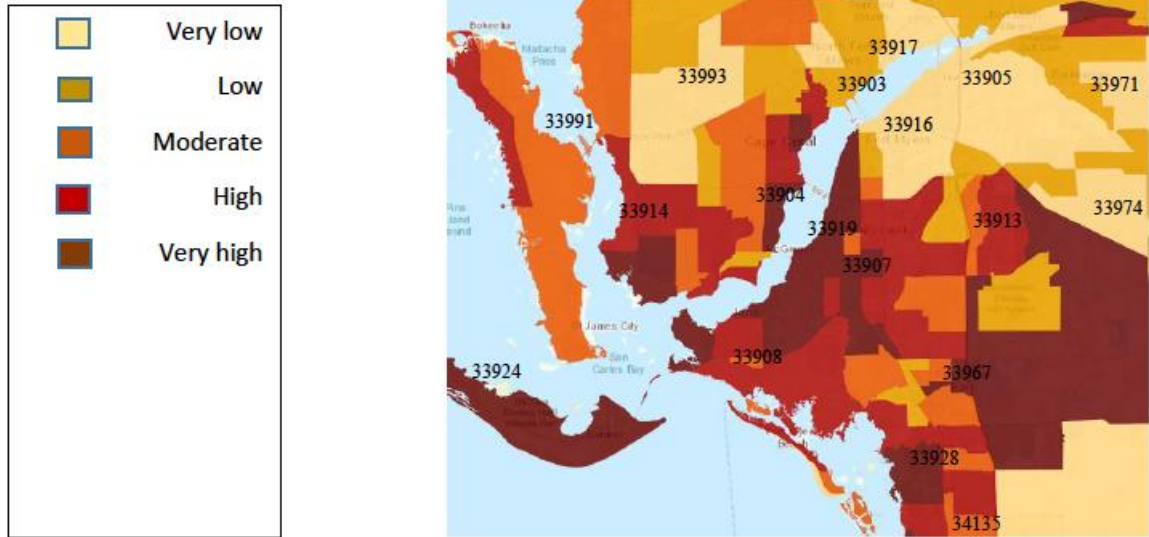

Figure 1. Cape Coral-Fort Myers Metropolitan Area Child Opportunity Map
Source: diversitydatakids.org

Table 3 highlights key demographic information for the communities with the highest and lowest numbers of asthma-related emergency room visits. Boca Grande is an exclusive community and falls within the very high child opportunity tract. This community has a median household income of $69,286 and the median value of owner-occupied homes is $1.5 million. With a population of only 842 residents, the community had no reports of children who had asthma-related ER visits. Captiva, another community with no reported asthma-related ER visits, falls within the high child opportunity tract. Located adjacent to Boca Grande, Captiva has a total population of 7,363 residents, of which over 98% is White and 9.1% are children. The median household income for Captiva is $102,956 and 8% of the population lives below the federal poverty level.

There are two Estero communities, ZIP codes 33928 and 33967, that fall within the very high child opportunity tract. The Estero-Bonita Springs (33928) community has a population of 56,088 residents, and 14% of the population is comprised of children. This community is the 15th most expensive ZIP code in Florida with a median household income of $58,415 and 14.7% of residents live below the federal poverty level. In 2017, only 12 children from this community had asthma-related ER visits, all of who were White. Estero Village (33967) has 33,048 residents and 12.5% of the population is children. This community is relatively affluent, having a median household income of $71,391 and only 6.5% of the population lives below the federal poverty level. In 2017, 30 children visited emergency rooms due to asthma. Fourteen of those children were Hispanic and 12 were White (Florida Environmental Public Health Tracking System, 2018).

The Fort Myers community (ZIP code 33916) falls within the very low child opportunity tract. This community has a total population of 79,943; 47.8% of the population is White, 27.7% is African American and 21.4% is Hispanic. This community also has a larger percentage of children, comprising 20.5% of the population. The median household income is less than $40,000 and 22.6% of the population lives below the federal poverty level. In 2017, more children (149) had asthma-related ER visits from this community than any other community in the area. Of those children, 90 were African American, 47 were Hispanic and 12 were White (Florida Environmental Public Health Tracking System, 2018). In fact, there were more than twice as many ER visits from children in this community than from the community with the next most asthma-related ER visits.

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The Fort Myers community (ZIP code 33905) also falls within the very lower child opportunity tract and had the second highest number (73) of children with asthma-related ER visits in 2017. This small community of 4,470 residents is majority Hispanic (62.2%), and children comprise 29% of the population (U.S. Census Bureau, 2017). Furthermore, the median household income for Tice is $31,186 and 41.4% of the population lives below the federal poverty level. Of the 73 children with asthma-related ER visits, 44 were Hispanic and 20 were White (Florida Environmental Public Health Tracking System, 2018).

The North Fort Myers community (ZIP code 33917) (N=39,407) paints a unique picture. This community has a majority White population (88.7%), but falls within the low child opportunity tract (U.S. Census Bureau, 2017). This community has a median household income of $40,366, and 14.1% of the population lives below the federal poverty level. In 2017, 24 children from this community had asthma-related ER visits, 18 of who were White (Florida Environmental Public Health Tracking System, 2018).

Looking at the other ZIP codes in the metropolitan area, communities with more asthma-related ER visits were more likely to be located within low child opportunity tracts. Communities with fewer asthma-related ER visits were more likely to be located within high child opportunity tracts.

Table 3.
Demographic Information for Select Communities

Neighborhood (Zip Code)	Population	% Children	Median Household Income	% Poverty
Boca Grande (33921)	842	- -	$69,286	- -
Captiva (33924)	7,363	9.1%	$102,956	8%
Estero/San Carlos Park (33967)	33,048	12.5%	$71,391	6.5%
Estero/Bonita Springs (33928)	56,088	14.7%	$58,415	14.7%
Fort Myers (33916)	79,943	20.5%	$38,971	22.6%
Fort Myers (33905)	4,470	29.0%	$31,186	41.4%
N. Fort Myers (33917)	39,407	9.2%	$40,366	14.1%

Source: U.S. Census Bureau (2017)

Discussion and Conclusion

This paper's aim was to demonstrate whether the Child Opportunity Index is useful in assessing asthma disparities among children by examining the distribution of child opportunities within a given metropolitan area. Results based on application of this measure, in conjunction with data generated by a state-level public health tracking system, revealed that children who live within high child opportunity tracts generally experienced fewer asthma-related emergency room visits than did children who live within low child opportunity tracts. Child Opportunity Maps also illustrated the clustering tendency of high and low child opportunity tracts. Communities at the neighborhood level are dynamic and fluid, and adjacent communities tend to offer similar child opportunities.

Race also appears to be a factor in the distribution of overall child opportunity. Communities with a higher proportion of African American and Hispanic children, which are more likely to be within low child opportunity tracts, reported more asthma-related ER visits. Predominantly White communities, which are more likely to be within high opportunity tracts, reported fewer, if any, asthma-related ER visits. However, predominantly White communities that fall within low child opportunity tracts also reported fewer asthma-related ER visits. These trends are consistent with literature suggesting that white children are less likely than African American or Hispanic children to experience asthma-related ER visits.

While these results are limited to a case study of a single metropolitan area, there may, nevertheless, be important policy implications, which help to inform future community planning, school siting guidelines, and community asthma management programs. The Child Opportunity Index uses a variety of indicators to understand the many factors that influence children's development, and, thus can be useful to health departments, parks and recreation and school districts as an index to address of asthma and other health problems facing children at the community level. For example, the Florida Asthma Coalition has established Asthma-Friendly Schools to "support the academic performance and improve the health status of students with asthma in Florida" (Florida Asthma Coalition, 2018). This program is voluntary, and provides a platform for schools with exemplary asthma management programs to be recognized by the community. Schools achieve recognition through a rigorous application process in which they must successfully demonstrate that they have a process that identifies students with asthma and educates students, faculty and staff about asthma and asthma action plans, while providing access to asthma medications and other support services to students (Volusia

County Schools, 2018). During the 2017-2018 academic year, 42 schools across the state were recognized as either bronze or platinum-level asthma friendly schools. Volusia County Schools, alone, had 27 of those recognized asthma-friendly schools (Volusia County Schools, 2018). Lee County Schools, which was the focus of the present study, has only had two recognized asthma-friendly schools in the existence of the program (Florida Asthma Coalition, 2018).

Although the Child Opportunity Index is useful in providing a visual distribution of child opportunity to describe asthma disparities among children, as the present study demonstrated, further research should focus on how this index might be used, along with other factors, to predict asthma-related ER visits. Furthermore, although Cape Coral-Fort Myers is a relatively large, racially and economically diverse metropolitan area, many of the communities have a small proportion of children. Future research can expand on this study by using the Child Opportunity Index to assess asthma and other health disparities in metropolitan areas with higher concentrations of children.

As the racial and ethnic composition of large metropolitan areas in the United States continues to increase, more research should focus on these dynamics and their influence on healthy development of children and others. The Child Opportunity Index is a useful tool in identifying communities that face educational, environmental and economic disadvantages. Further application and analysis based on this index may help to inform policies and promote more equitable health outcomes.

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