



Determinants of racial and ethnic disparities in utilization of hospital-based care for asthma among Medi-Cal children in Los Angeles

Yonsu Kim, Matthew Pirritano & Katrina Miller Parrish

To cite this article: Yonsu Kim, Matthew Pirritano & Katrina Miller Parrish (2021): Determinants of racial and ethnic disparities in utilization of hospital-based care for asthma among Medi-Cal children in Los Angeles, Journal of Asthma, DOI: [10.1080/02770903.2021.1955131](https://doi.org/10.1080/02770903.2021.1955131)

To link to this article: <https://doi.org/10.1080/02770903.2021.1955131>



Accepted author version posted online: 12 Jul 2021.



Submit your article to this journal [↗](#)



Article views: 11



View related articles [↗](#)



View Crossmark data [↗](#)



Determinants of racial and ethnic disparities in utilization of hospital-based care for asthma among Medi-Cal children in Los Angeles

Yonsu Kim, PhD*, Matthew Pirritano, PhD, MPH and Katrina Miller Parrish MD, FAAFP

LA Care Health Plan, Los Angeles, CA, United States

*Corresponding author, ykim@lacare.org, 1-949-702-9471

Abstract

Objective: We sought to identify racial/ethnic patterns of health care utilization for asthma among asthmatic children (ages 0-18) and address unequal access to optimal asthma management as a determinant of asthma disparities.

Methods: We used children Medi-Cal (California's Medicaid program) enrollees, including African American, Asian, Hispanic, and White children in Los Angeles and retrieved individual hospital utilization records of 69,118 asthmatic children (2013-2018). We applied Hierarchical Generalized Linear Models (HGMLs) to identify the patterns of health care utilization at the individual level, controlling for demographic and neighborhood characteristics.

Results: African American children show a higher ratio of ED to outpatient visits (OR = 1.32, 95% CI 1.08-1.62) and hospitalizations to outpatient visits (OR = 1.50, 95% CI 1.30-1.73). They also had a high ratio of ED visits (OR = 1.36, 95% CI 1.10-1.68) and hospitalizations (OR = 1.47, 95% CI 1.26-1.71) relative to PCP visits. A ratio of ED visits and hospitalizations decreased if a ratio of controller medications to total medications was greater than 0.5, but increased if children were male, under 11 years old, or living in low-income neighborhoods (Median household income < 25th percentile, \$45,629) with high poverty rates (>20%).

Conclusions: African American male children from disadvantaged neighborhoods are at the highest risk for higher utilization of hospital-based care for asthma. Our findings also indicate a lower ratio of controller medications contributed to increases in ED visits and hospitalizations, suggesting suboptimal management of asthma and a lack of intervention treatment through medications among minority children.

Keywords Health Disparities, ED Visits, Hospitalization, Children, Medicaid, Health care utilization

Introduction

Asthma, a leading cause of chronic illness among children, affects 6.2 million children (8.4%) in the US and presents pervasive disparities among minority children. Although childhood asthma is on a downward trend, racial and socioeconomic disparities in asthma have persisted (1). The Centers for Disease Control and Prevention (CDC) report that African American children disproportionately show a higher prevalence (13%) than White children (8%) in 2017. Moreover, African American children experienced twice the odds of utilizing emergency department (ED) visits and hospitalizations for asthma than white counterparts (2).

Studies have examined racial/ethnic disparities in asthma and addressed behavioral, environmental, and social risk factors at different levels (3–6). More attention has been paid to social and environmental context at the neighborhood level, which contributes to the prevalence gap for

Asthma disparities in hospital-based care

asthma morbidity. Higher rates of morbidity and health care utilization (i.e. ED visits) for asthma were identified in disadvantaged communities where residents are externally exposed to asthma risk factors such as air pollution (i.e. Ozone (O₃), Particulate Matter (PM_{2.5}, PM₁₀), Diesel Particulate Matter (PM)) due to dilapidated dwelling, lack of open/recreation, and living near major roads and ports (7–11). Heavy exposure to environmental risk factors may be associated with low neighborhood socioeconomic status that can be characterized as a low level of income, educational attainment, and social capital as well as a high level of unemployment, poverty rate, and exposure to crime. However, a recent study indicates that adjusting for individual, social, and environmental risk factors did not fully explain racial/ethnic disparities of asthmatic children (12).

In addition, literature addresses individual and family-level risk factors, including education level of caretakers, individuals' health behaviors, lifestyle, health literacy, and access to health care (13, 14). From the health policy perspective, access to health care may be considered a key element that contributes to asthma disparities, given that minority children are more likely to be uninsured and experience limited referrals and restrictive access to specialists (13, 14). Moreover, from the behavioral and cultural perspectives, Bryant-Stephens suggests that racial/ethnic minority caretakers are more likely than white counterparts to be associated with poor interaction with providers, poor understanding of the patient's cultural and educational context, lower literacy, and language barriers (13).

Studies suggest that frequent utilization of ED visits and hospitalizations among minority children may be attributable to a lack of optimal asthma care through primary care provider (PCP) visits and patient self-management (17, 18). However, little is known for key risk factors that contribute to higher utilization of hospital-based care among minority children.

Our study postulates that behavioral, cultural, or social contexts among racial/ethnic minorities are associated with limited access to optimized management for asthma. We sought to identify potential risk factors that may explain a higher rate of ED visits and hospitalizations among minority children with persistent asthma, using the individual level encounter records of Los Angeles Medi-Cal (California's Medicaid program) children enrollees, who are supposed to have equal access to healthcare.

Methods

Study Population and Data

We used data of Medi-Cal children enrollees who lived in Los Angeles County and retrieved asthma utilization records, which include ED visits, inpatient visits (hospitalizations), outpatient visits, and PCP visits (2013 – 2018) using ICD-10 codes. The 6-year time frame allowed us to track historical records of the individual's health services utilization for asthma. First, we identified 102 981 children, who had been ever diagnosed with asthma through outpatient or inpatient services, applying Clinical Classifications Software (CCS) by Healthcare Cost and Utilization Project (HCUP). CCS is a categorization scheme that maps ICD-9-CM procedures and ICD-10-PCS codes into the same categories.

Then, we selected 69 118 children (ages 0–18) whose race/ethnicity, gender, age, and medication use data were identified. The utilization data consist of date of service, type of service (outpatient, inpatient, and ED visits), provider, PCP indicator, severity of illness (SOI: 1 through 4), CCS disease category, and member's Independent Provider Association (IPA), all of which are

Asthma disparities in hospital-based care

associated with de-identified demographics such as age, race/ethnicity, gender, and geographic information. As a medical classification, SOI is assigned to the patients based on their total medical records. We also retrieved the individual's medication record from our pharmacy database (2014-2018) and calculated the asthma medication ratio (AMR: the ratio of controller medications relative to controller and reliever medications) over the study period at the individual level.

To identify the social impact of neighborhood on utilization, we extracted census tract level indicators from the American Community Survey (ACS), such as median household income, educational attainment (i.e. percent of less than 'high school completion'), poverty rates, population distribution by race/ethnicity, and other environmental variables, most of which are assumed to impact onset and acceleration of asthma. We converted the census tract level variables to zip code level to be associated with children's geographic information, referring to the Department of Housing and Urban Development (HUD) guidelines. We applied environmental variables from CalEnviroScreen (CES) 3.0 to control for air pollution mainly from transportation (O_3 , Diesel PM, $PM_{2.5}$, PM_{10}), distance to nearest freeway, traffic emissions, and various built environment metrics for our statistical analyses.

To eliminate confounding effects of urgent care visits on ED visits, we devised an algorithm that filters urgent care visits from outpatient visits with procedure code, revenue code, and CMS (Centers for Medicare & Medicaid Services)' place of service (POS) codes and removed the urgent care visits from outpatient visits. Using the service category, we identified PCP visits for asthma and used them as an indicator that represents more efficient and optimal asthma management by "primary care physicians". Outpatient visits in our data is composed of office (73.51%), on hospital campus-outpatient (23.09%), Federally Qualified Health Center (FQHC) (1.90%), independent clinic (1.09%), and public health clinic (0.39%).

Outcome Indicators

It may be assumed that the frequency of primary care utilization among minority children is higher than white counterparts given their higher morbidity and prevalence of asthma while little is known about the ratio of the utilization relative to ED visits and hospitalizations. Therefore, we developed outcome indicators that informed us whether or not children rely more on primary care than ED visits and hospitalizations and estimated ratios of ED visits and hospitalizations relative to PCP and outpatient visits. For this procedure, we counted the number of outpatient, PCP, ED visits, and hospitalizations for asthma at the individual level during the study period. First, we calculated a ratio of ED visits relative to outpatient visits at the individual level. To estimate odds, we gave a value of 1 if the ratio (i.e. ED to outpatient visits) is greater than the average ratio of all patients (grand mean) and 0 otherwise. For instance, a child with a value of 1 indicates the child's ratio of ED to outpatient visits is greater than the grand mean such that she or he shows a higher likelihood of ED visits relative to outpatient visits. In the same manner, we gave 1 if the ratio of hospitalizations to outpatient visits is greater than its average ratio and 0 otherwise and also applied PCP visits in place of outpatient visits. This procedure gave us four dependent variables, including the ratios of ED to outpatient visits, ED to PCP visits, hospitalizations to outpatient visits, and hospitalizations to PCP visits.

Statistical Methods

We applied Hierarchical Generalized Linear Models (HGML) which estimate fixed effects and random intercepts with the individual and neighborhood level variables, using SAS Enterprise

Asthma disparities in hospital-based care

Guide (v. 7.1). This multilevel modeling approach is widely used in identifying cluster (i.e. neighborhood) effects and thus allowed us to assess the effect of race/ethnicity on utilization patterns, after controlling for the individual level (i.e. age, gender, spoken language, etc.) and neighborhood socioeconomic (i.e. median household income, percent of less than 'high school completion', poverty rate, percent African Americans) characteristics. To verify the results of HGML, we used Generalized Estimating Equations (GEE). This approach is also commonly used to estimate the association between neighborhood risk factors and health outcomes in epidemiology studies (19).

Results

Our sample is composed of Hispanic (69.6%), African American (14.9%), White (11.6%), and Asian (4.0%) children, reflecting racial/ethnic diversity in Los Angeles. The proportions of Hispanic and African American children in this sample are higher than their population proportions of Los Angeles County population (48.6% for Hispanic, 9.0% for African American) in 2018. The gap indicates a higher proportion of children Medi-Cal enrollees and/or a higher prevalence of asthma among African American and Hispanic children.

Health Care Utilization for Asthma

Of all asthmatic children in our data (69 118), the average number of utilization was 2.68 (Median: 1.00, IQR: 2.00) for PCP visits, 3.49 (Median 2.00, IQR 3.00) for outpatient visits, 0.08 (Median: 0, IQR: 0) for hospitalizations, 0.04 (Median: 0, IQR: 0) for ED visits during the study period. The average of hospitalizations and ED visits are highest among African American children (Mean: 0.10, Median: 0, IQR: 0 for hospitalizations; Mean: 0.05, Median: 0, IQR: 0 for ED visits). Contrary, the average PCP visits are lowest among African American children, suggesting poor usage of the primary care system and more dependence on ED visits and hospitalizations. But we found no significant difference in PCP visits between African American and white children in the independent sample t test ($p = 0.378$). Unlike PCP, the average outpatient visits among African American children were relatively higher. Interestingly, Hispanic children are in the highest in PCP (Mean: 2.77, Median: 2, IQR: 2) and outpatient visits (Mean: 3.55, Median: 2; IQR: 3).

If our sample is restricted to those who ever experienced hospitalizations ('Ever hospitalized'), the proportion of African American children increases from 14.9% to 20.3% while that of Hispanic children dropped from 69.6 to 65.9%. The proportion of African American children increases to 20.0% if the sample is restricted to those who ever utilized ED visits ('ED utilizers') while other racial/ethnic groups' percentages are similar or slightly lower. Such relatively high utilization of ED visits and hospitalizations also suggest a lack of optimal asthma care through PCP visits among African American children.

We categorized all ages (0-18) into four age groups (ages 0-5, 6-10, 11-15, and 16-18). The ages 6-10 have the largest proportion of asthmatic children (37.8%), followed by ages 11-15 (33.5%). Their proportions increase to 47.0% for 'Ever hospitalized' and 48.8% for 'ED utilizers.' In contrast, ages 11-15 have the largest visits for outpatient (Mean: 3.78, Median: 2.00, IQR: 3.00) and PCP (Mean: 2.94, Median: 2.00, IQR: 3.00), and ages 16-18 have the lowest hospitalizations (Mean: 0.04, Median: 0, IQR: 0) and ED visits (Mean: 0.02, Median: 0, IQR: 0). 59.9% of asthmatic children are male. Furthermore, their proportions increase to 66.0% for 'Ever hospitalized' and 65.1% for 'ED utilizers.' The ratio of hospitalizations to PCP visits in figure 1 indicates the frequency of hospitalizations relative to outpatient visits by race/ethnicity, not adjusted for risk factors. For instance, a higher ratio of ED to PCP visits implies that they utilize ED visits more than PCP visits.

Asthma disparities in hospital-based care

African American children show the highest (0.021) while white children are the lowest (0.012). Notably, they are also the highest for the ratio of hospitalizations to PCP visits (0.046), but other races/ethnicities do not show substantial differences (Asian: 0.026, Hispanic: 0.027, White: 0.028).

Likelihood of ED visits and Hospitalization

Our statistical analyses show that African American children had significantly higher odds than white counterparts for all dependent variables, indicating a higher likelihood of ED visits and hospitalizations (OR= 1.32, 95% CI 1.08-1.62, $p < 0.01$ for the ratio of ED to outpatient visits; OR = 1.36, 95% CI: 1.10-1.68, $p < 0.01$ for ED to PCP visits; OR = 1.50, 95% CI: 1.30-1.73, $p < 0.0001$ for hospitalizations to outpatient visits; OR = 1.47, 95% CI 1.26-1.71, $p < 0.0001$ for hospitalizations to PCP visits) when other demographic and neighborhood risk factors were controlled. However, no significant results were found for other racial/ethnic minorities except the ratio of hospitalizations to PCP visits among Hispanic children, whose odds ratio is significant only at $p < 0.10$ level. Higher odds ratios of African American children indicate that they are more likely than white children to utilize ED visits and hospitalizations. Alternatively, higher odds ratios may suggest a lower likelihood of PCP or outpatient visits, which were used as denominators to create the binary variables in this study. Such variations in odds ratios are more likely attributable to the changes in ED visits or hospitalizations (numerators) than PCP and outpatient visits given that there is no significant difference in PCP visits by race/ethnicity. Moreover, it appears that the average outpatient visits among African American children were higher than white children. We found evidence that the use of controller medications substantially contributed to a reduction in ED visits and hospitalizations. The asthmatic children were more likely to utilize ED visits and hospitalization if a ratio of controller medications (AMR) is lower (< 0.5 : the median) for all analyses (OR = 1.97, 95% CI: 1.78-2.17, $p < 0.0001$ for the ratio of ED to outpatient visits; OR = 2.14, 95% CI: 1.93-2.37, $p < 0.0001$ for ED to PCP visits). The high ratio of controller medications had a stronger impact on reducing hospitalizations than ED visits, showing higher odds ratios (OR = 2.22, 95% CI: 2.06-2.38, $p < 0.0001$ for hospitalizations to outpatient visits; OR = 2.45, 95% CI: 2.28-2.64, $p < 0.0001$ for hospitalizations to PCP visits).

Ages 0-5 have the highest odds ratio for three dependent variables (OR = 2.65, 95% CI 2.13-3.29, $p < 0.0001$ for ED to outpatient visits; OR = 2.77, 95% CI 2.38-3.22, $p < 0.0001$ for hospitalizations to outpatient visits; OR = 2.52, 95% CI 2.15-2.96, $p < 0.0001$ for hospitalizations to PCP visits – reference: ages 16-19). Ages 6-10 show the highest odds ratios only for the ratio of ED to PCP visits (OR = 2.55, 95% CI 2.09-3.13, $p < 0.0001$). The results indicate that the younger age groups are more likely than the older age groups to utilize ED visits and hospitalizations. Male children show higher odds ratios than female children for all tests, implying that they are more likely than female children to rely on ED visits and hospitalizations. No significant effects were found for other individual level variables such as spoken language, SOI, and IPA.

We examined neighborhood socioeconomic status, which has been reported as the risk factor for asthma in prior research. Adjusting for other social and environmental factors for asthma at the neighborhood level, we found that neighborhood economic status is significantly associated with the patterns of health care utilization. Consistent with prior research on asthma disparities, living in low-income neighborhoods (Median household income $< 25^{\text{th}}$ percentile, \$45 629) has higher odds than middle ($\geq 25^{\text{th}}$ and $< 75^{\text{th}}$ percentile) and high ($\geq 75^{\text{th}}$ percentile, \$57 225) income neighborhoods for all dependents variables. The results suggest that children living in low-income neighborhoods are more likely than those in middle and high-income neighborhoods to utilize ED visits and hospitalizations. Interestingly, the odds involving ED visits are higher than hospitalizations

Asthma disparities in hospital-based care

(OR = 1.78, 95% CI 1.38-2.31, $p < 0.001$ for ED to outpatient visits; OR = 1.80, 95% CI 1.39-2.33, $p < 0.0001$ for ED to PCP visits, $p < 0.001$; OR = 1.30, 95% CI 1.09-1.54, $p < 0.01$ for hospitalizations to outpatient visits; OR = 1.31, 95% CI 1.10-1.57, $p < 0.01$ for hospitalizations to PCP visits). Concentrated poverty neighborhoods are associated with higher hospitalizations. The neighborhoods with a high poverty rate ($>20\%$) show higher odds for both ratios of hospitalizations to outpatient visits (OR = 1.48, 95% CI 1.10-1.99, $p < .01$) and hospitalizations to PCP visits (OR = 1.47, 95% CI 1.08-2.00, $p < 0.05$). We tested environmental and traffic characteristics at neighborhood level such as year structure built, time to commute, air pollution (O_3 , $PM_{2.5}$, PM_{10} , Diesel PM, traffic density, distance to major roads, street density, walkability index) but found no significant results that would suggest the impact of environmental risk factors on asthma care utilization.

We verified the results of our statistical analyses with GEE models. We used three different covariance matrices such as exchangeable, independent, and autoregressive working correlation structures and selected exchangeable working correlation for ED to outpatient visits and ED to PCP visits and autoregressive working correlation for hospitalizations to outpatient visits and hospitalizations to PCP visits based on the Quasi-likelihood Information Criterion (QIC). By comparing the results of the GEE models with HGLM, we confirmed that the two methods consistently provide similar odds ratios and 95% confidence interval across the four statistical tests (Table 2).

Discussion

The aim of this study lies in examining differentiated patterns of health care utilization by race/ethnicity and identifying risk factors that contribute to higher utilization of hospital-based care among minority children. We found that multiple characteristics, including race/ethnicity, AMR, age, gender, and neighborhood economic status were associated with the patterns of health care utilization as follows. First, we confirmed that African American children tend to more frequently utilize ED visits and hospitalizations, compared to white children. Unlike our hypothesis, we found no evidence that indicates lower utilization of PCP and outpatient visits for asthma among African American children. The results suggest a low barrier to accessing health services for asthma among Medi-Cal enrollees regardless of race/ethnicity.

The findings of our analyses provide evidence that a low AMR is a strong predictor for severe asthma exacerbations. Studies suggest appropriate use of controller medications considerably reduces the burden of asthma by reducing ED visits and hospitalizations (20, 21). Andrews et al. showed that the AMR was negatively associated with urgent care use (21), reporting that if it is less than 0.5, patients are more likely to utilize ED visits in the subsequent time periods (OR 1.5-2.0). Follow-up studies will need to assess racial/ethnic variations of the AMR and examine whether or not an increase in the AMR through optimal asthma management contributes to reducing asthma disparities.

Age and gender were found to contribute to the differentiated utilization for asthma care. The odds ratios were higher among younger age groups (ages 0-5 and 6-10) than older age groups (ages 11-15 and 16-18) and male children than female children. The results of the neighborhood level analyses would be of great interest, revealing that children are more likely to utilize ED visits and hospitalizations if they reside in economically disadvantaged communities. The findings of our geographical analyses provide insight into neighborhood concentrated disadvantage. A large percentage of African American children in our sample were identified in impoverished neighborhoods with low income and high poverty rates. Those neighborhoods were also identified to

Asthma disparities in hospital-based care

have low educational attainment and heavy exposure to environmental risk factors (22). In sum, our findings suggest more attention be paid to African American male children who are under 11 years old and live in low-income neighborhoods with concentrated poverty as at-risk children with asthma.

The strengths of this study include the analyses of the 6-year historical records of health care utilization among Medi-Cal insured children and the comparative analyses of different types of utilization at the individual level. Prior studies examined the racial differences of ED visits and hospitalizations for asthma to estimate the probability of utilization events by using the total population in the study area or all asthma care utilizers as denominators (17, 23). Our study extracted the individual's retrospective data of asthma care utilization and asthma medication dispenses. The use of this data allowed us to identify the distinct patterns of asthma health care utilization by race/ethnicity along with age, gender, neighborhood characteristics.

Geographically, our data covers all of the diverse neighborhoods across Los Angeles County, including a sufficient number of Hispanic and Asian children enrollees in the Medi-Cal program. By virtue of the use of the four different racial/ethnic groups, we were able to find that African American children had unequal access to optimal asthma care, even compared to Asian and Hispanic children. We employed a multilevel approach, assessing the potential impacts of social and environmental context on health care utilization for asthma. This approach accounted for the potential impacts of unidentified and time-invariant stressors at the neighborhood level for asthma in estimating the odds of ED visits and hospitalizations. The findings of the multilevel analyses underscore a higher likelihood of ED visits and hospitalizations among asthmatic children in economically disadvantaged urban communities.

We speculate that physical access to health care may be associated with frequencies, quality, and types of health care utilization. Garcia and Flores reported that the minority children living in low-income neighborhoods have limited access to health care for asthma, showing the association between geographic access to healthcare and health outcomes for pediatric asthma (24, 25). In line with prior research, higher odds of ED visits and hospitalizations were detected in the neighborhoods (i.e. Service Planning Area (SPA) 6). Given that double segregation by income and race/ethnicity, such social and physical environments may discourage caretakers of asthmatic children to efficiently utilize regular check-ups and follow-up visits and contribute to poor medication adherence. Taking into consideration geographic barriers to health care, we employed variables of transportation condition (i.e. the average time to commute) as a proxy but found no convincing evidence for the impact of geographic access to health care on asthma disparities. Future studies may examine whether or not geographical access affects utilization patterns of pediatric asthma, applying the distance to primary care services, which can be calculated with individual physical addresses or census blocks centroid. Literature indicates the positive associations between physician density and improving health outcomes such as colorectal cancer and heart failure (26, 27). Thus, the density of PCP or specialists can be applied to address limited physical access to health care that contributes to suboptimal care for pediatric asthma. The population and the sample in this study are Medicaid insured children in Los Angeles. Therefore, the findings of health services utilization may not be generalized to other populations that include commercially insured children.

Conclusion

Our findings underline that African American male children (under 11 years old) residing in disadvantaged communities are at the highest risk for higher utilization of hospital-based care for asthma and suggest that suboptimal management of asthma and a lack of controller medications

Asthma disparities in hospital-based care

among minority children. Literature documents that residential segregation by race and income may accelerate suboptimal asthma care due to poor facilities, limited access to specialists, and low density of providers (20, 25). Based on our findings that address suboptimal management for asthma as a determinant of asthma disparities, we suggest that health practitioners and policymakers should pay more attention to caretakers of minority children, especially from disadvantaged communities. Low health literacy, cultural attitudes, and poor communication with providers may account for lower adherence to controller medications and a higher likelihood of ED visits and hospitalizations among racial/ethnic minority children. The burden of pediatric asthma can be relieved by optimal asthma management with regular check-ups, follow-up visits, adherence to preventive medications, and appropriate use of asthma medications (28, 29). Asthma education (i.e. high health literacy), self-management training, or enhanced communication in health services would help caretakers with timely access to health care resources, particularly in the early stage of children's asthma development (14, 29–31). Moreover, the higher utilization of ED visits and hospitalizations contribute to rising health care costs. Reductions in ED visits and hospitalizations through an asthma action plan can significantly alleviate the financial burden of health care.

Declaration of Interest

Disclosure of funding

The authors received no financial support for the research.

Disclosure of interest

The authors report no conflict of interest.

Human Participant Protection statement

This study is exempt from IRB approval because we used a de-identified and aggregate dataset for health care utilization.

References

1. Bhan N, Kawachi I, Glymour MM, Subramanian SV. Time Trends in Racial and Ethnic Disparities in Asthma Prevalence in the United States From the Behavioral Risk Factor Surveillance System (BRFSS) Study (1999–2011). *Am J Public Health*. 2015 Jun;105(6):1269–75.
2. Crocker D, Brown C, Moolenaar R, Moorman J, Bailey C, Mannino D, et al. Racial and Ethnic Disparities in Asthma Medication Usage and Health-Care Utilization. *Chest*. 2009 Oct;136(4):1063–71.
3. Brewer M, Kimbro RT, Denney JT, Osiecki KM, Moffett B, Lopez K. Does neighborhood social and environmental context impact race/ethnic disparities in childhood asthma? *Health & Place*. 2017 Mar;44:86–93.
4. Forno E, Celedón JC. Health Disparities in Asthma. *Am J Respir Crit Care Med*. 2012 May 15;185(10):1033–5.
5. Williams DR, Sternthal M, Wright RJ. Social Determinants: Taking the Social Context of Asthma Seriously: TABLE 1. *Pediatrics*. 2009 Mar;123(Supplement 3):S174–84.

Asthma disparities in hospital-based care

6. Baltrus P, Xu J, Immergluck L, Gaglioti A, Adesokan A, Rust G. Individual and county level predictors of asthma related emergency department visits among children on Medicaid: A multilevel approach. *Journal of Asthma*. 2017 Jan 2;54(1):53–61.
7. Brandt S, Perez L, Künzli N, Lurmann F, Wilson J, Pastor M, et al. Cost of near-roadway and regional air pollution-attributable childhood asthma in Los Angeles County. *Journal of Allergy and Clinical Immunology*. 2014 Nov;134(5):1028–35.
8. Delfino RJ, Wu J, Tjoa T, Gullesterian SK, Nickerson B, Gillen DL. Asthma Morbidity and Ambient Air Pollution: Effect Modification by Residential Traffic-Related Air Pollution. *Epidemiology*. 2014 Jan;25(1):48–57.
9. Guarnieri M, Balmes JR. Outdoor air pollution and asthma. *The Lancet*. 2014 May;383(9928):1581–92.
10. Gupta RS, Carrión-Carire V, Weiss KB. The widening black/white gap in asthma hospitalizations and mortality. *Journal of Allergy and Clinical Immunology*. 2006 Feb;117(2):351–8.
11. Wilhelm M, Qian L, Ritz B. Outdoor air pollution, family and neighborhood environment, and asthma in LA FANS children. *Health & Place*. 2009 Mar;15(1):25–36.
12. Largent J, Nickerson B, Cooper D, Delfino RJ. Paediatric asthma hospital utilization varies by demographic factors and area socio-economic status. *Public Health*. 2012 Nov;126(11):928–36.
13. Bryant-Stephens T. Asthma disparities in urban environments. *Journal of Allergy and Clinical Immunology*. 2009 Jun;123(6):1199–206.
14. Belice PJ, Mosnaim G, Galant S, Kim Y, Shin H-W, Pires-Barracosa N, et al. The impact of caregiver health literacy on healthcare outcomes for low income minority children with asthma. *Journal of Asthma*. 2020 Dec 1;57(12):1316–22.
15. Canino G, McQuaid EL, Rand CS. Addressing asthma health disparities: A multilevel challenge. *Journal of Allergy and Clinical Immunology*. 2009 Jun;123(6):1209–17.
16. Liu SY, Pearlman DN. Hospital Readmissions for Childhood Asthma: The Role of Individual and Neighborhood Factors. *Public Health Rep*. 2009 Jan;124(1):65–78.
17. Ash M, Brandt S. Disparities in Asthma Hospitalization in Massachusetts. *Am J Public Health*. 2006 Feb;96(2):358–62.
18. Snyder DA, Thomas OW, Gleeson SP, Stukus DR, Jones LM, Regan C, et al. Reducing emergency department visits utilizing a primary care asthma specialty clinic in a high-risk patient population. *Journal of Asthma*. 2018 Jul 3;55(7):785–94.
19. Hubbard AE, Ahern J, Fleischer NL, Laan MV der, Lippman SA, Jewell N, et al. To GEE or Not to GEE: Comparing Population Average and Mixed Models for Estimating the Associations Between Neighborhood Risk Factors and Health. *Epidemiology*. 2010 Jul;21(4):467–74.
20. Elster A, Jarosik J, VanGeest J, Fleming M. Racial and Ethnic Disparities in Health Care for Adolescents: A Systematic Review of the Literature. *Arch Pediatr Adolesc Med*. 2003 Sep 1;157(9):867.
21. Andrews AL, Simpson AN, Basco Jr WT, Teufel RJ. Asthma medication ratio predicts emergency department visits and hospitalizations in children with asthma. *Medicare & medicaid research review*. 2013;3(4).

Asthma disparities in hospital-based care

22. Kim Y, Cho J, Wen F, Choi S. The built environment and asthma: Los Angeles case study. *Journal of Public Health [Berl]*. 2021 Jan 7; Available from: <https://doi.org/10.1007/s10389-020-01417-6>
23. Kim H, Kieckhefer GM, Greek AA, Joesch JM, Baydar N. Health care utilization by children with asthma. *Prev Chronic Dis*. 2009 Jan;6(1):A12.
24. Garcia E, Serban N, Swann J, Fitzpatrick A. The effect of geographic access on severe health outcomes for pediatric asthma. *Journal of Allergy and Clinical Immunology*. 2015 Sep;136(3):610–8.
25. Flores G, Snowden-Bridon C, Torres S, Perez R, Walter T, Brotanek J, et al. Urban Minority Children with Asthma: Substantial Morbidity, Compromised Quality and Access to Specialists, and the Importance of Poverty and Specialty Care. *Journal of Asthma*. 2009 Jan;46(4):392–8.
26. Kociol RD, Greiner MA, Fonarow GC, Hammill BG, Heidenreich PA, Yancy CW, et al. Associations of Patient Demographic Characteristics and Regional Physician Density With Early Physician Follow-Up Among Medicare Beneficiaries Hospitalized With Heart Failure. *The American Journal of Cardiology*. 2011 Oct;108(7):985–91.
27. Ananthakrishnan AN, Hoffmann RG, Saeian K. Higher Physician Density is Associated with Lower Incidence of Late-stage Colorectal Cancer. *J GEN INTERN MED*. 2010 Nov;25(11):1164–71.
28. Lewis P, Fagnano M, Koehler A, Halterman JS. Racial Disparities at the Point of Care for Urban Children with Persistent Asthma. *J Community Health*. 2014 Aug;39(4):706–11.
29. Oland AA, Booster GD, Bender BG. Psychological and lifestyle risk factors for asthma exacerbations and morbidity in children. *World Allergy Organization Journal*. 2017;10:35.
30. Koinis-Mitchell D, McQuaid EL, Jandasek B, Kopel SJ, Seifer R, Klein RB, et al. Identifying Individual, Cultural and Asthma-Related Risk and Protective Factors Associated With Resilient Asthma Outcomes in Urban Children and Families. *Journal of Pediatric Psychology*. 2012 May 1;37(4):424–37.
31. Rosas-Salazar C, Apter AJ, Canino G, Celedón JC. Health literacy and asthma. *Journal of Allergy and Clinical Immunology*. 2012 Apr;129(4):935–42.

Asthma disparities in hospital-based care

Table 1. Characteristics of pediatric patients with outpatient, hospitalizations, and ED visits by race, sex, age group, Los Angeles County, 2013–2018.

		Sample	SOI	PCP visits			Outpatient visits			Hospitalizations			ED visits		
		n (%)	(Avg.)	n (%)	Avg. (SD)	per 1,000	n (%)	Avg. (SD)	per 1,000	n (%)	Avg. (SD)	per 1,000	n (%)	Avg. (SD)	per 1,000
Race	Asian	2,750 (3.98)	1.42	7,170 (3.93)	2.60 (3.92)	434.55	8,675 (3.59)	3.15 (3.92)	525.76	185 (3.42)	0.07 (0.37)	11.21	84 (3.36)	0.03 (0.22)	5.10
	African American	10,284 (14.88)	1.44	24,965 (13.26)	2.43 (3.31)	404.59	36,225 (15.00)	3.52 (4.59)	587.08	1,139 (21.05)	0.11 (0.48)	18.46	532 (21.25)	0.05 (0.33)	8.62
	Hispanic	48,077 (69.56)	1.41	133,082 (71.92)	2.77 (3.61)	461.35	170,578 (70.65)	3.55 (4.88)	591.34	3,533 (65.28)	0.07 (0.39)	12.25	1,635 (65.32)	0.03 (0.25)	5.67
	White	8,007 (11.58)	1.40	19,791 (10.89)	2.47 (3.41)	411.95	25,971 (10.76)	3.24 (5.03)	540.59	555 (10.25)	0.07 (0.38)	11.55	252 (10.07)	0.03 (0.23)	5.25
	Total	69,118 (100.00)	1.41	185,008 (100.00)	2.68 (3.53)	470.01	241,449 (100.00)	3.49 (4.82)	582.21	5,412 (100.00)	0.08 (0.40)	13.05	2,503 (100.00)	0.04 (0.26)	6.04
	Female	27,520 (39.81)	1.44	69,211 (37.41)	2.51 (3.30)	419.16	88,406 (36.61)	3.21 (4.50)	535.40	1,886 (34.85)	0.07 (0.38)	11.42	856 (34.20)	0.03 (0.25)	5.18
Sex	Male	41,598 (60.18)	1.39	115,797 (62.59)	2.78 (3.66)	463.95	153,043 (63.39)	3.43 (4.81)	613.28	3,526 (65.15)	0.08 (0.42)	14.13	1,647 (65.80)	0.04 (0.27)	6.60
	Total	69,118 (100.00)	1.41	185,008 (100.00)	2.68 (3.53)	470.01	241,449 (100.00)	3.49 (4.82)	582.21	5,412 (100.00)	0.08 (0.40)	13.05	2,503 (100.00)	0.04 (0.26)	6.04
Age	0 – 5	9,543 (13.80)	1.47	16,732 (9.04)	1.75 (2.18)	292.22	23,082 (9.56)	2.42 (2.66)	403.12	1,162 (21.47)	0.12 (0.50)	20.29	501 (21.02)	0.05 (0.32)	8.75
	6 – 10	26,123 (37.79)	1.38	74,603 (40.32)	2.86 (3.68)	475.97	98,170 (40.66)	3.76 (4.90)	626.33	2,560 (47.30)	0.10 (0.45)	16.33	1,227 (49.0)	0.05 (0.32)	7.83

Asthma disparities in hospital-based care

													2)	30)	
	11 – 15	23,126 (33.46)	1.3 9	68,095 (36.81)	2.94 (3.96)	490.7 5	87,518 (36.25)	3.78 (5.35)	630.7 3	1,285 (23.74)	0.06 (0.33)	9.26	594 (23.73)	0.0 3 (0.21)	4.2 8
	16 – 18	10,326 (14.94)	1.5 0	25,578 (13.83)	2.47 (3.19)	412.8 4	32,679 (13.53)	3.16 (4.78)	527.4 6	405 (7.48)	0.04 (0.31)	6.54	181 (7.23)	0.0 2 (0.20)	2.9 2
	Total	69,118 (100.00)	1.4 1	185,008 (100.00)	2.68 (3.53)	470.0 1	241,449 (100.00)	3.49 (4.82)	582.2 1	5,412 (100.00)	0.08 (0.40)	13.05	2,503 (100.00)	0.0 4 (0.26)	6.0 4

Note: per 1,000 refers to average annual rate per 1,000 people. SOI refers to severity of illness (available only for hospitalizations). PCP (Primary Care Provider), ED (Emergency department).

Asthma disparities in hospital-based care

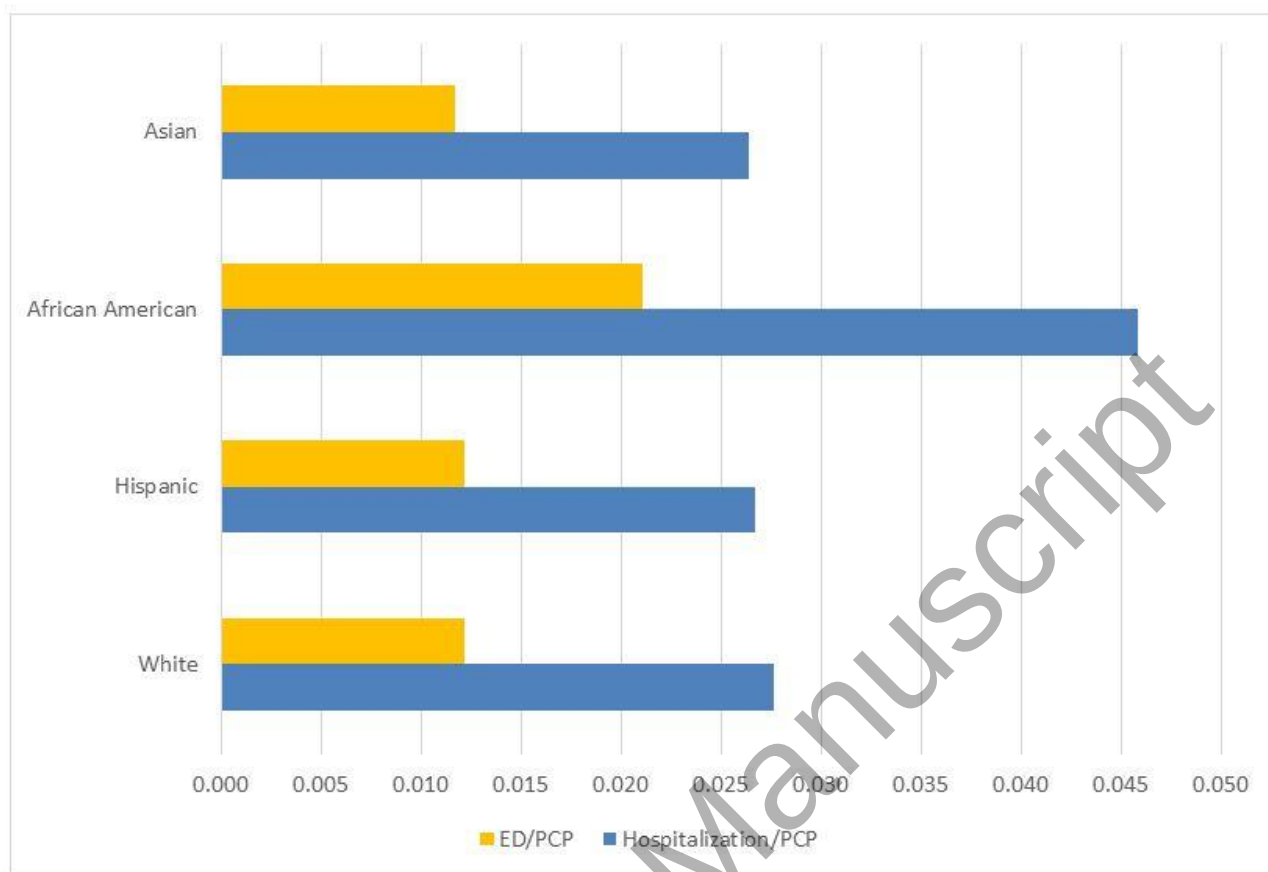
Table 2. Odds ratios of hospitalizations to PCP visits, hospitalizations to PCP visits, ED to outpatient visits, and ED to PCP visits with confidence intervals (95%) by race, gender, age group, controller medication ratio, neighborhood household income, poverty, Los Angeles County, 2013–2018.

		ED to outpatient visits		ED to PCP visits		Hospitalizations to outpatient visits		Hospitalizations to PCP visits	
		HGLM	GEE	HGLM	GEE	HGLM	GEE	HGLM	GEE
Race	Asian	1.11 (0.81, 1.51)	1.11 (0.80, 1.54)	1.15 (0.83, 1.60)	1.15 (0.81, 1.63)	0.95 (0.76, 1.20)	0.99 (0.77, 1.27)	0.99 (0.78, 1.25)	1.02 (0.78, 1.32)
	African American	1.32 (1.08, 1.62)	1.31 (1.04, 1.66)	1.36 (1.10, 1.68)	1.34 (1.06, 1.71)	1.50 (1.30, 1.73)	1.48 (1.25, 1.75)	1.47 (1.26, 1.71)	1.45 (1.20, 1.74)
	Hispanic	1.07 (0.91, 1.27)	1.07 (0.88, 1.31)	1.15 (0.96, 1.38)	1.14 (0.93, 1.40)	1.08 (0.95, 1.22)	1.09 (0.96, 1.22)	1.13 (0.99, 1.29)	1.14 (0.99, 1.31)
	White (ref.)	-	-	-	-	-	-	-	-
Gender	Male	1.25 (1.13, 1.39)	1.25 (1.13, 1.39)	1.24 (1.11, 1.38)	1.24 (1.11, 1.38)	1.22 (1.13, 1.32)	1.21 (1.13, 1.31)	1.21 (1.12, 1.31)	1.20 (1.12, 1.30)
	Female (ref.)	-	-	-	-	-	-	-	-
Ages	0 – 5	2.65 (2.13, 3.29)	2.63 (2.11, 3.28)	2.39 (1.90, 3.01)	2.38 (1.92, 2.95)	2.77 (2.38, 3.22)	2.72 (2.36, 3.13)	2.52 (2.15, 2.96)	2.48 (2.14, 2.87)
	6 – 10	2.63 (2.17, 3.20)	2.63 (2.20, 3.14)	2.55 (2.09, 3.13)	2.55 (2.14, 3.04)	2.46 (2.14, 2.81)	2.42 (2.14, 2.75)	2.40 (2.09, 2.77)	2.37 (2.07, 2.72)
	11 – 15	1.64 (1.33, 2.01)	1.64 (1.36, 1.96)	1.67 (1.35, 2.06)	1.67 (1.39, 2.00)	1.53 (1.32, 1.76)	1.52 (1.33, 1.74)	1.51 (1.30, 1.75)	1.50 (1.31, 1.73)
	16 – 18 (ref.)	-	-	-	-	-	-	-	-
AMR	< .5	1.97 (1.78, 2.17)	1.95 (1.76, 2.16)	2.14 (1.93, 2.37)	2.12 (1.91, 2.36)	2.22 (2.06, 2.38)	2.21 (1.98, 2.47)	2.45 (2.28, 2.64)	2.45 (2.19, 2.74)
	≥ .5 (ref.)	-	-	-	-	-	-	-	-
Median	Q1	1.78 (1.38, 2.31)	1.77 (1.37, 2.28)	1.80 (1.39, 2.33)	1.78 (1.37, 2.31)	1.30 (1.09, 1.54)	1.32 (1.07, 1.61)	1.31 (1.10, 1.57)	1.34 (1.10, 1.64)
Household	Q2	1.21 (0.93, 1.58)	1.22 (0.92, 1.60)	1.24 (0.95, 1.61)	1.23 (0.92, 1.63)	1.05 (0.88, 1.25)	1.02 (0.87, 1.20)	1.06 (0.89, 1.27)	1.05 (0.90, 1.22)
Income	Q3 (ref.)	-	-	-	-	-	-	-	-
Poverty rate	> 20%	1.47 (0.95, 2.29)	1.45 (0.96, 2.21)	1.59 (0.99, 2.53)	1.58 (0.99, 2.52)	1.48 (1.10, 1.99)	1.44 (1.07, 1.93)	1.47 (1.08, 2.00)	1.43 (1.05, 1.95)
	≤ 20% (ref.)	-	-	-	-	-	-	-	-
N		69,118	69,118	69,118	69,118	69,118	69,118	69,118	69,118

Note: Median household income (neighborhood level): Q1 < 25th percentile (\$45 629), 25th percentile ≤ Q2 < 75th percentile (\$57 225), Q3 ≥ 75th percentile. AMR (The ratio of controller medication dispense events relative to total asthma medication dispense events), PCP (Primary Care Provider), ED (Emergency department).

Asthma disparities in hospital-based care

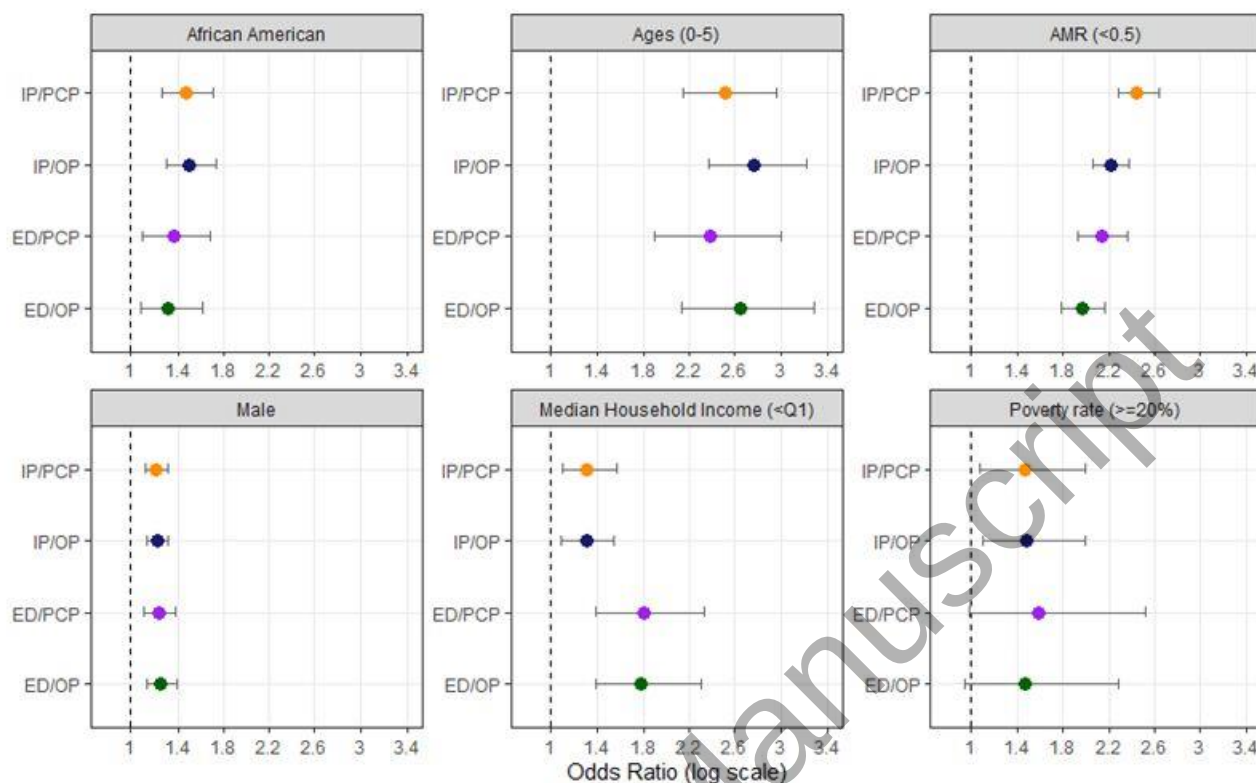
Figure 1. The ratios of ED to outpatient visits and the ratio of hospitalizations to outpatient visits by race/ethnicity in Los Angeles County, 2013–2018.



Note: ED/OP (ED to outpatient visits), ED/PCP (ED to PCP visits), IP/OP (Hospitalizations to outpatient visits), IP/PCP (Hospitalizations to PCP visits), Median Household Income (<Q1) ('less than 25th percentile (< \$45,629)' in Los Angeles County), AMR (where the ratio of controller medications relative to total medications is lower than 0.5)

Asthma disparities in hospital-based care

Figure 2. Odds ratios of the variables at high risk for asthma (African American children, Ages 0-5, AMR (<0.5), male children, low income neighborhoods, neighborhood poverty rate $\geq 20\%$), Los Angeles County, 2013-2018.



Note: ED/OP (ED to outpatient visits), ED/PCP (ED to PCP visits), IP/OP (Hospitalizations to outpatient visits), IP/PCP (Hospitalizations to PCP visits), Median Household Income (<Q1) ('less than 25th percentile (< \$45,629)' in Los Angeles County), AMR (where the ratio of controller medications relative to total medications is lower than 0.5)