

Asthma Prevalence Among Medicaid-Enrolled Children



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What is already known about this topic? National and recent self-reported asthma prevalence estimates are available for the general child population and at the state level. Small-area asthma prevalence measures are sparsely available for children.

What does this article add to our knowledge? This study provides 2 measures of small-area asthma prevalence for the Medicaid-enrolled children nationally at the state, county, and census tract levels, evaluating differences between and within states and highlighting areas of high prevalence and utilization.

How does this study impact current management guidelines? This study's findings, measures, and maps can be used by community and public health departments across the country for identifying high-prevalence areas of at-risk populations to better use resources for improvement in diagnosis and for guiding asthma health care and management.

BACKGROUND: Small-area asthma prevalence measures, which are crucial for targeting interventions, are currently sparsely available for children.

OBJECTIVE: To provide measures of in-contact asthma prevalence for the 2012 Medicaid child population so as to highlight areas in need of targeted asthma interventions.

METHODS: Using the 2012 Medicaid Analytic eXtract claims files, we developed 2 prevalence metrics differentiated by persistent and diagnosed asthma. We developed prevalence measures at the state, county, and census tract levels, with statistical inferences to highlight areas of high prevalence where interventions should be focused. We compared the measures with asthma prevalence estimates derived from a sample of the child population that self-reported whether they have been diagnosed with asthma regardless of in-contact asthma.

RESULTS: A total of 1.98 million (8.1%) and 1.71 million (6.9%) Medicaid-enrolled children were identified with in-contact asthma diagnosis and persistent asthma, respectively. Among 40 states, 17 had lower prevalence estimates for the Medicaid-enrolled children compared with similar child asthma self-reported prevalence estimates from the Centers for Disease Control and Prevention. High-prevalence regions spanned

primarily in the southern Midwest region, from Texas to West Virginia and from Illinois to north Florida.

CONCLUSION: There are large variations in the differences between the self-reported estimates from the Centers for Disease Control and Prevention for the general population and the in-contact estimates for the Medicaid-enrolled children, highlighting potential asthma misdiagnosis in the Medicaid population in many states. Small-area estimates point to areas of high prevalence, consistently throughout the south and southeast. © 2018 American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol Pract 2019;7:1207-13)

Key words: Medicaid claims; Small-area estimates; Pediatric asthma; In-contact prevalence

INTRODUCTION

Asthma is the third leading cause of pediatric emergency room (ER) visits resulting in hospitalizations.¹ In 2013, children missed 13.8 million school days because of asthma.² The US Centers for Disease Control and Prevention (CDC) has identified pediatric asthma as a priority condition for intervention.³ Although asthma is not preventable, evidence-based health care guidelines suggest that multicomponent, multitiered interventions can reduce severe outcomes associated with pediatric asthma.^{4,5} To target such interventions, estimates of asthma prevalence are needed.

National- and state-level estimates of pediatric asthma prevalence are commonly disseminated by the CDC.⁶ These estimates are derived from national surveys⁷ including the National Health Interview Survey (NHIS)⁸ and the Behavioral Risk Factor Surveillance System (BRFSS).⁹ The NHIS CDC estimates provide national-level lifetime, current, and asthma attack prevalence for children through personal household interviews. The BRFSS CDC estimates provide state-level percentages of children whose parents self-report that their child has been currently diagnosed with asthma. Neither survey provides or contrasts self-reported

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Abbreviations used

BRFSS- Behavioral Risk Factor Surveillance System

CDC- Centers for Disease Control and Prevention

ER- emergency room

HEDIS- Healthcare Effectiveness Data and Information Set

MAX- Medicaid Analytic eExtract

NHIS- National Health Interview Survey

diagnosed prevalence with in-contact prevalence, which is defined as the percentage of children who are using the health care system for asthma treatment. This is particularly of interest for the Medicaid-enrolled children who may be disproportionately undertreated for asthma because of low health care access.^{10,11} The Medicaid system provides health care benefits for more than 36 million children nationally,¹² approximately half of the child population, mostly from socioeconomically disadvantaged families.

The 2009 Children's Health Insurance Reauthorization Act required the US Department of Health and Human Services to create quality measures for use by state Medicaid programs. Among these measures, only 1 measure of adherence to asthma medication is included.¹³ Consequently, asthma prevalence measures are disseminated by few state health departments. Notably, although prevalence estimates are commonly available at the state level, small-area prevalence estimates are not commonly available. Geographical granularity for in-contact prevalence can assist in prioritizing asthma management interventions for children diagnosed and undiagnosed. To quantify differences due to geographical location, we define and discuss 2 prevalence measures to model condition severity at the state, county, and census tract levels. We define in-contact prevalence measures for children with an asthma diagnosis and with persistent asthma using a modified Healthcare Effectiveness Data and Information Set (HEDIS) approach to potentially capture intermittent asthma, or when asthma may be diagnosed but not treated. The values and differences of these 2 measures can give an understanding of regional asthma severity, diagnosis rate, and health care utilization for a particular area.

METHODS

Data sources

We analyzed patient-level claims from the 2012 Medicaid Analytic eExtract (MAX) files obtained from the Centers for Medicare and Medicaid Services. The research was approved by the Centers for Medicare and Medicaid Services (Data Use Agreement No. 23621) and by the Institutional Review Board of Georgia Tech (Protocol No. H11287). All data derived from the MAX files meet a minimum cell size of 11 patients according to the Data Use Agreement; areas shaded in gray in the maps of the results did not meet this requirement.

Study population

Our study included children aged 4 to 17 years with at least 1 month of Medicaid eligibility in 2012 from all states except for Kansas (2011), Rhode Island (2011), Colorado (2010), and Idaho (2010), for which we use earlier years because of data unavailability for the year 2012. Children younger than 4 years were excluded because many of these children had other wheezing disorders that

were similar to asthma and thus difficult to diagnose (eg, viral bronchiolitis).^{14,15}

We filtered all MAX prescription drug claims to only include National Drug Codes for asthma controller and short-term medication.¹⁶ We also filtered all MAX inpatient and other services claims to include only primary asthma diagnosis, *International Classification of Diseases, 9th Revision, Clinical Modification* code 493.XXX, and aggregated all claims to visit level by service date, identifying claims by type and place of service. We further classified patients with certain visit types and prescriptions over the entire year into 2 asthma severity levels.

First, we define children with an *asthma diagnosis* as those who meet at least 1 of the following criteria:

1. at least 1 physician office visit and another asthma care event (physician office visit, asthma controller medication, or short-term medication);
2. at least 1 controller asthma medication;
3. at least 1 asthma-related ER visit; or
4. at least 1 asthma-related hospitalization.

The HEDIS algorithm provides the definition of patients with persistent asthma specific to asthma controller medications. A modified version of this algorithm allows for the highest sensitivity and specificity for detecting persistent asthma.¹⁷ According to this modified HEDIS definition, children with *persistent asthma* are those who meet at least 1 of the following criteria:

1. at least 3 outpatient visits;
2. at least 1 asthma controller medication;
3. at least 1 ER visit (and a physician office visit, another ER visit, or asthma short-term medication); or
4. at least 1 hospitalization.

We considered an alteration of the third criterion by restricting to have at least another care event because of potential misdiagnosis of asthma in ERs.¹⁸⁻²⁰

Prevalence measures

We considered the following 2 in-contact prevalence measures to capture differences within a geographical area:

1. *Diagnosis prevalence per-member-year*: The percentage of children diagnosed with asthma among all Medicaid-enrolled children.
2. *Persistent prevalence per-member-year*: The percentage of children with persistent asthma among all Medicaid-enrolled children.

The comparison of these 2 distinct estimates for asthma prevalence is necessary to assess and compare prevalence; although the diagnosis measure is most comparable with the self-reported CDC measures and has higher specificity, the persistent measure is more sensitive by using the modified HEDIS algorithm to detect acute asthma conditions. These measures are in percentages, taking values between 0 and 100. We will use the term *prevalence* to refer to *in-contact prevalence per-member-year*, unless noted otherwise.

Linking each patient with the MAX person summary file and aggregating by zip code, we derived outcome measures for all states and counties and then estimated them at the census tract level using the US Department of Housing and Urban Development-US Postal Service Crosswalk Files.²¹ We derived the census tract estimates by taking a weighted average of the zip code prevalence estimates for the zip codes within the area of each census tract, where the weights were specified using the residential population of the zip codes.

TABLE I. 2012 state-level in-contact asthma prevalence for pediatric Medicaid patients (aged 4-17 y)

State	Diagnosis		Persistent		Difference		CDC CI
	Estimates	IQR	Estimates	IQR	Median	Variance	
Alaska	4.80%	4.9%-6.2%	4.10%	4.2%-5.5%	0.71%	7.78×10^{-8}	
Alabama	15.90%	12.8%-18.9%	14.20%	10.9%-17%	1.67%	5.51×10^{-7}	9.7%-13.0%
Arkansas	8.00%	6.5%-9.3%	6.70%	5.3%-7.7%	1.26%	3.49×10^{-7}	
Arizona	6.80%	6.2%-7.7%	4.90%	4.7%-5.7%	1.73%	2.78×10^{-7}	6.8%-10.6%
California	4.70%	3.3%-5.1%	4.00%	2.8%-4.3%	0.63%	9.23×10^{-8}	7.7%-10.0%
Colorado*	4.90%	4.2%-5.5%	4.40%	3.8%-5.1%	0.38%	7.21×10^{-8}	
Connecticut	11.70%	10%-12.9%	9.90%	8.3%-10.9%	1.73%	4.20×10^{-7}	10.4%-14.0%
District of Columbia	5.10%	4.6%-5.4%	2.50%	2.1%-2.7%	2.53%	1.19×10^{-7}	10.0%-19.0%
Delaware	9.60%	8.4%-10.7%	8.40%	7.3%-9.4%	1.33%	9.35×10^{-8}	
Florida	8.70%	7%-9.5%	7.30%	5.6%-8%	1.34%	4.06×10^{-7}	
Georgia	7.20%	5.9%-7.9%	6.30%	5.1%-7%	0.80%	1.32×10^{-7}	9.0%-13.0%
Hawaii	7.50%	6.5%-8.4%	6.10%	5.2%-6.8%	1.48%	1.99×10^{-7}	9.5%-13.2%
Iowa	7.40%	5.8%-8.7%	6.70%	5%-8.1%	0.63%	1.81×10^{-7}	4.9%-8.0%†
Idaho*	4.70%	3.9%-5.3%	4.40%	3.6%-5%	0.28%	3.69×10^{-8}	
Illinois	8.60%	7.1%-9.8%	7.90%	6.5%-8.9%	0.67%	1.07×10^{-7}	7.5%-11.5%
Indiana	7.70%	6.5%-8.8%	6.90%	5.8%-8%	0.70%	1.53×10^{-7}	6.8%-9.4%†
Kansas†	9.30%	8%-10.3%	8.70%	7.5%-9.6%	0.63%	1.46×10^{-7}	9.1%-12.0%
Kentucky	10.20%	7.7%-11.7%	9.20%	7%-10.7%	0.91%	2.76×10^{-7}	8.7%-11.9%
Louisiana	12.10%	9.1%-13.5%	11.00%	7.7%-12.2%	1.11%	3.21×10^{-7}	6.6%-9.8%†
Massachusetts	8.20%	6.8%-9.1%	6.90%	5.7%-7.8%	1.16%	3.74×10^{-7}	7.6%-11.9%†
Maryland	10.60%	8.6%-11.5%	8.60%	6.8%-9.5%	1.92%	3.56×10^{-7}	8.8%-12.0%
Maine	7.70%	6.5%-8.8%	7.00%	5.8%-8.1%	0.64%	2.20×10^{-7}	7.7%-11.9%
Michigan	7.70%	6.4%-8.5%	6.20%	5.2%-6.8%	1.44%	5.41×10^{-7}	8.2%-10.9%†
Minnesota	6.80%	5.8%-7.9%	5.50%	4.8%-6.4%	1.22%	3.49×10^{-7}	
Missouri	9.80%	8.1%-11%	9.00%	7.3%-10%	0.83%	2.29×10^{-7}	8.2%-12.3%
Mississippi	9.50%	7.8%-10.6%	8.70%	6.9%-9.9%	0.69%	2.04×10^{-7}	12.2%-15.9%
Montana	4.80%	3.7%-6.1%	4.20%	3.2%-5.3%	0.55%	2.38×10^{-7}	6.0%-9.7%
North Carolina	8.30%	6.9%-9.2%	6.80%	5.7%-7.6%	1.27%	2.92×10^{-7}	9.3%-14.1%†
North Dakota	5.50%	4.1%-7.3%	5.00%	3.7%-6.8%	0.44%	1.66×10^{-7}	5.0%-8.3%†
Nebraska	9.00%	7.8%-10.7%	8.10%	6.9%-9.6%	0.79%	2.83×10^{-7}	6.0%-8.0%
North Hampshire	7.70%	6.6%-8.4%	6.60%	5.9%-7.3%	0.99%	2.65×10^{-7}	8.7%-12.5%
New Jersey	7.70%	6.4%-8.6%	5.90%	4.9%-6.6%	1.65%	4.49×10^{-7}	7.8%-9.9%
New Mexico	6.60%	5.8%-7.4%	5.30%	4.8%-6.2%	1.14%	2.24×10^{-7}	6.2%-8.6%
Nevada	2.50%	1.8%-2.9%	2.10%	1.5%-2.6%	0.30%	9.68×10^{-8}	9.0%-13.9%
New York	9.00%	7.3%-9.8%	7.00%	5.6%-7.7%	1.84%	5.16×10^{-7}	7.4%-11.3%
Ohio	8.50%	7.4%-9.2%	7.00%	6.1%-7.8%	1.46%	2.53×10^{-7}	7.5%-9.9%
Oklahoma	8.60%	7.4%-10%	7.50%	6.3%-8.8%	1.13%	2.09×10^{-7}	7.1%-10.2%
Oregon	4.00%	3.3%-4.6%	3.20%	2.7%-3.7%	0.70%	9.67×10^{-8}	5.7%-9.4%
Pennsylvania	3.20%	1.5%-5.3%	2.40%	0.9%-5.3%	0.69%	1.96×10^{-7}	9.2%-11.7%
Rhode Island†	9.60%	8.8%-10.4%	8.80%	8.1%-9.8%	0.65%	1.29×10^{-7}	9.1%-13.7%†
South Carolina	9.10%	7.6%-10.2%	8.40%	7%-9.4%	0.66%	1.28×10^{-7}	
South Dakota	6.00%	5.5%-7.8%	5.60%	5.1%-7.4%	0.34%	6.96×10^{-8}	
Tennessee	12.80%	10.5%-14.9%	11.90%	9.6%-14.1%	0.87%	1.75×10^{-7}	6.5%-10.3%
Texas	13.00%	10.4%-14.5%	11.80%	9.3%-13.3%	1.09%	2.48×10^{-7}	6.4%-9.4%
Utah	3.90%	3.4%-4.3%	3.80%	3.3%-4.2%	0.10%	1.47×10^{-8}	6.2%-8.1%
Virginia	9.00%	7.2%-10.1%	7.00%	5.4%-7.9%	1.89%	5.34×10^{-7}	
Vermont	7.20%	5.9%-8.6%	6.10%	5.1%-7.4%	1.14%	4.88×10^{-7}	6.4%-10.3%†
Washington	3.90%	3.3%-4.7%	2.80%	2.4%-3.4%	1.06%	1.32×10^{-7}	5.7%-7.8%

(continued)

TABLE I. (Continued)

State	Diagnosis		Persistent		Difference		CDC CI
	Estimates	IQR	Estimates	IQR	Median	Variance	
Wisconsin	6.20%	4.7%-7%	5.30%	4.1%-6%	0.74%	2.01×10^{-7}	8.7%-14.0%
West Virginia	10.20%	7.9%-11.3%	10.00%	7.8%-11.1%	0.13%	4.92×10^{-8}	6.3%-9.5%
Wyoming	7.50%	6.5%-8.9%	6.90%	5.6%-8.2%	0.66%	1.15×10^{-7}	6.5%-11.3%
Total	8.00%	5.7%-9.8%	6.90%	4.8%-8.5%	1.01%	4.91×10^{-7}	

Notes. The table displays statewide in-contact asthma prevalence state estimates and census tract IQR for diagnosis and persistent cases per-member-year (percentage of members per year) derived from the 2012 MAX claims files. In addition, it displays the median and variance of the difference in the measures using the trimmed (2.5%-97.5% quantiles) measures to eliminate outliers and the CDC pediatric asthma CIs.

IQR, Interquartile range.

*2010 MAX data.

†CI is CDC prevalence estimates within 2 y of 2012 (2010-2014). Missing CIs indicate data were not available for the state from 2010 to 2014.

‡2011 MAX data. 95% CI for pediatric (ages 0-17 y) current asthma prevalence.²² This CI is influenced by the response rate and size for the self-reported prevalence estimates.

We benchmarked the prevalence estimates with state-level self-reported diagnosis prevalence for all children provided by the CDC²² on the basis of the 2010 to 2014 BRFSS. CDC asthma prevalence measures were estimated on the basis of randomized samples of participants answering questions about their children (eg, "Has a doctor, nurse, or other health professional ever said that the child has asthma?" or "Does the child still have asthma?"). The CDC survey does not consider whether a child is seeking treatment and neither the severity of the condition. This comparison between national standards of self-reported diagnosed asthma and Medicaid in-contact asthma gives contextual information concerning national levels of prevalence and characteristics of Medicaid-enrolled children in contrast to the entire child population.

Statistical analysis

Comparing measures. We used a Wilcoxon signed rank test to evaluate whether the medians of the 2 measures were plausibly similar. The test was applied for the prevalence estimates pooled from all states with a significance level of .01.

Between-state analysis. We used a 1-way ANOVA to evaluate whether the mean of the asthma prevalence was the same in all states and a pairwise Tukey test to identify which of the mean prevalence pairs are different. The test is more conservative in detecting differences between states because of the spatial dependence in the prevalence estimates.

High-prevalence maps. Using existing methods,^{23,24} we identified census tracts where the difference in asthma prevalence was statistically significantly larger than a high-prevalence threshold I , which we defined using the prevalence third quantile. We considered the prevalence spatial process $Z(s)$, where s is a spatial unit (ie, census tract). We tested whether $Z(s) > I$ for all census tracts by estimating simultaneous confidence bands $[l(s), u(s)]$ for the thresholded expected regression function $E[Z(s)] - I$. Simultaneous confidence bands account for the comparison across multiple locations. We defined a high-prevalence community as the spatial unit s such that $l(s) > 0$. The results are displayed as point maps, where the points correspond to the centroids of the census tracts of high prevalence.

RESULTS

Study population

Across all 50 states and the District of Columbia, approximately 1.98 million children (8.1%) and 1.71 million children (6.9%) have diagnosed asthma and persistent asthma, respectively. Across all states, the average number of enrollment months per patient is larger for the population of children with asthma (11.2 months for diagnosed asthma and 11.3 months for persistent asthma) than for all children (9.8 months), with the difference between state average enrollment ranging from 0.41 (Massachusetts) to 3.2 (North Carolina) months. The difference in the enrollment months for children with diagnosed versus persistent asthma is not statistically different from 0 ($P > .1$) according to the Mann-Whitney test. Table E1 in this article's Online Repository at www.jaci-inpractice.org contains the state-level summary statistics of the study population.

Prevalence measures

Table I presents the state-level prevalence measures for all 50 states and the District of Columbia alongside CDC CI estimates, which are available for 40 states and the District of Columbia. Among these states, the prevalence derived using the 2012 MAX data is higher than the upper bound of the CDC self-reported diagnosed and persistent prevalence estimates for 6 states (Alabama, Louisiana, Nebraska, Tennessee, Texas, and West Virginia). For these states, the differences between diagnosis prevalence and the CDC upper bound range between 0.7 (West Virginia) and 3.6 (Texas). Moreover, the estimates for asthma diagnosis are lower than the CDC lower bound for 17 states (Arizona, California, District of Columbia, Georgia, Hawaii, Michigan, Mississippi, Montana, North Carolina, North Hampshire, New Jersey, Nevada, Oregon, Pennsylvania, Utah, Washington, and Wisconsin). For these states, the differences between asthma diagnosis prevalence and the CDC lower bound range between 0.1 (Arizona) and 6.5 (Nevada). For the persistent asthma measure, only 7 states (Iowa, Illinois, Indiana, Kentucky, Missouri, North Dakota, and Oklahoma) were contained within the CDC CI.

Statistical analysis

Comparing prevalence measures. Figure E1 in this article's Online Repository at www.jaci-inpractice.org presents the

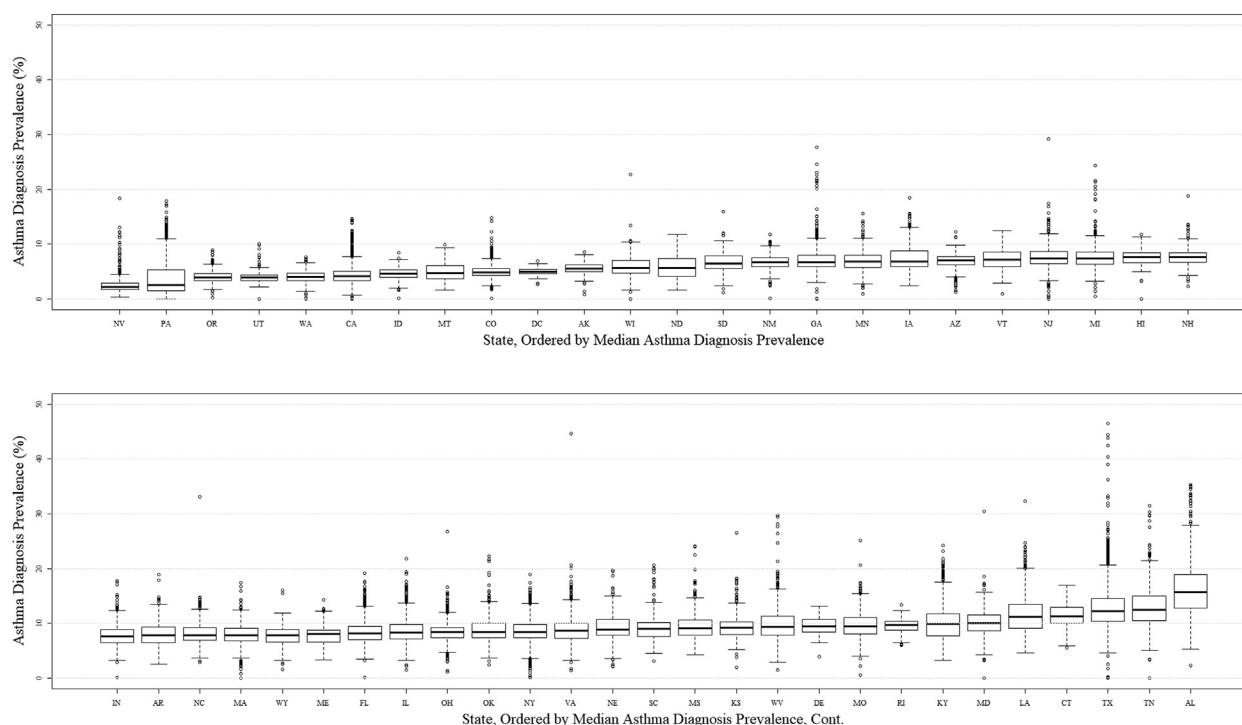


FIGURE 1. Medicaid pediatric asthma diagnosis prevalence census tract box plots by state. Prevalence per-member-year measures for asthma diagnosis derived from the 2012 MAX claims files, ordered by median prevalence. Plots use standard quartiles and whiskers bounds. Box plots for the persistent measure can be found in [Figure E2](#) in this article's Online Repository at www.jaci-inpractice.org.

maps showing the differences between the persistent and diagnosis prevalence estimates. [Table I](#) provides the median and variance of the difference between diagnosis and persistent asthma measures.

Using the Wilcoxon signed rank test, both measures are significantly different, with the *P* values at the county and census tract levels less than .001. By its definition, the diagnosis prevalence measures are always greater or equal to the persistent prevalence measures. The ratio between diagnosis and persistent asthma prevalence ranges from 1.019 (West Virginia) to 2.028 (District of Columbia) with a median of 1.143.

Between-state analysis (census tract level). [Figure 1](#) displays the box plots for the census tract diagnosis measures by state. [Figure E2](#) in this article's Online Repository at www.jaci-inpractice.org provides an equivalent display for the persistent measure. The state-level median of census tract ranges from 2.2% to 15.7% and from 1.7% to 14.0% for census tract diagnosis and persistent prevalence, respectively. The census tract—level measures vary significantly, from 0.0% (20 census tracts among 13 states) to 46.5% (1 census tract [Texas]) for the diagnosis prevalence estimate. The states containing census tracts higher than 5 SDs from the mean diagnosis prevalence (26.0%) were Alabama, Georgia, Kansas, Louisiana, Maryland, North Carolina, New Jersey, Ohio, Tennessee, Texas, Virginia, and West Virginia.

Between-state analysis (county level). [Figure 2](#) and [Figure E3](#) in this article's Online Repository at www.jaci-inpractice.org provide the national county maps for the diagnosis and persistent per-member-year measures, respectively. For enrollment comparison, [Figure E4](#) in this article's Online Repository at www.jaci-inpractice.org

www.jaci-inpractice.org provides the map of the county-level average enrollment months for the study population and asthma-diagnosed children. At the county level, diagnosis prevalence ranges slightly less than the census tract level, from 0.0% (District of Columbia) to 41.7% (Texas). The states containing counties with higher than 3 SDs from the mean of diagnosis prevalence estimate (20.1%) included Alabama, Georgia, Kentucky, Louisiana, Missouri, Oklahoma, Tennessee, Texas, and West Virginia.

For both prevalence measures at the census tract level, the state-level means were not equal according to the 1-way ANOVA test. More than 85% of the Tukey pairwise comparison *P* values were less than .01.

High-prevalence maps. The third quartile of census tract prevalence defines the threshold level (*I*) as 8.5% and 9.8% for the diagnosis and persistent per-member-year high-prevalence maps, respectively.

[Figure 3](#) displays the geographical layout of the high-prevalence census tracts. Approximately 23.1% of all census tracts nationwide are high-prevalence census tracts; out of these, both measures identify 77.1%. Both measures agree that high prevalence is primarily in the southern Midwest region. Small spotted regions exist outside of this range, with the most predominant regions by population being centered on New York City (New York) and Annapolis (Maryland).

DISCUSSION

The in-contact prevalence measures presented in this study capture multiple aspects of asthma prevalence. The percentage of children diagnosed with an asthma condition defined as the per-

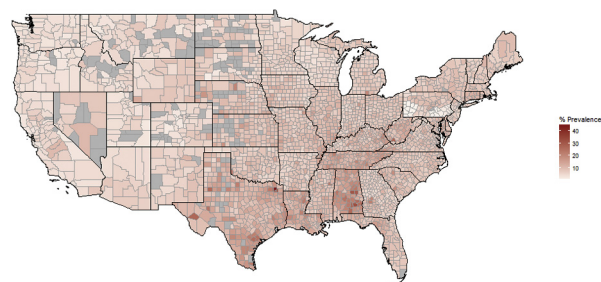


FIGURE 2. National county-level in-contact asthma diagnosis per-member-year. All values in percent of diagnosis patients out of total patients (aged 4-17 years) have been derived from the 2012 MAX claim files. Counties shaded in gray represent those with less than 11 diagnosis cases. Alaska (mean 3.8%, 20 counties) and Hawaii (mean 7.3%, 4 counties) have been excluded.

member-year prevalence in this study is comparable with prevalence estimates provided by the CDC, because it does not access the severity of the condition. We also provide measures for diagnosed and persistent asthma, with only 2 states (District of Columbia and Washington) having more than 40% more children with diagnosed asthma than with persistent asthma. Differences between these 2 measures illustrate not only the severity of the condition but also the level of utilization and quality of care because the definition of persistent asthma implies that an asthma-diagnosed child uses the system.

The national in-contact prevalence in the Medicaid-enrolled child population (6.9% persistent, 8.1% diagnosis) is comparable with the national CDC self-reported prevalence asthma estimate of 8.9%,⁶ but there are differences in estimates at the state level. Generally, it is expected that children from low-income households will have a higher prevalence of asthma.²⁵ Three states (Alabama, Tennessee, and Texas) with higher asthma prevalence for the Medicaid population than the CDC are also the states with the highest asthma prevalence for the Medicaid population. We identified 17 states with lower diagnosed asthma prevalence in the Medicaid population as compared with the CDC estimates, thus pointing to potential underdiagnosis of asthma in the Medicaid child population compared with the general child population.

The asthma prevalence estimates in the Medicaid child population vary widely across the states. Because asthma may be attributed to demographic characteristics and geographical variations, including variation caused by environmental triggers such as pollution, pollen level, and weather,²⁶⁻²⁹ estimates of asthma prevalence between states are expected to vary. However, the differences in both prevalence measures for the Medicaid population are extreme, suggesting disparities in how asthma is treated and diagnosed across states.

The asthma prevalence estimates in the Medicaid child population also vary widely within each state. The state-level diagnosis prevalence varies from 2.5% to 15.9%. At more granular levels, prevalence varies from 0% to 45.2% (county) and 46.5% (census tract). These large disparities are much wider than those estimated by the state-level CIs provided by the CDC. Local environmental asthma triggers or demographic characteristics potentially explain the high-prevalence communities appearing in clusters around city centers. Other extremely low- or high-prevalence communities

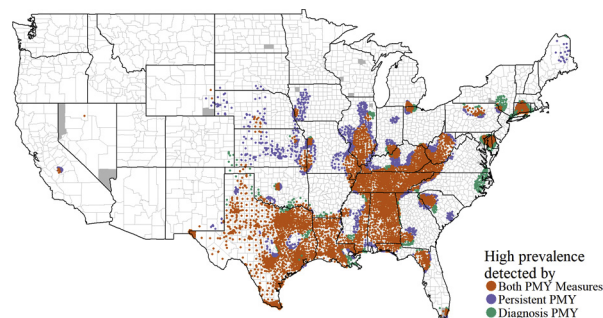


FIGURE 3. National high-prevalence map using asthma in-contact prevalence per-member-year measures. Counties without data available are marked in gray. Blue and green points correspond to high-prevalence census tracts identified by the persistent and diagnosis per-member-year measures respectively, derived from the 2012 MAX claims files. Orange points correspond to census tracts identified by both per-member-year measures. Alaska and Hawaii do not contain high-prevalence census tracts and have been excluded. *PMY*, Per-member-year.

may also reflect overdiagnosis or underdiagnosis of the neighboring communities.

To identify communities with the highest prevalence, we used statistical inference, assuming high prevalence if larger than the third quartile of the prevalence estimates across all communities in the United States. This approach highlights an important finding—the overwhelming number of communities identified as having high prevalence are in the south, the southeast, and the Midwest. Some southeast states, including Georgia and North Carolina, do not display the highest prevalence but are known to have high asthma prevalence due to environmental triggers (eg, pollen).³⁰ These 2 states are also among those states with a lower asthma prevalence estimate for the Medicaid child population than the CDC estimates for the general child population, pointing to systematic disparities in asthma diagnosis and consequently in treatment.

Nevertheless, western states are not included in the high-prevalence map almost entirely, indicating that asthma is not a prevalent concern for states in this part of the country. The central and eastern states show more variations, including communities with high diagnosed asthma or high persistent asthma (but not both). In these states, we also see small clusters of high prevalence. Understanding the triggers of high prevalence in these communities should be a first step before targeting interventions for asthma because these communities behave differently from those in their neighborhood.

Study limitations

One limitation of this study is the reliance on claims data. Although clinical definitions of intermediate and persistent asthma from organizations such as the National Heart, Lung, and Blood Institute include all patients in and out of treatment, the MAX files include only those claims that have been submitted for reimbursement. Therefore, estimates on the health care outcomes such as prevalence of a condition may be biased where certain subgroups have difficulty in maintaining Medicaid coverage, lack access to care, or are susceptible to particularly disparate utilization.³¹ Moreover, Medicaid MAX files can have data quality issues, especially for states with large populations on managed care.³² Similarly, in-contact prevalence measures may

not accurately represent prevalence for areas where children are enrolled in Medicaid for a fraction of the year, such as if they shift between Medicaid and commercial insurances. We considered children of ages between 4 and 17 years, although asthma among children younger than 4 years is also of concern. Medicaid-enrolled individuals older than 18 years and children not enrolled in Medicaid are also a concern but were outside the scope of this study. By studying a maximum of 1 year of a child's health care, prevalence could be under-represented for patients who sought care over or between multiple years. Finally, the prevalence estimates are for 2012, and although asthma prevalence has historically seen a slow increase,⁸ the most recent years of Medicaid claims data may provide different estimates, particularly in the context of recent health policies.

CONCLUSIONS

This study is the first to provide a comprehensive measurement approach for in-contact asthma prevalence for the Medicaid child population, identifying significant disparities in diagnosis of asthma between and within states. Moreover, this study provides a heat map of high-prevalence communities, highlighting areas to be targeted for asthma management interventions. These findings can be used by community and public health departments across the country for allocating resources toward improvement in diagnosis and for guiding asthma health care and management. The census tract-level and county-level prevalence estimates are available upon request.

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ONLINE REPOSITORY

TABLE E1. State-level data overview for 2012 in-contact asthma for pediatric Medicaid patients (aged 4-17 y) from the MAX claims files

State	Total		Asthma diagnosis			Persistent asthma		
	Patients	Enrollment months	Patients	Enrollment months	Tract SD*	Patients	Enrollment months	Tract SD*
Alabama	371,980	3,944,562	59,000	672,505	0.0514	52,670	600,749	0.0511
Alaska	61,998	637,634	2,955	33,231	0.0143	2,544	28,585	0.0148
Arizona	586,578	5,623,301	39,714	435,187	0.0126	28,579	313,847	0.0101
Arkansas	325,375	3,515,403	26,015	298,437	0.022	21,641	248,443	0.0203
California	3,548,125	30,246,113	164,979	1,898,560	0.0179	140,334	1,615,296	0.0166
Colorado†	315,874	2,510,534	15,346	164,437	0.0143	13,995	150,210	0.0129
Connecticut	219,714	2,398,380	25,684	295,601	0.0199	21,651	249,159	0.0177
Delaware	76,816	745,595	7,404	83,078	0.0169	6,427	72,043	0.0146
District of Columbia	58,776	652,013	2,989	34,834	0.0081	1,476	17,098	0.008
Florida	1,368,578	13,790,568	119,429	1,329,391	0.0216	99,561	1,109,379	0.0207
Georgia	936,771	7,517,959	67,119	727,066	0.0205	58,633	635,583	0.0189
Hawaii	101,758	1,122,129	7,673	89,779	0.0152	6,161	72,167	0.0139
Idaho†	123,108	1,132,902	5,779	62,980	0.0115	5,424	59,147	0.0111
Illinois	1,235,031	13,216,855	105,631	1,236,131	0.0216	97,105	1,136,230	0.0217
Indiana	504,872	5,160,772	38,894	443,333	0.0186	34,925	398,055	0.0178
Iowa	206,012	2,132,149	15,234	171,284	0.0246	13,795	155,075	0.0249
Kansas‡	158,881	1,642,409	14,842	166,620	0.0227	13,864	155,898	0.0227
Kentucky	373,981	3,733,076	38,083	429,491	0.031	34,276	386,695	0.0304
Louisiana	528,661	6,000,831	64,196	755,452	0.0347	58,216	685,014	0.0365
Maine	95,934	1,010,031	7,343	83,942	0.0183	6,727	76,886	0.0182
Maryland	402,812	4,392,169	42,645	495,100	0.0221	34,541	401,083	0.0201
Massachusetts	438,549	4,185,322	35,935	406,192	0.0197	30,070	339,582	0.0181
Michigan	784,994	8,112,231	60,121	688,247	0.0184	48,411	553,469	0.0174
Minnesota	303,426	3,092,201	20,661	231,923	0.0173	16,770	188,351	0.0139
Mississippi	336,441	2,900,050	31,883	356,087	0.0253	29,283	327,102	0.0257
Missouri	441,887	4,416,165	43,224	488,016	0.023	39,749	449,240	0.0228
Montana	74,108	595,552	3,518	39,838	0.0172	3,116	35,309	0.0157
Nebraska	128,172	1,322,422	11,494	129,437	0.0234	10,387	116,844	0.0222
Nevada	161,078	1,551,223	4,004	42,520	0.0193	3,428	36,667	0.0175
North Hampshire	74,437	749,657	5,697	62,925	0.0182	4,914	54,194	0.017
New Jersey	546,954	5,039,411	42,130	484,667	0.0189	32,009	368,103	0.0161
New Mexico	253,183	2,767,055	16,766	193,814	0.014	13,440	155,578	0.0124
New York	1,328,405	14,095,087	119,455	1,370,600	0.0215	93,443	1,072,721	0.0182
North Carolina	821,144	7,509,211	67,713	765,404	0.0176	56,188	634,410	0.0158
North Dakota	34,459	298,945	1,877	20,138	0.021	1,713	18,352	0.0211
Ohio	860,121	9,498,760	73,215	851,875	0.0236	60,020	698,115	0.0225
Oklahoma	387,168	3,910,221	33,373	373,337	0.0222	28,975	324,798	0.0206
Oregon	298,313	2,466,956	11,786	129,156	0.0107	9,563	104,720	0.0102
Pennsylvania	756,398	7,990,435	24,006	273,361	0.0312	18,343	208,649	0.031
Rhode Island‡	74,043	790,557	7,088	80,081	0.0126	6,491	73,421	0.0128
South Carolina	426,772	4,448,746	38,827	447,582	0.0224	35,856	414,254	0.0223
South Dakota	64,334	643,619	3,832	41,987	0.019	3,598	39,402	0.0186
Tennessee	528,505	5,723,101	67,564	777,886	0.0331	62,689	721,701	0.0334
Texas	2,110,497	21,041,905	273,714	3,004,184	0.0353	249,923	2,745,064	0.0354
Utah	174,433	1,306,624	6,807	72,691	0.0098	6,559	70,073	0.01
Vermont	51,590	524,481	3,720	42,200	0.0191	3,162	35,812	0.0166
Virginia	476,262	4,563,515	42,788	487,357	0.0245	33,519	381,838	0.0233
Washington	554,427	5,736,703	21,564	246,681	0.0109	15,233	173,707	0.0091

(continued)

TABLE E1. (Continued)

State	Total		Asthma diagnosis			Persistent asthma		
	Patients	Enrollment months	Patients	Enrollment months	Tract SD *	Patients	Enrollment months	Tract SD *
West Virginia	141,760	1,456,222	14,392	159,898	0.0359	14,115	156,849	0.036
Wisconsin	401,467	3,936,453	25,030	285,435	0.0186	21,258	243,255	0.0157
Wyoming	38,508	375,182	2,902	31,435	0.0218	2,644	28,621	0.0213
Total	24,673,470	242,173,397	1,986,040	22,491,393	0.036	1,707,414	19,336,843	0.0342

*SD for in-contact persistent per-member-year measure for all census tracts with available data.

†2010 data.

‡2011 data.

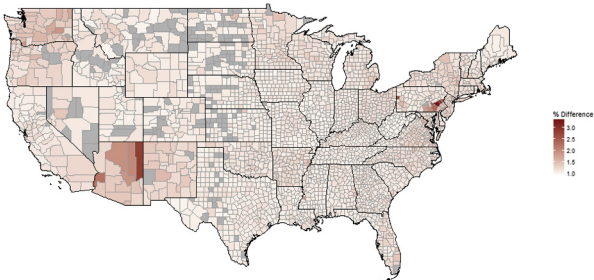


FIGURE E1. County-level in-contact asthma prevalence difference from the MAX claims files. It shows the metric difference county heat map for persistent versus diagnosis, calculated as the diagnosis per-member-year prevalence divided by the persistent per-member-year prevalence. Alaska (mean, 1.26, 20 counties) and Hawaii (mean, 1.22, 4 counties) have been excluded.

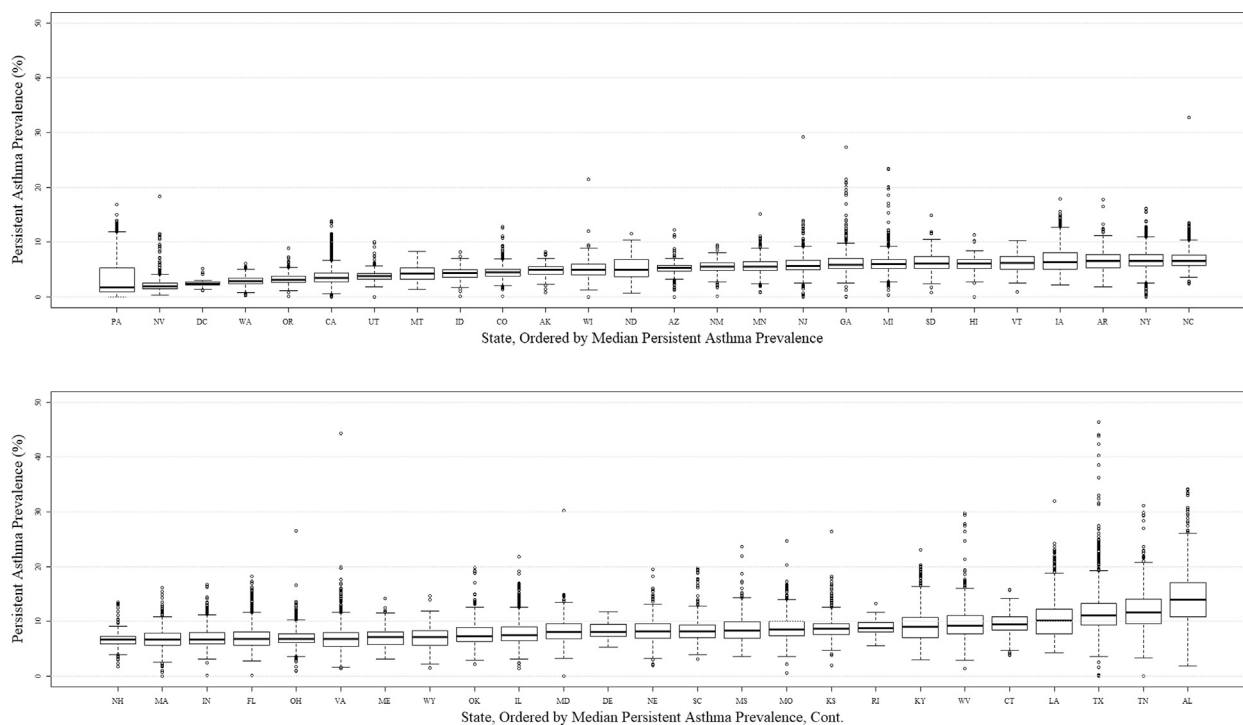


FIGURE E2. Medicaid pediatric persistent asthma prevalence census tract box plots by state. Prevalence per-member-year measures for persistent asthma were derived from the 2012 MAX claims files, ordered by median prevalence. Plots use standard quartiles and whisker bounds.

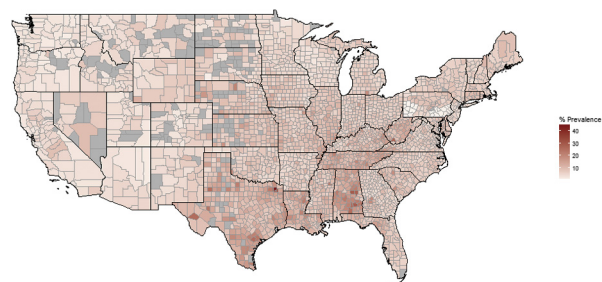


FIGURE E3. National county-level in-contact persistent asthma per-member-year. All values in percent of patients with persistent asthma out of total patients (aged 4-17 years) were derived from the 2012 MAX claim files. Counties shaded in gray represent those with less than 11 diagnosis cases. Alaska (mean, 3.1%, 20 counties) and Hawaii (mean, 5.9%, 4 counties) have been excluded.

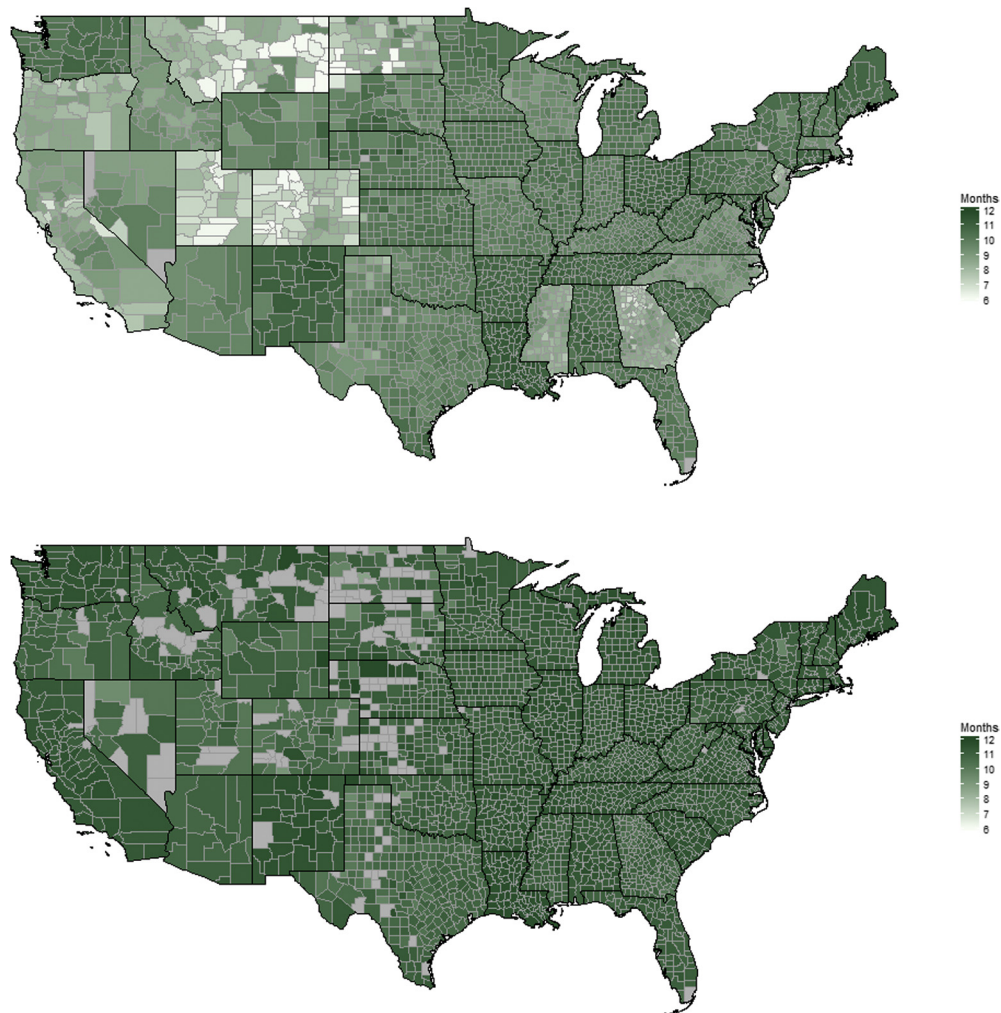


FIGURE E4. Average county enrollment months for children aged 4 to 17 years from the MAX claims files. All values are in average months per year of enrollment for all children (top) and children with an asthma diagnosis (bottom). Counties shaded in gray represent those with fewer than 11 pediatric patients. Alaska (mean, 10.1 mo, 20 counties) and Hawaii (mean, 11.0 months, 4 counties) have been excluded. Counties with average member enrollment of less than 6 months ($n = 33$) are lower bounded at 6 months.