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# Population Health Considerations for Pediatric Asthma: Findings from the 2011–2012 California Health Interview Survey

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## Abstract

Childhood asthma is a prevalent and costly chronic condition. Optimal management enables secondary and tertiary prevention. The goal was to identify population health considerations for pediatric asthma in California to inform the development of quality improvement interventions. California Health Interview Survey 2011–2012 is a random-digit dial telephone survey conducted in 5 languages. It includes 44,000 households from all 58 counties in California. This study assessed factors related to symptom control and health care use in children ages 2–11 years with asthma. An estimated 492,385 (9.6%) of children in California currently have asthma. Urban and rural residents face comparable asthma disease burdens. School-age male children as well as Asian and African American children are disproportionately affected. Asthma causes significant morbidity, with poorer health status, high utilization of emergency care, and the need for daily medication use. Only 38% of children with asthma have a recent asthma management plan. Half of all children with asthma did not receive influenza immunization in the past year, although this reflects the overall low rate of influenza vaccination. Parents of children with asthma frequently utilize the Internet for health information and communication with their child's health care provider. Children with asthma in California face several population-level challenges, including poor health status, low influenza vaccination rates, high use of emergency care, and suboptimal use of health literacy tools. Focusing on improved care coordination and preventive care for high-risk groups is especially urgent given the expansion of public health insurance and impending shortages in the primary care workforce. (*Population Health Management* 2015;xx:xxx–xxx)

## Background

**A**STHMA IS A SIGNIFICANT PEDIATRIC public health problem and a major cause of childhood disability and health care use. This treatable chronic condition adversely affects children's activity, academic performance, sleep, and development. Asthma is responsible for direct medical costs from prevention and treatment of exacerbations, and indirect costs from missed school and work days. Approximately 10% of children in the United States currently have asthma.<sup>1</sup> Nationally, the prevalence of childhood asthma is currently at historically high levels.<sup>2</sup>

Optimal management of asthma is effective in secondary and tertiary prevention. Hospitalization for asthma is an ambulatory care-sensitive condition and is associated with poorer quality of outpatient care.<sup>3,4</sup> Asthma severity and inadequate

control of symptoms are associated with poor adherence to asthma management plans and suboptimal use of asthma medications. Approximately 30% of prescriptions for controller medications for asthma prescribed by allergy specialists to low-income children are never filled.<sup>5</sup> A large number of children with asthma receive prescriptions for rescue medications in settings other than their medical home.<sup>5</sup> Environmental tobacco smoke exposure is associated with increased emergency department visits, hospital admissions, and life-threatening exacerbations.<sup>6</sup> Children with asthma are at increased risk of developing complications of influenza virus.<sup>7</sup> Asthma exacerbations and adverse outcomes are avoidable with environmental control measures, optimal medication use, and patient education.<sup>8</sup>

Clinical practice guidelines recommend early and aggressive management of childhood asthma. They recommend that

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patients be assessed for asthma severity and receive tailored treatment with close monitoring of symptoms and medications. Specifically, clinicians should provide parents and caregivers with a regularly updated written asthma management plan, administer annual influenza immunization for all children with asthma, prescribe daily controller medications in children with persistent asthma, and screen for environmental tobacco exposure.<sup>8</sup>

State-specific population-level surveys may be a useful tool to identify social determinants of health and unique considerations that may benefit from tailored interventions. The overall goal of this study was to identify population health considerations related to pediatric asthma to inform the development of state-level quality improvement interventions. This study specifically assessed sociodemographic factors, outcomes, health care use, and preventive interventions in children ages 2–11 years with asthma in California.

## Methods

The analyses included children in the most recently available sample of the California Health Interview Survey (CHIS), the largest state health survey in the United States.<sup>9</sup> Public use files from the 2011–2012 CHIS Child Survey were used, which consists of individual records for children younger than age 12; children younger than age 2 were excluded from the study analyses because of the difficulty in definitively diagnosing asthma in infants and toddlers.<sup>10</sup> The CHIS is a random-digit dial telephone survey conducted by the UCLA Center for Health Policy Research, the California Department of Health Care Services, and the California Department of Public Health. The biannual survey, first conducted in 2001, includes self-reported data on a variety of topics including health status, health conditions, health behaviors, access to and use of health care, and health insurance. Public use data sets have been released every 2 years. The 2011–2012 continuous survey included more than 44,000 households from all 58 counties in California. Informed consent was provided by adult proxy respondents of eligible children over the telephone. Detailed survey methodology can be obtained from the CHIS Web site.<sup>11</sup>

Screener response rates for CHIS 2011–2012 were 31.6% for the landline sample and 33% for the cell phone sample. The extended interview response rate for the landline and cell phone samples were comparable and were 73% for children. Overall response rates are composites of screener completion rates (success in introducing the survey to a household and randomly selecting an adult to be interviewed) and extended interview completion rates (success in getting 1 or more selected persons to complete the extended interview). Overall response rates for children in CHIS 2011–2012 were 23.1% (landline) and 24.1% (cell phone).

The complex survey methodology of CHIS was accounted for in variance estimates using the Jackknife option of the SURVEYFREQ procedure in SAS (SAS Institute Inc., Cary, NC).<sup>12</sup> Sampling weights were utilized to obtain population-representative data for California. Chi-square was used to test for statistical differences. Primary outcome variables were children who currently have asthma. Independent variables included were (1) sociodemographic: age, sex, urban/rural residence, race/ethnicity, parental education, household income, English language literacy, and

health insurance; (2) health care access: delays in receiving needed care, delays in filling prescription medications for asthma; (3) asthma control: health status, asthma symptoms, emergency department use, hospitalizations, confidence in managing asthma, provision of asthma management plans, delay in filling prescriptions, delay in medical care, exposure to environmental tobacco smoke, influenza immunization, and missed school days.

## Results

The 2011–2012 CHIS provides data representative for California's population of 5,112,305 children ages 2–11 years. Of these, 11.9% had received a diagnosis of asthma by a physician and 9.6% (95% confidence interval [CI]=8.2–11.0, population estimate 492,385) are considered by their parent to currently have asthma.

### Demographic factors

As expected, school-age children had a greater prevalence of asthma compared to younger preschool children (Table 1). However, asthma outcomes such as frequency of asthma exacerbations, daily medication use for asthma, emergency care, and hospital admissions for asthma did not vary significantly by age. Males had higher asthma prevalence compared to females (11.5% vs 7.7%) and had significantly higher rates of asthma exacerbations compared to females (67.9% vs 47.6%,  $P=0.002$ ). Rates of pediatric asthma were comparable in urban and rural areas. Race and ethnic differences in prevalence exist, with the prevalence of asthma being highest in Asian and African American children.

Pediatric asthma in California does not appear to be significantly associated with poverty, with rates of asthma being similar in households at the 0–99% and  $\geq 300\%$  Federal Poverty Levels.<sup>13</sup> Most parents of children with asthma had completed high school. Parental education level was not significantly associated with recent asthma exacerbations, use of daily medications for asthma, and overall frequency of emergency department visits or hospital admissions for asthma. However, parents who were college educated were significantly less likely to report that they visited an emergency department for their child's asthma related to an inability to see their own health care provider than parents with lower education levels (8.1% vs 13.9%,  $P=0.048$ ). Parents who had completed high school were more likely to have received an asthma management plan from their health care provider compared to parents with less than a high school education (59.2% vs 87.1%,  $P<0.0001$ ).

### Asthma management

The majority of children with asthma (96.3%) had a usual source of primary care. Children who used daily medications to control their asthma were less likely to have a usual source of primary care compared to those who did not use daily medications (41.9% vs 54.8%,  $P=0.0001$ ). Only 38.1% of children with asthma were provided a written asthma management plan by their physician in the past year (Table 2). Approximately 42% of children with asthma used daily prescription medication to control symptoms and 5.7% of children with asthma delayed filling or did not fill prescribed medications for asthma because of cost or lack of insurance.

TABLE 1. SOCIODEMOGRAPHIC CHARACTERISTICS OF CHILDREN WITH ASTHMA COMPARED TO THE GENERAL POPULATION OF CHILDREN IN CALIFORNIA, 2011–2012 CALIFORNIA HEALTH INTERVIEW SURVEY

	All Children N	Population Estimate	Children with Current Asthma % with Asthma	95% CI	Population Estimate	P value
Age						0.19
2–5 years	2501	2,124,745	8.5%	6.3–10.7%	180,802	
6–11 years	3868	2,987,560	10.4%	8.7–12.2%	311,582	
Sex						0.006*
Male	3288	2,603,834	11.5%	9.4–13.5%	298,471	
Female	3081	2,508,470	7.7%	6.0–9.5%	193,914	
Residence						0.95
Urban	5324	4,655,473	9.6%	8.2–11.1%	447,917	
Rural	1045	456,832	9.8%	6.4–13.1%	44,468	
Race/ethnicity						0.12
Latino	1984	1,863,014	9.9%	7.4–12.3%	184,169	
Native American	111	39,982	5.9%	1.1–10.7%	2,364	
Asian	747	607,121	14.6%	6.8–22.3%	88,536	
African American	270	373,646	12.1%	7.1–17.1%	45,316	
White	2724	1,635,841	7.2%	5.3–9.1%	117,922	
Other/2 or more	533	592,700	9.1%	3.5–14.7%	54,078	
Parent Education						0.001*
<High school	1177	1,059,615	9.3%	6.5–12.1%	98,430	
High school	1149	1,042,466	6.6%	4.1–9.2%	69,323	
Some college	1401	1,236,921	14.4%	10.8–18.0%	178,310	
College Educated	2642	1,773,303	8.3%	5.9–10.6%	146,322	
Household income						0.94
0–99% FPL	1324	1,414,555	10.2%	7.2–13.3%	144,886	
100–199%	1401	1,163,528	9.1%	6.7–11.6%	106,302	
200–299%	788	653,107	10.3%	4.6–15.9%	66,947	
≥300% FPL	2856	1,881,115	9.3%	7.0–11.5%	174,250	
Poor parental English-language literacy	1520	1,174,400	6.5%	4.3–8.6%	76,141	0.01*
Health insurance						0.67
Private	3619	2,546,296	9.9%	7.6–12.2%	252,647	
Public	2508	2,371,962	9.6%	7.5–11.6%	227,661	
Uninsured	242	194,047	6.2%	0.3–12.1%	12,077	
Health status						<.0001*
Excellent/Very Good	4917	3,808,431	6.4%	4.9–7.9%	244,210	
Good/Fair/Poor	1452	1,303,873	19.0%	15.3–22.7%	248,175	

\*Indicates statistically significant difference,  $P \leq 0.05$ .  
CI, confidence interval; FPL, federal poverty level.

Approximately 6.5% of parents of children with asthma had limited English language literacy. Compared to all parents, those with children with asthma were significantly more likely to use the Internet to obtain information on their child's health (51.1% vs 35.6%,  $P=0.0004$ ). Parents of children with asthma were significantly more likely to have telephoned or e-mailed their health care provider with medical questions in the past year compared to parents of children in the general population (58.6% vs 31.1%,  $P<0.0001$ ). Approximately 71% of parents reported that they felt very confident in controlling their child's asthma.

#### Health status

Parents of children with asthma are significantly more likely to report poorer health status in their children, compared to parents of children who do not have asthma. Parents of 50.6% of all 2–11-year-old children in California reported their child's health status as excellent, compared to

30.2% of parents whose children had asthma. Approximately 51.2% of children diagnosed with asthma had excellent or very good health status compared to 77.2% of children in the general population.

#### Preventive care

Approximately half of all children with asthma were not immunized for influenza vaccination in the past 12 months. Although children with asthma were slightly more likely to receive influenza vaccination than children without asthma, overall influenza immunization rates among children in California were only 49%. Environmental tobacco smoke exposure rates for children with asthma were not significantly different compared to children in the general population (2.0% vs 2.5%). Data trends from CHIS from 2003 to the most recent sample show overall declining rates of adults in children's homes who smoke indoors, especially for children with asthma.

TABLE 2. ASTHMA MANAGEMENT AND SYMPTOM CONTROL IN CHILDREN IN CALIFORNIA, 2011–2012 CALIFORNIA HEALTH INTERVIEW SURVEY

	All Children with Asthma		Private Insurance		Public Insurance		Uninsured		P value
	% (95% CI)	Population Estimate	% (95% CI)	Population Estimate	% (95% CI)	Population Estimate	% (95% CI)	Population Estimate	
Asthma attack in past year	59.9% (52.3–67.5)	294,992	35.0% (26.3–43.8)	172,580	24.2% (17.6–30.9)	119,337	0.6% (0–1.2)	3005	0.006*
Emergency department/urgent care visit for asthma in past year	31.4% (23.3–39.5)	154,492	28.2% (16.8–39.6)	71,237	36.6% 23.9–49.3)	83,255	0	0	0.33†
Emergency department/urgent care visit for asthma in past year because of inability to see health care provider	18.8% (12.1–25.5)	92,549	17.6% (6.6–28.6)	44,524	21.1% (13.2–28.9)	48,025	0	0	0.63†
Overnight hospital admission for asthma in past year	4.1% (1.4–6.7)	20,020	3.2% (0.6–5.8)	8053	5.3% (1.0–9.5)	11,967	0	0	0.29†
Children with asthma on daily prescription medication to control asthma	42.2% (33.3–51.1)	207,637	36.8% 23.5–50.0)	92,853	49.1% (36.9–61.2)	111,673	25.8% (0–74.7)	3110	0.28
Children diagnosed with asthma who delayed/did not get prescribed medications in past 12 months because of cost/lack of insurance	5.7% (2.2–9.3)	28,144	2.6% (0.4–4.8)	6518	9.5% (2.2–16.8)	21,627	0	0	0.001**†
Parent very confident about controlling child's asthma	70.7% (63.2–78.1)	348,068	76.9% (65.8–88.0)	194,304	62.8% 52.8–72.8)	143,073	88.5% (70.1–100)	10,691	0.056
Provided written asthma management plan by health care provider	38.1% (30.5–45.8)	187,839	37.2% (7.3–47.0)	93,887	40.6% (29.5–59.6)	92,333	13.4% (0.0–31.5)	1619	0.03*

\*Indicates statistically significant difference,  $P \leq 0.05$ .

†Indicates that comparison for variable is between public and private insurance because there were no uninsured children for that variable. CI, confidence interval.

### *Adverse health outcomes*

As shown in Table 2, approximately 60% of children with asthma reported having an asthma attack in the past year. Children with asthma missed an average of 3.1 (95% CI = 2.13–4.06) school days in the past year because of symptoms. A third of children with asthma received emergency department or urgent care for asthma in the past year and approximately 19% of children with asthma obtained this care because of an inability to see their own health care provider. Approximately 4% of children with asthma were hospitalized overnight for asthma in the past year. Emergency care use for asthma was not associated with children's sex, usual source of care, or parental education, but was significantly higher in children ages 2–5 years compared to children ages 6–11 years (31.6% vs 14.2%,  $P = 0.0399$ ). Overnight hospital admissions for asthma were not significantly associated with children's age, children's sex, or parental education.

### *Health insurance*

Compared to children with private health insurance, in the past year a greater proportion of children with public health insurance (Medicaid and Children's Health Insurance Program) used emergency services, obtained emergency services because of their inability to access their own health care provider, had an overnight hospital admission for asthma, and used daily prescription medication to control asthma, although these differences were not statistically significant. Children with asthma who have public health insurance were significantly more likely to report that they delayed or did not fill prescribed medications in the past 12 months because of cost (9.5%), compared to children with private insurance or those in the general population (Table 2).

## **Discussion**

Many children with asthma in California face several avoidable adverse outcomes, including poor health status and high emergency department use. Immunization rates for influenza are suboptimal. The majority of children with asthma have a usual source of primary care. California is in the midst of implementing the Affordable Care Act and is increasing the number of individuals with health insurance coverage. However, high rates of expensive emergency care is a symptom of failure of primary care to adequately prevent and treat asthma, and may continue unless targeted population-level interventions are implemented.<sup>14</sup>

Pediatric emergency department visits in California are increasing in all insurance categories, with children with Medicaid making up a large proportion of visits.<sup>15</sup> Given projected shortages in the primary care workforce, roles of other health professionals should be optimized to enhance care coordination. For example, the role of pharmacists and managed care insurance providers could be expanded to include tracking medication use for asthma, notifying the medical home of suboptimal medication utilization, and reminding families about the need for influenza vaccination. Follow-up of children hospitalized for asthma in a patient-centered medical home is associated with reduced readmission rates.<sup>4</sup> Hence, optimizing care coordination between the inpatient and outpatient settings through the use of care coordinators and health educators could further improve outcomes.

Care for asthma also needs to be expanded outside the clinical setting. Because asthma is a leading cause of school absenteeism, school nurses and other school personnel may be valuable partners in identifying higher risk children, providing health education, screening for influenza vaccination adherence, and coordinating their efforts with primary care providers.<sup>16</sup> Environmental factors and allergies are a key trigger of asthma exacerbations among school-age children.<sup>17</sup> Social workers and community health workers could be engaged in home visits to identify and control environmental triggers, provide patient and family education on disease self-management and influenza vaccination, and coordinate care within the medical home.<sup>17</sup>

This study demonstrates that parents with higher education levels were significantly more likely to have received an asthma management plan from their child's health care provider than parents with less than a high school education. Health literacy interventions for asthma should include parental education on the appropriate management of symptom exacerbations. A large majority of parents improperly administer inhaled asthma medications to their children.<sup>18</sup> More than 60% of children covered by public health insurance discontinued prescribed asthma medications within 3 months of starting them, with minorities and children from disadvantaged families being more likely to do so.<sup>19</sup> Analyses from the present study show that children with asthma with public health insurance were more likely to delay or not fill prescribed medications because of cost compared to children with private insurance or the general population. Co-payments in low-income populations adversely affect the likelihood of filling prescription medications, especially in sicker individuals.<sup>20</sup> Children covered by Medicaid in California are not charged a co-payment for prescription medications for asthma. The Children's Health Insurance Program in California charged a nominal co-payment, which may partially account for these findings. Beginning in 2013, children previously covered through the Children's Health Insurance Program transitioned to the state's expanded Medicaid program, and are no longer subject to a co-payment for prescription asthma medications. For children covered by Medicaid whose parents reported that they delayed or did not fill prescribed medications because of cost, this study's findings may indicate other reasons for non-adherence, such as parental perception of cost, or the need to intensify early and periodic patient and family education on the need for controller medications, even when patients are not actively experiencing symptoms.

National data indicate that asthma is most prevalent in black and Native American children, with lowest rates in Asian children.<sup>21</sup> However, data from the present study indicate that the prevalence of asthma in Asian children is comparable to that of black children in California. This may reflect demographic patterns in the state, but has implications related to tailoring interventions to specific populations and minimizing language barriers in health care delivery.

Electronic registries are an effective and efficient population health tool to track and manage asthma, as well as to identify clinical practice variation and high-risk patients.<sup>22</sup> Standardizing clinical care within and between practices will allow children with asthma and their families to receive consistent messages and help medical homes adhere to evidence-based clinical guidelines. Tracking and reporting

data from registries also could enable effective resource allocation, identify areas for clinical quality improvement, and enable the provision of higher value care. Practice-based registries can enable clinicians to identify those patients among their clinical population of children with asthma who need targeted interventions. Specifically, registries can help identify those with uncontrolled and severe asthma, controller medication underuse, and beta-agonist overuse. Clinicians can track and manage asthma action plan updates, spirometry testing, influenza vaccination, environmental trigger assessment, body mass index assessment, and provision of asthma education. The present study noted high emergency department use by children with asthma. Emergency department overuse may be a proxy for uncontrolled asthma, asthma severity, suboptimal adherence to clinical practice guidelines, poor access to specialists, or inappropriate emergency department use. Identifying children with asthma who recurrently utilize costly emergency department care may help characterize a population with higher risk for adverse clinical outcomes. Registries can help identify patients who may be overutilizing emergency or hospital care or underutilizing primary care.

Influenza vaccination rates in this study are comparable to national influenza vaccination rates in the United States.<sup>23</sup> Although there have been modest increases in childhood influenza vaccinations rates nationally, they continue to remain well below the Healthy People 2020 target of 80%. This finding is concerning given the severity and unpredictability of influenza in children and their high hospitalization rates and pediatric deaths in recent influenza seasons.<sup>23</sup> The overall low childhood influenza vaccination coverage in California highlights the urgent need to increase immunization rates in all children, especially those with asthma, by identifying and addressing barriers. Potential interventions include expanding access to vaccines through schools and pharmacies, modifying school immunization requirements, implementing patient and clinician reminder systems, and employing immunization registries at the point of care and at the population level.

A limitation of this study includes its low overall response rate. Historically, CHIS response rates are comparable to response rates of other scientific telephone surveys in California. Survey response rates have been declining over the past decade, both in California as well as in the rest of the United States. Although CHIS data are limited to California and may present concerns regarding generalizability, it is commonly believed that data from California may represent a “first look” at future national trends.<sup>24</sup> Modeled after the National Health Interview Survey, CHIS is repeated with greater frequency and oversamples racial and ethnic minority groups in the most diverse state in the country to obtain a statistically representative sample. Significant effort is taken to include non-English speakers and surveys are administered in 5 languages. Another limitation of this study is that the data are based on parental report and subject to recall bias, and that accuracy of the primary measure depends on health care providers accurately diagnosing asthma and communicating this information to the parent. Although environmental tobacco smoke exposure has been declining since 2003 in CHIS, these data are collected through parental self-report and are subject to possible underreporting related to social desirability bias, especially for children with asthma.<sup>25</sup>

Despite these limitations, this study identifies several considerations that can inform the development of population-level interventions. The authors recommend that next steps include the development of targeted strategies to increase influenza vaccination rates, especially in children with asthma. It is critical that interventions to improve asthma care delivery leverage interprofessional team-based care within and outside the primary care setting to optimize medication use, provide patient and family education, and ensure adequate monitoring of symptoms, especially for high-risk patients. Data from this study indicate that parents of children with asthma frequently utilize the Internet to seek health information for their children and communicate with their health care provider by telephone or e-mail more frequently than parents in the general population. Reducing reliance on in-person clinic visits and utilizing communication technology within primary care for coordinated case management could more effectively utilize limited resources.

In conclusion, this study identifies that population-level management of childhood asthma in California is an important area of need. Attention to improving health care delivery for children with asthma is critical, especially for children with public insurance because these children are at risk for avoidable adverse outcomes that affect their overall health status and health care use. Focusing on improved care coordination and preventive care for these high-risk groups is especially urgent given the expansion of public health insurance in California and the impending shortages in the primary care workforce.

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