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Journal

Pediatrics, 144(2)

ISSN

0031-4005

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Publication Date

2019-08-01

DOI

10.1542/peds.2018-2769

Peer reviewed

Asthma Hospitalizations Among Homeless Children in New York State

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abstract

BACKGROUND AND OBJECTIVES: Asthma is widely prevalent among US children, particularly in homeless children, who often lack proper medication storage or the ability to avoid environmental triggers. In this study, we assess asthma-attributed health care use among homeless youth. We hypothesize that asthma hospitalization rates, symptom severity, and admission through the emergency department (ED) will be higher among homeless youth compared with nonhomeless youth.

METHODS: This secondary data analysis identified homeless and nonhomeless pediatric patients (<18 years old) with a primary diagnosis of asthma from New York statewide inpatient databases between 2009 and 2014. Hospitalization rate, readmission rate, admission through the ED, ventilation use, ICU admittance, hospitalization cost, and length of stay were measured.

RESULTS: We identified 71 837 asthma hospitalizations, yielding 73.8 and 2.3 hospitalizations per 1000 homeless and nonhomeless children, respectively. Hospitalization rates varied by nonhomeless income quartile, with low-income children experiencing higher rates (5.4) of hospitalization. Readmissions accounted for 16.0% of homeless and 12.5% of nonhomeless hospitalizations. Compared with nonhomeless patients, homeless patients were more likely to be admitted from the ED (odds ratio 1.96; 95% confidence interval: 1.82–2.12; $P < .01$), and among patients >5 years old, homeless patients were more likely to receive ventilation (odds ratio 1.45; 95% confidence interval: 1.01–2.09; $P = .04$). No significant differences were observed in ICU admittance, cost, or length of stay.

CONCLUSIONS: Homeless youth experience an asthma hospitalization rate 31 times higher than nonhomeless youth, with higher rates of readmission. Homeless youth live under uniquely challenging circumstances. Tailored asthma control strategies and educational intervention could greatly reduce hospitalizations.



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Dr Sakai-Bizmark conducted literature searches, conceptualized and designed the study, developed the models, contributed to data interpretation, drafted the initial manuscript, and revised the manuscript; Ms Mena and Dr Marr conducted literature searches, contributed to the discussion section, and reviewed and revised the manuscript; Ms Webber performed data analyses, created the tables, conducted literature searches, contributed to data interpretation, and reviewed and revised the manuscript; Drs Chang and Kwong supervised the study overall, confirmed the interpretation of the results, and critically reviewed and revised the manuscript; and all authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

DOI: <https://doi.org/10.1542/peds.2018-2769>

Accepted for publication Apr 24, 2019

WHAT'S KNOWN ON THIS SUBJECT: Asthma is widely prevalent among US children, particularly in homeless children, who often lack proper medication storage or ability to avoid environmental triggers. Poor treatment adherence and follow-up have been reported, making homeless children susceptible to attacks.

WHAT THIS STUDY ADDS: Because of high prevalence and attack susceptibility, use of health care by homeless patients with asthma could be high. However, no prior studies have quantified these levels. This study offers new insight on asthma-attributed health care use among homeless and nonhomeless youth.

To cite: Sakai-Bizmark R, Chang RR, Mena LA, et al. Asthma Hospitalizations Among Homeless Children in New York State. *Pediatrics*. 2019;144(2):e20182769

Asthma is the most common chronic health condition faced by children¹ and was the primary reason for hospital admission after emergency department (ED) visits among children <18 years of age in 2011.² Racial and socioeconomic differences in asthma prevalence have been reported,³⁻⁷ with highest prevalence among those living below the federal poverty level⁸ and among minorities.^{3,4,9-11} Additionally, children from disadvantaged households are more likely to be diagnosed with more severe forms of asthma,¹² are more likely to discontinue preventive medication,¹³ and are more likely to seek treatment of asthma at the ED.¹⁴

In 2004, McLean et al¹⁵ reported an asthma prevalence of 39.8% among homeless children in New York City on the basis of face-to-face interviews at 3 shelters in 1998-1999. Their subsequent study from 1999 to 2002 revealed a prevalence of asthma symptoms among homeless youth in New York near 35%, with only half receiving physician diagnoses.¹⁶ In addition to the high asthma prevalence, poor adherence to treatment and lack of regular follow-up among homeless youth have been reported.¹⁵⁻¹⁸ Asthma attacks can often be prevented or reduced in severity with regular use of a preventive controller medication and avoidance of certain triggers, such as smoking. However, homeless patients may lack proper storage for medications or the ability to control their living environment, often rendering these measures infeasible. Lack of a permanent address may hamper a patient's ability to access care or maintain scheduled appointments with providers.

Because of the high prevalence and exacerbated susceptibility to asthma among homeless youth, health care use could be high. However, no recent efforts have been made to quantify levels of asthma-attributed health care use in this population. In this

study, we aim to present basic characteristics of asthma hospitalizations among homeless children and examine differences between homeless and nonhomeless youth in symptom severity and health care use. We hypothesize that asthma severity and health care use will be higher among homeless youth compared with nonhomeless youth.

METHODS

We used years 2009-2014 of the Healthcare Cost and Utilization Project's (HCUP) State Inpatient Database (SID) from New York, which is compiled by the Agency for Healthcare Research and Quality.¹⁹ The SID includes all inpatient discharges from community hospitals in the state. This state was selected for the analysis because it contains the highest number of homeless families with children in the nation, representing 30% of the entire homeless population.²⁰

Pediatric patients (<18 years) with a primary diagnosis of asthma were identified by using *International Classification of Diseases, Ninth Revision, Clinical Modification* code 493. Homeless patients were identified from their zip code, which was coded as "H" in the SID to designate homelessness, whereas patients with complete zip codes were classified as nonhomeless.²¹

Population estimates for homeless youth were derived from the US Department of Housing and Urban Development 2009-2014 Continuum of Care: Homeless Populations and Subpopulations reports, which provide summary information on point-in-time unduplicated counts of homeless individuals in New York.²²⁻²⁷ Annual population estimates of homeless youth were calculated on the basis of the total number of reported homeless families with children, the average number of children per homeless family, and the number of unaccompanied youth. The

average number of children per family was calculated by dividing the total number of children in homeless families by the number of homeless households with children reported in the 2013-2014 Continuum of Care: Homeless Populations and Subpopulations report. We then multiplied this average by the number of homeless households with children to estimate the total number of children in homeless families each year before 2013. Final population estimates included the total number of children in homeless families plus the number of unaccompanied youth. Corresponding population estimates for nonhomeless youth were calculated by using 2009-2014 census data from the US Census Bureau.²⁸

The primary predictor of interest was homelessness. Study outcomes of interests included (1) admission through the ED, (2) ICU admittance, (3) ventilation use (noninvasive and/or mechanical ventilation), (4) hospitalization cost, and (5) length of stay (LOS).

Other variables of interest included age group, race, insurance type, and year. Age group was broken into 4 categories: age in years (1) 0 to 4, (2) 5 to 9, (3) 10 to 14, and (4) 15 to 17. Race was defined as non-Hispanic white, African American, Hispanic, and other, and insurance type was categorized as public, private, self-pay, and other form of insurance. The category self-pay likely encompasses those with no insurance and is therefore used as a proxy for uninsured patients.

Demographic data were tabulated to compare characteristics of homeless and nonhomeless patients. Hospitalization costs were estimated by multiplying the total charges provided in the SID by the hospital-level cost-to-charge ratios available through HCUP.²⁹ To account for inflation, costs were converted to 2015 US dollars by using the medical

care component of the Consumer Price Index.³⁰

Hospitalization rates were calculated by using population estimates as described above. Nonhomeless population estimates were stratified by income quartile on the basis of the zip code-level median income and the corresponding population. The number of cases was divided by population estimates for each group and multiplied by 1000 to represent cases per 1000 children. Rates were then compared between homeless and nonhomeless youth.

Year trends in hospitalization rates were evaluated for homeless and nonhomeless youth overall and stratified by income quartile. The outcome (total cases) was offset by the log-transformed population size for each unit of analysis. A negative binomial regression model was used in favor of the Poisson model because of overdispersion in data.

Multilevel logistic regression was used to model ventilation use and ICU admittance; LOS was modeled by using multilevel negative binomial regression, whereas multilevel general linear regression was used to model log-transformed cost. Admittance from the ED was modeled by using logistic regression without including hospital-level effects because this outcome is decided at the ED level, and data limitations prevented our ability to account for ED random effect. Associations between homelessness and outcomes were assessed overall and stratified by age groups (<5 and ≥5 years old) to test differences between younger and older children. Age-stratified cut points were determined on the basis of previous research demonstrating that the majority of asthma hospitalizations were for patients <5 years old.³¹ All models were adjusted for patient characteristics (age, race group, sex, insurance type, and high-risk comorbidities, as defined in a previous publication³²),

TABLE 1 Descriptive Statistics of Asthma Hospitalizations Among Homeless and Nonhomeless Children in New York

Variables	Total (N = 71 837)	Homeless (n = 11 202)	Nonhomeless (n = 60 635)	P
Outcome				
Ventilation use, including noninvasive and invasive, n (%)	2042 (2.8)	282 (2.5)	1760 (2.9)	.02
ICU, n (%)	9337 (13.0)	853 (7.6)	8484 (14.0)	<.01
Hospitalization cost, median (IQR), \$ ^a	3174 (2141–4866)	2338 (1781–3935)	3316 (2234–5089)	<.01
LOS, median (IQR), d	2 (1–3)	2 (1–3)	2 (1–3)	.13
Emergency admission, n (%)	61 321 (85.4)	10 303 (92.0)	51 018 (84.1)	<.01
Age group, y, n (%)				
0–4	37 835 (52.7)	6272 (56.0)	31 563 (52.1)	<.01
5–9	19 884 (27.7)	2984 (26.6)	16 900 (27.9)	.01
10–14	10 288 (14.3)	1459 (13.0)	8829 (14.6)	<.01
15+	3829 (5.3)	487 (4.4)	3342 (5.5)	<.01
Race, n (%)				
White	13 718 (19.2)	125 (1.1)	13 593 (22.5)	<.01
African American	26 634 (37.2)	4994 (44.6)	21 640 (35.8)	<.01
Hispanic	20 518 (28.7)	3839 (34.3)	16 679 (27.6)	<.01
Other	10 716 (15.0)	2234 (20.0)	8482 (14.0)	<.01
Sex, n (%)				
Female	28 116 (39.1)	4512 (40.3)	23 604 (38.9)	.01
Male	43 721 (60.9)	6690 (59.7)	37 031 (61.1)	.01
Insurance type, n (%)				
Public	43 573 (60.7)	9341 (83.4)	34 183 (56.4)	<.01
Private	22 846 (31.8)	148 (1.3)	22 698 (37.4)	<.01
Self-pay	4234 (5.9)	1711 (15.3)	2523 (4.2)	<.01
Other	1184 (1.7)	≤10 cases ^b	≤10 cases ^b	<.01
Year, n (%)				
2009	14 005 (19.5)	1893 (16.9)	12 112 (20.0)	<.01
2010	11 759 (16.4)	1606 (14.3)	10 153 (16.7)	<.01
2011	11 444 (15.9)	1755 (15.7)	9689 (16.0)	.41
2012	11 774 (16.4)	1963 (17.5)	9811 (16.2)	<.01
2013	11 089 (15.4)	1963 (17.5)	9126 (15.1)	<.01
2014	11 766 (16.4)	2022 (18.1)	9744 (16.1)	<.01

IQR, interquartile range.

^a Costs are presented in 2015 US dollars to adjust for inflation.

^b A number is not presented because of the data-use agreement with HCUP; any given cell of tabulated data with ≤10 observation values is considered a low number of cases.

year fixed effect, and hospital random effects.

Sensitivity analyses were performed. First, regression models were fit as described above to compare associations between homelessness and outcomes when comparing homeless patients with nonhomeless patients residing in low-income neighborhoods. Second, readmission rates among homeless and nonhomeless patients were descriptively assessed. Rates were calculated on the basis of the mean number of asthma-attributed hospitalizations per patient in a given calendar year by using unique

encrypted patient-level identifiers to track patients over time.³³ Costs and LOS were also explored on the basis of the annual accumulation per patient.

For all analyses, we used SAS version 9.4 (SAS Institute, Inc, Cary, NC).

The Institutional Review Board at Los Angeles Biomedical Research Institute at Harbor University of California, Los Angeles Medical Center approved this study.

RESULTS

A total of 71 837 asthma hospitalizations were identified

among children in New York between 2009 and 2014 (Table 1), of whom 11 202 (15.6%) were homeless patients, and 60 635 (84.4%) were nonhomeless patients. Overall, 85.4% were admitted from the ED, 2.8% required ventilation use, and 13.0% were admitted to the ICU. The median hospitalization cost was \$3174, and the median LOS was 2 days. Most patients were <5 years of age (52.7%), African American (37.2%), boys (60.9%), and on public insurance (60.7%). Use of ventilation, ICU admittance, and costs were significantly lower among homeless patients ($P < .01$), whereas admissions from the ED were higher among homeless patients compared with nonhomeless patients ($P < .01$). The age distribution also differed between homeless and nonhomeless patients, with the age distribution skewing younger among homeless patients ($P < .01$). Homeless patients were significantly less likely to be white ($P < .01$) and were significantly more likely to be African American ($P < .01$) and Hispanic ($P < .01$) compared with nonhomeless patients. Homeless patients were also more likely to be girls ($P = .01$) and more likely to be on public insurance ($P < .01$) or be uninsured ($P < .01$).

When looking at incidence rates of asthma hospitalizations per 1000 children, we found that homeless children had substantially higher rates of asthma-related hospitalizations than nonhomeless children. Overall, the rate of hospitalization was 73.8 per 1000 homeless children and 2.3 per 1000 nonhomeless children in New York between 2009 and 2014. When stratified by zip code-level income quartile, results reveal higher rates of hospitalization among nonhomeless children living in lower-income neighborhoods, with hospitalization rates of 5.4, 2.0, 1.8, and 1.3 per 1000 children in first-, second-, third-, and fourth-quartile income neighborhoods, respectively. Among

nonhomeless children, there was a downward trend in incidence rates of asthma hospitalizations from 2.8 in 2009 to 2.3 in 2014 ($P = .01$; Table 2).

After we adjusted for patient characteristics, time fixed effects, and hospital random effects, regression results revealed that homeless patients had significantly higher odds of admission from the ED (odds ratio [OR] 1.96; 95% confidence interval [CI]: 1.82–2.12; $P < .01$), and among patients >5 years old, homeless patients had significantly higher odds of receiving ventilation (OR 1.45; 95% CI: 1.01–2.09; $P = .04$). No significant differences were observed between homeless and nonhomeless patients in ICU admittance, cost, or LOS (Table 3). When comparing homeless patients with nonhomeless patients from low-income neighborhoods, significant differences remained in the odds of admission from the ED, with homeless patients having 1.60 higher odds of being admitted from the ED (95% CI: 1.47–1.73; $P < .01$; Table 4).

Within a given year, 13.0% of pediatric patients with asthma were readmitted to the hospital for asthma-related care. Readmission rates differed by homeless status, with a higher percentage of homeless patients (16.0%) readmitted than nonhomeless patients (12.5%; $P < .01$). Annually, accumulated per-patient costs were lower among homeless patients on average compared with nonhomeless patients, with median inflation-adjusted costs

of \$2550 and \$3487, respectively ($P < .01$). The median accumulated LOS was 2 days, with no significant difference between groups ($P = .44$; Table 5).

DISCUSSION

To the best of our knowledge, this is the first population-based study on asthma hospitalization among homeless youth in the United States.

The asthma hospitalization rate among nonhomeless youth in our study (2.3 per 1000 nonhomeless youth) is slightly higher than that of a previous report in which the authors estimated a rate of 1.8 per 1000 nonhomeless youth.³¹ However, asthma prevalence in New York has been reported to be higher than the national average,³⁴ and therefore it is reasonable to expect higher hospitalization rates compared with those previously reported.

We demonstrated a 31 times higher rate of asthma hospitalization among homeless youth compared with nonhomeless youth. There are several possible explanations for this result.

First, the prevalence of asthma is significantly higher in low-income and minority populations.^{3,4,9–11} Given the disproportionate number of homeless minorities, children who are homeless are more likely to have asthma than nonhomeless children.²⁰ More specifically, the racial composition of homeless youth in the United States is 37.0% white and 50.1% African American, whereas the general pediatric population is 70%

TABLE 2 Time Trend in Pediatric Asthma Hospitalizations Per 1000 Homeless and Nonhomeless Children in New York, Stratified by Income

	Total	2009	2010	2011	2012	2013	2014	<i>P</i> trend
Homeless	73.8	82.3	65.1	73.5	80.3	71.8	70.9	.52
Nonhomeless	2.3	2.8	2.4	2.2	2.3	2.1	2.3	.01
Income quartile ^a								
First	5.4	6.6	5.0	5.4	5.4	5.1	4.9	.02
Second	2.0	2.1	1.9	1.9	2.0	1.8	2.0	.25
Third	1.8	2.1	1.9	1.7	1.7	1.6	1.8	<.01
Fourth	1.3	1.5	1.3	1.2	1.3	1.3	1.4	.33

^a Median household income for the patient's zip code.

TABLE 3 Results From Regression Models Used to Evaluate the Association Between Homelessness and Health Care Outcomes

	All Patients (<18 y)			<5 y			≥5 y					
	Estimate ^a	SE	95% CI	P	Estimate ^a	SE	95% CI	P	Estimate ^a	SE	95% CI	P
Emergency admission												
Homeless	1.96	0.06	1.82–2.12	<.01	1.91	0.1	1.73–2.10	<.01	2.00	0.12	1.78–2.25	<.01
Nonhomeless	Reference				Reference				Reference			
ICU use ^b												
Homeless	0.88	0.07	0.75–1.02	.10	0.86	0.10	0.68–1.09	.21	0.87	0.09	0.71–1.07	.19
Nonhomeless	Reference				Reference				Reference			
Ventilation use, including noninvasive and invasive ^b												
Homeless	1.15	0.17	0.88–1.54	.35	0.84	0.19	0.54–1.32	.46	1.45	0.27	1.01–2.09	.04
Nonhomeless	Reference				Reference				Reference			
Hospitalization cost ^{b,c}												
Homeless	1.01	0.01	0.98–1.03	.64	0.99	0.02	0.96–1.02	.58	1.00	0.02	0.97–1.04	.91
Nonhomeless	Reference				Reference				Reference			
LOS ^b												
Homeless	1.01	0.02	0.98–1.04	.62	1.01	0.02	0.96–1.05	.73	0.99	0.02	0.95–1.03	.65
Nonhomeless	Reference				Reference				Reference			

^a Estimates are expressed as ORs for the ED, the ICU, and ventilation use outcomes and are expressed as risk ratios for cost and LOS.

^b Adjusted models included age, ethnicity and/or race, sex, and insurance type with year fixed effect and hospital random effect.

^c Hospitalization costs were adjusted for inflation.

white and 15% African American.³⁵ In our study, the racial composition of homeless youth was overwhelmingly minorities, with white children making up just 1.1% of homeless asthma hospitalizations, compared with 22.5% of nonhomeless asthma hospitalizations. A recent analysis of 2001–2016 National Health Interview Survey data revealed that asthma prevalence among non-Hispanic African American children (15.7%) was more than double that of non-Hispanic white children (7.1%).¹⁰ Still, differences in racial distribution and prevalence cannot solely explain the 31 times higher hospitalization rate in homeless youth. Our study revealed that nonhomeless hospitalization rates were highest among those living within the lowest-income quartiles. Yet, even compared with low-income children, homeless youth were still hospitalized at a 13.6 times higher rate.

Second, poor asthma control among homeless patients, including lack of regular follow-up and poor adherence to treatment, has been reported.^{15–18} A 2009 New York State Department of Health brief on potentially avoidable hospitalizations revealed that 14.5% of pediatric asthma hospitalizations among Medicaid recipients were potentially avoidable on the basis of 30-day readmittance for ambulatory care sensitive conditions.³⁶ According to the American Lung Association’s Asthma Guidelines-Based Care Coverage Project, New York’s Medicaid program provides varied and inconsistent coverage of quick-relief and controller medications. Even when covered, barriers such as copayments still exist.^{37,38} Such coverage and cost barriers are likely to disproportionately affect homeless patients, leading to poor asthma control. Using unique patient identifiers in our analysis, we found that homeless patients had a 1.3 times higher rate of readmission than nonhomeless patients in a given

TABLE 4 Results From Regression Models Used to Evaluate the Association Between Homelessness and Health Care Outcomes, Compared With Nonhomeless Patients From Low-income Neighborhoods

	Estimate ^a	SE	95%CI	P
Emergency admission				
Homeless	1.60	0.07	1.47–1.73	<.01
Nonhomeless	Reference			
ICU use ^b				
Homeless	0.88	0.09	0.72–1.08	.22
Nonhomeless	Reference			
Ventilation use, including noninvasive and invasive ^b				
Homeless	1.05	0.18	0.75–1.46	.78
Nonhomeless	Reference			
Hospitalization cost ^{b,c}				
Homeless	1.01	0.01	0.99–1.04	.34
Nonhomeless	Reference			
LOS ^b				
Homeless	1.02	0.02	0.98–1.05	.40
Nonhomeless	Reference			

^a Estimates are expressed as ORs for the ED, the ICU, and ventilation use outcomes and are expressed as risk ratios for cost and LOS.

^b Adjusted models included age, ethnicity and/or race, sex, and insurance type with year fixed effect and hospital random effect.

^c Hospitalization costs were adjusted for inflation.

year, with overall rates mirroring those reported by the New York State Department of Health. Previous studies revealed that asthma was present in 30% to 40% of homeless children,^{15,16} which was 3 to 4 times higher than the New York State average.³⁹ With a 3 to 4 times higher prevalence resulting in a 31 times higher hospitalization rate, admissions among homeless patients are still disproportionately high and cannot fully be explained by readmissions. Our findings provide additional evidence of poor asthma control among homeless youth.

Third, environmental factors could contribute to asthma hospitalizations. Shelter environments are generally poor⁴⁰ and often expose homeless

youth to second-hand and third-hand tobacco smoke.⁴¹ In fact, smoking is estimated to be 4 times more prevalent in homeless adults than in the general US population.⁴² Disadvantaged communities are exposed to a wide array of interpersonal and environmental risk factors, contributing to high asthma prevalence and poor health outcomes.^{3,5,43,44} Such exposures could contribute to high hospitalization rates, as reported in our study.

We also demonstrated that admission through the ED was significantly higher in homeless youth than in nonhomeless youth, and the significant difference remained when we compared homeless youth with

nonhomeless youth living in low-income communities. High use of the ED among homeless patients has been well documented.⁴⁵ Our study revealed higher rates of ED use in homeless patients even when compared with low-income patients, who also reportedly have high use of the ED.⁴⁶ These findings are consistent with a previous study that revealed that homeless individuals visited the ED at a rate of >8 times that of low-income age- and sex-matched controls.⁴⁷

Our study failed to demonstrate significant differences in cost and LOS between the 2 groups, which is consistent with a recent study⁴⁸ but contradicts previous reports showing higher cost and longer LOS among homeless people.^{49–52} None of these studies were specific to asthma hospitalization or pediatric patients; therefore, results may not be applicable to our study population. No significant differences were detected between homeless and nonhomeless patients in ventilation use and ICU admittance, suggesting no difference in symptom severity between homeless and nonhomeless admissions. The differences in hospitalization rates require further elucidating because these trends could reflect any number of influences, including changes in public policy or more effective treatments.

This study has a number of limitations. First, homeless population estimates are based on point-in-time counts of sheltered and unsheltered persons and are likely to be conservative because of the transient and hard-to-reach nature of homelessness. Unsheltered children may be a particularly undercounted group because they may remain hidden out of sight during the counts.⁵³ Children represented just 1% of New York's total counted unsheltered homeless population in 2014.²⁵ Because the majority of homeless children are sheltered, they

TABLE 5 Annual Readmission Rate and Total Accumulated LOS and Cost Per Homeless and Nonhomeless Patient With Asthma

Variables	Total (N = 61 959)	Homeless (n = 9732)	Nonhomeless (n = 52 227)	P
Readmission rate (per 100 patients), %	13.0	16.0	12.5	<.01
Accumulated costs, median (IQR), \$	3365 (\$2192–5433)	2550 (\$1931–4217)	3487 (\$2302–5643)	<.01
Accumulated LOS, median (IQR), d	2 (1–3)	2 (1–3)	2 (1–3)	.44

IQR, interquartile range.

are less likely to be undercounted compared with other homeless groups.

Second, in addition to our using a conservative homeless population estimate, the number of homeless patients with asthma may also be underestimated. For example, hospitalization records containing full zip codes were assumed to be for nonhomeless patients because HCUP includes a special homelessness indicator for patients without zip codes. However, some patients or medical staff may be reporting shelter zip codes for recording. Other patients may choose not to disclose homeless status because of societal stigmatization of this group.

Third, the presented rates of hospitalization among nonhomeless patients could be underestimated because homeless individuals are included in census population counts. Still, homeless children account for a small fraction of the total youth population, so the degree of underestimation is small (ie, 2.3 per 1000 nonhomeless children compared with 2.4 per 1000 children) when the number of homeless youth is subtracted from the total population to calculate the nonhomeless population.

Fourth, all primary analyses were conducted at the hospital-admission level, with each admission included as a unique observation. This means that patients who were discharged and subsequently readmitted may have been double counted. The extent to which readmission occurred among homeless and nonhomeless

patients was explored as a sensitivity analysis. However, data limitations prevented our ability to track individual patients beyond a given data year. Also, the occurrence of multihospital admissions per patient prevented our ability to model outcomes at an individual level while accounting for hospital-level random effects.

Fifth, in this study, we used an administrative database, which lacks clinical detail beyond the *International Classification of Diseases, Ninth Revision, Clinical Modification* code. The rate of asthma hospitalizations reported in this study could be biased from the quality of coding. However, this limitation has minimal impact on our findings because the quality of coding is unlikely to differ between homeless and nonhomeless patients.

Last, homeless children were more likely to be uninsured than nonhomeless children in our study, which could bias results when considering the hospitalization rate as a measure of well-being. According to US Census estimates, 3.3% to 4.8% of children in New York were uninsured between 2009 and 2014, with higher rates (5.8%) among children living below a 1.38 poverty threshold.⁵⁴

These percentages align with the characteristics of patients identified in our study. The hospitalization rate could be a proxy for overall well-being because if the asthma is well controlled, hospitalization would not be necessary. However, Kushel et al⁵⁰ found that health insurance was associated with greater use of

ambulatory care, greater inpatient hospitalization, and lower reporting of barriers to needed care. Because homeless children are more likely to be uninsured than nonhomeless children, those with asthmatic symptoms requiring hospitalization may be missing from our sample at a disproportionately higher rate, leading to an underestimation of the hospitalization rate and an overestimation of well-being. Therefore, the difference in well-being between homeless and nonhomeless children could be even greater in magnitude.

CONCLUSIONS

We demonstrated that homeless youth experience asthma hospitalization at a rate 31 times that of nonhomeless youth, with rates remaining substantially higher among homeless children even when compared with low-income children. Homeless youth live under special conditions; therefore, more targeted efforts are needed to identify underlying causes of this discrepancy and to develop effective interventions to improve well-being in homeless children with asthma.

ABBREVIATIONS

CI: confidence interval
ED: emergency department
HCUP: Healthcare Cost and Utilization Project
LOS: length of stay
OR: odds ratio
SID: State Inpatient Database

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PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

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FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: Dr Sakai-Bizmark is funded by the National Institutes of Health Research Scientist Development award (NHLBI K01HL141697). The contents of this work are solely the responsibility of the authors and do not necessarily represent the official views of the National Heart, Lung, and Blood Institute. Funded by the National Institutes of Health (NIH).

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

COMPANION PAPER: A companion to this article can be found online at www.pediatrics.org/cgi/doi/10.1542/peds.2019-0500.

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