Original Article

Sociodemographic Factors Associated With Hospital Care for Pediatric Migraine: A National Study Using the Kids' Inpatient Dataset

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ARTICLE INFO

ABSTRACT

BACKGROUND: Although migraine often starts in childhood or adolescence, hospital care for migraine in children is not well described. We examined patient and hospital characteristics associated with hospital care for migraine among children in the United States.
METHODS: We queried the Kids' Inpatient Database (2003 to 2009) for hospitalizations of children aged 3-20. Sociodemographic and hospital characteristics were compared between hospitalizations for migraine and for other common medical conditions. Multivariate logistic regression models estimated the associations between patient, hospital, and socioeconomic characteristics and inpatient migraine care.
RESULTS: We identified 11,696 pediatric migraine hospitalizations, the majority (68.7%) occurring at teaching hospitals, involving a female (68.8%) child, ages 13-20 (71%, mean age: 14.6 years). As compared to the overall inpatient sample, migraine hospitalizations were less likely to involve children who were Black (adjusted odds ratio [AOR] 0.54, 95% confidence interval [CI] 0.49 to 0.60), Hispanic (AOR = 0.58, 95% CI 0.50 to 0.68), or Asian (AOR = 0.42, 95% CI 0.32 to 0.55), and more likely to involve females (AOR = 1.49, 95% CI 1.40 to 1.59). Migraine inpatients were more likely to live in higher income postal ZIP code areas (versus lowest ZIP code income quartile: AOR = 1.32, 95% CI 1.18 to 1.48). The average length of stay for migraine was 2.54 (SEM 0.6) days.
CONCLUSIONS: Children who are hospitalized for migraines have distinct sociodemographic characteristics and a short length of stay. Understanding the reasons for these variations will inform the design of interventions aimed at reducing the need for pediatric migraine hospitalization.

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Introduction

Headaches are common among school-aged children, and headache prevalence increases with age. Current data suggest that 66% to 71% of children between ages 12 and 15 have at least one headache every three months, and 33% to 40% of affected children have at least one headache per week.[1] Outpatient epidemiology studies have routinely demonstrated that migraine is more common among girls[1-4] and that peak onset of migraine occurs around puberty.[3,4] Migraine significantly affects childhood quality of life and school performance.[5-10] It has also been associated with an array of comorbidities, ranging from asthma to emotional and behavioral problems, placing a child with migraine at risk of increased health-care utilization (e.g., emergency department visits, hospitalizations).[11,12]

Although several studies have examined the epidemiology of emergency department treatment for pediatric migraine, there are limited data about children who receive inpatient care. Reducing the need for migraine-related hospitalizations in children or examining the effects of programs designed to reduce inpatient migraine care (such as outpatient infusion centers) requires baseline knowledge of inpatient pediatric migraine burden and detailed knowledge about the children who receive migraine care in the hospital setting. Yet, the epidemiology of hospital care for migraine headaches in children is unknown.[12,13] To overcome this knowledge gap, we examined inpatient care for pediatric migraine in the United States using a national, population weighted dataset. We investigated the distributions of age, sex, race, primary payer type, postal ZIP (zone improvement plan) code income quartile, hospital teaching status, hospital region, and hospital bed size in a cohort of children and adolescents aged three to 20 admitted for migraine.

Methods

Data source

We used patient, clinical, geographic, socioeconomic, payer, and cost data from the Kids' Inpatient Database (KID). The KID is an all-payer hospital discharge database developed for the Healthcare Cost and Utilization Project sponsored by the Agency for Healthcare Research and Quality.[14] It contains approximately three million pediatric hospitalizations each year and can be weighted to allow for estimates of the entire US population. Hospitals included in the KID are community (nonfederal, general, short term, and specialty) hospitals and ranged in number from 4836 (2003) to 5128 (2009). Geographical participation in the KID is extensive; 26 of 50 states participated in 2003, increasing to 44 of 50 in 2009. The data are collected every three years; this study used KID hospitalizations from 2003, 2006, and 2009. Hospitalizations are measured by encounter and not specific patient identifiers, so an individual patient could contribute more than one hospitalization to the database in any year. The encounter-level unit of analysis does not allow rehospitalization analysis.

Study population

All children ages three to 20 were included in the analysis. All discharges with an admitting (principle) diagnosis of migraine were identified using the following International Classification of Diseases, Ninth Revision (ICD-9) codes: 346.0x "migraine with aura," 346.1x "migraine without aura," 346.2x "variants of migraine, not elsewhere classified," 346.3x "hemiplegic migraine, 346.4x 'menstrual migraine," 346.5x "persistent migraine aura without cerebral infarction," 346.7x "chronic migraine without aura," 346.8x "other forms of migraine," and 346.9x "migraine unspecified." For descriptive analyses, we created a general inpatient reference group, composed of hospitalizations of children without ICD-9 codes for migraine. All observations with missing values for any of the patient or hospital level characteristics listed below were excluded.

Pediatric migraine epidemiology

We examined the epidemiology of inpatient pediatric migraine with respect to (1) patient (age, sex, race); (2) socioeconomic (the mean household income for the patient's postal or ZIP code, categorized by quartiles); (3) hospital characteristics (teaching status, size [number of beds], geographical region); and (4) primary payer characteristics (private insurance, Medicare program, Medicaid program, self-pay, health maintenance organization). We also examined the variation in admission source (emergency department, routine, transfer) across patient characteristics. To provide broader context to our descriptive data, we queried the 2003 to 2009 KID and extracted the following diagnoses from the top 10 diagnosis categories for admission—asthma (three), appendicitis and other appendiceal disorders (six), mood disorders (five), epilepsy, convulsions (10). These conditions were chosen because they can result in hospitalization throughout most of childhood, relate to different organ systems or disease processes, and can be recurrent or chronic illnesses. Patient, socioeconomic, hospital, and primary payer characteristics associated with hospitalization for these common conditions were compared with those associated with migraines.

Pediatric migraine hospitalization outcomes

The KID does not contain clinical symptom data; thus, we could not reliably examine outcomes such as pain score or verify determine when or if headache resolution had occurred at the time of discharge or determine which drug therapies were used. However, we were able to examine the length of stay (LOS) for each hospitalization, calculate the total number of days lost to inpatient migraine care by children in KID dataset, and determine if any patient or hospital characteristics were associated with increased LOS.

Statistical analysis

Chi-square tests were used to compare baseline characteristics between children diagnosed with migraine and the general inpatient sample. Differences in mean for continuous variables between migraine and nonmigraine patients were calculated using a two-tailed t test with a significance level of 0.05. LOS was analyzed using t test to compare the mean LOS for patient and hospital characteristics of pediatrics admitted for migraine. Univariate and multivariate logistic regression models were built to determine which patient, hospital, and geographic characteristics were associated with an admitting diagnosis of migraine, generating unadjusted and adjusted odds ratios (OR, AOR). The logistic regression models took into account the survey design of the KID and were analyzed using the survey logistic procedure in the statistical software. Patient and hospital characteristics that had statistically significant type 3 analysis of effects at alpha < 0.05 based on the chi-square test statistic for the parameter were included in the final adjusted model. Many of the variables in the KID have multiple levels, and this approach accounts for multiple degrees of freedom of such variables, thus providing a stronger picture of the overall effect of the variable on the outcome. All statistical analyses were generated using SAS software, Version 9.4 of the SAS System for Windows (SAS Institute Inc., Cary, NC, USA).

Results

Patient, hospital characteristics of inpatient care for pediatric migraine

We identified 11,696 hospitalizations for migraine in the KID from 2003, 2006, and 2009. The point prevalence of migraine as the admitting diagnosis in the KID was 2.3 (±0.09) per 1000 admissions. As displayed in Table 1, the majority of hospitalizations for migraine were of female (68.0%) and white (70.5%) children. The mean age of children with a hospitalization for migraine was 14.6 (±0.07) years, and 71% were between ages 13 and 20. Although females were more common, males were younger (average age male = 13.6 years, 95% CI: 13.4 to 13.8, average age female = 15.0 years, 95% CI: 14.9 to 15.2; t test, P value < 0.0001). As shown in the Figure, migraine inpatient care most often involved older children. Children aged 16, 17, and 12 had the highest proportions of discharges (15.6%, 10.4%, and 10.7%, respectively). Most pediatric migraine hospitalizations in the KID were at a teaching hospital (68.7%). The primary sources of admission were the emergency department (36.5%) and home (27.9%), but this variable was missing in 31.8% of hospitalizations, limiting the interpretability of these data.

As shown in Table 2, hospitalizations of children with migraine differed from those of children with other common conditions. Chi-square analyses found statistically significant differences in the distribution of race, age, primary payer, ZIP code income, and hospital teaching status (P < 0.05 for all). Hospitalizations of children with migraines most frequently involved white children (70.5%), which greatly differed from hospitalizations for asthma (37.2% white), but was more comparable with

TABLE 1. Hospitalizations for Migraine, Kids' Inpatient Dataset 2003 to 2009 (N = 11,696)

| Characteristic	Migraine Admissions, n (%)
Race	
White	8250 (70.5)
Black	1315 (11.2)
Hispanic	1566 (13.4)
Asian, Pacific Islander	124 (1.1)
Native American	54 (0.5)
Other	388 (3.3)
Age (mean, SEM)	14.57 (0.07)
3-5	190 (1.62)
6-8	763 (6.53)
9-11	1189 (10.17)
12-14	2847 (24.34)
15-17	4081 (34.89)
18-20	2626 (22.45)
Sex	
Male	3742 (32.0)
Female	7955 (68.0)
Primary payer	
Medicare program	24 (0.2)
Medicaid program	2796 (23.9)
Private insurance	7887 (67.4)
Self-pay	416 (3.6)
No charge	29 (0.2)
Other	545 (4.7)
ZIP income quartile	
0-25th percentile	2635 (22.5)
26th-50th percentile	2621 (22.4)
51st-75th percentile	2962 (25.3)
76th-100th percentile	3478 (29.7)
Teaching hospital	
Yes	8058 (68.7)
No	3664 (31.3)
Hospital bed size	
Small	1405 (12.0)
Medium	3297 (28.2)
Large	6994 (59.8)
Source of admission	
Emergency department	4263 (36.5)
Another hospital	333 (2.8)
Another health facility	120 (1.0)
Court/law	*
Routine	3258 (27.9)
Missing	3721 (31.8)

Abbreviation:
SEM = Standard error of the mean
* We are unable to report values less than 10, according to the KID data use agreement.

hospitalizations for appendicitis (58.1% white), mood disorders (66.2% white), and epilepsy (55.1% white). The mean age for migraine admissions was 14.6 years (standard error of the mean [SEM] 0.07), between that of mood disorders (15.8 years, SEM 0.10) and appendicitis (13.1 year, SEM 0.07). Migraine and mood disorder hospitalizations were similar, in that they most frequently involved females (68.8% and 54.4%, respectively). Migraine hospitalizations had the highest frequency of privately insured children (67.4%) and a relatively uniform distribution across income levels. Teaching hospitals most frequently provided care for all common conditions except appendicitis.

Table 3 displays the results of multivariable logistic regression models that examined patient race, sex, primary payer type, ZIP income quartile, and hospital teaching status in hospitalizations of children for migraine. Children who received inpatient migraine care were less likely to be black (AOR = 0.54, 95% CI: 0.49 to 0.60),
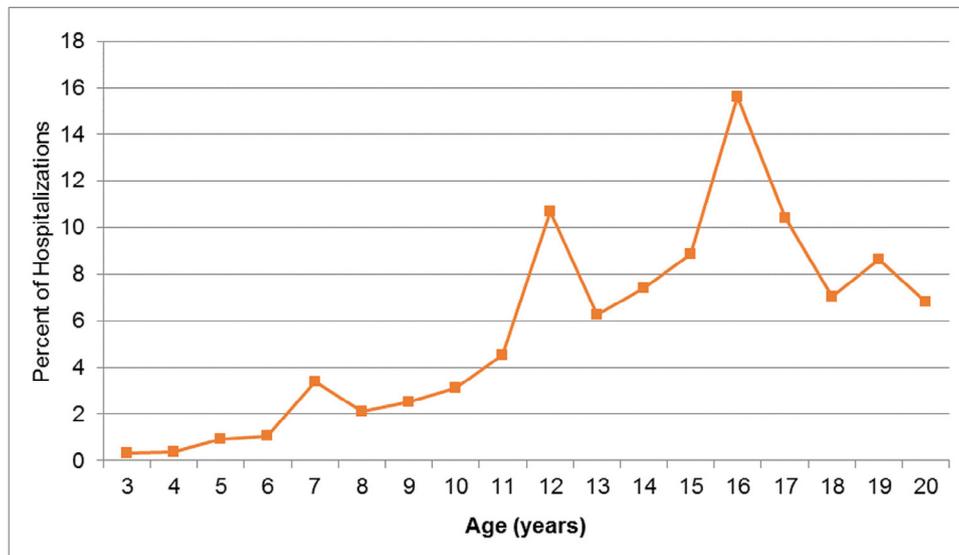
FIGURE. Age distribution of hospitalizations for migraine in the Kids' Inpatient Dataset 2003 to 2009. (The color version of this figure is available in the online edition)

Hispanic (AOR = 0.58, 95% CI: 0.50 to 0.68), or Asian (AOR = 0.42, 95% CI: 0.32 to 0.55). Migraine hospitalizations were 55% more likely to be of female children (AOR = 1.49, 95% CI: 1.40 to 1.59). Medicaid program participants and persons with no health-care coverage (self-pay) were underrepresented among pediatric migraine

hospitalizations (AOR Medicaid program: 0.37, 95% CI: 0.34 to 0.40; AOR self-pay: 0.32, 95% CI: 0.19 to 0.55). Migraine hospitalization tended to occur at academic centers (AOR teaching hospital: 1.74, 95% CI: 1.49 to 2.02). Finally, children hospitalized for migraine were more likely to reside in higher income ZIP codes (51st to

TABLE 2. Hospitalizations for Migraine Compared With Common Conditions of Childhood*, Kids' Inpatient Dataset 2003 to 2009

Characteristic	Migraine	Asthma	Appendicitis	Mood Disorders	Epilepsy, Convulsions
Race					
White	8,250 (70.5)	79,063 (37.2)	122,517 (58.1)	68,714 (66.2)	56,348 (55.1)
Black	1,315 (11.2)	75,849 (35.7)	14,308 (6.8)	15,635 (15.1)	19,678 (19.2)
Hispanic	1,566 (13.4)	42,336 (19.9)	58,413 (27.7)	11,511 (11.1)	17,798 (17.4)
Asian, Pacific Islander	124 (1.1)	3,533 (1.7)	4,344 (2.1)	1,153 (1.1)	2,137 (2.1)
Native American	54 (0.5)	1,223 (0.6)	1,438 (0.7)	1,092 (1.1)	601 (0.6)
Other	388 (3.3)	10,692 (5)	9,924 (4.7)	5,750 (5.5)	5,708 (5.6)
Age (mean, SEM)	14.57 (0.07)	8.56 (0.04)	13.07 (0.07)	15.79 (0.10)	10.66 (0.08)
3-5	190 (1.62)	68,970 (32.4)	9,573 (4.5)	314 (0.3)	24,078 (23.5)
6-8	763 (6.53)	56,925 (26.8)	30,876 (14.6)	2,959 (2.9)	19,757 (19.3)
9-11	1189 (10.17)	30,641 (14.4)	32,967 (15.6)	5,844 (5.6)	12,892 (12.6)
12-14	2847 (24.34)	26,203 (12.3)	49,811 (23.6)	22,204 (21.4)	14,579 (14.3)
15-17	4081 (34.89)	16,204 (7.6)	45,680 (21.7)	37,191 (35.8)	14,922 (14.6)
18-20	2626 (22.45)	13,756 (6.5)	42,036 (19.9)	35,343 (34.0)	16,040 (15.7)
Sex					
Male	3,742 (32.0)	126,279 (59.4)	127,287 (60.3)	47,381 (45.6)	54,737 (53.5)
Female	7,955 (68.0)	86,418 (40.6)	83,657 (39.7)	56,473 (54.4)	47,532 (46.5)
Primary payer					
Medicare program	24 (0.2)	331 (0.2)	271 (0.1)	416 (0.4)	353 (0.4)
Medicaid program	2,796 (23.9)	100,700 (47.3)	63,263 (30)	42,323 (40.8)	41,401 (40.5)
Private insurance	7,887 (67.4)	92,549 (43.5)	121,782 (57.7)	48,830 (47.0)	51,786 (50.6)
Self-pay	416 (3.6)	11,716 (5.5)	16,545 (7.8)	5,930 (5.7)	3,894 (3.8)
No charge	29 (0.2)	678 (0.3)	1,275 (0.6)	586 (0.6)	359 (0.4)
Other	545 (4.7)	6,724 (3.2)	7,809 (3.7)	5,770 (5.6)	4,476 (4.4)
ZIP income quartile					
0-25th percentile	2,635 (22.5)	81,482 (38.3)	55,341 (26.2)	28,914 (27.8)	28,196 (27.6)
26th-50th percentile	2,621 (22.4)	50,508 (23.8)	51,760 (24.5)	26,664 (25.7)	23,799 (23.3)
51st-75th percentile	2,962 (25.3)	43,981 (20.7)	51,129 (24.2)	24,564 (23.7)	23,532 (23.0)
76th-100th percentile	3,478 (29.7)	36,726 (17.3)	52,714 (25)	23,712 (22.8)	26,742 (26.2)
Teaching hospital					
Yes	8,058 (68.7)	129,826 (61.0)	101,950 (48.3)	58,009 (55.9)	80,086 (78.3)
No	3,664 (31.3)	82,871 (39.0)	108,994 (51.7)	45,845 (44.1)	22,183 (21.7)

Abbreviation:
SEM = Standard error of the mean
* Childhood is defined in this study as persons of ages three to 20 years.

TABLE 3. Odds of Hospitalization for Migraines According to Patient and Hospital Characteristics, Kids' Inpatient Dataset 2003 to 2009

Characteristic	Odds Ratio (95% CI)			
	Unadjusted		Adjusted*	
Race				
White	—	—	—	—
Black	0.43	0.39-0.48	0.54	0.49-0.60
Hispanic	0.43	0.37-0.51	0.58	0.50-0.68
Asian, Pacific Islander	0.44	0.33-0.57	0.42	0.32-0.55
Native American	0.47	0.32-0.69	0.64	0.44-0.94
Other	0.53	0.44-0.63	0.59	0.50-0.71
Age (per year increase)	1.005	1.000-1.010	1.02	1.01-1.03
Sex				
Male	—	—	—	—
Female	1.22	1.14-1.29	1.49	1.40-1.59
Primary payer type				
Private insurance	—	—	—	—
Medicare program	0.30	0.18-0.51	0.33	0.20-0.55
Medicaid program	0.31	0.28-0.34	0.37	0.34-0.40
Self-pay	0.40	0.35-0.47	0.49	0.42-0.57
No charge	0.29	0.17-0.50	0.32	0.19-0.55
Other	0.68	0.58-0.79	0.76	0.65-0.88
ZIP income quartile				
0-25th percentile	—	—	—	—
26th-50th percentile	1.28	1.17-1.41	1.03	0.95-1.13
51st-75th percentile	1.65	1.51-1.82	1.15	1.05-1.26
76th-100th percentile	2.35	2.09-2.63	1.32	1.18-1.48
Teaching hospital				
No	—	—	—	—
Yes	1.64	1.42-1.89	1.74	1.49-2.02

Abbreviation:
CI = Confidence interval
* Adjusted for race, age, sex, primary payer, ZIP income quartile, and hospital teaching status.

75th percentile: AOR 1.315, 95% CI: 1.05 to 1.26; 75th to 100th percentile: AOR 1.32, 95% CI: 1.18 to 1.48).

Length of stay among migraine inpatients

As displayed in Table 4, children in the KID sample spent 29,735 days obtaining inpatient treatment for migraine during our study period. The average LOS for children admitted for migraine was 2.54 (SEM 0.06) days. We found statistically significant differences in the mean LOS according to sex, age, primary payer, hospital teaching status, or region of the county (Table 4). However, the LOS did not vary by a day or more across members of any category, which calls into question the clinical meaningfulness of this statistical result. For example, comparison of the mean LOS for males versus females was significant (*P* < 0.0001); however, both groups were discharged, on average, on the third day of hospitalization (mean LOS: 2.28 for males, 2.66 for females).

Discussion

Migraine is estimated to affect between 2.4% and 17% of prepubertal children, and between 5% and 18% of postpubertal children in United States.[15,16] In spite of being relatively common, there are limited data on inpatient care for pediatric migraine. To address this knowledge gap, we used the KID to examine demographic, socioeconomic, and hospital characteristics associated with inpatient migraine care. Our primary findings were (1) demographic characteristics of the hospitalized pediatric

TABLE 4. Length of Stay (LOS), Hospitalizations for Migraine in Children (Kids' Inpatient Dataset, 2003–2009).

Characteristic	Migraine Admissions Mean LOS in days (SEM)	P
Race		
White	2.58 (0.07)	Ref.
Black	2.44 (0.10)	0.19
Hispanic	2.45 (0.10)	0.31
Asian, Pacific Islander	2.79 (0.31)	0.43
Native American	2.19 (0.18)	0.04
Other	2.49 (0.13)	0.56
Age		
3-5	1.99 (0.12)	Ref.
6-8	2.30 (0.13)	0.07
9-11	2.32 (0.08)	0.02
12-14	2.43 (0.08)	0.003
15-17	2.67 (0.09)	<0.0001
18-20	2.68 (0.09)	<0.0001
Sex		
Male	2.28 (0.05)	Ref.
Female	2.66 (0.07)	<0.0001*
Primary payer group		
Medicare program	3.20 (0.91)	0.48
Medicaid program	2.55 (0.07)	0.95
Private insurance	2.55 (0.08)	Ref.
Self-pay	2.11 (0.11)	0.0008*
No charge	2.73 (0.62)	0.78
Other	2.63 (0.18)	0.62
ZIP income quartile		
0-25th percentile	2.47 (0.08)	Ref.
26th-50th percentile	2.58 (0.08)	0.16
51st-75th percentile	2.53 (0.07)	0.42
76th-100th percentile	2.58 (0.08)	0.23
Hospital teaching		
Yes	2.62 (0.09)	0.02*
No	2.38 (0.05)	Ref.
Source of admission		
Emergency department	2.44 (0.05)	0.15
Another hospital	2.45 (0.26)	0.68
Another health facility	2.55 (0.19)	0.96
Court/Law	†	†
Routine	2.56 (0.07)	Ref.
Missing	2.65 (0.16)	0.62

Abbreviation:
SEM = standard error of the mean
* Statistically significant.
† The HCUP user agreement prohibits display of data with very small numbers, so we are unable to display the contents of this cell.

migraine population differ from the general pediatric population and (2) inpatient migraine care is consolidated at specialty centers.

Several studies report that migraine is more prevalent among females after puberty.[17,18] A similar sex pattern was observed in our national study; hospitalizations of children with migraines were 40% more likely to involve a girl. In the United States, white individuals are more often diagnosed with migraine than black or Asian persons.[19,20] Our inpatient data reflected this pattern as well; migraine hospitalizations in the KID most often involved white children. We also provide previously unreported data on Hispanic and native American children and demonstrate that these demographic groups are 50% to 60% less likely than whites to be represented in the inpatient migraine population. Explanations for these patterns are wide ranging and beyond the power of this dataset. Contributing factors suggested by adult literature could include, but are not limited to, genetic predisposition, differences in migraine features, care-seeking

behaviors, provider factors (responsiveness to complaints of pain, aggressiveness of treatment, ease of admitting), disparities in access and quality of care, or cultural perceptions of pain.[20-24]

Among adults, inpatient care for status migrainosus more commonly involves persons from lower socioeconomic strata.[24] Our pediatric data indicated an opposite pattern; hospitalizations of children for migraine most often involved a child from an affluent, not poor, neighborhood. Many study and data characteristics could explain this finding. Children may be more likely than adults to be admitted for an initial headache evaluation, and there may be a difference in care-seeking behaviors or increased intensity of health care delivered to children from wealthier families in response to migraine symptoms. If this discrepancy in care during childhood translates into less disabling migraines in adulthood, our data may provide an alternative explanation for the inverse relationship between self-reported migraine prevalence or disability and socioeconomic status observed among adults. That is, socioeconomically disadvantaged children with migraine, regardless of race, may have barriers to effective care, resulting in further socioeconomic downward drift and increased reporting of disability as observed in adult studies. If so, these data suggest that interventions to reduce the disabling effects of migraine may need to target children, not adults.

We found an average LOS of approximately 2.5 days, which may not seem impressive at first. Considering the recurrent nature of migraine and the high threshold for hospitalization (failure to achieve headache control at home, usually for a least a day), our data suggest that the subset of the pediatric migraine population that requires hospitalization may have significant migraine disability. These children would likely miss school during their hospital stay in addition to time missed due to prehospitalization and posthospitalization symptoms. The burden is twofold: migraine symptoms affect a child's schoolwork, and missing school while hospitalized would further negatively impact schoolwork. Our finding that teaching hospitals care for a significant proportion of the migraine inpatient population identifies teaching hospitals as an appropriate place to develop and test interventions to reduce school absence and inability to participate in hobbies and social activities. We did not find substantial variation in LOS across patient and hospital variables, however, suggesting that LOS may not be the most informative outcome for pediatric migraine hospitalizations. For children, patient-centered outcomes, such as return to school, pain score, hospital readmission, emergency department visit, or revisit, may be more appropriate outcomes for future studies.

There are multiple strengths to this study, including our use of a nationally representative dataset, which allowed us to examine care outside of specialty clinics or tertiary centers, and report previously undescribed sociodemographic patterns of migraine care. Every study has limitations, however, and our use of a retrospective design and claims data may introduce outcome misclassification due to coding errors or case mix bias more likely. Furthermore, our study design cannot account for rehospitalizations of the same patient because the KID is encounter-based, not patient-based. Finally, the KID has grown over the years examined, and there may have been changes in the hospital sample that specifically affect the migraine patient estimates, but not the general inpatient sample, and were not considered in the KID sampling strategy. In spite of these limitations, this study provides benchmark data on the prevalence, sociodemographic, and hospital characteristics associated with inpatient care for pediatric migraine. Our study findings provide baseline information for future research that examines trends in inpatient care for pediatric migraine, evaluations of programs aimed at reducing socioeconomic disparities in health-care utilization for migraine.

Conflict of interest

The authors declare no potential conflicts of interest with respect to the research or authorship.

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