



Weekend Versus Weekday Asthma-Related Emergency Department Utilization

Talia Mahony, MD; Valerie S. Harder, PhD, MHS; Nikkolson Ang, BA; Charles E. McCulloch, PhD; Judith S. Shaw, EdD, MPH, RN; Robert Thombly, BS; Michael D. Cabana, MD, MPH; Lawrence C. Kleinman, MD, MPH; Naomi S. Bardach, MD, MAS

From the Department of Pediatrics, University of California, San Francisco (T Mahony and NS Bardach); Department of Pediatrics, Larner College of Medicine, University of Vermont (VS Harder and JS Shaw), Burlington, Vt; Philip R. Lee Institute for Health Policy Studies, University of California, San Francisco (N Ang, R Thombly, and NS Bardach); Department of Epidemiology and Biostatistics, University of California, San Francisco (CE McCulloch); Department of Pediatrics, Albert Einstein College of Medicine (MD Cabana), Bronx, NY; Children's Hospital at Montefiore (MD Cabana), Bronx, NY; and Rutgers Robert Wood Johnson School of Medicine (LC Kleinman), New Brunswick, NJ

The authors declare no conflicts of interest.

Address correspondence to Naomi S. Bardach MD MAS, Philip R. Lee Institute for Health Policy Studies, University of California, San Francisco, 490 Illinois St, San Francisco, CA 94158 (e-mail: naomi.bardach@ucsf.edu).

Received for publication May 19, 2021; accepted September 8, 2021.

ABSTRACT

OBJECTIVE: To assess variation in asthma-related emergency department (ED) use between weekends and weekdays.

METHODS: Cross-sectional administrative claims-based analysis using California 2016 Medicaid data and Vermont 2016 and Massachusetts 2015 all-payer claims databases. We defined ED use as the rate of asthma-related ED visits per 100 child-years. A weekend visit was a visit on Saturday or Sunday, based on date of ED visit claim. We used negative binomial regression and robust standard errors to assess variation between weekend and weekday rates, overall and by age group.

RESULTS: We evaluated data from 398,537 patients with asthma. The asthma-related ED visit rate was slightly lower on weekends (weekend: 18.7 [95% confidence interval (CI): 18.3–19.0], weekday: 19.6 [95% CI, 19.3–19.8], $P < .001$). When stratifying by age group, 3- to 5-year-olds had higher rates of asthma-related ED visits on weekends than weekdays (weekend:

33.7 [95% CI, 32.6–34.7], weekday: 29.8 [95% CI, 29.1–30.5], $P < .001$) and 12- to 17-year-olds had lower rates of ED visits on weekends than weekdays (weekend: 13.0 [95% CI: 12.5–13.4], weekday: 16.3 [95% CI: 15.9–16.7], $P < .001$). In the other age groups (6–11, 18–21 years) there were not statistically significant differences between weekend and weekday rates ($P > .05$).

CONCLUSIONS: In this multistate analysis of children with asthma, we found limited overall variation in pediatric asthma-related ED utilization on weekends versus weekdays. These findings suggest that increasing access options during the weekend may not necessarily decrease asthma-related ED use.

KEYWORDS: asthma; emergency department utilization; health care delivery; quality measurement

ACADEMIC PEDIATRICS 2022;22:640–646

WHAT'S NEW

In this multistate analysis of children with asthma, we did not find substantial differences between asthma-related emergency department utilization on weekends versus weekdays. These findings suggest that increasing access during the weekend may not necessarily decrease asthma-related emergency department use.

ASTHMA IS A common pediatric disease, affecting 1 in 12 US children,¹ and contributing to over 500,000 emergency department (ED) visits for children annually.² These visits generate enormous cost: in 2010 alone, the cost of pediatric asthma-related ED visits totaled \$272 million in direct costs alone,³ with indirect costs, such as loss of work and school days, likely substantially higher. Factors including

access to primary care, proper clinical diagnosis and management, as well as exposure to asthma triggers may all influence rates of asthma-related ED utilization in children.

Prior studies have hypothesized that lack of weekend access to primary or urgent care has contributed to ED overutilization.⁴ However, prior studies examining ED utilization have produced conflicting results: some studies report higher ED utilization rates on weekends compared to weekdays,⁵ while others report higher weekday rates.^{6–9} Multiple studies have reported highest ED utilization rates on Mondays.^{6,8} These prior studies have largely examined adult ED utilization rates, both for asthma in particular and for ED use in general.

It is not known if pediatric asthma-related ED utilization varies between weekend and weekdays. As children accounted for 22% of ED visits in the United States in 2011,¹⁰ the ability to characterize pediatric ED patterns

represents an important gap in the literature. Children have different utilization patterns from adults due to factors including dependence on caregivers and access to school-based nursing and assessment, and pediatric asthma has different drivers than adult asthma.¹¹ If rates are substantially higher on weekends, this pattern would suggest increasing weekend primary care access as a potential avenue to decreasing asthma-related ED visits, thereby potentially decreasing healthcare costs, and societal costs due to loss of school and work time.

To assess whether pediatric asthma-related ED utilization varies between weekends and weekdays, we conducted a multistate cross-sectional study using administrative claims. Because pediatric asthma exacerbations vary by age,¹² season,¹³ and geographic region, we also assessed variation in weekend versus weekday ED utilization by age group, season, and state.

METHODS

DATA SOURCES

We used administrative data from the California (CA) Medicaid claims 2016, the Vermont (VT) all-payer claims database (APCD) 2016, and the Massachusetts (MA) APCD. APCDs are comprehensive databases that provide claims from most insurers (commercial, Medicaid, and Medicare), but do not include individuals covered by TRICARE, Veteran's Affairs, the Federal Employees Health Benefits Program, or some commercial self-pay insurance plans.^{14,15} The Massachusetts and Vermont APCDs were developed in 2009 and have been used in peer-reviewed literature and for population-based reports on health.^{14–18}

STUDY POPULATION

To define asthma-related ED utilization, and therefore our study population, we used a quality measure from the Pediatric Quality Measures Program (PQMP). The PQMP was established under The Children's Health Insurance Program Reauthorization Act, funded through the Center for Medicare and Medicaid Services and overseen by the Agency for Healthcare Research and Quality. The PQMP was established to address gaps in assessing quality in pediatric care and led to the development of numerous pediatric quality measures,¹⁹ including the one used in this study. The measure specifications defined both the population of interest (denominator) and the outcome definition for asthma-related ED visits.

Per the measure specifications, we included all patients aged 3 to 21 years old in the measurement year (2015 in MA, 2016 in VT and CA). Inclusion criteria are: 1) 3 months of consecutive enrollment in the same insurance plan (the measurement month and the 2 months before) and 2) evidence of claims for identifiable asthma (below) during a look-back period, including the measurement month, all previous months in the measurement year (2015 or 2016), and the year (2014 or 2015) before the measurement year^{20–23} (Supplemental Figure 1).

We used the definition of "identifiable asthma" from the PQMP measure. Definition details have been

published previously^{12,23,24} and are summarized in Supplemental Table 1.

Asthma-related prescriptions included long-acting β -agonist or inhaled corticosteroid, antiasthmatic combinations, methylxanthines, and/ or mast-cell stabilizers. Patients meeting the sole criterion of using short-acting β -agonists were not included because these patients likely have less severe asthma. Patients with any diagnoses of cystic fibrosis or emphysema were excluded.

PREDICTORS

Our main predictor was weekend ED use. Weekend visits were defined as ED claims for care that started on Saturday or Sunday. Because the claims datasets did not include time-stamp, we were not able to include Friday evening visits, which could be considered part of the weekend. We examined variation in weekend versus weekday ED visit rate by age group (preschool: 3–5 years, school-aged: 6–11 years, high school: 12–17 years, post-secondary: 18–21 years), season (January–March, April–June, July–September, October–December) and state (CA, VT, MA). Age group and season were determined by the first day of ED claim. Insurance type was assessed as Medicaid versus non-Medicaid, and, more granularly, as preferred provider organization, health maintenance organization, Medicaid managed care, Medicaid fee-for-service, and Other.

OUTCOME

To assess ED utilization, we calculated the rate of asthma-related ED visits per 100 child-years for children ages 3 to 21 years with identifiable asthma. This is equivalent to the number of ED visits that occurred in 100 children with asthma over one year. The denominator and numerator definitions follow the asthma-related ED visit rate measure specifications developed^{20,21,25} and refined^{12,23,24} through the PQMP.^{19,22,26} The denominator represents the person-time (months) experience among eligible children with identifiable asthma. The numerator was a count of all ED visits or hospitalizations with a primary or secondary diagnosis of asthma in a child who was eligible in the assessment month. We included claims with a second diagnosis of asthma because the primary diagnosis was often a related symptom (eg, fever or wheezing) or a known asthma trigger (eg, upper respiratory tract infection, pneumonia, or influenza). This reflected measure development work that showed that the measure was more accurate when including hospitalizations because claims are often not submitted for ED care that leads to hospitalization.²⁷ To avoid double counting, an ED visit was excluded from the numerator if a hospitalization occurred within the same or the next (allowing for ED visits that crossed midnight) calendar day. Detailed measure definitions and codes are available at: <http://chip.per.ucsf.edu/studies/implement/documents>.

STATISTICAL ANALYSES

We used negative binomial regression and robust standard errors, clustered by individual, to assess variation in asthma-related ED visit rate by day of the week; and to compare weekend versus weekday visit rates, overall and stratified by age group and stratified by season. A priori, we considered a clinically significant difference in visit rates to be at least 4 visits per 100 child years, which is approximately 20% of the number of visits overall. This reflects an assumption that the burden of additional weekend visits would need to be large enough to support providing more outpatient access over the weekend, a large-scale systems change. Negative binomial regression accommodates for the over-dispersed distribution of the outcome and robust standard errors account for patient-level clustering.

We obtained predicted ED visit rates per member-month using the post-estimation “margins” command.²⁸ This calculates a marginal (or average) rate by averaging predicted values for each category of the predictor, which is interpreted as the per member-month rate for each predictor category.²⁸ To calculate the rate per 100 child-years we multiplied the marginal rates by 1200 (12 months in a year \times 100 children). We chose to use rates using margins because they have a more intuitive interpretation, and are more easily compared with the raw rates, than are β -coefficients derived from the regression model.

We tested for interactions between age group and weekend ED use, and between season and weekend ED use in each state dataset separately by including an interaction term in the negative binomial models. Due to restrictions in data-sharing to protect patient confidentiality, we were not able to aggregate all state datasets in one location. Hence, we performed analyses for each state dataset separately and then used a meta-analysis to summarize the results of the individual state analyses. Because we were able to run exactly the same analysis code across all the state databases, this approach was as

efficient as conducting an analysis on the individual level data.²⁹ We used the Stata “metan” command with the “fixed” option to perform the meta-analyses.

SENSITIVITY ANALYSIS

Because CA Medicaid comprised 75% of included patients, we assessed whether the relationships between days of the week and ED use differed by insurance type in the MA APCD, using interaction analyses.

For all analyses, we used SAS version 9.4 (SAS Institute, Inc., Cary, NC) for data management and to calculate ED visits per member-month. All other calculations used STATA 16 (STATA Corp, College Station, Tex). The University of California, San Francisco’s Institutional Review Board approved this study.

RESULTS

In this sample of 398,537 children with identifiable asthma, there were 61,328 asthma-related ED visits, for an overall rate of 19.4 asthma-related ED visits per 100 child-years. The proportion of visits varied by state, with CA contributing the most and VT the least (CA: 47,524 visits (75%), MA: 12,675 visits (23%), VT: 1,093 visits (2%)). Rates varied by age, with 3- to 5-year-olds having the highest asthma-related visit rate and 12- to 17-year-olds the lowest (30.8 vs 15.4 per 100 child-years). Rates also varied by state (CA: 19.7, MA: 18.6 and VT: 16.7 visits per 100 child-years) and season (winter: 24.9 vs summer: 16.3 per 100 child-years) (Table 1).

The difference in the overall rate of asthma-related ED visits on weekdays and weekends was of small magnitude, though it was statistically significantly different. The overall rate of asthma-related ED visits per 100 child-years was slightly higher on weekdays (19.6; 95% confidence interval (CI), 19.3–19.8) compared to weekends (18.7; 95% CI, 18.3–19.0; $P < .001$). Findings were

Table 1. Asthma Rates by Age, Season of the Year, and State

	Patients With Identifiable Asthma, n (%) [†]	ED Visits, n (%) [‡]	Visits per 100 Child-Years (95% CI)
Overall	398,537 (100)	61,328 (100)	19.4 (19.2–19.5)
Age groups			
3–5 years	69,025 (17)	15,952 (26.0)	30.9 (30.2–31.5)
6–11 years	16,9703 (43)	22,722 (37.0)	16.3 (16.0–16.5)
12–17 years	11,7830 (30)	14,523 (23.7)	15.4 (15.0–15.7)
18–21 years	41,979 (11)	8,095 (13.2)	25.6 (24.7–26.6)
Quarter*			
Winter	284,397 (71)	17,059 (27.8)	24.9 (24.5–25.4)
Spring	325,030 (82)	15,098 (24.6)	18.4 (18.0–18.7)
Summer	346,401 (87)	13,718 (22.4)	16.3 (16.0–16.7)
Fall	378,336 (95)	15,417 (25.1)	18.8 (18.4–19.1)
State			
CA 2016	298,854 (75)	47,524 (77.5)	19.7 (19.5–19.8)
MA 2015	90,752 (23)	12,675 (20.7)	18.6 (18.3–18.9)
VT 2016	8931(2)	1093 (1.8)	16.7 (15.7–17.7)

CA indicates California; MA, Massachusetts; VT, Vermont; ED, emergency department; and CI, confidence interval.

*Winter: January–March; Spring: April–June; Summer: July–September; Fall: October–December.

[†]Asthma assessed on a monthly basis, by rolling look-back in the prior year. See methods for additional details.

[‡]Percent of total ED visits occurring within that category (age group, quarter, or state)

Table 2. Weekend Versus Weekday Asthma-Related Emergency Department Visit Rate Differences by Time of Year

	Visits per 100 Child-Years (95% CI)	P Value
Overall		
Weekends	18.7 (18.3–19.0)	<.001
Weekdays	19.6 (19.3–19.8)	Ref
Difference*	–0.9	
Jan–March		
Weekends	24.0 (23.3–24.7)	.001
Weekdays	25.2 (24.7–25.7)	Ref
Difference*	–1.2	
April–June		
Weekends	17.5 (17.0–18.1)	.002
Weekdays	18.7 (18.3–19.1)	Ref
Difference*	–1.2	
July–Sept		
Weekends	15.8 (15.2–16.3)	.007
Weekdays	16.6 (16.2–16.9)	Ref
Difference*	–0.8	
Oct–Dec		
Weekends	18.4 (17.8–18.9)	.11
Weekdays	18.9 (18.5–19.3)	Ref
Difference*	–0.5	

CI indicates confidence interval.

Difference: Weekend rate – Weekday rate.

similar when stratified by quarter of the year and interaction terms were not statistically significant (Table 2).

There was some variation overall by day of the week. Asthma-related ED visit rates were highest on Mondays (21.9; 95% CI, 21.4–22.4). The rate declined slightly throughout the week then rose on Sunday (Tuesday: 20.1 [95% CI, 19.6–20.5], Wednesday: 19.8 [95% CI, 19.3–20.2], Thursday: 18.6 [95% CI, 18.2–19], Friday: 17.6 [95% CI, 17.2–18], Saturday: 17.7 [95% CI, 17.3–18.1], Sunday: 19.6 [95% CI, 19.1–20]). The overall difference across the days was statistically significant ($P < .001$) (Fig. 1).

When stratifying the comparison of weekend to weekday visits by age group, 3- to 5-year-olds had higher rates of asthma-related ED visits on weekends (weekend: 33.7

[95% CI, 32.6–34.7], weekday: 29.8 [95% CI, 29.1–30.5], difference: 3.9, $P < .001$) and 12- to 17-year-olds had lower rates of ED visits on weekends (weekend: 13.0 [95% CI, 12.5–13.4], weekday: 16.3 [95% CI, 15.9–16.7], difference: –3.3, $P < .001$). The differences between weekend and weekday utilization in other age groups were not statistically significant (Fig. 2). These patterns were consistent across all three states. Interaction terms for these relationships were statistically significant (range of P values for age groups, across states: <0.001–0.09).

There was some variation in weekday versus weekend asthma-related ED visit rate by state. Findings in VT and CA in 2016 were similar to the overall findings across states, with weekday rates higher than weekend rates, though the difference was more pronounced in VT than the overall (weekend: 14.9 [95% CI, 13.1–16.8], weekday: 17.4 [95% CI, 18.8–19.1], $P = .033$). Massachusetts in 2015 had a slightly higher rate on weekends (weekend: 19.3 [95% CI, 18.5–20.1], weekday: 18.3 [95% CI, 17.9–18.8], $P < .014$).

In sensitivity analyses using MA data, there were no statistically significant interactions between insurance type and weekend versus weekday asthma-related ED utilization.

DISCUSSION

In this multistate analysis of children with asthma with Medicaid and commercial insurance, we found limited overall variation in pediatric asthma-related ED utilization rates on weekends versus weekdays (–0.9 visits fewer per 100 child-years on weekends). These relationships were similar by season. However, there were differences based on age group: 3- to 5-year-olds had substantially higher rates of ED visits on weekends than weekdays and 12- to 17-year-olds had lower rates of ED visits on weekends than weekdays. Relationships by state were similar to the overall findings. We also found higher

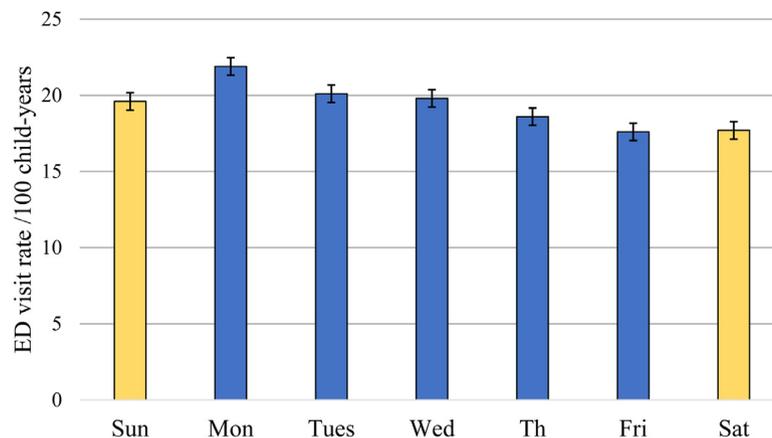


Figure 1. Asthma-related emergency department visit rates by day of the week. Testing for overall difference across days was statistically significant ($P < .001$). Rates by day of the week: Monday: 21.9 (95% CI, 21.4–22.4); Tuesday: 20.1 (95% CI, 19.6–20.5); Wednesday: 19.8 (95% CI, 19.3–20.2); Thursday: 18.6 (95% CI, 18.2–19.0); Friday: 17.6 (95% CI, 17.2–18.0); Saturday: 17.7 (95% CI, 17.3–18.1); Sunday: 19.6 (95% CI, 19.1–20). CI indicates confidence interval.

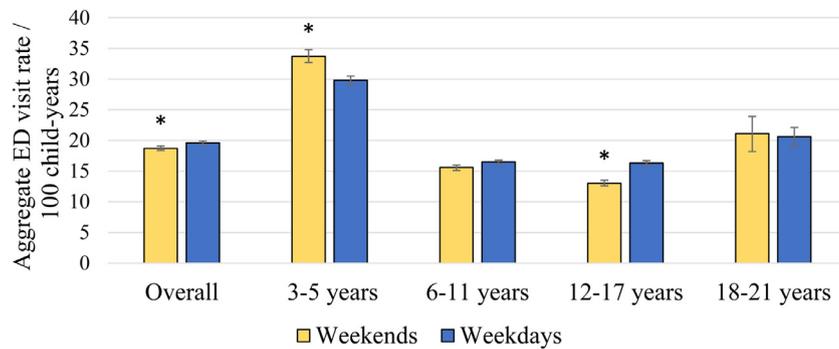


Figure 2. Weekend versus weekday asthma-related emergency department visit rate differences overall and by age group. Asterisks denote statistically significant differences between weekend and weekday visit rates ($P < .001$). Testing for interaction between age group and difference between weekend and weekday visit rates was statistically significant in each of CA, MA, and VT. CA indicates California; MA, Massachusetts; and VT, Vermont.

ED utilization rates on Mondays compared to other days of the week.

Our findings are consistent with other studies of ED utilization, mainly among the adult population; prior studies have not found higher overall ED utilization on weekends compared to weekdays and have found ED utilization to be highest on Mondays.^{6,30,31} Prior studies have not primarily studied variation by age in the proportion of weekend to weekday ED visits. A 2004 study of patients of all ages in Nebraska,⁵ found that the ratio of ED-only weekend to weekday visits was highest in patients <1 years old and declined with age. This is consistent with our finding of highest relative weekend utilization in younger children, although our minimum age was 3 years old.

Though the choice to seek emergency medical care is likely based on a complicated web of care-seeking decisions and behaviors, our findings generate specific hypotheses, and suggest potential policy implications. Our finding that ED utilization differs by age group may be driven by a variety of factors. Parents of younger children (3–5 age group) may have less experience managing asthma and so may not be prepared to manage symptoms at home and may be more reliant on ED services until they develop skills for the recognition and management of exacerbations. Parent perception of children <5 years of age may be that their children are more vulnerable with less respiratory reserve than parents of school-aged children. Thus, parents of younger children may be more likely to bring in their child with mild asthma symptoms, compared to parents of older children with mild symptoms.

In addition, the 3- to 5-year-olds, who had higher weekend use compared to weekdays, are dependent on adult caregivers to recognize exacerbations and bring them to the emergency room. It is possible that parents or guardians are more likely to recognize exacerbations than weekday caregivers for 3- to 5-year-olds, leading to increased weekend visits. In contrast, teens had higher weekday use. School personnel may play a role in identifying weekday asthma exacerbations symptoms for older teens and referring these students to the ED. As school-based clinics have been shown to decrease ED utilization for children with asthma,³²

schools without existing clinics may be a potential target for intervention. In addition, as adolescents transition to self-management, they may be less willing to miss weekend activities to address an asthma exacerbation, leading to higher weekday use.

Finally, older children may be exposed to more asthma triggers on school days compared to weekends.³³ Studies have identified the presence of significant asthma triggers at schools, including dust mite, cat, and cockroach allergens.^{34,35} The relative role of home versus school exposure to asthma triggers is not yet well understood, however, it likely varies by age. For example, Banda et al found that more home triggers were associated with asthma hospitalization in children 0 to 4 years old, whereas school triggers like classroom carpeting were associated with asthma exacerbations in children 12 to 18.³⁶ These hypotheses suggest directions for future research, such as partnering with parents of younger children or partnering with schools to explore the relationship between schools and asthma exacerbations, including both asthma trigger exposure and recognition of asthma exacerbations by school personnel.

Our findings have potential pertinent policy implications. Our main finding suggests that opening more urgent care clinics or primary care clinics on weekends would be unlikely to lead to substantial decreases in asthma-related pediatric ED visits. This is likely true even in MA where the rates were slightly higher on weekends, given the small magnitude of the effect size (1 ED visit/100 child-years more on weekends than weekdays). Our findings are relevant to policy makers and payers, particularly those interested in high-value care (eg, accountable care organizations). As these health care entities look to overutilization of the ED as a potential area for cost savings and improving value^{37,38} our findings indicate that improving non-ED access on the weekends would be unlikely to increase value. In addition, the measure we used to assess asthma ED utilization rates is a quality measure developed under the Centers for Medicaid and Medicare Services-funded PQMP^{20,22} for potential use in state Medicaid program assessments of health plan and provider quality. Hence, our findings are relevant for payers or providers interested in improving performance on a national quality

measure and improving population health management for Medicaid patients.

Results from the analysis by day of the week suggests Monday as an alternative day for health care delivery system change, a potentially more feasible endeavor. Efforts to increase Monday access to primary care, including scheduling fewer well-child checks on Mondays and leaving more openings for same-day appointments, may decrease Monday ED utilization. Anticipating Monday spikes in ED utilization might also be helpful for ED resource allocation and staffing decisions.

We note a number of limitations. Our data include systems with weekend urgent care access but there is no indicator for this system-level characteristic in the data. It is possible that different weekend verses weekday ED utilization patterns might emerge if systems with and without weekend urgent care access were analyzed separately. However, prior studies that examined patient-level data about weekend access to primary care and ED utilization for any diagnosis have not found a statistically significant association between weekend access and ED utilization.^{39,40} More readily accessible data on types of access and parent decision-making to access care would facilitate a deeper understanding of how to optimize care delivery. In addition, administrative claims data do not include time stamps, so we were unable to assess variation between daytime and evening or nighttime ED visits. It is possible that there may be some misclassification, as Friday night may be considered part of the weekend. Finally, this study excludes patients with claims for only bronchodilators as a home medication and therefore may exclude patients with severe asthma but poor-quality primary care who would be likely to use the ED. However, including these patients would likely not change the overall implications of the study, as nonevidence-based management of asthma in primary care requires interventions more upstream than increasing open hours.

In summary, this multistate, multipayer analysis of pediatric asthma-related ED utilization found limited overall variation across all seasons in pediatric ED utilization rates on weekends compared to weekdays, but did find variation by age group. These findings suggest that increasing access options during the weekend may not necessarily decrease asthma-related ED use, except potentially in younger children. Higher weekday use in 12- to 17-year-olds suggests further work to explore the role schools may play in recognizing asthma exacerbations.

ACKNOWLEDGMENTS

Financial statement: Supported by the Agency for Healthcare Research and Quality (U18HS025297 [to MDC, NSB, VSH, JSS, CEM] and U18HS020518, HHSP233201600221A, and HHSP233201550088A [to LCK]) and the Health Resources and Services Administration (grant U3DMC32755-01-00).

SUPPLEMENTARY DATA

Supplementary data related to this article can be found online at <https://doi.org/10.1016/j.acap.2021.09.005>.

REFERENCES

1. CDC.gov. CDC vital signs. 2018. Available at: <https://www.cdc.gov/vitalsigns>. Accessed February 9, 2018.
2. CDC. Asthma-related healthcare use data. National Ambulatory Medical Care Survey. 2016. Available at: <https://www.cdc.gov/asthma/healthcare-use/healthcare-use-2016.htm>. Accessed January 19, 2020.
3. Pearson WS, Goates SA, Harrykissoon SD, et al. State-based Medicaid costs for pediatric asthma emergency department visits. *Prev Chronic Dis*. 2014;11:E108. <https://doi.org/10.5888/pcd11.140139>.
4. New England Healthcare Institute. A matter of urgency: reducing emergency department overuse. 2010. Available at: https://www.nehi.net/writable/publication_files/file/nehi_ed_overuse_issue_brief_032610final.pdf. Accessed May 7, 2020.
5. Schoenfeld EM, McKay MP. Weekend emergency department visits in Nebraska: higher utilization, lower acuity. *J Emerg Med*. 2010;38:542–545. <https://doi.org/10.1016/J.JEMERMED.2008.09.036>.
6. Castner J, Yin Y, Loomis D, et al. Medical Mondays: ED utilization for Medicaid recipients depends on the day of the week, season, and holidays. *J Emerg Nurs*. 2016;42:317–324. <https://doi.org/10.1016/j.jen.2015.12.010>.
7. Pukurdopol P, Wiler JL, Hsia RY, et al. Association of Medicare and Medicaid insurance with increasing primary care-treatable emergency department visits in the United States. Pines J, ed *Acad Emerg Med*. 2014;21:1135–1142. <https://doi.org/10.1111/acem.12490>.
8. Krefis AC, Fischereit J, Hoffmann P, et al. Temporal analysis of determinants for respiratory emergency department visits in a large German hospital respiratory epidemiology. *BMJ Open Resp Res*. 2018;5:338. <https://doi.org/10.1136/bmjresp-2018-000338>.
9. Baibergerova A, Thabane L, Akhtar-Danesh N, et al. Effect of gender, age, and severity of asthma attack on patterns of emergency department visits due to asthma by month and day of the week. *Eur J Epidemiol*. 2005;20:947–956. <https://doi.org/10.1007/s10654-005-3635-6>.
10. Goto T, Hasegawa K, Faridi M, et al. Emergency department utilization by children in the USA, 2010–2011. *West J Emerg Med*. 2017;18:1042–1046. <https://doi.org/10.5811/westjem.2017.7.33723>.
11. Trivendi M, Denton E. Asthma in children and adults—what are the differences and what can they tell us about asthma? *Front Pediatr*. 2019;7:256.
12. Bardach NS, Neel C, Kleinman LC, et al. Depression, anxiety, and emergency department use for asthma. *Pediatrics*. 2019;144:e20190856. <https://doi.org/10.1542/peds.2019-0856>.
13. Gerhardsson de Verdier M, Gustafson P, McCrae C, et al. Seasonal and geographic variations in the incidence of asthma exacerbations in the United States. *J Asthma*. 2017;54:818–824. <https://doi.org/10.1080/02770903.2016.1277538>.
14. VHCURES Overview: a guide for data users. Montpelier. Available at: <https://gmcboard.vermont.gov/sites/gmcb/files/documents/VHCURES>. Accessed January 16, 2020.
15. Overview of the Massachusetts all-payer claims database. 2016. Available at: www.chiamass.gov/. Accessed January 16, 2020.
16. Geissler KH, Lubin B, Marzilli Ericson KM. Access is not enough. *Med Care*. 2016;54:350–358. <https://doi.org/10.1097/MLR.000000000000488>.
17. Massachusetts Division of Health Care Finance and Policy. Measuring health care quality and cost in Massachusetts. 2009. Available at: <https://archives.lib.state.ma.us/bitstream/handle/2452/206144/ocn492419500-2009.pdf?sequence=1&isAllowed=y>. Accessed August 18, 2018.
18. Wasserman RC, Varni SE, Hollander MC, et al. Change in site of children's primary care: a longitudinal population-based analysis. *Ann Fam Med*. 2019;17:390–395. <https://doi.org/10.1370/afm.2416>.
19. Mistry K, Chesley F, Llanos K, et al. Advancing children's health care and outcomes through the pediatric quality measures program. *Acad Pediatr*. 2014;14(5, Suppl):S19–S26. Available at: <https://www.sciencedirect.com/science/article/pii/S1876285914002484>. Accessed December 4, 2019.
20. Kleinman L, Soloway L, Homer C. *New pediatric quality measures program (PQMP) measure of emergency department (ED) use for*

- children with asthma. San Diego, CA: Academy Health Research Meeting; 2014.
21. Collaboration for the Advancement of Pediatric Quality Measures. Rate of Emergency Department Visit Use for Children Managed for Persistent Asthma. Agency for Healthcare Research and Quality; 2015. Available at: <http://www.capquam.org>. Accessed October 22, 2021.
 22. Agency for Healthcare Research and Quality. About the pediatric quality measures program. 2017. Available at: <http://www.ahrq.gov/pqmp/about/index.html>. Accessed March 28, 2018.
 23. Implement for Child Health. "Pediatric Asthma Emergency Department Use" technical specifications. University of California San Francisco; 2018. Available at: <https://chipper.ucsf.edu/studies/implement/documents>. Accessed October 22, 2021.
 24. Harder V, Shaw J, McCulloch C, et al. Statewide asthma learning collaborative participation and asthma-related emergency department use. *Pediatrics*. 2020;146:e20200213. Available at: <https://pediatrics.aappublications.org/content/146/6/e20200213.abstract>. Accessed February 8, 2021.
 25. Collaboration for Advancing Pediatric Quality Measures. Rate of Emergency Department Visit Use for Children Managed for Persistent Asthma Technical Specifications. 2015. Available at: <http://222.capquam.org/docs/Asthma/Tech%20Specs%20Asthma%205.pdf>. Accessed October 10, 2018.
 26. PQMP 1.0 Centers of Excellence. 2021. Accessed 17 October 2021.
 27. Egorova N, Gesten F, Anarella J. *Measuring undesirable utilization outcomes when assessing the quality of care for children with asthma: findings and considerations*. San Diego, CA: Academy Health Research Meeting; 2014.
 28. Norton EC, Miller MM, Kleinman LC. Computing adjusted risk ratios and risk differences in Stata. *Stata J Promot Commun Stat Stata*. 2013;13:492–509. <https://doi.org/10.1177/1536867X1301300304>.
 29. Lin DY, Zeng D. On the relative efficiency of using summary statistics versus individual-level data in meta-analysis. *Biometrika*. 2010;97:321–332. <https://doi.org/10.1093/biomet/asq006>.
 30. Wargon M, Guidet B, Hoang TD, et al. A systematic review of models for forecasting the number of emergency department visits. *Emerg Med J*. 2009;26:395–399. <https://doi.org/10.1136/emj.2008.062380>.
 31. Marcilio I, Hajat S, Gouveia N. Forecasting daily emergency department visits using calendar variables and ambient temperature readings. Merchant RC, ed *Acad Emerg Med*. 2013;20:769–777. <https://doi.org/10.1111/acem.12182>.
 32. Guo JJ, Jang R, Keller KN, et al. Impact of school-based health centers on children with asthma. *J Adolesc Health*. 2005;37:266–274. <https://doi.org/10.1016/j.jadohealth.2004.09.006>.
 33. Mohr LB, Luo S, Mathias E, et al. Influence of season and temperature on the relationship of elemental carbon air pollution to pediatric asthma emergency room visits. *J Asthma*. 2008;45:936–943. <https://doi.org/10.1080/02770900802404082>.
 34. Amr S, Bollinger ME, Myers M, et al. Environmental allergens and asthma in urban elementary schools. *Ann Allergy Asthma Immunol*. 2003;90:34–40. [https://doi.org/10.1016/S1081-1206\(10\)63611-3](https://doi.org/10.1016/S1081-1206(10)63611-3).
 35. Abramson SL, Turner-Henson A, Anderson L, et al. Allergens in school settings: results of environmental assessments in 3 city school systems. *J Sch Health*. 2006;76:246–249. <https://doi.org/10.1111/j.1746-1561.2006.00105.x>.
 36. Banda E, Persky V, Chisum G, et al. Exposure to home and school environmental triggers and asthma morbidity in Chicago inner-city children. *Pediatr Allergy Immunol*. 2013;24:734–741. <https://doi.org/10.1111/pai.12162>.
 37. Sadowski LS, Kee RA, VanderWeele TJ, et al. Effect of a housing and case management program on emergency department visits and hospitalizations among chronically ill homeless adults. *JAMA*. 2009;301:1771. <https://doi.org/10.1001/jama.2009.561>.
 38. Kumar GS, Klein R. Effectiveness of case management strategies in reducing emergency department visits in frequent user patient populations: a systematic review. *J Emerg Med*. 2013;44:717–729. <https://doi.org/10.1016/j.jemermed.2012.08.035>.
 39. Zickafoose JS, DeCamp LR, Prosser LA. Association between enhanced access services in pediatric primary care and utilization of emergency departments: a national parent survey. *J Pediatr*. 2013;163:1389–1395.e6. <https://doi.org/10.1016/J.JPEDI.2013.04.050>.
 40. Lowe RA, Localio AR, Schwarz DF, et al. Association between primary care practice characteristics and emergency department use in a Medicaid managed care organization. *Med Care*. 2005;43:792–800. <https://doi.org/10.1097/01.mlr.0000170413.60054.54>.