

Divergent Shifts in Paediatric Emergency Care Before, During, and After the COVID-19 Pandemic: An Interrupted Time Series Analysis

Chutong Liu

Western University

Anna Gunz

Western University

Rodrick Lim

Western University

Anne Hicks

University of Alberta

Eric Lavigne

Environmental Health Science and Research Bureau, Health Canada

Piotr Wilk

`pwilk3@uwo.ca`

Western University

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Abstract

Background

The COVID-19 pandemic resulted in the implementation of various public health measures that significantly disrupted healthcare utilization. This study examines the impact of the pandemic on paediatric emergency department (ED) visit trends in Ontario, Canada.

Methods

We performed interrupted time series analysis using administrative health data for ED visits reported across 206 EDs in Ontario from April 2011 to May 2023 (13,103,307 visits). Using negative binomial regression, we analyzed monthly trends in ED visits across four age groups (0–4, 5–9, 10–14, and 15–17 years). ED visits were categorized as urgent or non-urgent based on the Canadian Triage and Acuity Scale (CTAS).

Results

Prior to pandemic onset, urgent ED visits increased at a rate of 0.22% per month, while non-urgent visits declined by 0.35% per month. The immediate reduction in visits was most severe in the 0–4 age group (–58.7%) and least severe in the 15–17 age group (–45.2%). Overall, no significant differences existed in the rate of recovery between urgent and non-urgent visits. Across the four age groups, the 0–4 age group demonstrated the steepest post-pandemic recovery in urgent visits (+ 3.32% per month).

Conclusion

The pandemic caused an unprecedented decline in pediatric ED utilization. While total volumes have largely recovered by the end of the pandemic, the shift towards a larger proportion of urgent visits has intensified. These findings suggest a change in how paediatric patients use EDs, highlighting the need for healthcare systems to adapt to this shift.

INTRODUCTION

In response to the rapid transmission of SARS-CoV-2, various public health measures were implemented in Canada to reduce viral spread, including stay-at-home orders, mask mandates, and closure of nonessential services (1). These policies had profound effects on healthcare delivery, which may have altered pre-pandemic trends in the provision of care.

Prior to the COVID-19 pandemic, a steady decline in the proportion of non-urgent emergency department (ED) visits was observed in Canada (2, 3), including in paediatric ED visits, reflecting sustained system-

level efforts to reduce avoidable visits through initiatives such as virtual care (4). At the onset of the pandemic in March 2020, non-urgent ED visits dropped drastically, whereas urgent visits decreased to a lesser extent, indicating that the relative proportion of urgent ED visits increased (5, 6). Thus, while during the early phases of the pandemic, fewer children presented to EDs, those who did were sicker and needed urgent care (7).

Although changes in volume of urgent and non-urgent paediatric ED visits in Canada during the first months of the pandemic have been assessed (7), no studies have investigated these changes throughout the entire duration of the pandemic. Understanding longer-term trends is critical to determine whether the pandemic resulted in a disruption of pre-pandemic efforts in reducing non-urgent ED utilization. This study aimed to evaluate the impact of the COVID-19 pandemic on trends in urgent and non-urgent paediatric ED visits among children in Ontario, overall and across age subgroups. Examining these trends provides a comprehensive assessment of the pandemic's impact on paediatric emergency care, which informs health system planning and resource allocation for future public health emergencies (8).

METHODS

Study Design and Time Period

The aim of this study is to examine how the COVID-19 pandemic affected trends in urgent and non-urgent paediatric ED visits among children in Ontario, overall and across age subgroups. We conducted a retrospective, population-based study using routinely collected administrative health data reported across 206 EDs in Ontario from April 2011 to the end of the pandemic in May 2023. Data were divided into the pre-pandemic (April 2011 to February 2020) and pandemic (March 2020 to May 2023) periods. Interrupted time series (ITS) methods were used to estimate level and slope changes associated with the pandemic (9). ITS is a quasi-experimental design commonly used to assess the effects of population-level interventions (10, 11). This method estimates the expected outcome trend in the absence of the intervention (i.e., the counterfactual), using pre-intervention data.

Study Setting

These data were obtained from the National Ambulatory Care Reporting System (NACRS) database administered by the Canadian Institute for Health Information. In Ontario, reporting ED encounters to NACRS is mandated, thus ensuring near-complete data coverage (6). We selected Ontario as it is the most populous province in Canada and to minimize heterogeneity in ED utilization related to interprovincial differences in health system organization.

Population

We included paediatric ED visits reported across 206 EDs in Ontario. Analyses were stratified by age groups (0–4, 5–9, 10–14, and 15–17 years). Visits missing triage scores (~ 0.4%) were excluded from acuity-stratified analyses.

Intervention

The intervention point was defined as March 2020, corresponding to Ontario's official entry into the COVID-19 pandemic and the implementation of widespread public health measures (12, 13).

Outcome Measures

The outcome was the monthly count of urgent and non-urgent ED visits, obtained by aggregating ED visit-level records from NACRS. The Canadian Triage and Acuity Scale (CTAS) was used to distinguish between urgent (levels 1–3) and non-urgent (levels 4–5) visits.

Sample Size

The study analyzed 13,103,307 paediatric ED visit data reported across 206 EDs in Ontario between April 2011 and May 2023.

Data Analysis

Statistical analyses followed the methodology described by Bernal et al., which has been widely applied in evaluations of pandemic-related health system impacts (9, 10). Specifically, observed trends were compared with counterfactual trends to quantify changes in monthly ED visit counts attributable to the pandemic (9, 10). A segmented negative binomial model was used to account for overdispersion in the count data (14). The model included terms representing the pre-intervention time trend, an indicator for the intervention, and the post-intervention trend to capture the baseline trend, the immediate change at pandemic onset, and subsequent gradual changes in trend during the pandemic. Monthly periodicity was controlled for using Fourier terms (11). Changes in paediatric population size were accounted for using an offset term representing the log of the relevant age-specific population, derived from the 2011, 2016, and 2021 census counts and population projections for intercensal years (15). Slopes for the pre-pandemic and pandemic periods were estimated and interpreted as percent changes in ED visit rates per month. Counterfactual trends were generated by setting the intervention and post-intervention trend terms to zero, thereby estimating expected monthly visit counts had the pandemic not occurred. The fitted and observed trends were plotted to visualize changes in ED utilization over time. Relative risks (RRs) with 95% confidence intervals (CIs) were calculated to estimate the immediate relative change in ED visit rates following pandemic onset (16). Differences in model parameters between urgent and non-urgent ED visits were evaluated by fitting negative binomial models with an interaction term between time and visit acuity (10).

RESULTS

Descriptive Statistics

The study sample consists of 146 monthly observations of paediatric ED visit counts in Ontario. A total of 13,103,307 visits were recorded during the study period, of which 7,994,202 were urgent and 5,054,354 were non-urgent (Table 1). During the pre-pandemic, there were on average 55,612 urgent visits and 39,286 non-urgent visits per month. Comparatively, during the pandemic, there were 52,403 urgent visits and 21,814 non-urgent visits per month.

Table 1. Descriptive statistics for paediatric ED visits in Ontario during the pre-pandemic and pandemic periods.

Visit Type	Period	ED Visits (Number)	ED Visits (Monthly Average)
All ED Visits	Total	13103307	89749
	Pre-pandemic period	10196263	95292
	Pandemic period	2907044	74540
Urgent Visits	Total	7994202	54755
	Pre-pandemic period	5950490	55612
	Pandemic period	2043712	52403
Non-urgent Visits	Total	5054354	34619
	Pre-pandemic period	4203617	39286
	Pandemic period	850737	21814
0–4 Age Group	Total	5443013	37281
	Pre-pandemic period	4223415	39471
	Pandemic period	1219598	31272
5–9 Age Group	Total	2784349	19071
	Pre-pandemic period	2159638	20184
	Pandemic period	624711	16018
10–14 Age Group	Total	2663626	18244
	Pre-pandemic period	2073650	19380
	Pandemic period	589976	15128
15–17 Age Group	Total	2212319	15153
	Pre-pandemic period	1739560	16258
	Pandemic period	472759	12122

Legend:

Total: April 2011–May 2023

Pre-pandemic period: April 2011–February 2020

Pandemic period: March 2020–May 2023

Interrupted Time Series Analysis

Urgent vs. non-urgent ED visits. For urgent visits, a significant positive pre-pandemic trend of 0.22% visits per month was observed before the pandemic, indicating a gradual increase in high acuity ED utilization (Table 2). At the onset of the pandemic, urgent visits declined by 52% (RR = 0.48, 95% CI 0.44–0.53), followed by a significant increase of 2.68% visits per

month ($p < .001$) (Fig. 1A). In contrast, non-urgent ED visits exhibited a significant negative pre-pandemic trend of –0.35% visits per month (Fig. 1B). At pandemic onset, non-urgent visits declined by 54% (RR = 0.46, 95% CI 0.42–0.50), after which the trend shifted to a significant ($p < .001$) positive trend of 1.71% visits per month. By March 2023, post-pandemic trends for both urgent and non-urgent ED visits had returned to levels consistent with counterfactual predictions.

During the pre-pandemic, the monthly trend in non-urgent ED visits differed significantly from that of urgent visits by –0.019%, (Table 4). However, no significant difference was observed between urgent and non-urgent ED visits in the immediate level change at pandemic onset ($p = 0.846$). Similarly, no significant difference was seen in the pandemic-period trends ($p = 0.196$). Both urgent and non-urgent visits increased over time during the pandemic, but the difference was insignificant.

Table 2. Parameter estimates of paediatric ED visits before and during the COVID-19 pandemic.

Acuity Level	Period	Change in percentage of ED visits per month (Slope)	Immediate relative change at pandemic onset (Relative Risk, 95% CI)
All ED Visits	Pre-pandemic	–0.02% ($p = 0.691$)	0.47 (0.43, 0.52)
	Pandemic	2.39% ($p < 0.001$)	
Urgent Visits	Pre-pandemic	0.22% ($p < 0.001$)	0.48 (0.44, 0.53)
	Pandemic	2.68% ($p < 0.001$)	
Non-urgent Visits	Pre-pandemic	–0.35% ($p < 0.001$)	0.46 (0.42, 0.50)
	Pandemic	1.71% ($p < 0.001$)	

Legend:

Pre-pandemic period: April 2011–February 2020

Pandemic period: March 2020–May 2023

ED visits stratified by age. For urgent ED visits, the 0-4 and 10-14 age groups exhibited the smallest and largest positive pre-pandemic trends, respectively (0.15% visits per month, 0.32% visits per month) (Table 3; Fig. 2A-1, Fig. 2C-1). At pandemic onset, the 0-4 (RR = 0.42, 95% CI 0.37–0.48) and 5-9 age groups (RR = 0.42, 95% CI 0.37–0.47) experienced the highest immediate declines in urgent visits by 58% (Fig. 2A-1, 2B-1), while the 15-17 age group experienced the smallest decline by 36% (RR = 0.64, 95% CI 0.60–0.69) (Fig. 2D-1). During the pandemic, the 0-4 age group showed the fastest recovery in urgent ED visits (3.32% visits per month) (Fig. 2A-1), whereas the 15-17 age group exhibited the slowest recovery (1.25% visits per month) (Fig. 2D-1).

For non-urgent ED visits, the 15-17 age group had the most pronounced pre-pandemic decline (–0.47% visits per month) (Fig. 2D-2). Comparatively, the 5-9 age groups had the least negative pre-pandemic trend (–0.26% visits per month) (Fig. 2B-2). At the pandemic onset, the largest immediate decline in non-urgent ED visits occurred in the 10-14 age group (57%; RR = 0.43, 95% CI 0.39–0.48) (Fig. 2C-2), while the smallest decline was found in the 15-17 age group (50%; RR = 0.50, 95% CI 0.46–0.55) (Fig. 2D-2). During the pandemic, the 0-4 age group experienced the fastest rebound in non-urgent ED visits (2.07% visits per month) (Fig. 2A-2), whereas the 15-17 age group showed the slowest growth in non-urgent visits (1.19% visits per month) (Fig. 2D-2).

Table 3. Parameter estimates of paediatric ED visits before and during the COVID-19 pandemic, stratified by age.

Age Group	Acuity Level	Period	Change in percentage of ED visits per month (Slope)	Difference between pre-pandemic and pandemic trends (Relative Risk, 95% CI)
0-4	Urgent Visits	Pre-pandemic	0.15% ($p = 0.005$)	0.42 (0.37, 0.48)
		Pandemic	3.32% ($p < 0.001$)	
	Non-urgent Visits	Pre-pandemic	-0.28% ($p < 0.001$)	0.47 (0.42, 0.52)
		Pandemic	2.07% ($p < 0.001$)	
5-9	Urgent Visits	Pre-pandemic	0.24% ($p < 0.001$)	0.42 (0.37, 0.47)
		Pandemic	3.22% ($p < 0.001$)	
	Non-urgent Visits	Pre-pandemic	-0.26% ($p < 0.001$)	0.44 (0.39, 0.48)
		Pandemic	1.98% ($p < 0.001$)	
10-14	Urgent Visits	Pre-pandemic	0.32% ($p < 0.001$)	0.57 (0.52, 0.62)
		Pandemic	1.87% ($p < 0.001$)	
	Non-urgent Visits	Pre-pandemic	-0.41% ($p < 0.001$)	0.43 (0.39, 0.48)
		Pandemic	1.54% ($p < 0.001$)	
15-17	Urgent Visits	Pre-pandemic	0.24% ($p < 0.001$)	0.64 (0.60, 0.69)
		Pandemic	1.25% ($p < 0.001$)	
	Non-urgent Visits	Pre-pandemic	-0.47% ($p < 0.001$)	0.50 (0.46, 0.55)
		Pandemic	1.19% ($p < 0.001$)	

Legend:

Pre-pandemic period: April 2011–February 2020

Pandemic period: March 2020–May 2023

In the 0-4 age group, the pre-pandemic positive trend for urgent ED visits was significantly greater than the negative trend for non-urgent visits (difference of -0.015%) (Table 4). During the pandemic, the trend for urgent ED visits remained larger than that for non-urgent visits (difference of -0.028%, $p = .018$).

Similarly, in the 5-9 age group, urgent ED visits increased significantly faster than non-urgent visits before the pandemic (difference of -0.017%). During the pandemic, urgent ED visits continued to recover at a significantly faster rate (difference of -0.026%, $p = .018$) (Table 4). For 0-4 and 5-9 age groups, there was no significant difference in the immediate level change between urgent and non-urgent visits.

In the 10-14 age group, urgent ED visits demonstrated a significantly greater pre-pandemic trend compared to non-urgent visits (difference of -0.024%). Non-urgent visits also had a significantly larger immediate decline compared with urgent visits (difference of -21.610%, $p = .002$). However, no difference was observed between the recovery trends in urgent and non-urgent visits during the pandemic (difference of 0.010%, $p = .329$). In the 15-17 age group, the positive pre-pandemic trend for urgent ED visits was again significantly greater (difference of -0.024%) (Table 4). At pandemic onset, non-urgent ED visits experienced a significantly greater immediate decline (difference of -21.150%, $p = .002$). Subsequently, both urgent and non-urgent visits increased, with non-urgent visits displaying a faster relative recovery due to their steep pre-pandemic decline (difference of 0.018%, $p = .040$).

Table 4. Percentage differences in ITS model parameters for ED visits, with urgent visits as reference.

Age Group	Difference in trends in percentage of urgent and non-urgent ED visits per month during the pre-pandemic	Relative difference in immediate level change	Difference in trends in percentage of urgent and non-urgent ED visits per month during the pandemic
All Age Groups	-0.019% ($p < 0.001$)	-1.433% ($p = 0.846$)	-0.012% ($p = 0.196$)
0-4	-0.015% ($p < 0.001$)	14.450% ($p = 0.120$)	-0.028% ($p = 0.018$)
5-9	-0.017% ($p < 0.001$)	7.296% ($p = 0.394$)	-0.026% ($p = 0.018$)
10-14	-0.024% ($p < 0.001$)	-21.610% ($p = 0.002$)	0.010% ($p = 0.329$)
15-17	-0.024% ($p < 0.001$)	-21.150% ($p = 0.002$)	0.018% ($p = 0.040$)

DISCUSSION

Interpretation of Findings

This study examines trends in paediatric ED visits in Ontario before and during the COVID-19 pandemic, stratified by visit urgency and age. Consistent with national trends, urgent visits were increasing while non-urgent visits were declining prior to the pandemic (2, 3). Following pandemic onset, both types of visits declined sharply and subsequently returned to levels consistent with pre-pandemic trends by May

2023. Interestingly, while overall paediatric ED visit volumes declined substantially across all age groups at pandemic onset, younger children (ages 0 – 9), particularly those ages 0 – 4, experienced a sharper reduction in ED volumes and a faster recovery. Younger children also experienced larger declines in urgent visits, whereas older children experienced greater declines in non-urgent visits. Across most age groups, trends in urgent ED visits were more strongly affected by pandemic onset, but among adolescents aged 15–17 years, non-urgent visits demonstrated a faster rebound than urgent visits. These age-specific differences may reflect variations in health-seeking behaviours, the prevalence of

age-specific conditions, and access to alternative healthcare services. The immediate decline in ED visits at pandemic onset is likely attributable, in part, to parental avoidance of ED settings due to concerns about SARS-CoV-2 exposure (17). The more rapid recovery of urgent ED visits among younger children may be explained by their greater susceptibility to infectious illnesses and heightened parental concern prompting timely care-seeking for acute conditions (18). In contrast, the more pronounced decline in non-urgent visits among older children and adolescents may reflect deferral of lower-acuity concerns to alternative care modalities, including virtual care, which became more widely available during the pandemic, while visits for urgent conditions continued to present to EDs (19). Recovery patterns differed by age and acuity, with faster rebound in urgent visits among younger children and more variable patterns in adolescents. This pattern suggests differential recovery trends by visit acuity, potentially reflecting variations in care-seeking behaviour and healthcare access across age groups and visit types.

Comparison to Previous Studies

Our findings are consistent with prior studies. In a study across three Swiss paediatric EDs, the reduction in ED visits following pandemic onset was most pronounced among children aged 0–4 years, for both urgent and non-urgent visits (20, 21). Similarly, a study from a South Korean tertiary care centre reported an increase in lower-acuity visits during the pandemic, attributed to an increase in adolescent ED presentations alongside a decline in visits among infants (< 12 months) and young children (1–6 years) (22).

Strengths and Limitations

To our knowledge, this is one of the first Canadian studies to examine the long-term impact of the COVID-19 pandemic on paediatric ED visits, stratified by age and acuity. A large dataset covering all EDs across Ontario ensured strong statistical power and broad coverage. The ITS design with segmented negative binomial regression is a strong, appropriate, and effective method to assess the impact of the interruption in a real-world setting.

Some limitations warrant consideration of these findings. The administrative data may contain misclassification of triage acuity as CTAS scoring is clinician-dependent and data were aggregated from diverse healthcare centers across Ontario. This heterogeneity may be exacerbated during the pandemic, where up-triaging for respiratory symptoms may be performed. Moreover, ED avoidance cannot be distinguished from true reductions in disease incidence, and the observed trends likely reflect a convergence of both factors. For example, a decrease in asthma exacerbations during lockdown was

observed across Canada, but when masking mandates were lifted, asthma exacerbations rebounded (23). This suggests that during the pandemic, children were sick less and visited EDs less, contributing to the observed trends alongside avoidance. Consequently, results should be seen as a measure of total healthcare utilization rather than a measurement for the pediatric disease burden during the pandemic.

Clinical Implications

Study findings have important clinical implications for paediatric emergency care. The greater recovery in urgent ED visits amongst younger children suggests an increased reliance on EDs for high acuity care. This knowledge has implications for ED staffing and pediatric resource allocation for future crises. Furthermore, the rapid rebound in non-urgent visits among adolescents may be partially explained by an increase in mental health–related presentations, which disproportionately affect older adolescents (24). This highlights the need for improving

adolescent mental health supports, especially when risk factors such as social isolation and economic concerns caused by lockdowns are present (25). Overall, these findings underscore the need for targeted strategies to ensure timely access to appropriate services during future health system disruptions.

Research Implications

Our study represents the first Canadian study to explore the long-term impact of the pandemic on paediatric ED utilization across age groups and acuity levels. Future research should utilize ICD-10 codes, which provides a definitive clinical characterization of patient presentations, to determine reasons for those ED visits, validating our current explanation for patient health-seeking behaviours.

CONCLUSION

In this population-based study of paediatric ED utilization in Ontario, the COVID-19 pandemic was associated with an abrupt decline in both urgent and non-urgent ED visits, followed by a gradual recovery to pre-pandemic levels by May 2023. However, the patterns of these trends varied by visit acuity and age, with younger children experiencing sharper declines and faster recoveries, and adolescents showing distinct patterns in non-urgent ED use. These findings highlight the importance of considering age- and acuity-specific patterns when evaluating the impact of public health emergencies on paediatric emergency care.

Abbreviations

ED	Emergency Department
ITS	Interrupted Time Series

Declarations

Conflict of interest disclosure:

The authors report no conflict of interest.

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

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Author Contribution

CL performed the statistical analysis and was a major contributor in writing the manuscript. PW was a major contributor in writing the manuscript. All authors read and approved the final manuscript.

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Not applicable

Data Availability

NACRS Emergency Department Visits and Lengths of Stay by Province/Territory data were deposited into the Canadian Institute for Health Information (CIHI) database and are available at the following URL: <https://www.cihi.ca/en/access-data-and-reports/data-tables>

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Figures

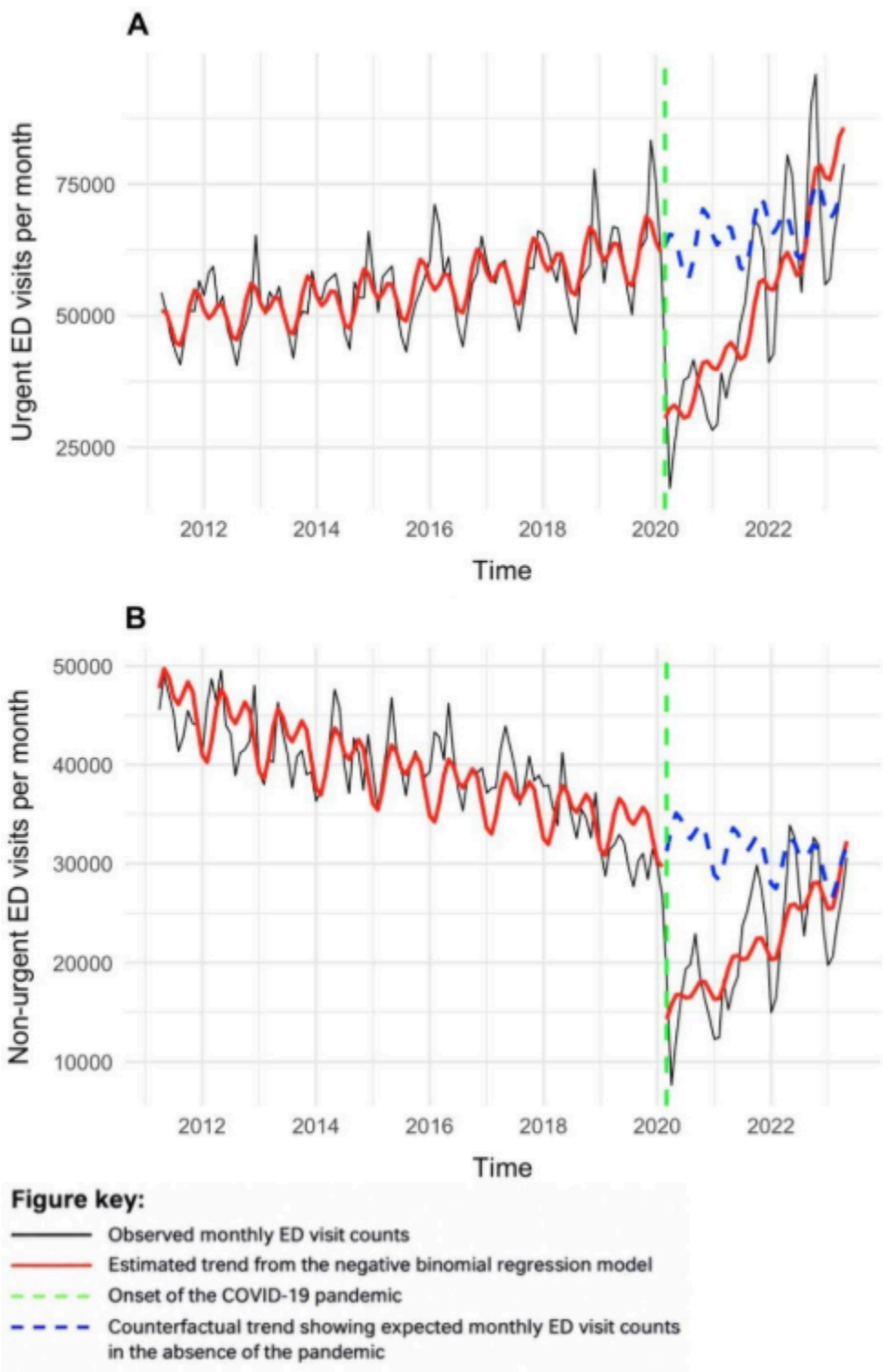


Figure 1

Monthly urgent (A) and non-urgent (B) paediatric ED visits before and during the pandemic. The intervention point corresponds to pandemic onset in March 2020.

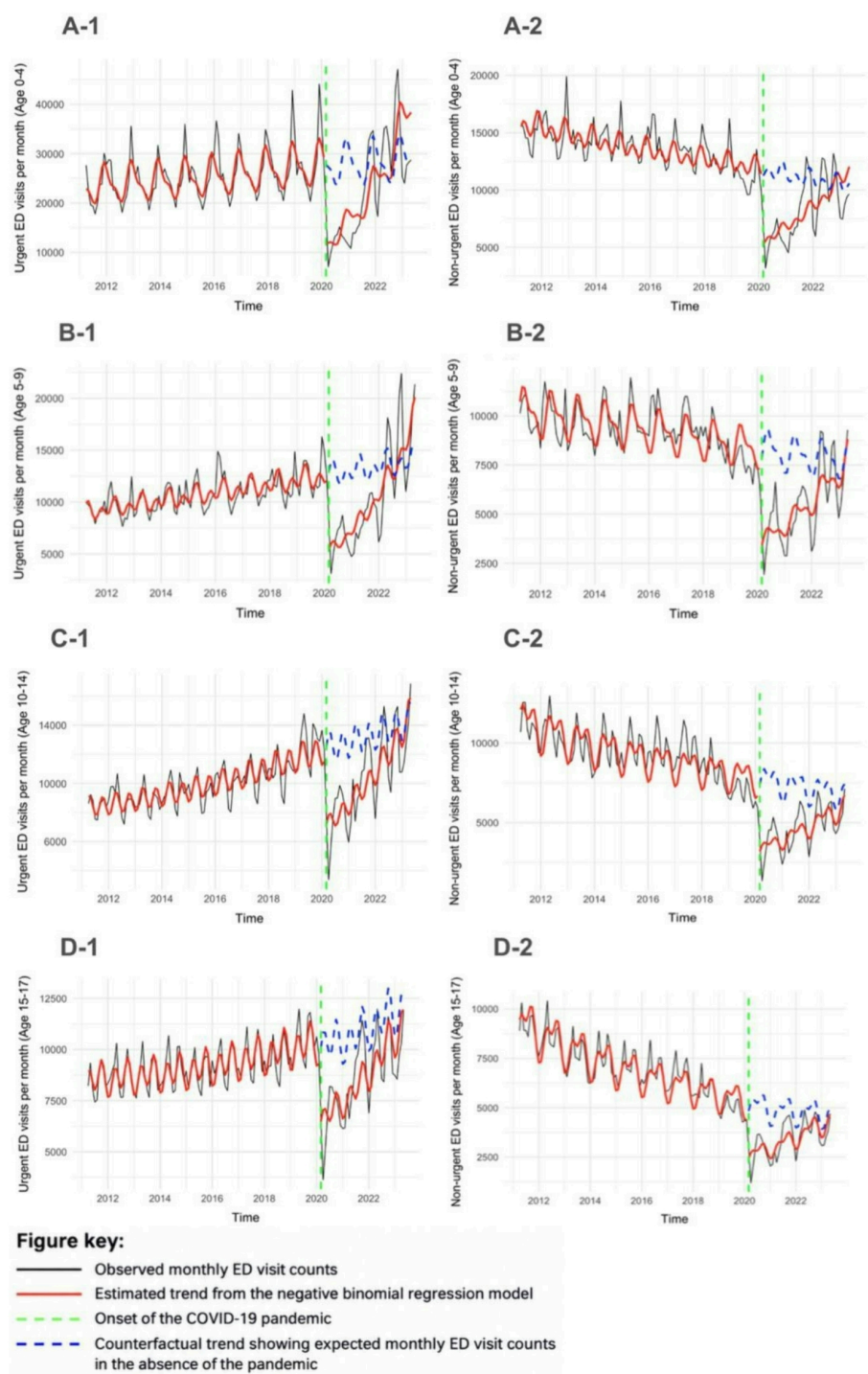


Figure 2

Monthly urgent and non-urgent paediatric ED visits before and during the pandemic, stratified by age.

The intervention point corresponds to pandemic onset in March 2020. Panels A-1 and A-2 display urgent and non-urgent ED visits, respectively, for children aged 0–4 years; panels B-1 and B-2 for ages 5–9 years; panels C-1 and C-2 for ages 10–14 years; and panels D-1 and D-2 for ages 15–17 years.

Supplementary Files

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