

Changes in emergency department use in British Columbia, Canada, during the first 3 years of the COVID-19 pandemic

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Abstract

Background: Previous studies have shown reductions in the volume of emergency department visits early in the COVID-19 pandemic, but few have evaluated the pandemic's impact over time or stratified analyses by reason for visits. We aimed to quantify such changes in British Columbia, Canada, cumulatively and during prominent nadirs, and by reason for visit, age and acuity.

Methods: We included data from the National Ambulatory Care Reporting System for 30 emergency departments across BC from January 2016 to December 2022. We fitted generalized additive models, accounting for seasonal and annual trends, to the monthly number of visits to estimate changes throughout

the pandemic, compared with the expected number of visits in the absence of the pandemic. We determined absolute and relative differences at various times during the study period, and cumulatively since the start of the pandemic until the overall volume of emergency department visits returned to expected levels.

Results: Over the first 16 months of the pandemic, the volume of emergency department visits was reduced by about 322 300 visits, or 15% (95% confidence interval 12%–18%), compared with the expected volume. A sharp drop in pediatric visits accounted for nearly one-third of the reduction. The timing of the return to baseline volume

of visits differed by subgroup. The largest and most sustained decreases were in respiratory-related emergency department visits, visits among children, visits among oldest adults and non-urgent visits. Later in the pandemic, we observed increased volumes of highest-urgency visits, visits among children and visits related to ear, nose and throat.

Interpretation: We have extended evidence that the impact of the COVID-19 pandemic and associated mitigation strategies on emergency department visits in Canada was substantial. Both our findings and methods are relevant in public health surveillance and capacity planning for emergency departments in pandemic and nonpandemic times.

Since the first case of COVID-19 was reported in British Columbia, Canada, on Jan. 28, 2020, 5 major pandemic waves of SARS-CoV-2 transmissions were seen in the province.¹ Mitigation strategies in BC included physical distancing, restrictions on public and private gatherings, temporary stay-at-home orders and closure of nonessential services, although the level of restrictions varied over time.^{2,3} These strategies precipitated changes in health services use.

Previous studies using data from early in the pandemic reported substantial reductions in emergency department visits for a range of health conditions, both internationally^{4–9} and within Canada.^{10–16} Reduced volumes of emergency department visits may have contributed to increases in morbidity and mortality rates for life-threatening conditions such as cardiovascular

conditions and cancers.^{17–19} In addition, previous studies noted large decreases in pediatric emergency department visits for a variety of conditions, suggesting that some age groups were disproportionately affected by the pandemic.^{10,13,14,20} Provisional data from Canadian emergency departments also suggested changes in emergency department use by acuity score, which represents the level of urgency with which medical attention is necessary.^{10,13,14,21} Differences in acuity may provide insights on the severity of the impact of the pandemic and the mitigation strategies on emergency department visits.

Although changes in emergency department use in BC have been assessed among children during the first few months of the pandemic,¹⁴ they have not been evaluated for the larger BC population or cumulatively throughout the entire pandemic

period. In addition, few studies have evaluated trends by reason for visit, or used innovative statistical modelling methods to quantify the impacts. Evaluation of the effects of the pandemic and associated measures can provide a historical account and inform health care service planning for both postpandemic recovery and mitigation of potential consequences of restrictions for future pandemics. Insights from this study can also trigger further research on the drivers of the changes and inform strategies for emergency care.

We sought to assess the impact of the COVID-19 pandemic and associated measures on emergency department visits in BC during the first 3 years of the pandemic and at prominent nadirs, and to quantify the changes in visits by reason for visit, age group and acuity.

Methods

Study setting

We conducted a study of people who visited an emergency department in BC that was included in our study between January 2016 and December 2022. British Columbia is the westernmost province of Canada, with an estimated population of 5.2 million in 2021.²² The province is divided into 5 health regions, with more than 60% of the population concentrated in Fraser and Vancouver Coastal Health regions in the Lower Mainland.

Data sources

We extracted deidentified emergency department visit data from the Ministry of Health (MOH) National Ambulatory Care Reporting System (NACRS) database via the BC COVID-19 Cohort.²³ The BC COVID-19 Cohort was established as a public health surveillance platform that integrates several administrative data sets under the BC Centre for Disease Control's public health mandate (Appendix 1, available at www.cmaj.ca/lookup/doi/10.1503/cmaj.221516/tab-related-content). Studies using data from the BC COVID-19 Cohort have been published previously.^{24,25}

The MOH NACRS database includes emergency department visits from 30 hospitals across BC, which accounts for about 70% of all visits in the province. The coverage differs geographically, with 100% of visits included for the Fraser and Vancouver Coastal Health regions, but around 20%, 30% and 75% of visits included for the Northern, Interior and Vancouver Island Health regions, respectively. Hospitals included in the database tend to have larger volumes of visits and are located in more populous areas. We excluded visits from patients who resided outside of the province (4.7%).

Subgroup definition

We grouped the reasons for emergency department visits into 14 categories using the patients' presenting complaints, coded with the Canadian Emergency Department Information System (CEDIS) Presenting Complaint List, version 5.1 (Appendix 1, eTable 1). The list captures patient symptoms and reasons or problems for seeking emergency medical care.^{26,27} Another commonly used metric to describe patient conditions is the discharge diagnosis made by health care providers, captured in

codes from the Canadian version of the *International Classification of Diseases, 10th Revision* (ICD-10-CA). We chose to use CEDIS rather than the discharge diagnosis because it is a mandatory field for NACRS reporting, so it has complete coverage for all visits included in the study. In contrast, the completeness of discharge diagnosis codes differs geographically in BC, ranging from 0% to 95%. Thus, presenting complaints recorded in CEDIS are often used for public health surveillance, and are more inclusive of smaller emergency departments and of more rural and remote locations of the province. Moreover, a comparable gold standard list of ICD diagnostic code groupings does not exist to enable a similar analysis of both all visits and types of visits. Presenting complaints also form the basis for triage and support many planning activities of health care services provided at emergency departments. The CEDIS system has been found to have good inter-rater reliability in BC and Ontario.^{28,29}

To incorporate a public health perspective, we made some modifications to the CEDIS groupings. Notably, we created a new injury category, grouping together all codes from the environmental and trauma categories and adding injury-specific codes from other categories. We also reported separately on sexual assault by removing it from the obstetrics and gynecology category. More details can be found in Appendix 1, eTable 1.

To assess the acuity of emergency department visits, we used the Canadian Triage and Acuity Scale (CTAS), a validated triage system in Canada that ranks patient care by severity of illness on a scale of 1 (resuscitation) to 5 (nonurgent).³⁰ The CTAS scores were assigned by triage nurses after initial assessment of the patient's presentation.

In addition to creating subgroups according to reason for visit and acuity, we grouped emergency department visits by 10-year age group, and by health region of residence or the attending hospital, if residence information was unavailable (0.3%).

Statistical analysis

We used generalized additive models³¹ to assess the impact of the pandemic on the overall number of visits and constructed separate models for reason for visit, age group, acuity and health region. We also explored respiratory visits by age group as a sub-analysis because pandemic measures may have affected this category, in particular.

We used generalized additive models because they allow for estimation of multiple nonlinear seasonal and annual trends. They also make fewer assumptions on subsequent rates compared with other time-series methods that are designed to estimate counterfactuals such as interrupted time-series. We modelled the number of emergency department visits as a negative binomial, given overdispersion after adjusting for seasonal and annual trends. We considered estimates to be statistically significant if the corresponding 95% confidence intervals (CIs) did not cross the null. More details on statistical modelling are included in Appendix 1.

In addition to visual illustration of the monthly time-series of emergency department visits modelled with and without the effect of the pandemic, we also conducted 3 analyses, stratified by reason for visit, age group, acuity and health region. One analysis

considered the timing of the return to the prepandemic baseline volume of emergency department visits, defined as the first month after February 2020 when the 95% CIs of the estimated number of visits with and without impact of the pandemic overlapped for at least 3 consecutive months. A second analysis determined the difference (absolute and relative) between emergency department visits modelled with and without the effect of the pandemic for the months of April and December 2020. These 2 months were the 2 major nadirs in overall emergency department visits, when the lowest number of visits were documented during the pandemic. Our final analysis was the cumulative difference (absolute and relative) between emergency department visits modelled with and without the effect of the pandemic from February 2020 until the time of overall return to prepandemic baseline, although the exact timing may have differed by subgroup. The first case of COVID-19 was reported in January 2020, and a substantial reduction in the volume of emergency department visits was observed as of February 2020.

We also determined the monthly rates of hospital admissions among emergency department visits for all reasons to facilitate the interpretation of changes in acuity and severity of the emergency department visits.

We performed all analyses using R version 4.1.1. We rounded absolute numbers greater than 1000 to the nearest 100 and rounded those between 10 and 1000 to the nearest 10. We rounded all percentages to the nearest 1%.

Ethics approval

This study was conducted as part of the BC Centre for Disease Control's population health surveillance mandate, specifically to support monitoring and assessment of the consequences of the COVID-19 pandemic; ethics approval was not required.

Results

We included a total of 10 704 800 emergency department visits, with a monthly average of 127 400 visits over the study period. Visits for gastrointestinal and genitourinary conditions, injuries, cardiovascular and orthopedics conditions contributed the largest proportions of total visits (Figure 1). The number of visits for all conditions had a seasonal pattern, generally peaking between May and July, and followed an increasing annual trend (Figure 2), which likely reflects, at least in part, population growth in BC. Two notable nadirs occurred in April and December 2020; overall trends in emergency department visits returned to prepandemic baseline in May 2021.

With the seasonal and annual trends accounted for in the model, the April and December 2020 nadirs saw 55 900 (95% CI 46 900–64 100) and 24 800 (95% CI 18 000–31 200) fewer visits overall, respectively (Figure 2 and Table 1). This represents a 42% (95% CI 36%–48%) and 19% (95% CI 14%–23%) reduction, respectively. Cumulatively, during the 16-month period between February 2020 and May 2021, 322 300 (95% CI 244 000–404 900) fewer visits occurred. Trends were similar across regions, with the exception of Vancouver Island Health region, where visit volumes were consistently higher than expected from July 2020 to the end of the study period (Appendix 1, eFigure 1 and eTable 4).

When evaluated by reason for visit, we observed the largest reductions among respiratory visits, with a 35% (95% CI 32%–37%) cumulative reduction (Figure 2 and Table 1). The most prominent relative reduction was seen during the second nadir, with a 48% (95% CI 44%–51%) drop in December 2020, which would normally be the peak respiratory season. We observed statistically significant reductions in at least 1 of the nadirs and

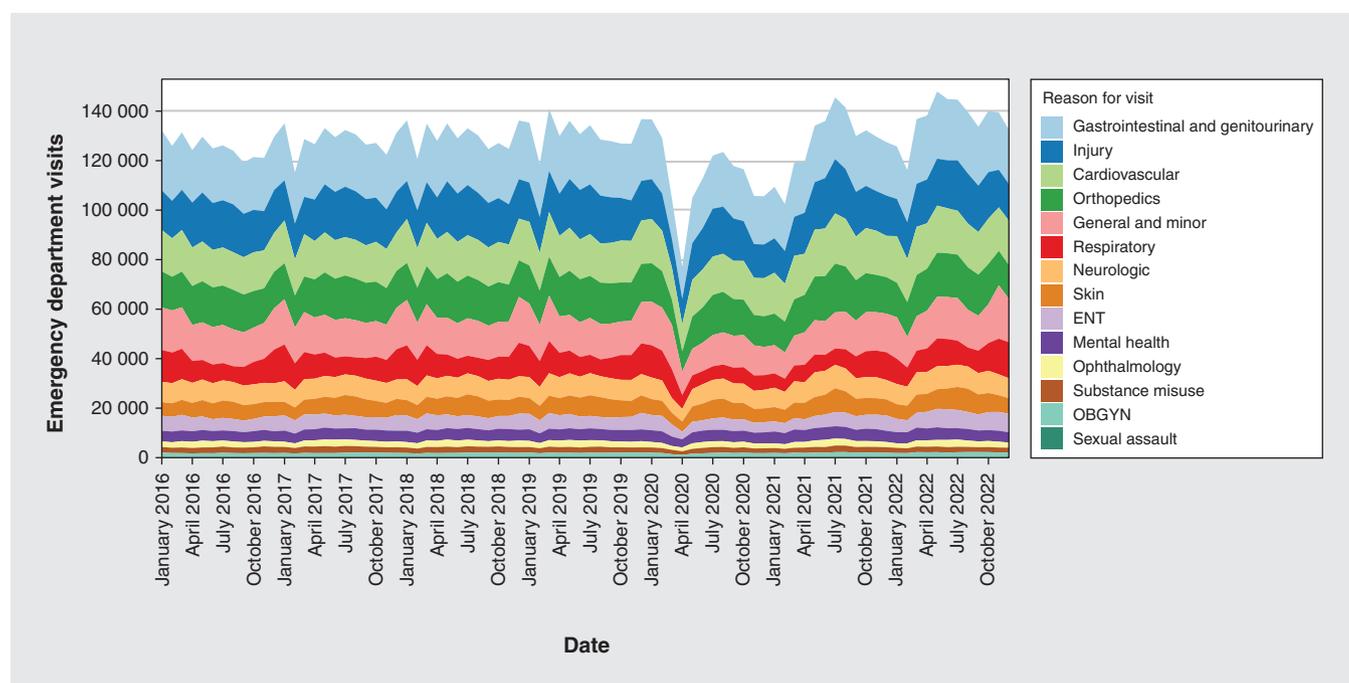


Figure 1: Number of monthly emergency department visits in British Columbia from January 2016 to December 2022, stratified by reason for visit. Note: ENT = ears, nose and throat; OBGYN = obstetrics and gynecology.

cumulatively for all reasons for an emergency department visit. Cumulative visits for mental health and substance misuse saw the smallest relative reduction. For most visit reasons, visits returned to baseline volume in 2021, but this occurred in May 2020 for mental health, substance misuse, obstetrics and gynecology and sexual assault visits (Table 2). Visits for cardiovascular and neurologic conditions temporarily surpassed

expected levels shortly after returning to prepandemic baseline, while visits for ears, nose and throat (ENT) and for general and minor reasons maintained extended periods of higher-than-expected levels later on in 2022 (Figure 2).

The largest reductions by age group were among children younger than 10 years (Figure 3 and Appendix 1, eTable 2). Cumulatively, 93 600 (95% CI 85 200–101 900) fewer visits

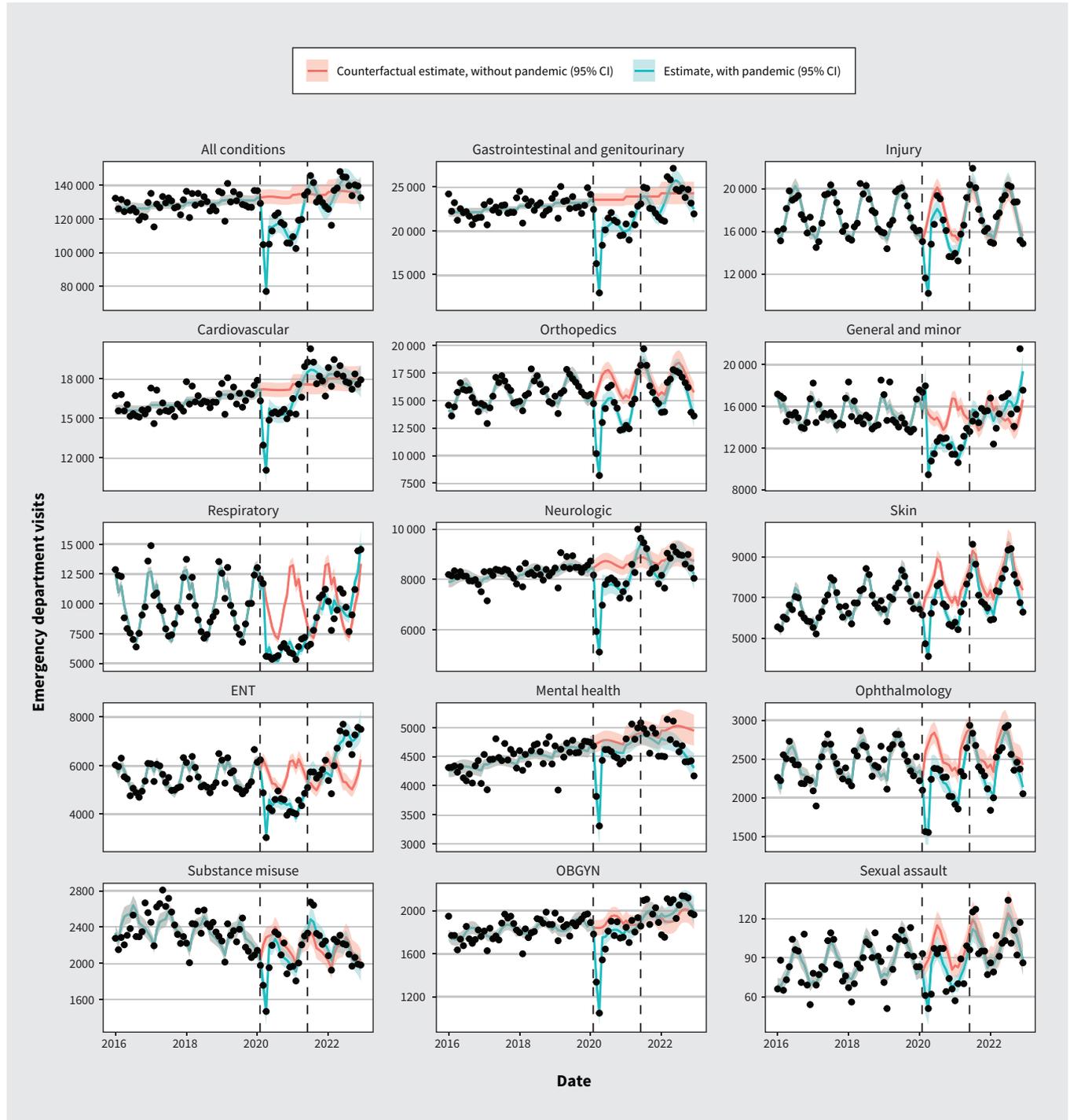


Figure 2: Number of estimated visits by reason for visit. Blue and red lines and areas show estimates and 95% confidence intervals (CIs) with and without the effect of the pandemic, respectively. Black points represent observed monthly emergency department visits. The first vertical dashed line indicates the first report of the first COVID-19 case in British Columbia (Jan. 28, 2020) and the second indicates the overall return to baseline levels of emergency department visits (May 2021). Y-axes vary by reason for visit. Note: ENT = ears, nose and throat, OBGYN = obstetrics and gynecology.

occurred among children younger than 10 years, accounting for nearly one-third of the 322 300 total visits that did not take place. The relative reduction by age group ranged from 42% among children younger than 10 years to 8% among adults aged 60–69 years, particularly for respiratory visits during the 2020/21 winter season (Appendix 1, eFigure 2 and eTable 5). Visits for adults aged 30–39 and 50–79 years briefly returned to pre-pandemic baseline volume in May 2020 before dropping again; visits for all other age groups returned to baseline between February and July 2021 (Table 2).

Emergency department visits with the highest acuity (resuscitation) were significantly reduced only during the April nadir (Figure 4 and Appendix 1, eTable 4), while visits of all other

acuity levels were significantly reduced during the 16-month period, ranging from 13% to 19% fewer visits cumulatively. The volume of visits triaged to CTAS resuscitation was higher than expected from May 2020 to the end of the study period, while the volume of visits triaged to other CTAS categories remained below expected from the start of the pandemic until May 2021. Rates of hospital admission after emergency department visits increased sharply in March 2020 and stayed elevated until around May 2021 (Appendix 1, eFigure 3).

Total emergency department visits increased substantially in the summer of 2021, particularly among visits for cardiovascular and neurologic conditions, as well as for substance misuse (Figure 2); visits among adults aged 20–69 years (Figure 3);

Table 1: Absolute and relative difference of emergency department visits with and without pandemic effect in model in April 2020 and December 2020, and cumulative for the period between February 2020 and May 2021 by reason for visit

Reason for visit	April 2020		December 2020		Cumulative (February 2020–May 2021)*	
	Absolute (95% CI)	Relative, % (95% CI)	Absolute (95% CI)	Relative, % (95% CI)	Absolute (95% CI)	Relative, % (95% CI)
All conditions	–55 900 (–64 100 to –46 900)	–42 (–48 to –36)	–24 800 (–31 200 to –18 000)	–19 (–23 to –14)	–322 300 (–404 900 to –244 000)	–15 (–18 to –12)
Cardiovascular	–6100 (–7300 to –4900)	–36 (–42 to –29)	–1600 (–2500 to –780)	–9 (–14 to –4)	–26 300 (–36 700 to –16 100)	–10 (–13 to –6)
ENT	–2900 (–3400 to –2500)	–49 (–54 to –42)	–1700 (–2100 to –1400)	–28 (–33 to –23)	–20 200 (–23 800 to –16 700)	–22 (–26 to –19)
Gastrointestinal and genitourinary	–10 600 (–12 100 to –9100)	–45 (–51 to –39)	–3600 (–4800 to –2400)	–15 (–20 to –11)	–56 600 (–71 400 to –41 400)	–15 (–18 to –11)
General and minor	–5800 (–7000 to –4600)	–38 (–45 to –31)	–4200 (–5000 to –3300)	–25 (–29 to –20)	–44 100 (–53 800 to –34 900)	–18 (–21 to –15)
Injury†	–7100 (–8300 to –5800)	–41 (–47 to –34)	–1600 (–2300 to –800)	–10 (–15 to –5)	–30 000 (–40 900 to –19 300)	–11 (–14 to –7)
Mental health	–1400 (–1800 to –1000)	–30 (–37 to –22)	–140 (–370 to 60)	–3 (–8 to 2)	–3900 (–6900 to –1300)	–5 (–9 to –2)
Neurologic	–3500 (–4100 to –2900)	–41 (–47 to –34)	–940 (–1400 to –480)	–11 (–16 to –6)	–15 200 (–20 400 to –9500)	–11 (–15 to –7)
OBGYN	–790 (–930 to –650)	–43 (–49 to –36)	–100 (–200 to 0)	–5 (–10 to –1)	–2500 (–3800 to –1300)	–8 (–12 to –4)
Ophthalmology	–1200 (–1400 to –940)	–43 (–49 to –36)	–360 (–490 to –230)	–15 (–21 to –10)	–6600 (–8300 to –4900)	–16 (–20 to –13)
Orthopedics	–8300 (–9500 to –7300)	–50 (–55 to –45)	–2700 (–3500 to –1900)	–17 (–22 to –13)	–42 400 (–52 100 to –32 700)	–16 (–19 to –12)
Respiratory	–4700 (–5400 to –3800)	–45 (–51 to –39)	–6300 (–6900 to –5700)	–48 (–51 to –44)	–56 400 (–62 200 to –50 600)	–35 (–37 to –32)
Sexual assault	–40 (–50 to –20)	–42 (–58 to –23)	–10 (–20 to –10)	–17 (–27 to –7)	–250 (–370 to –120)	–16 (–23 to –9)
Skin	–3200 (–3700 to –2600)	–44 (–50 to –37)	–1100 (–1500 to –790)	–17 (–21 to –12)	–19 400 (–23 900 to –14 800)	–16 (–20 to –13)
Substance misuse	–810 (–1000 to –620)	–36 (–43 to –28)	–130 (–230 to –20)	–6 (–11 to –1)	–2500 (–4000 to –1100)	–7 (–11 to –3)

Note: CI = confidence interval; ENT = ears, nose and throat; OBGYN = obstetrics and gynecology.

*The period from the start of the pandemic until the overall volume of emergency department visits returned to expected (baseline) levels.

†The injury category groups together all codes from the environmental and trauma categories and injury-specific codes from other categories. See details in Appendix 1, eTable 1, available at www.cmaj.ca/lookup/doi/10.1503/cmaj.221516/tab-related-content.

and the most urgent visits (Figure 4). This increase was likely related to the unprecedented extreme heat event in June 2021.^{32,33} In addition, paramedic-attended opioid overdose events reached the highest rate ever recorded around the same time.³⁴

Visits for gastrointestinal and genitourinary conditions increased sharply in February–April 2022, driven by presenting complaints of abdominal pain and nausea or vomiting (data not shown). This observation coincided with an increase in norovirus load in wastewater (N. Prystajecy, Public Health Laboratories, BCCDC, Vancouver: personal communication, 2023), as well as with the norovirus outbreaks reported during the same time.³⁵

For ENT visits, the return to baseline was relatively brief, and was followed by a surge in visits from the end of 2021 through 2022, surpassing the expected range. The increase was driven by visits for sore throats and earaches, especially in the pediatric population (data not shown).

Interpretation

We observed time-varying decreases in the overall volume of emergency department visits for the first 16 months of the COVID-19 pandemic in BC. The timing of when visit volumes returned to prepandemic baseline varied by reason for visit, age

group and acuity. The largest and most sustained changes were observed among children, visits for respiratory-related conditions and nonurgent visits.

The estimated reduction of total visits during the nadir in April 2020 (42%) in this study was comparable to previous studies assessing changes in emergency department visits early in the pandemic from both Canadian (35%–37%)^{12,15,21} and international (42%–64%)^{5,36,37} jurisdictions. Previous studies also found the largest and most sustained reductions among children^{8,13,14,37,38} and visits of lower acuity.^{10,13,14,20,21} A larger reduction in visits with lower acuity was also reflected in the elevated rates of hospital admission after emergency department visits shown in this study.

Changes in health care-seeking behaviour may explain some of the changes in emergency department visits. People may have avoided visiting emergency departments given their perceived risk of acquiring SARS-CoV-2, similarly observed in previous SARS outbreaks.^{39–43} They may have also had concerns that the health care system was overwhelmed.⁴⁴ The shift to telemedicine early in the pandemic may have also contributed to the change in patterns of emergency department visits.^{45,46}

Some of the changes may also be explained by changes in disease incidence. For example, the dramatic reduction in

Table 2: Timing of returning to prepandemic baseline volume of emergency department visits by reason for visit, age group and acuity

Variable	Month back to baseline (after February 2020)	Time to return to prepandemic baseline volume after February 2020, mo
All visits	May 2021	16
Reason for visit		
Mental health, substance misuse, OBGYN, sexual assault	May 2020	4
Cardiovascular	January 2021	12
Injury, neurologic	February 2021	13
Orthopedics, skin	April 2021	15
Gastrointestinal and genitourinary, ophthalmology	May 2021	16
ENT, general and minor, respiratory	June 2021	17
Age group, yr		
30–39, 50–59, 60–69, 70–79	May 2020	4
40–49	February 2021	13
20–29, 80–89	April 2021	15
10–19	May 2021	16
≥ 90	June 2021	17
< 10	July 2021	18
Acuity (CTAS score)		
Resuscitation (1)	May 2020	4
Emergent (2), urgent (3), less urgent (4), nonurgent (5)	May 2021	16

Note: CTAS = Canadian Triage and Acuity Scale; ENT = ears, nose and throat; OBGYN = obstetrics and gynecology.

*The injury category groups together all codes from the environmental and trauma categories and injury-specific codes from other categories. See details in Appendix 1, eTable 1, available at www.cmaj.ca/lookup/doi/10.1503/cmaj.221516/tab-related-content.

respiratory and ENT visits was likely related to decreases in non-COVID-19-related respiratory illnesses as a result of pandemic response measures.⁴⁷ The relaxation of these measures and the resurgence of non-COVID-19 respiratory infections, such as respiratory syncytial virus, in the pediatric population may be the reason behind the return to the baseline level. This explanation is corroborated by the 2022 surge in visits among children younger than 10 years and in visits for sore throats and earaches, common symptoms of respiratory infections among children. In fall 2022, BC also saw early influenza activity, with higher rates of test positivity in the pediatric population than is typical.⁴⁸

Emergency department visits for mental health and substance misuse decreased and returned to baseline within 4 months of the pandemic, resulting in the smallest relative reduction over the

16-month period compared with visits for other reasons. These trends are consistent with data from studies in the United States.⁴⁹⁻⁵¹ Triangulation of emergency department data for 2019-2021 with other administrative data sources for mental health-related services in BC highlighted the considerable impact of the pandemic on the mental health of children and youth in particular.⁵² The worsening of the ongoing toxic drug crisis in BC,³⁴ as well as increased use of regulated substances such as alcohol and cannabis during the pandemic⁵³⁻⁵⁵ may have also contributed to the observed trends in substance misuse.

Limitations

We did not investigate reasons for the observed trends; we can only speculate on the driving factors. Our study also focused solely on emergency department visits; these results do not reflect the



Figure 3: Number of estimated visits by age group. Blue and red lines and areas show estimates and 95% confidence intervals (CIs) with and without the effect of the pandemic, respectively. Black points represent observed monthly emergency department visits. The first vertical dashed line indicates report of the first COVID-19 case in British Columbia (Jan. 28, 2020) and the second indicates the overall return to baseline levels of emergency department visits (May 2021). Y-axes vary by patient age group.

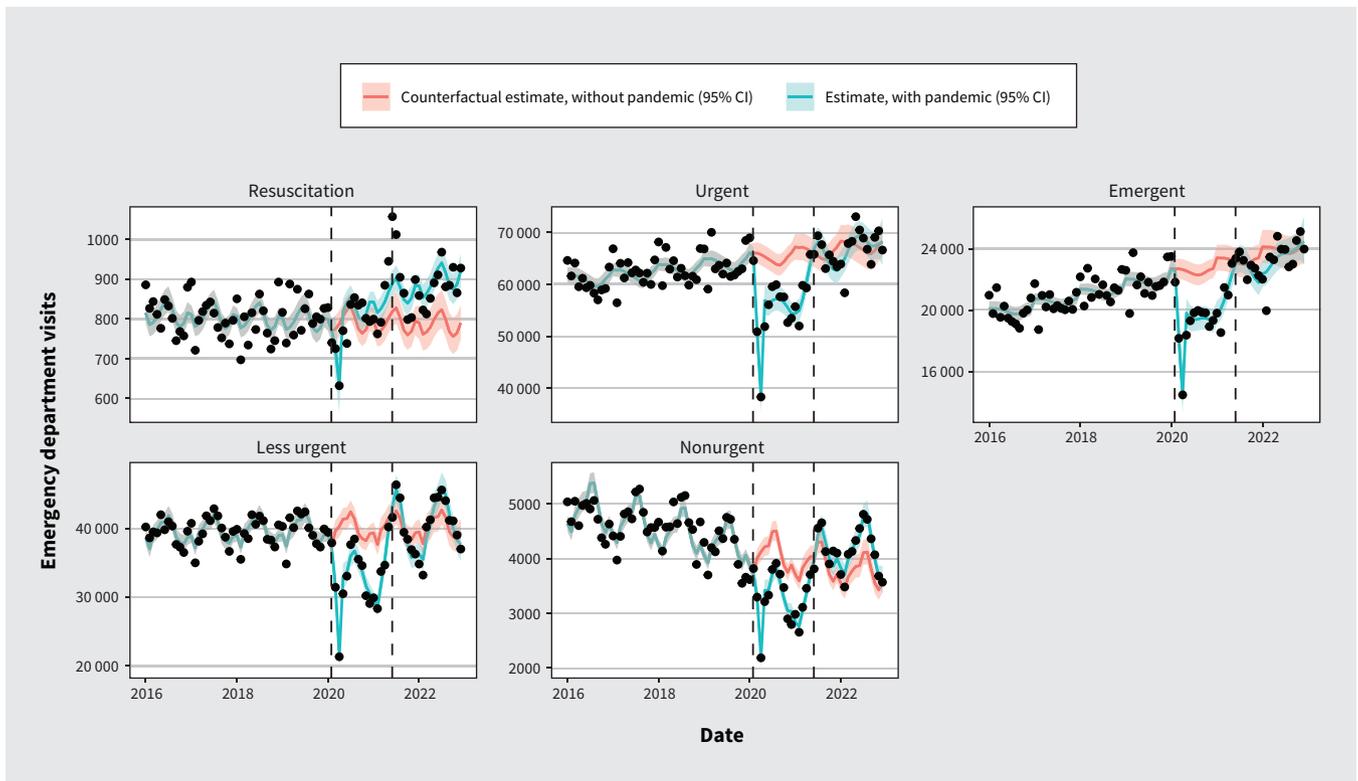


Figure 4: Number of estimated visits by acuity level (Canadian Triage and Acuity Scale). Blue and red lines and areas show estimates and 95% confidence intervals (CIs) with and without the effect of the pandemic, respectively. Black points represent observed monthly emergency department visits. The first vertical dashed line indicates report of the first COVID-19 case in British Columbia (Jan. 28, 2020) and the second indicates the overall return to baseline levels of emergency department visits (May 2021). Y-axes vary by visit urgency.

overall change in health care use, and we cannot determine if the decreases meant patients were untreated or if they sought other forms of care, although reductions in physician visits and ambulance dispatches were also reported in BC early in the pandemic.^{56,57} In addition, we did not capture data from emergency departments that did not participate in regular reporting to NACRS, which are generally in communities with smaller populations. Trends observed in this study may not be representative of these communities. Codes in CEDIS are not clinical diagnostic codes and are based on assessment at triage. Coding practices for CEDIS and CTAS may differ regionally across BC. This is an expected and common limitation of routine administrative data sources. Since the objective of our study was to assess trends, and coding practices are unlikely to have changed during the study period, our results likely reflect the true trends in reason for visits and acuity.

Conclusion

We quantified the changes in overall volume of emergency department visits in BC for the first 3 years of the pandemic. The largest and most sustained decreases were observed for respiratory-related visits, visits among children and nonurgent visits. The timing with which emergency department use returned to baseline varied by reason for visit and type of patient. More studies on the drivers of these trends will not only aid in better planning of emergency department capacity for future public health emergencies, but can also inform strategies to help the public make decisions about seeking emergency

care. The statistical modelling approach can be further developed into surveillance tools to monitor health care services use and plan for surge capacity.

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