

A comparative analysis of pediatric mental health-related emergency department utilization in Montréal, Canada before and during the COVID-19 pandemic

Gabrielle Beaudry¹, BA, Olivier Drouin^{2,3,4,5}, MD MSc MPH, Jocelyn Gravel^{2,3,6}, MD MSc, Anna Smyrnova², PhD, Andreas Bender⁷, PhD, Massimiliano Orri⁸, PhD, Marie-Claude Geoffroy^{8,9}, PhD, Nicholas Chadi^{2,3,10}, MD MPH

Affiliations:

¹Department of Psychiatry, University of Oxford, Oxford (UK)

²Sainte-Justine Hospital Research Center, Montréal, Québec (Canada)

³Department of Pediatrics, Université de Montréal, Montréal, Québec (Canada)

⁴Division of General Pediatrics, Sainte-Justine University Hospital Centre, Montréal, Québec (Canada)

⁵Department of Social and Preventive Medicine, School of Public Health, Université de Montréal, Montréal, Québec (Canada)

⁶Division of Pediatric Emergency Medicine, Sainte-Justine University Hospital Centre, Montréal, Québec (Canada)

⁷Department of Statistics, LMU Munich, Munich (Germany)

⁸McGill Group for Suicide Studies, Douglas Mental Health University Institute, Department of Psychiatry, McGill University, Montréal, Québec (Canada)

⁹Department of Educational and Counselling Psychology, McGill University, Montréal, Québec (Canada)

¹⁰Division of Adolescent Medicine, Sainte-Justine University Hospital Centre, Montréal, Québec (Canada)

Correspondence: Nicholas Chadi, MD MPH, Division of Adolescent Medicine, Department of Pediatrics, Sainte-Justine University Hospital Centre, 3175 Ch de la Cote Ste-Catherine, Montréal, QC, H1T 3C5, email: Nicholas.chadi@umontreal.ca

Word count: 3000

ABSTRACT

Background: Reports on longitudinal trends in mental health–related (MHR) emergency department (ED) utilization spanning the pre- and post-pandemic periods are lacking, along with evidence comparing healthcare services utilization by sociodemographic subgroups. The aim of this study was to evaluate COVID-19–associated changes in MHR ED utilization among youth overall and by age, sex, and socioeconomic status (SES).

Methods: This retrospective cross-sectional study analyzed MHR ED utilization before and during the COVID-19 pandemic at a large urban pediatric tertiary care hospital in Montréal, Canada. All ED visits for children (5–11 years) and adolescents (12–17 years) between April 1, 2016 and November 30, 2021 were included. The main outcome was the monthly count of MHR ED visits. Pre-pandemic and pandemic periods were compared using an interrupted time series design. The effect of seasonality (in months), age (in years), sex (male or female), and SES (low, average, high) were compared using a generalized additive model.

Results: There were a total of 437,147 ED visits (204,215 unique patients) during the five-year study period of which 9,748 (5.8%) were MHR visits (7,686 unique patients). We observed an increase of 69% (95% CI, +53% to +85%; $p = .001$) in the mean monthly count of MHR ED visits during the pandemic period, which remained significant after adjusting for seasonality (44% increase, 95% CI, +38% to +51%; $p = .001$). The chance of presenting for a MHR ED visit increased non-linearly with age. There were increased odds of presenting for a MHR ED visit among girls between the pre-pandemic and pandemic periods (OR 1.42, 95% CI 1.29–1.56). No difference by SES group during and before the COVID-19 pandemic was found (OR 1.01, 95% CI 0.89–1.15 [low]; OR 1.09, 95% CI 0.96–1.25 [high]).

Conclusions: Our study shows important increases in MHR ED utilization among youth, and especially among girls, during the first 20 months of the COVID-19 pandemic, highlighting the need for sustained, targeted and scalable mental health resources to support youth mental health during the current and future crises.

BACKGROUND

Since COVID-19 was declared a global pandemic,(1) public health measures implemented to reduce transmission of the virus have led to considerable changes in the delivery of pediatric healthcare services.(2) Delivery modes, such as telemedicine, rapidly gained importance,(3, 4) while utilization of most in-person services plummeted in the first months of the pandemic.(5) Large fluctuations in pediatric emergency department (ED) utilization have been observed.(6-17) Pediatric EDs are integral to the assessment, treatment and coordination of care for children and adolescents, and often serve as a safety net for vulnerable and underserved patients.(18) Increasingly, EDs also play a pivotal role in pediatric mental health emergencies, as exemplified by the rising pre-pandemic trends in mental health-related (MHR) ED visits documented in the last decade.(19, 20)

Reported number and proportion of MHR ED visits have not consistently followed the pattern of overall pediatric ED visits following the pandemic onset. While both MHR and overall ED visits first decreased during 2020,(7-12, 14-17, 21-24) some studies have reported increased MHR ED utilization during 2021 and early 2022.(13, 25) During this time, overall pediatric ED utilization has remained lower than pre-COVID-19 levels.(6, 25)

So far, the bulk of the evidence regarding changes in pediatric MHR ED utilization has originated from the United States, thereby limiting the generalisability of findings to other countries. Potential regional and national differences could stem from varying COVID-19 epidemiology, public health responses, healthcare systems, socioeconomic and sociocultural factors, and availability of mental health services.(26) Moreover, it remains unclear whether MHR ED utilization has differed across pediatric subpopulations. To date, only two studies have examined sociodemographic-specific differences — notably, related to age, sex and socioeconomic status (SES).(13, 25) The first was conducted in two large pediatric centers in New South Wales, Australia, and found increased MHR ED utilization among youth between June 2020 and February 2021, with higher increases among girls and children from socioeconomically advantaged areas.(13) The second study, which analyzed data from the National Syndromic Surveillance Program in the US, showed that adolescent girls aged 12–17 years accounted for the largest increases in both the number and proportion of MHR ED visits seen in 2020, 2021 and January 2022 when compared to 2019.(25) Additional research is required to prevent further exacerbation of intersectional inequalities in youth mental health,(27) and to inform effective service planning and resource allocation in pediatric emergency care.

In this study, we aimed to identify changes in MHR ED utilization before and during the COVID-19 pandemic in Montréal, Canada. We further sought to determine whether COVID-19 showed differential associations by sociodemographic group, with respect to age, sex, and SES.

METHODS

Study design, setting and population

For this retrospective cross-sectional study, we used an interrupted time series (ITS) design to compare MHR ED utilization before and during COVID-19 at the *Centre hospitalier universitaire* (CHU) Sainte-Justine. The CHU Sainte-Justine is a high-volume tertiary pediatric university hospital located in Montréal (Québec), Canada. The study population was comprised of all ED visits for children (5–11 years) and adolescents (12–17 years) between April 1, 2016, and November 30, 2021. We excluded ED visits for younger children (<5 years) as psychiatric consultation or treatment is uncommon in this age group.(19) The primary cohort was defined as all MHR ED visits with complete patient information. Visits for which patients left the hospital prior to receiving care were excluded due to lack of diagnosis. Ethical approval was obtained from the CHU Sainte-Justine Research Ethics Committee (Protocol ID: MP-21-2021-2930). All patient data were deidentified; thus, informed consent was not required. We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.(28)

Outcomes and variables

Exposure

The main exposure was a dummy variable coding the pre-pandemic (0) and the pandemic period (1). We defined the start of the pandemic period as March 1, 2020, consistent with the initial implementation of COVID-19–related public health measures in the province of Québec.(29) Thus, the pre-pandemic period spanned from April 1, 2016, to February 29, 2020, whereas the pandemic period spanned from March 1, 2020 to November 30, 2021.

Outcomes

The outcomes of the ITS analysis included the monthly count of MHR ED visits stratified into the pre-pandemic and pandemic periods. The outcome for the generalized additive model (GAM) was the type of ED visits, being MHR visits or non-MHR visits.

Sociodemographic characteristics

We employed a computer query tool (B-Care) to interrogate various hospital administrative databases. We focused on a patient-level ED database that includes demographic (sex, age and 6-digit postal code) and clinical (primary discharge diagnosis) information. The primary discharge diagnosis — recorded by the treating physicians based on a local list of 658 diagnoses — was used to determine the type of ED visits. We report the list of included MHR ED diagnoses in eTable 1.

Patients' sex assigned at birth was coded as male or female. Patients' age at diagnosis was considered both as a continuous and as a dichotomous variable (5–11 years vs 12–17 years). We selected an age cut-off at 12 years to reflect the difference between primary (elementary school) and secondary (middle and high school) education, as public health measures have differed across levels of education in Québec. SES was determined by linking the patients' postal code at the time of diagnosis with Statistics Canada's Postal Code Conversion File, thus allowing us to identify the relevant dissemination area based on the most recent Canadian Census (from 2016). We then linked this area-level information to Pampalon's material deprivation index, which combines measures of income, employment, and education. According to this index, SES is categorized into quintiles from Q1 (least materially deprived) to Q5 (most materially deprived).⁽³⁰⁾ Based on previous literature, we combined the two lowest and the two highest

quintiles to create three distinct material deprivation profiles: most privileged (Q1–Q2), average (Q3), and most deprived (Q4–Q5).(31)

Statistical analysis

We first used descriptive statistics to summarize patient characteristics for MHR ED visits. Kruskal-Wallis and χ^2 tests were employed to compare between-time period differences for continuous and categorical variables, respectively. To investigate changes in MHR ED utilization between the pre-pandemic and pandemic periods, we conducted an ITS analysis of aggregated monthly MHR ED visits using a Bayesian structural time series model (BSTS). We treated the monthly count of MHR ED visits as a time series and the month at which the exposure first occurred as the event of interest. The outcome was decomposed into trend-cycle, seasonal, and remainder components. The seasonal component was then removed to obtain a time series adjusted for seasonal variations in MHR ED visits.

To investigate associations between sociodemographic characteristics and the outcome, a generalized additive model (GAM) with binomial response and a logistic link was specified. GAMs are an extension of generalized linear models (GLMs), whereby predictors are linked to the outcome using smooth functions, allowing for greater flexibility in incorporating nonlinear forms of the predictors.(32) Model parameters were estimated via restricted maximum likelihood (REML).(33) The following covariates were included in the model: seasonality (in months) and age (in years), continuous variables modeled as semi-parametric smoothed terms; COVID-19 exposure (the main exposure), sex, and SES, categorical variables modeled as parametric linear terms. For the smoothed terms, we specified factor-smooth interactions, by which a separate

smooth function was estimated for each level of COVID-19 exposure (i.e., pre-pandemic and pandemic periods). An interaction between linear terms and COVID-19 exposure was also specified. As part of a sensitivity analysis, we fitted another model with age as a dichotomous variable.

Analyses were performed using R version 4.1.2 (R Project for Statistical Computing). ITS analysis was conducted using the CausalImpact and seasonal packages.(34, 35) We used the mcgv package for GAM estimation.(33) Statistical significance was set at two-sided p-value <.05.

RESULTS

Between April 2016 and November 2021, there were a total of 437,147 ED visits (204,215 unique patients). Among these visits, children and adolescents aged 5 to 17 years accounted for 168,749 ED visits (99,313 unique patients), of which 9,748 (5.8%) were MHR visits (7,686 unique patients). Patient characteristics are summarised in Table 1. We found significant differences between time periods (pre-pandemic [2016–2019] and pandemic [2020, 2021]) for all patient characteristics, with the exception of SES. There were missing data for the SES (approximately 5% of visits per year), and the age of patients in the included MHR ED visits was significantly higher than that of the excluded ones (eTable 2). The monthly count of MHR ED visits is presented by time period and sociodemographic characteristics in Figures 1 and 2, respectively. The frequency of MHR ED visits per unique patient can be found in the Supplement (eTable 3).

Bayesian structural time series analysis revealed that after an initial decrease in MHR ED visits between March and June 2020, monthly visit counts exceeded those from pre-pandemic years as shown in Figure 3 (deseasonalized data), eFigures 1-2 (raw data) and eFigure 3 (raw and deseasonalized data). Overall, we observed an increase of 69% (95% CI, +53% to +85%; $p = .001$) in the mean monthly count of MHR ED visits, which remained significant after adjusting for seasonality (44% increase, 95% CI, +38% to +51%; $p = .001$). As such, during the pandemic period, the monthly count of MHR ED visits averaged 177, whereas if the pandemic had not occurred, an average of 122 (Bayesian CI_{95} 114–130) would have been expected, yielding an absolute effect of +54 (Bayesian CI_{95} 47–62), as shown in eTable 4.

Parametric and non-parametric GAM estimates are reported in Table 2, and represented graphically in eFigure 4. The GAM estimation indicated that the chance of presenting for a MHR vs non-MHR visit was influenced by seasonality (EDF = 7.34, $p < 0.001$) and age (EDF = 7.14, $p < 0.001$). Overall, the probability of a MHR ED visit was higher in the earlier and later months of the year (i.e. during the winter period), and tended to decrease during the summer period. However, this pattern was more pronounced during the pandemic period (EDF = 3.04, $p < 0.01$), as shown in eFigure 4b. The chance of presenting for a MHR ED visit increased non-linearly with age. With respect to COVID-19, the effect of age (as a continuous variable) was similar between time periods for youth up to 14 years old but differed for adolescents aged 15–17 years (EDF = 4.11, $p < 0.001$). More specifically, eFigure 4b shows a decrease for those aged 15–17 years during COVID-19, whereas an increase was observed among the latter before COVID-19. This result was corroborated in the sensitivity analysis treating age as a dichotomous variable (eTable 5).

We present the parametric estimates as odds ratio (OR) and corresponding 95% CI in a forest plot (eFigure 4a). Female individuals were more likely to present for a MHR ED visit than male individuals, both before (OR 1.42, 95% CI 1.35–1.50) and during the COVID-19 pandemic (OR 2.02, 95% CI 1.73–2.35). By contrast, the chance was lower among youth who were the most materially deprived (OR 0.77, 95% CI 0.71–0.83 [pre-pandemic]; OR 0.78, 95% CI 0.70–0.86 [pandemic]) and those who were the most materially privileged (OR 0.84, 95% CI 0.78–0.91 [pre-pandemic]; OR 0.92, 95% CI 0.82–1.02 [pandemic]), compared to their counterparts in the average SES group.

Between the pre-pandemic and pandemic periods, the chance of presenting for a MHR ED visit increased among female individuals (OR 1.42, 95% CI 1.29–1.56). No difference by SES group during and before the COVID-19 pandemic was found (OR 1.01, 95% CI 0.89–1.15 [most deprived]; OR 1.09, 95% CI 0.96–1.25 [most privileged]).

DISCUSSION

This retrospective cross-sectional study found that the COVID-19 pandemic period was associated with an increase in MHR ED utilization, irrespective of its overall trend and annual seasonality. Monthly counts of MHR ED visits increased by approximately 44% during COVID-19 compared to prior years. During the pandemic period, the odds of presenting for a MHR ED visit were higher among girls than those during the pre-pandemic period. Conversely, lower odds of presenting for a MHR ED visit were found in older adolescents (>15 years) during COVID-19. To our knowledge, these findings are the first to describe the magnitude of changes in MHR ED utilization in youth during COVID-19 by sociodemographic factors in Canada.

Our findings support a substantial increase in MHR ED utilization in the pandemic period compared to the pre-pandemic period, despite an initial decrease in the first three months of COVID-19. These findings corroborate with previous international studies.(7-12, 14-17, 21-24) The strongest increase appeared to take place during winter months, a period when public health measures, including school closures were stricter.(36) In Canada, and specifically in Québec, where access to primary healthcare services remains limited for many, even in non-pandemic times,(37) the loss of supportive school and community structures could have contributed to this increased utilization of ED services.

Our analyses revealed that the odds of presenting to the ED for MHR diagnoses were greater among girls, and that this was intensified by the pandemic. These results coincide with those obtained in Australia and the US.(13, 25) In fact, an increase in MHR ED utilization among adolescent girls aged 12–17 years was also seen in New South Wales during the first year of the pandemic (January 2020 to February 2021).(13) Weekly ED visits for adolescent girls also increased for eating and tic disorders in 2020-2021 and depression and obsessive-compulsive disorder in 2021 compared to 2019 in the US.(25) Conversely, while some studies have suggested an increase in MHR symptoms among girls since the onset of the pandemic,(38, 39) a repeated cross-sectional study using representative data from Ontario and Québec, Canada’s two largest provinces, showed that the increases in mental health symptoms among adolescents appeared to be similar between boys and girls. Further, these trends were no greater between the years 2018 and 2019 (pre-pandemic) than between the years 2019 and 2020 (pre/post onset of the pandemic).(40) It can thus be suggested that reasons other than changes in population-level

mental health symptomatology, such as increases in help-seeking behaviours, may have contributed to the increased odds of MHR ED presentations among girls vs boys.(41)

In our study, there was a higher proportion of MHR ED visits by older (12–17 years) vs younger (5–11 years) youth, though increases in visit counts during the pandemic period could be seen in both age groups. Our findings are consistent with a recent Canadian study on healthcare services utilization for eating disorders in Ontario which showed a similar increase in MHR ED visits among younger (age 3–13 years) and older (ages 14–17 years) youths.(42) Interestingly, our non-linear estimate of the effect of age on MHR ED utilization was slightly smaller among older adolescents (ages 15–17 years) during the pandemic (vs pre-pandemic) period. Adolescence coincides with a key period of brain development and the formation of one’s personal and social identity.(43) Adolescents may be particularly vulnerable to public health preventive measures that can lead to disruptions in their social life,(44) but, as they get older, may also be able to develop new coping strategies such as connecting with peers online and outdoors, and engaging in leisure and health-promoting activities. Younger youth, who may not have the means or capacity to develop the same coping mechanisms, appear to have been equally, if not more strongly affected by school closures and other pandemic-related measures, which may have contributed to the increase in MHR ED utilization seen in this age group.(45)

Our study revealed that prior to the onset of the pandemic, MHR ED visits were less likely to be attributed to youth from both socioeconomically advantaged and disadvantaged areas when compared to those from average SES areas. Our model indicated that this same pattern remained during the pandemic. Indeed, our data showed an absolute increase in number of visits that was

similar for all three SES groups, suggesting that pandemic-related effects on pediatric healthcare service utilization were similar across the SES spectrum. Our findings differ from those reported by Hu and colleagues in Australia, where increases in MHR ED utilization were higher for youth from socioeconomically advantaged areas.(13) Though increased utilization of MHR ED services may serve as an indicator of worsening youth mental health in some circumstances, this indicator alone does not adequately capture the exacerbation of existing healthcare inequalities among youth from lower vs higher SES, and may be more reflective of SES-related differences in access to appropriate services.(46, 47)

Limitations

There are limitations to our study. First, our findings are based on a single, large, tertiary pediatric center, and might not be generalizable to other clinical settings. However, this center is the largest pediatric hospital with the greatest number of ED visits in the province. Second, the comprehensiveness of the outcome and patient characteristics was limited by data availability. We could only identify the primary diagnosis as recorded by the treating physician at the ED (without confirmation by a mental health provider), despite it being common for patients to present multiple diagnoses. Third, when considering SES, the geocoding of postal codes could not provide patient-level data and resulted in missing data (~5% overall). Use of census information on dissemination areas from 2016, rather than the exact year during which the ED visits occurred, might have introduced bias. Finally, MHR ED utilization (as measured by the monthly number of visits) offers only a single viewpoint on youth mental health, and should therefore be considered in the larger context of other physician- and non-physician-based mental healthcare services utilization.(2) Increased MHR ED utilization could also be a reflection of

other societal disruptions, such as the loss of access to other school- and community-based services.(48)

CONCLUSIONS

The COVID-19 pandemic has placed an unprecedented stress on pediatric mental health services as shown by abrupt increases in MHR ED visits. While EDs can serve an important purpose in providing rapid mental health services for youth in situations of crisis, there is a need for sustained, targeted and scalable mental health resources to support youth mental health. This appears to be especially true for girls and should be considered in preparation for future public health crises.

List of abbreviations: CHU, *centre hospitalier universitaire*; COVID-19, coronavirus disease 2019; ED, emergency department; GAM, generalized additive model; GLM, generalized linear model; ITS, interrupted time series; MHR, mental health-related; REML, restricted maximum likelihood; SES, socioeconomic status; STROBE, Strengthening the Reporting of Observational Studies in Epidemiology; UK, United Kingdom; US, United States.

DECLARATIONS

Ethics approval and consent to participate: Ethical approval was obtained from the CHU Sainte-Justine Research Ethics Committee (Protocol ID: MP-21-2021-2930).

Consent for publication: All patient data were deidentified; thus, informed consent was not required.

Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests.

Funding: GB is funded by a Fonds de recherche du Québec — Santé (FRQS) Doctoral Training Award. NC and OD are funded by a Fonds de recherche du Québec — Santé (FRQS) Clinical Research Scholar Award. MCG holds a Canada Research Chair — Tier 2. These funders had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The authors are solely responsible for the design, interpretation and reporting of this study.

Authors' contributions: NC and OD conceived the study. GB and NC designed the study. JG oversaw the data collection and AS performed the data extraction. OD obtained ethical approval. GB had full access to all data and conducted the analyses, with feedback from AB. GB and NC drafted the manuscript. AB, MO and MCG revised the manuscript for important intellectual content. All authors contributed to the interpretation of data and read and approved the final manuscript.

Acknowledgements: Not applicable.

REFERENCES

1. World Health Organization. WHO Director-General's opening remarks at the media briefing on COVID-19—11 March 2020. News release. 2020 [updated 11 March 2020]. Available from: <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020>.
2. Saunders NR, Kurdyak P, Stukel TA, Strauss R, Fu L, Guan J, et al. Utilization of physician-based mental health care services among children and adolescents before and during the COVID-19 pandemic in Ontario, Canada. *JAMA Pediatr*. 2022:e216298.
3. Webster P. Virtual health care in the era of COVID-19. *Lancet*. 2020;395(10231):1180-1.
4. Mann DM, Chen J, Chunara R, Testa PA, Nov O. COVID-19 transforms health care through telemedicine: evidence from the field. *J Am Med Inform Assoc*. 2020;27(7):1132-5.
5. Williams TC, MacRae C, Swann OV, Haseeb H, Cunningham S, Davies P, et al. Indirect effects of the COVID-19 pandemic on paediatric healthcare use and severe disease: a retrospective national cohort study. *Arch Dis Child*. 2021;106(9):911-7.
6. Adjemian J, Hartnett KP, Kite-Powell A, DeVies J, Azondekon R, Radhakrishnan L, et al. Update: COVID-19 pandemic-associated changes in emergency department visits — United States, December 2020–January 2021. *MMWR Morb Mortal Wkly Rep*. 2021;70(15):552-6.
7. Cheek JA, Craig SS, West A, Lewena S, Hiscock H. Emergency department utilisation by vulnerable paediatric populations during the COVID-19 pandemic. *Emerg Med Australas*. 2020;32(5):870-1.
8. Dann L, Fitzsimons J, Gorman KM, Hourihane J, Okafor I. Disappearing act: COVID-19 and paediatric emergency department attendances. *Arch Dis Child*. 2020;105(8):810-1.

9. DeLaroche AM, Rodean J, Aronson PL, Fleegler EW, Florin TA, Goyal M, et al. Pediatric emergency department visits at US children's hospitals during the COVID-19 pandemic. *Pediatrics*. 2021;147(4):e2020039628.
10. Dopfer C, Wetzke M, Zychlinsky Scharff A, Mueller F, Dressler F, Baumann U, et al. COVID-19 related reduction in pediatric emergency healthcare utilization – a concerning trend. *BMC Pediatr*. 2020;20(1):427.
11. Finkelstein Y, Maguire B, Zemek R, Osmanlliu E, Kam AJ, Dixon A, et al. Effect of the COVID-19 pandemic on patient volumes, acuity, and outcomes in pediatric emergency departments: a nationwide study. *Pediatr Emerg Care*. 2021;37(8):427–34.
12. Hartnett KP, Kite-Powell A, DeVies J, Coletta MA, Boehmer TK, Adjemian J, et al. Impact of the COVID-19 pandemic on emergency department visits — United States, January 1, 2019–May 30, 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(23):699-704.
13. Hu N, Nassar N, Shrapnel J, Perkes I, Hodgins M, O'Leary F, et al. The impact of the COVID-19 pandemic on paediatric health service use within one year after the first pandemic outbreak in New South Wales Australia – a time series analysis. *Lancet Reg Health West Pac*. 2022;19:100311.
14. Isba R, Edge R, Jenner R, Broughton E, Francis N, Butler J. Where have all the children gone? Decreases in paediatric emergency department attendances at the start of the COVID-19 pandemic of 2020. *Arch Dis Child*. 2020;105(7):704.
15. Pelletier JH, Rakkar J, Au AK, Fuhrman D, Clark RSB, Horvat CM. Trends in US pediatric hospital admissions in 2020 compared with the decade before the COVID-19 pandemic. *JAMA Netw Open*. 2021;4(2):e2037227.

16. Pines JM, Zocchi MS, Black BS, Carlson JN, Celedon P, Moghtaderi A, et al. Characterizing pediatric emergency department visits during the COVID-19 pandemic. *Am J Emerg Med.* 2021;41:201-4.
17. Ramgopal S, Pelletier JH, Rakkar J, Horvat CM. Forecast modeling to identify changes in pediatric emergency department utilization during the COVID-19 pandemic. *Am J Emerg Med.* 2021;49:142-7.
18. Schuur JD, Venkatesh AK. The growing role of emergency departments in hospital admissions. *N Engl J Med.* 2012;367(5):391-3.
19. Zima BT, Rodean J, Hall M, Bardach NS, Coker TR, Berry JG. Psychiatric disorders and trends in resource use in pediatric hospitals. *Pediatrics.* 2016;138(5):e20160909.
20. Mapelli E, Black T, Doan Q. Trends in pediatric emergency department utilization for mental health-related visits. *J Pediatr.* 2015;167(4):905-10.
21. Leeb RT, Bitsko RH, Radhakrishnan L, Martinez P, Njai R, Holland KM. Mental health–related emergency department visits among children aged <18 years during the COVID-19 pandemic — United States, January 1–October 17, 2020. *MMWR Morb Mortal Wkly Rep.* 2020;69(45):1675-80.
22. Krass P, Dalton E, Doupnik SK, Esposito J. US pediatric emergency department visits for mental health conditions during the COVID-19 pandemic. *JAMA Netw Open.* 2021;4(4):e218533.
23. Leff RA, Setzer E, Cicero MX, Auerbach M. Changes in pediatric emergency department visits for mental health during the COVID-19 pandemic: a cross-sectional study. *Clin Child Psychol Psychiatry.* 2021;26(1):33-8.

- 409 24. Chadi N, Spinoso-Di Piano C, Osmanlliu E, Gravel J, Drouin O. Mental health–related
410 emergency department visits in adolescents before and during the COVID-19 pandemic: a
411 multicentric retrospective study. *J Adolesc Health*. 2021;69(5):847-50.
- 412 25. Radhakrishnan L, Leeb RT, Bitsko RH, Carey K, Gates A, Holland KM, et al. Pediatric
413 emergency department visits associated with mental health conditions before and during the
414 COVID-19 pandemic — United States, January 2019–January 2022. *MMWR Morb Mortal*
415 *Wkly Rep*. 2022;71(8):319-24.
- 416 26. Leary E, Zachary I, Kyeong NY. Regional differences in serious psychological distress
417 and overall physical and mental health. *Community Ment Health J*. 2021:1-9.
- 418 27. Silliman Cohen RI, Bosk EA. Vulnerable youth and the COVID-19 pandemic. *Pediatrics*.
419 2020;146(1):e20201306.
- 420 28. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP, et al.
421 The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE)
422 statement: guidelines for reporting observational studies. *PLoS Med*. 2007;4(10):e296.
- 423 29. Urrutia D, Manetti E, Williamson M, Lequy E. Overview of Canada’s answer to the
424 COVID-19 pandemic’s first wave (January–April 2020). *Int J Environ Res Public Health*.
425 2021;18(13):7131.
- 426 30. Pampalon R, Hamel D, Gamache P, Philibert MD, Raymond G, Simpson A. An area-
427 based material and social deprivation index for public health in Québec and Canada. *Can J*
428 *Public Health*. 2012;103(8 Suppl 2):S17-S22.
- 429 31. Gamache P, Hamel D, Blaser C. Material and social deprivation index: a summary:
430 INSPQ; 2019 [Available from: <http://www.inspq.qc.ca/en/publications/2639>].

32. Hastie T, Tibshirani R. Generalized additive models for medical research. *Stat Methods Med Res.* 1995;4(3):187-96.
33. Wood SN. Fast stable restricted maximum likelihood and marginal likelihood estimation of semiparametric generalized linear models. *J R Stat Soc Series B Stat Methodol.* 2011;73(1):3-36.
34. Brodersen KH, Gallusser F, Koehler J, Remy N, Scott SL. Inferring causal impact using Bayesian structural time-series models. *Ann Appl Stat.* 2015;9(1):247-74.
35. Sax C, Eddelbuettel D. Seasonal adjustment by X-13ARIMA-SEATS in R. *J Stat Soft.* 2018;87(11):1-17.
36. Institut national de santé publique du Québec. Ligne du temps COVID-19 au Québec: INSPQ; 2022 [Available from: <https://www.inspq.qc.ca/covid-19/donnees/ligne-du-temps>].
37. Laberge M, Gaudreault M. Promoting access to family medicine in Québec, Canada: analysis of bill 20, enacted in November 2015. *Health Policy.* 2019;123(10):901-5.
38. Hawes MT, Szenczy AK, Klein DN, Hajcak G, Nelson BD. Increases in depression and anxiety symptoms in adolescents and young adults during the COVID-19 pandemic. *Psychol Med.* 2021:1-9.
39. Magson NR, Freeman JY, Rapee RM, Richardson CE, Oar EL, Fardouly J. Risk and protective factors for prospective changes in adolescent mental health during the COVID-19 pandemic. *J Youth Adolesc.* 2021;50(1):44-57.
40. Bélanger RE, Patte KA, Leatherdale ST, Gansaonré RJ, Haddad S. An impact analysis of the early months of the COVID-19 pandemic on mental health in a prospective cohort of Canadian adolescents. *J Adolesc Health.* 2021;69(6):917-24.

41. Richardson C, Phillips S, Paslakis G. One year in: the impact of the COVID-19 pandemic on help-seeking behaviors among youth experiencing eating disorders and their caregivers. *Psychiatry Res.* 2021;306:114263.
42. Toulany A, Kurdyak P, Guttman A, Stukel TA, Fu L, Strauss R, et al. Acute care visits for eating disorders among children and adolescents after the onset of the COVID-19 pandemic. *J Adolesc Health.* 2022;70(1):42-7.
43. Hollenstein T, Loughheed JP. Beyond storm and stress: typicality, transactions, timing, and temperament to account for adolescent change. *Am Psychol.* 2013;68(6):444-54.
44. Branje S, Morris AS. The impact of the COVID-19 pandemic on adolescent emotional, social, and academic adjustment. *J Res Adolesc.* 2021;31(3):486-99.
45. Viner R, Russell S, Saule R, Croker H, Stansfield C, Packer J, et al. School closures during social lockdown and mental health, health behaviors, and well-being among children and adolescents during the first COVID-19 wave: a systematic review. *JAMA Pediatr.* 2022.
46. Li W, Wang Z, Wang G, Ip P, Sun X, Jiang Y, et al. Socioeconomic inequality in child mental health during the COVID-19 pandemic: first evidence from China. *J Affect Disord.* 2021;287:8-14.
47. Han JM, Song H. Effect of subjective economic status during the COVID-19 pandemic on depressive symptoms and suicidal ideation among South Korean adolescents. *Psychol Res Behav Manag.* 2021;14:2035-43.
48. Masonbrink AR, Hurley E. Advocating for children during the COVID-19 school closures. *Pediatrics.* 2020;146(3):e20201440.

Table 1. Characteristics of ED visits, April 1, 2016 to November 2021

	Prepandemic	Pandemic			
All ED visits	2016-2019 (N=118728)	2020 (N=23317)	2021 (N=26704)	Overall (N=168749)	
MHR visits	5927 (5.0%)	1521 (6.5%)	2300 (8.6%)	9748 (5.8%)	
Other visits	112801 (95.0%)	21796 (93.5%)	24404 (91.4%)	159001 (94.2%)	
MHR ED visits	2016-2019 (N=5927)	2020 (N=1521)	2021 (N=2300)	Overall (N=9748)	p-value
Age (continuous)					
Median (IQR)	14.3 (11.0-16.0)	14.4 (11.7-16.1)	14.4 (12.2-15.9)	14.3 (11.4-16.0)	0.045
Age group					
5–11 years	1803 (30.4%)	413 (27.2%)	547 (23.8%)	2763 (28.3%)	<0.001
12+ years	4124 (69.6%)	1108 (72.8%)	1753 (76.2%)	6985 (71.7%)	
Sex					
Female	3521 (59.4%)	970 (63.8%)	1615 (70.2%)	6106 (62.6%)	<0.001
Male	2406 (40.6%)	551 (36.2%)	685 (29.8%)	3642 (37.4%)	
SES					
Most privileged	1918 (32.4%)	514 (33.8%)	805 (35.0%)	3237 (33.2%)	0.087
Average	1009 (17.0%)	252 (16.6%)	408 (17.7%)	1669 (17.1%)	
Most deprived	2755 (46.5%)	675 (44.4%)	972 (42.3%)	4402 (45.2%)	
Missing	245 (4.1%)	80 (5.3%)	115 (5.0%)	440 (4.5%)	

Note. Data are n (%). Counts include multiple visits for the same patient. Between-time period differences were assessed using Kruskal-Wallis (for continuous variables) and χ^2 tests (for categorical variables).

Abbreviations: ED, emergency department; MHR, mental health-related; SES, socioeconomic status.

Table 2. Semi-parametric GAM for MHR ED utilization, April 1, 2016 to November 2021

	Parametric terms		
	Estimate	SE	p-value
Intercept	-3.312	0.039	<0.001
Time period			
Prepandemic (ref)			
Pandemic	0.126	0.067	0.062
Sex			
Male (ref)			
Female	0.353	0.028	<0.001
SES			
Most deprived	-0.267	0.038	<0.001
Average (ref)			
Most privileged	-0.174	0.040	<0.001
Sex (female): time period (pandemic)	0.348	0.048	<0.001
SES (most deprived): time period (pandemic)	0.012	0.064	0.850
SES (most privileged): time period (pandemic)	0.089	0.067	0.184
	Smooth terms		
	EDF		p-value
Seasonality	7.345		<0.001
Age	7.137		<0.001
Seasonality: time period (pandemic)	3.038		0.004
Age: time period (pandemic)	4.106		<0.001

Note. The colon symbol is employed to represent the interaction between two terms. Age and seasonality are measured in years and months, respectively.
Abbreviations: ED, emergency department; EDF, effective degrees of freedom (of the functional parameters); GAM, generalized additive model; MHR, mental health-related; SE, standard error (for the parameter estimate); SES, socioeconomic status

FIGURE TITLES AND LEGENDS

Figure 1. MHR ED utilization at the CHU Sainte-Justine from April 1, 2016 to November 30, 2021 (by time period)

Abbreviations: CHU, *centre hospitalier universitaire*; ED, emergency department; MHR, mental health-related.

Figure 2. MHR ED utilization at the CHU Sainte-Justine from April 1, 2016 to November 30, 2021 (by age group, sex and SES)

Note. Panels A, B and C show the time series of the monthly number of MHR ED visits by age group, sex and SES, respectively.

Abbreviations: CHU, *centre hospitalier universitaire*; ED, emergency department; MHR, mental health-related; SES, socio-economic status.

Figure 3. Bayesian structural time series model (using deseasonalized data)

Note. Time paths of the actual and predicted values are represented by the black and blue-dotted lines, respectively. The blue shaded areas indicate 95% confidence intervals. The original panel measures the difference between actual and predicted values. The pointwise panel corresponds to the average impact of the exposure (i.e. COVID-19–associated public health measures), whereas the cumulative panel refers to the cumulative impact of the latter.

Abbreviations: ED, emergency department; MHR, mental health-related.

Figure 1. MHR ED utilization at the CHU Sainte-Justine from April 1, 2016 to November 30, 2021 (by time period)

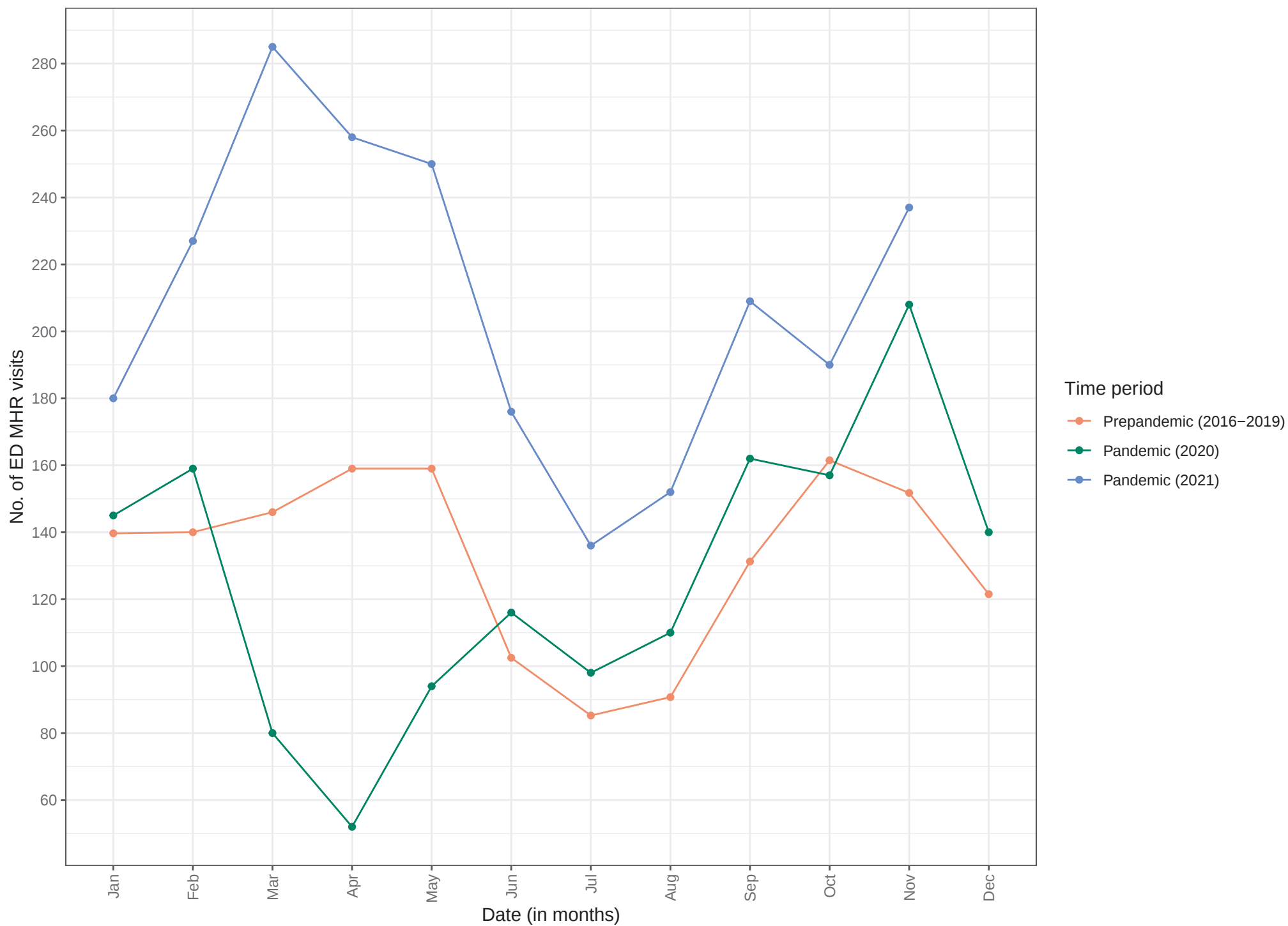
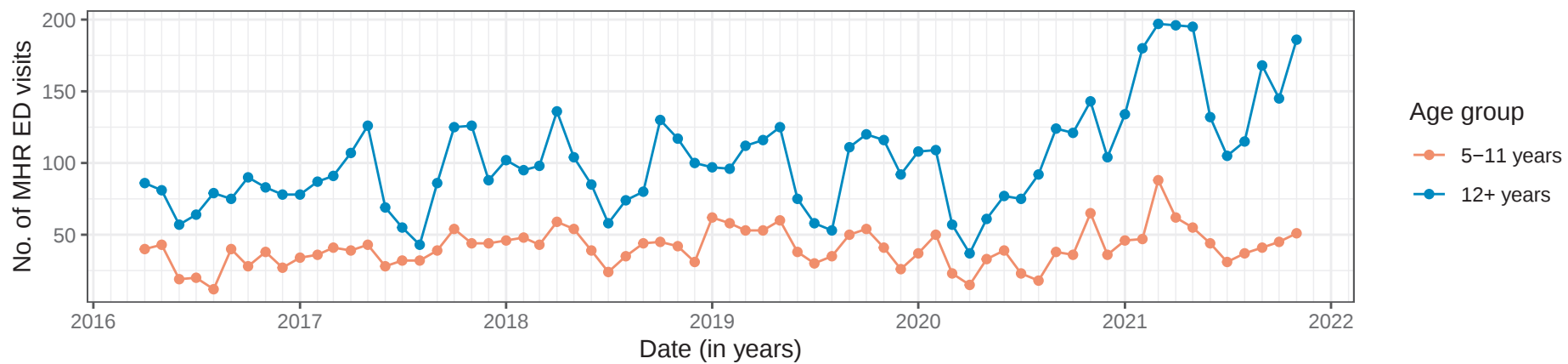
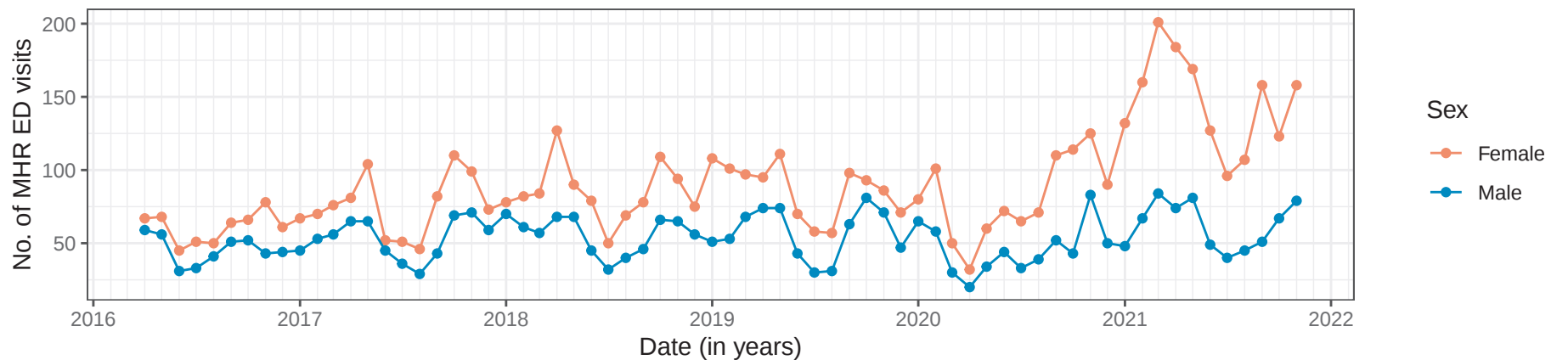


Figure 2. MHR ED utilization at the CHU Sainte-Justine from April 1, 2016 to November 30, 2021 (by age group, sex and SES)

A



B



C

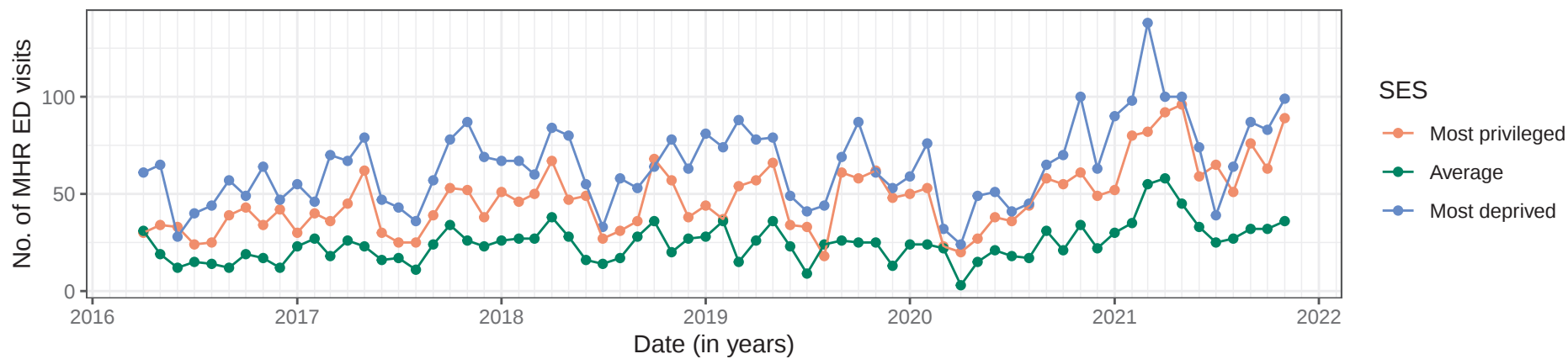


Figure 3. Bayesian structural time series model (using deseasonalized data)

