Received: 1 April 2022 | Accepted: 28 June 2022
DOI: 10.1002/jhm.12920

ORIGINAL RESEARCH

Journal of Hospital Medicine | shm Society of Hospital Medicine

Trends in all-cause mortality and inpatient and outpatient visits for ambulatory care sensitive conditions during the first year of the COVID-19 pandemic: A population-based study

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Funding information
Ontario Health Data Platform (OHDP); Ottawa Hospital Academic Medical Organization (TOHAMO)

Abstract

Background: The impact of the COVID-19 pandemic on the management of ambulatory care sensitive conditions (ACSCs) remains unknown.

Objectives: To compare observed and expected (projected based on previous years) trends in all-cause mortality and healthcare use for ACSCs in the first year of the pandemic (March 2020 to March 2021).

Design, Setting and Participants: We conducted a population-based study using provincial health administrative data on general adul population (Ontario, Canada).

Outcomes and Measures: Monthly all-cause mortality, and hospitalizations, emergency department (ED) and outpatient visit rates (per 100,000 people at-risk) for seven combined ACSCs (asthma, chronic obstructive pulmonary disease, angina, congestive heart failure, hypertension, diabetes, and epilepsy) during the first year were compared with similar periods in previous years (2016–2019) by fitting monthly time series autoregressive integrated moving-average models.

Results: Compared to previous years, all-cause mortality rates increased at the beginning of the pandemic (observed rate in March to May 2020 of 79.98 vs. projected of 71.24 [66.35–76.50]) and then returned to expected in June 2020—except among immigrants and people with mental health conditions where they remained elevated. Hospitalization and ED visit rates for ACSCs remained lower than projected throughout the first year: observed hospitalization rate of 37.29 versus projected of 52.07 (47.84–56.68); observed ED visit rate of 92.55 versus projected of 134.72 (124.89–145.33). ACSC outpatient visit rates decreased initially (observed rate of 4299.57 vs. projected of 5060.23 [4712.64–5433.46]) and then returned to expected in June 2020.

INTRODUCTION

Ambulatory care sensitive conditions (ACSCs) are chronic conditions for which effective and timely access to outpatient care can prevent complications, hospitalizations[1,2] and potentially improve survival. Thus, the COVID-19 pandemic-related restrictions on nonurgent health services may affect the management and outcomes of ACSCs.

In our recent narrative review, we found that during the early stages of the COVID-19 pandemic, in-person outpatient and inpatient care for individuals with chronic conditions substantially decreased in many countries due to lack of access to personal protective equipment, mandated restrictions on nonurgent in-person medical visits and elective procedures, public health instructions to stay home, and patients' fear of potential COVID-19 exposure in hospitals and clinics.[3] Others have also proposed that modified lifestyles and a reduction in environmental risk factors due to public health measures resulted in reduced exposure to traffic, air pollution, allergens, and other respiratory infections[4,5] coupled with improved adherence to treatment of chronic conditions due to a shift toward virtual care and the absence of prior distractions (e.g., work, travel, etc.),[3,6,7] decreased need for in-person health care.

Despite possible health benefits associated with public health measures, the observed decrease in outpatient visits for patients with ACSCs may have led to harmful consequences such as increased emergency department (ED) visits and hospitalizations; however, with those also reduced, it could have resulted in death. Studies of the pandemic to date have only focused on its first few months and select outcomes (i.e., mortality or hospitalization) and have not examined specific vulnerable populations; thus, knowledge of the longer-term impact of the pandemic on the management of ACSCs remains limited. To address this gap, we conducted a population-based study to compare actual (observed) and expected (projected based on previous years) trends in all-cause mortality and health service use for ACSCs for the general adult population, as well as several vulnerable subgroups (such as older adults, people of lower socioeconomic status, immigrants, and those with pre-existing mental health conditions) that may be disproportionately affected,[8,9] in the first year of the pandemic.

METHODS

Study design

Using provincial health administrative data (Ontario, Canada), we examined temporal patterns in observed versus projected rates of all-cause mortality, hospitalizations, ED and outpatient visits for seven ACSCs combined, in the general adult population during the first year of the COVID-19 pandemic (March 2020 to March 2021) compared to similar periods in previous years (2016–2019). The use of anonymized data in this project was authorized under section 45 of Ontario's Personal Health Information Protection Act, which does not require review by a Research Ethics Board.

Data sources

Since 1991, ICES has housed high-quality administrative databases on publicly funded health services, including individual-level information on outpatient and inpatient visits within Ontario.[10] These databases have been validated for accuracy[11,12] and are regularly updated (https://datadictionary.ices.on.ca/Applications/DataDictionary/Default.aspx; Supporting Information: Text E1). The Registered Persons Database contains data on demographics and vital statistics. The Discharge Abstract Database records hospitalizations. The National Ambulatory Care Reporting System Database records ED visits. The Ontario Health Insurance Plan database captures physician billing, and the Canadian Census includes neighborhood socioeconomic details. Ontario Mental Health Reporting System (OMHRS) contains data on inpatient mental health admissions. The Immigration, Refugees and Citizenship Canada Permanent Resident database (IRCC-PR, formerly

Citizenship and Immigration Canada)[13] includes information on immigrants between 1985 and May 2017. The COVID-19 Integrated Testing Data set is a comprehensive data set of all available COVID-19 diagnostic laboratory results in Ontario. In Ontario, Canada, physician virtual billing codes in response to COVID-19 were effective on March 14, 2020, and extended until September 30, 2022.[14] We also noted Public Health Units (PHU) ($n = 34$ in Ontario).[15] These databases were linked using unique encoded identifiers.

Population and setting

An open cohort of all adult (18 years and older) Ontario residents before and during the COVID-19 outbreak (January 2016 to March 2021) who were alive and insured at the beginning of each month within the study period were considered for inclusion. Ontario is the most populous province of Canada, with universal health insurance and a population of more than 14.5 million.[16] The open cohort design allowed subjects to enter as they aged or leave when they died, moved out of the province or lost their insurance—thus reflecting accurate trends.

Time frame definitions

We considered *March 17, 2020*, as the start of the outbreak. Our open cohort was followed for death, insurance loss or until *March 31, 2021*. Our study time frame captured the state of emergency in Ontario (declared March 17, 2020)[17] and the first wave of COVID-19 (March to May 2020), along with a phased reopening during a period of declining and then relatively low case and COVID-19 hospitalization incidence (June to September 2020).[18] This period was followed by a second wave of increasing cases and COVID-19 hospitalizations starting in mid-September 2020, which continued until March 2021. Thus, rates were reported and compared for the following four periods[18]: (i) *pre-COVID*-19 period: Januray to February 2020 (the first identified case of COVID-19 in Canada occurred on January 22, 2020); (ii) *Wave I* of the COVID-19 outbreak: March to May 2020; (iii) *Summer lull* of the COVID-19 outbreak: June to August 2020; and (iv) *Wave II* of the COVID-19 outbreak: September 2020 to March 2021. Of note, the COVID-19 variant Delta (B.1.617.2) was not prevalent in Canada until May 2021.[19] Similar periods in previous years (January 2016 to December 2019) were used for comparison and to calculate projected rates. To avoid arbitrary time categorization, observed and projected rates were visualized monthly.

Outcomes of interest

The primary outcomes were all-cause mortality, and hospitalizations, ED and outpatient visits for ACSCs. We identified outpatient and ED visits, and hospitalizations with a most responsible diagnosis of one of seven chronic ACSCs[20,21]: *angina, asthma, congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), diabetes, epilepsy, and hypertension* (see definitions in the Supporting Information: Table E1). Outpatient visits for ACSCs were categorized by specialty (primary care, specialist with a relevant specialty [cardiologist, respirologist, endocrinologist, neurologist, internal medicine], and any specialist) and by visit location (virtual vs. in-person). In Ontario, physician billing codes in response to COVID-19, including virtual (telephone or video) visits were implemented on March 14, 2020.[14]

To specifically examine and compare rates in vulnerable subgroups, we stratified analyses by sex, age group (18–24, 25–34, 35–49, 50–64, 65+), neighborhood income (low [lower two quintiles] vs. high [upper three quintiles]), immigration status, residence location (rural vs. urban) and mental health status (based on mental health and addictions-related outpatient services). They were also stratified by COVID-19 hotspot determined by examining the COVID-19 infection rate for each PHU (high/low). The PHU was considered a COVID-19 hotspot if the highest weekly percent of positive COVID-19 tests within a given month was ≥10%, accompanied by a monthly incident rate of positive COVID-19 tests of ≥100 per 100,000 people.[22]

Statistical analyses

Data were aggregated monthly to create a 63-period time series from January 2016 to March 2021. Monthly rates were calculated as the number of events per 100,000 people. Autoregressive integrated moving-average (ARIMA) modelling was used to calculate projected outcome rates. ARIMA is a time series model where information from the past can be used to predict future values. Specifically, ARIMA models regress a series of current observed rates on past values, fitting autoregressive (AR) and moving-average (MA) terms to account for seasonal and underlying trends[23] (please see more details in Supporting Information: Text E2; Figure E1). We used SAS software's adaption of the United States Census Bureau's X-13ARIMA-SEATS program (X13),[24,25] which includes an automated model selection procedure.[26] The selection procedure uses multiple algorithms to select ARIMA terms and the best fitting model.[24] Briefly, a default model is estimated along with residual diagnostics to be compared with the selected model at a later step. Empirical root tests determine the order of differencing to make the series stationary, and an iterative process is used to fit multiple models with different AR and MA terms. The best model is selected using the Bayesian Information Criterion (BIC) and compared to the default model. The better performing model is retained, and a final model evaluation is performed during which orders of differencing or model terms may be adjusted (Supporting Information: Figure E1).

We used the final model for each outcome to project monthly rates for 13 months following February 2020. We compared observed and projected monthly rates, considering observed rates outside the projected 95% confidence intervals (CIs) to be significantly different.[27] A small subset of models failed to converge due to exceedingly rare outcomes. Comparisons between projected and observed rates are presented graphically as a time series and in tabular form using mean rates across the four time periods.

We performed all data analyses in SAS software version 9.4 using SAS Enterprise guide version 7.15.3 in the secure environment at ICES following Ontario privacy standards.

RESULTS

Of the mean of 12,033,120.11 (SD of 26,0613.81) individuals studied (2016–2021), 6,144,698.22 (SD of 128,757.96) were female (~51.1%); 2,545,283.21 (SD of 134,232.64) were of 65 years and older (~21.2%); 4,835,012.95 (SD of 78492.97); lived in low income neighbourhoods (~40.2%); 2,485,847.70 (SD of 36,328.53) were immigrants (~20.7%); 1,209,757.73 (SD of 19,900.63) lived in rural areas (10.1%); and 1,932,109.27 (SD of 52,366.04) utilized mental health and addictions-related outpatient services (~16.1%) (Supporting Information: Table E2). Cohort characteristics by year and subgroups are presented in Supporting Information: Tables E2, E3.

Crude rates and rate ratios of all-cause mortality, hospitalizations, and ED and outpatient visits in comparison to similar periods in previous years are presented in Table 1 and Supporting Information: Tables E4, E5.

Mortality

All-cause mortality monthly rates per 100,000 people at-risk were higher in the first 3 months of the pandemic compared to previous years (observed rate in *Wave I* of 79.98 vs. projected of 71.24, 95% CI: 66.35–76.50). They remained higher than projected by the end of the year, although the difference was not statistically significant (observed rate in *Wave II* of 75.93 vs. projected of 72.6, 95% CI: 66.58–79.16) (Table 2; Figure 1a). Age, immigration status, rurality, and presence of mental health conditions influenced trends in all-cause mortality rates (Table 2). In *Wave I*, increased mortality was seen for all except those 18–24 and 35–49 years, those without mental health conditions and those who lived in rural areas. Mortality rates remained persistently elevated for the rest of the year among immigrants (observed rate in *Wave II* of 33.49 vs. projected of 27.4, 95% CI: 25.1–29.92) and individuals with mental health conditions (observed rate in *Wave II* of 218.07 vs. projected of 199.53, 95% CI: 186.38–213.6) (Table 2; Figure 1a). Although models failed to converge by COVID-19 hotspot status, observed mortality rates were similar for the entire population and areas with low COVID-19 rates (Table 1).

Hospitalizations

Overall hospitalization monthly rates per 100,000 people at-risk for ACSCs remained lower than expected during the whole first year of the pandemic: observed hospitalization rate in *Wave II* of 37.29 versus projected of 52.07, 95% CI: 47.84–56.68 (Table 3; Figure 1b). In subgroup analysis, they recovered to expected levels in individuals 34 years old and younger after *Wave I*, but remained lower in all other groups (Table 3).

ED visits

ED visit monthly rates per 100,000 people at-risk for ACSCs remained lower than projected during the whole first year of the pandemic: observed ED visits rate in *Wave II* of 92.55 versus projected of 134.72, 95% CI: 124.89–145.33 (Supporting Information: Table E6; Figure 1B). There was no variation in rates among subgroups (Supporting Information: Table E6).

Outpatient visits

Overall, for ACSCs combined, outpatient visit monthly rates decreased during *Wave I* and then returned to expected levels for the rest of the year. Further, we observed higher-than-projected rates in ACSCs-relevant specialty visits toward the end of the year: observed rates in *Wave II* of 925.00 versus projected of 844.20, 95% CI: 778.42–915.60 (Supporting Information: Table E7; Figure 1C). Virtual visit rates were significantly increased: observed rate in *Wave II* of 3026.95 versus projected of 49.87, 95% CI: 46.24–53.51. Immigration status, rurality, and pre-existing mental health status influenced the trends in outpatient visit rates (Supporting Information: Table E7). Specifically, among immigrants, we noted an initial decrease in *Wave I* followed by an increase compared to projected for the rest of the year. Among people residing in rural areas, primary care visit rates remained below projected for the whole year. Finally, an increase in specialist visits rates compared to projected was noted for individuals who utilized mental health services, but not for those who did not.

DISCUSSION

In our large population-based, retrospective, open cohort study, reductions in outpatient visits for ACSCs at the beginning of the COVID-19 pandemic and shifts to virtual care, combined with reduced hospital admissions, may have been associated with temporally increased mortality that persisted and disproportionately affected immigrants and those with pre-existing mental health conditions. To the best of our knowledge, this is the first population-based study to examine the longer-term impact of the COVID-19 pandemic beyond the first wave and compare observed versus expected trends in all-cause mortality, hospitalizations, ED and outpatient visits for ACSCs during the first year of the pandemic.

While increased mortality due to COVID-19 infection was expected, many believe the entire increase was not exclusively the

TABLE 1 Monthly rates of all-cause mortality, and hospitalizations, ED and outpatient visits for the ambulatory care sensitive conditions combined during the first year of the COVID-19 pandemic with the crude RR and CI to compare to similar periods in previous years

	January to February Monthly rates per 100,000 people at risk			March to May Monthly rates per 100,000 people at risk			June to August Monthly rates per 100,000 people at risk			September to March Monthly rates per 100,000 people at risk		
Outcomes	2017–2019	Pre-COVID 2020	RR (95% CI)	2017–2019	Wave I 2020	RR (95% CI)	2017–2019	Summer Lull 2020	RR (95% CI)	2017–2019	Wave II 2020–2021	RR (95% CI)
All-cause mortality	76.87	75.30	0.98 (0.86–1.11)	70.49	79.98 [82.22][a]	**1.13 (1.07–1.21)**	65.26	68.04 [67.92][a]	**1.04 (1.03–1.06)**	72.79	75.93 [78.07][a]	1.04 (0.98–1.11)
Hospitalizations	55.74	53.63	0.96 (0.83–1.12)	54.34	35.67 [38.78][a]	**0.66 (0.61–0.71)**	46.04	38.04 [37.96][a]	**0.83 (0.80–0.85)**	51.63	37.29 [39.02][a]	**0.72 (0.67–0.78)**
ED visits	139.91	134.36	0.96 (0.83–1.11)	138.99	87.85 [98.06][a]	**0.63 (0.56–0.71)**	119.25	91.16 [91.12][a]	**0.76 (0.74–0.79)**	133.2	92.55 [97.22]	**0.69 (0.65–0.74)**
Outpatient visits												
Total	4677.50	4831.94	1.03 (0.92–1.16)	5137.32	4299.57 [4120.02][a]	**0.84 (0.78–0.90)**	4766.66	4569.5 [4570.77][a]	0.96 (0.91–1.01)	4857.87	4900.78 [4741.87][a]	1.01 (0.94–1.08)
Primary care	3725.07	3808.68	1.02 (0.90–1.16)	4068.76	3,369.89 [3222.85][a]	**0.83 (0.77–0.89)**	3783.98	3538.93 [3539.82][a]	**0.94 (0.88–0.99)**	3858.51	3784.52 [3641.19][a]	0.98 (0.91–1.05)
Any specialty	952.44	1023.26	1.07 (0.97–1.19)	1068.56	929.68 [897.17][a]	**0.87 (0.81–0.94)**	982.68	1030.57 [1030.95][a]	1.05 (0.99-1.11)	999.36	1116.27 [1100.68][a]	1.12 (1.03–1.21)
Relevant specialty	765.30	821.99	1.07 (0.97–1.19)	863.38	812.09 [774.79][a]	0.94 (0.87–1.01)	792.49	861.39 [861.68][a]	1.09 (1.02–1.15)	807.68	925 [905.87][a]	1.15 (1.06–1.24)
Virtual	16.82	37.83	**2.25 (1.35–3.75)**	19.34	2792.41 [2641.42][a]	**144.41 (90.11–231.43)**	21.04	3013.76 [3015.4][a]	**143.21 (93.96–218.27)**	103.61	3026.95 [2885.46][a]	**29.21 (9.88–86.32)**

Note: In bold: statistically significant

Abbreviations: CI, confidence intervals; ED, emergency department; RR, rate ratios.

[a]From: Public Health Units (PHU) with low COVID-19 infection rate. The PHU was considered a COVID-19 hotspot if the highest weekly percent of positive COVID-19 tests within a given month was ≥10%, accompanied by a monthly incident rate of positive COVID-19 tests of ≥100 per 100,000 people.[22] We found too few PHUs with a high COVID rates in our time series to report on COVID hotspots, potentially because the definition identifying high COVID rate PHUs lacked sensitivity.

TABLE 2 Observed and projected monthly rates and 95% CI estimated by ARIMA models for all-cause mortality: rates were calculated as the number of events per 100,000 people at risk

Rates	Population							
	Pre-COVID January to February 2020		Wave I March to May 2020		Summer Lull June to August 2020		Wave II September 2020 to March 2021	
	Observed	Projected (95% CI)	Observed	Projected (95% CI)	Observed	Projected (95% CI)	Observed	Projected (95% CI)
Entire population	75.30	74.75 (70.33–79.46)	**79.98**[a]	71.24 (66.35–76.50)	68.04	65.42 (60.24–71.05)	75.93	72.60 (66.58–79.16)
Subgroups								
Age, years								
18–24	3.03	3.77 (2.67–4.87)	3.55	3.62 (2.52–4.73)	4.38	3.62 (2.50–4.75)	4.25	3.62 (2.47–4.78)
25–34	5.50	5.51 (4.33–6.69)	**6.62**[a]	5.19 (3.88–6.50)	**6.94**[a]	5.19 (3.82–6.56)	6.25	5.19 (3.82–6.56)
35–49	10.52	9.76 (8.34–11.41)	10.20	9.81 (8.38–11.48)	11.13	9.9 (8.46–11.59)	11.05	9.83 (8.38–11.52)
50–64	37.27	37.95 (34.97–41.18)	**39.72**[a]	35.1 (32.05–38.46)	36.30	33.74 (30.31–37.56)	37.45	35.62 (31.86–39.82)
65+	283.08	291.96 (276.91–307.82)	**300.37**[a]	269.42 (253.74–286.08)	247.03	246.62 (230.66–263.67)	279.66	282.6 (264.23–302.25)
Sex								
Female	72.75	74.12 (70.11–78.37)	**77.11**[a]	67.22 (63.19-71.52)	63.31	61.74 (57.7–66.05)	72.27	70.17 (65.57–75.09)
Male	77.97	77.74 (73.05–82.74)	**82.98**[a]	75.78 (70.67–81.27)	72.98	69.69 (64.72–75.03)	79.74	76.75 (71.03–82.94)
Immigrants								
Yes	27.97	27.49 (25.23–29.96)	**32.69**[a]	26.39 (24.2–28.79)	**27.54**[a]	24.54 (22.49–26.76)	**33.49**[a]	27.4 (25.1–29.92)
No	87.32	87.19 (81.86–92.86)	**91.93**[a]	83 (77.13–89.33)	78.23	76.33 (70.11–83.11)	86.55	84.48 (77.27–92.36)
Neighborhood-level income quintile								
High	65.66	66.68 (63.27–70.28)	**68.31**[a]	60.91 (57.34–64.71)	58.04	55.9 (52.18–59.89)	64.39	62.85 (58.62–67.37)
Low	89.69	90.87 (85.43–96.64)	**97.37**[a]	84.3 (78.74–90.26)	82.82	77.5 (71.97–83.46)	92.92	86.71 (80.48–93.42)
Rural location								
Yes	103.30	103.34 (94.89–112.54)	100.06	99.2 (90.69–108.5)	89.97	90.56 (81.75–100.32)	93.74	100.53 (88.98–113.6)
No	72.09	71.76 (67.68–76.09)	**77.65**[a]	68.13 (63.59–72.99)	65.45	62.74 (57.86–68.04)	73.73	69.61 (63.92–75.79)
Mental health conditions								
Yes	202.68	211.15 (199.1–223.94)	**232.72**[a]	188.26 (176.6–200.69)	**185.67**[a]	172.13 (160.8–184.26)	**218.07**[a]	199.53 (186.38–213.6)
No	50.54	50.42 (48.09–52.87)	50.34	48.48 (46.13–50.96)	45.58	45.26 (42.77–47.89)	48.74	49.45 (46.28–52.84)

Note: Similar periods in previous years (2016–2019) were used to calculate projected rates.

Abbreviation: CI, confidence intervals.

[a]In bold: observed rates outside the projected 95% confidence intervals of projected rates were considered as significantly different.

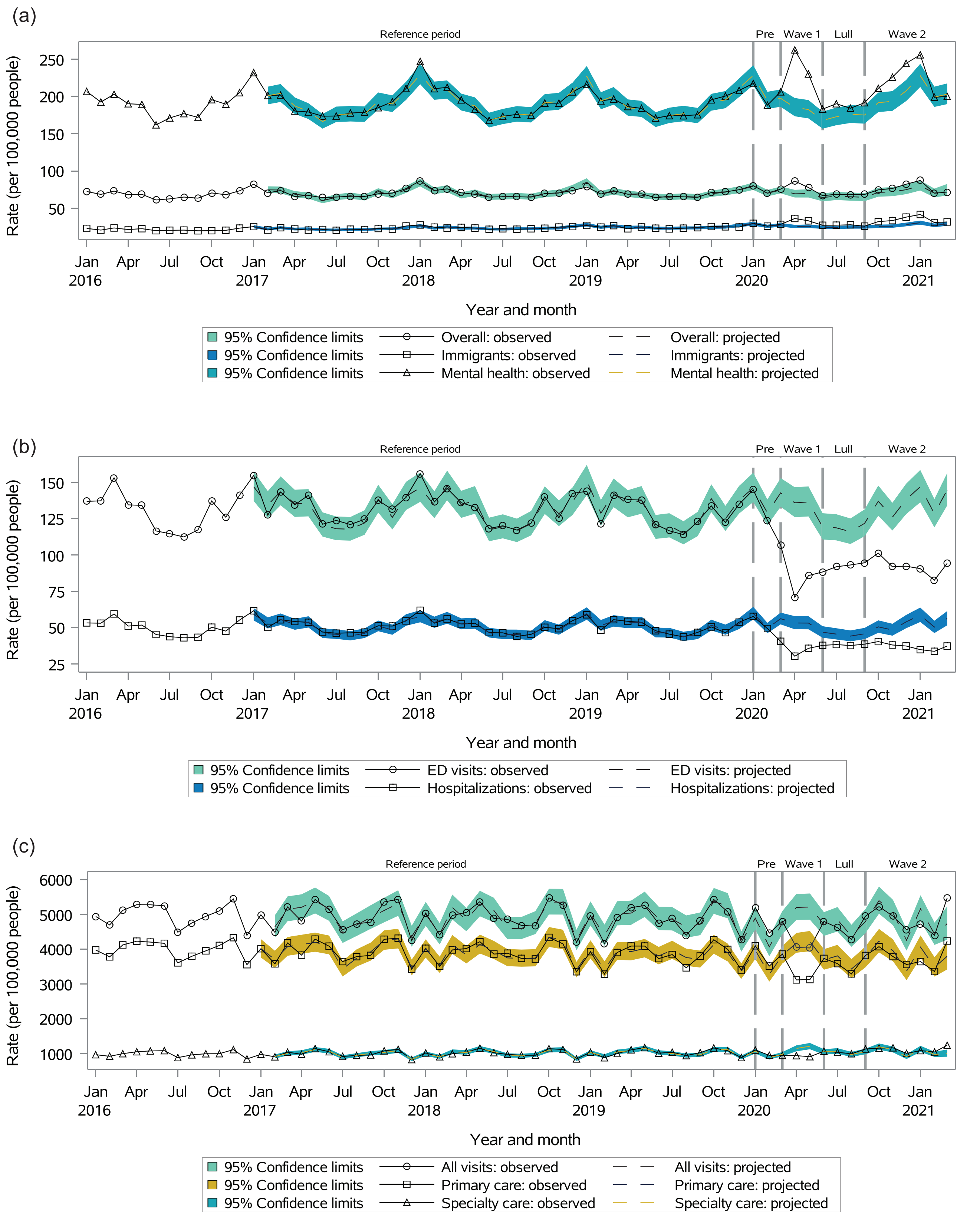

FIGURE 1 Observed versus projected monthly rates per 100,000 people at-risk: (a) All-cause mortality (overall, among immigrants and among individuals with mental health conditions); (b) Hospitalizations and emergency department (ED) visits (overall); and (c) Outpatient visits (all visits combined, primary care and specialist visits).

TABLE 3 Observed and projected monthly rates and 95% CI estimated by ARIMA models for hospitalizations for the ACSCs: rates were calculated as the number of events per 100,000 people at risk

	Population							
	Pre-COVID January to February 2020		Wave I March to May 2020		Summer Lull January to August 2020		Wave II September 2020 to March 2021	
Rates	Observed	Projected (95% CI)	Observed	Projected (95% CI)	Observed	Projected (95% CI)	Observed	Projected (95% CI)
Entire population	53.63	54.8 (51.01–58.87)	**35.67**[a]	54.25 (50.08–58.76)	**38.04**[a]	45.62 (41.93–49.64)	**37.29**[a]	52.07 (47.84–56.68)
Subgroups								
Age, years								
18–24	10.38	9.91 (7.73–12.69)	**7.69**[a]	10.19 (7.87–13.20)	8.45	10.19 (7.63–13.61)	8.44	10.19 (7.30–14.23)
25–34	8.85	8.56 (7.41–9.90)	**6.02**[a]	8.62 (7.46–9.97)	8.38	8.79 (7.60–10.16)	7.54	8.68 (7.49–10.05)
35–49	11.79	12.01 (10.63–13.57)	**9.37**[a]	11.90 (10.53–13.44)	10.30	10.95 (9.69–12.39)	**9.83**[a]	12.21 (10.79–13.83)
50–64	39.53	38.81 (35–43.04)	**27.22**[a]	36.96 (33.33–40.99)	**27.57**[a]	32.41 (29.23–35.94)	**25.81**[a]	37.00 (33.34–41.05)
65+	173.60	177.1 (160.74–195.13)	**112.01**[a]	185.33 (166.99–205.70)	**118.70**[a]	149.82 (134.47–166.91)	**117.52**[a]	169.12 (150.91–189.57)
Sex								
Female	52.61	54.54 (49.97–59.52)	**33.12**[a]	53.74 (49.24–58.65)	**35.48**[a]	44.83 (41.08–48.92)	**35.60**[a]	51.68 (47.27–56.50)
Male	54.69	55.59 (51.65–59.83)	**38.32**[a]	55.52 (51.53–59.82)	**40.71**[a]	46.66 (43.31–50.28)	**39.05**[a]	53.08 (49.22–57.24)
Immigrants								
Yes	20.47	20.25 (18.42–22.08)	**14.00**[a]	21.54 (19.70–23.38)	**16.18**[a]	19.68 (17.52–21.85)	**16.06**[a]	20.48 (18.14–22.83)
No	62.05	63.78 (59.27–68.62)	**41.14**[a]	63.21 (58.19–68.66)	**43.54**[a]	52.83 (48.40–57.67)	**42.61**[a]	60.61 (55.49–66.19)
Neighborhood-level income quintile								
High	43.03	43.08 (40.17–46.2)	**27.76**[a]	43.23 (40.31–46.35)	**29.83**[a]	35.75 (33.34–38.34)	**29.76**[a]	41.19 (38.41–44.18)
Low	69.51	71.29 (65.68–77.39)	**47.44**[a]	70.77 (64.54–77.60)	**50.24**[a]	60.29 (54.69–66.46)	**48.52**[a]	67.55 (61.20–74.55)
Rural location								
Yes	71.87	72.26 (65.1–80.2)	**45.87**[a]	72.48 (65.20–80.57)	**49.20**[a]	58.33 (52.47–64.85)	**46.22**[a]	68.02 (61.11–75.71)
No	51.52	52.68 (48.92–56.73)	**34.46**[a]	51.73 (47.52–56.32)	**36.70**[a]	43.89 (40.09–48.05)	**36.23**[a]	49.93 (45.59–54.68)
Mental health conditions								
Yes	101.53	104.95 (96.06–114.67)	**67.66**[a]	103.94 (95.13–113.57)	**74.55**[a]	90.14 (82.50–98.49)	**74.69**[a]	101.43 (92.80–110.87)
No	44.32	45.89 (42.04–50.09)	**29.46**[a]	44.83 (41.07–48.93)	**31.07**[a]	37.30 (34.17–40.72)	**30.14**[a]	42.45 (38.81–46.44)

Note: Similar periods in previous years (2016–2019) were used to calculate projected rates.

Abbreviations: ACSC, ambulatory care sensitive condition; CI, confidence intervals.

[a]In bold: observed rates outside the projected 95% confidence intervals of projected rates were considered as significantly different.

consequence of COVID-19 infection.[28] This may also be due to a multitude of social and behavioral factors. First, several surveys in North America suggested that some people with acute illness did not seek medical attention and be admitted to hospitals when required.[29–31] This deficiency in care-seeking behavior could have been compounded by deficiencies in the outpatient care setting as well,[32–34] as evident by a reduction in inpatient and outpatient visits. Second, the transition to virtual care may have also contributed as healthcare provider assessments may be limited and less effective when not seeing patients in person, especially for individuals with lower income, lower self-rated health, and recent immigrants.[31]

Mortality was not increased during *Wave II*. This could have been for many reasons, including better preparedness (differential triaging of access to diagnostic testing, procedures, and in-person visits) and less fear. Immigrants and individuals with mental health conditions, however, remained vulnerable with increased mortality throughout the first year of the pandemic. This is consistent with previous work that has shown that immigrants, especially new arrivals, could be at increased risk of contracting COVID-19[35–37] and COVID-19 mortality.[38] Several explanations exist[39]: immigrants are more likely to (i) have low income and live in overcrowded dwellings or multigenerational households[40]; (ii) be employed in occupations associated with a greater risk of infection, such as occupations with lack of paid sick leave or within healthcare and long-term care settings[41]; and (iii) have lower health literacy and official language proficiency, making it more difficult for some immigrants to understand and follow public health directives on reducing the risk of COVID-19 infection.[42] Our findings are consistent with a recent systematic review and meta-analysis demonstrating that mental health disorders were associated with increased COVID-19-related mortality.[43] The pandemic also added barriers to obtaining health services,[29] which likely disproportionately impacted these vulnerable groups who already experienced barriers to care. For example, having to obtain the means to receive virtual care and navigating a healthcare system where there were numerous closures and additional restrictions.[31] For immigrants, there could have been historical or cultural factors that led to increased fear and possibly even distrust in the healthcare system beyond what other groups felt. Thus, immigrants and individuals with mental health conditions are high-risk populations, requiring enhanced preventive and disease management strategies.

Our findings are also consistent with global trends in hospitalizations during the COVID-19 pandemic. However, previous studies examining health services use during the COVID-19 pandemic mostly focused on its early stages and hospitalizations,[3] unlike our study, which expanded beyond these early stages. Globally, reductions in hospital admissions (overall and for separate chronic conditions) have been reported in response to the COVID-19 pandemic.[4,44–49] Our study also expands upon these previous findings by examining mortality—a likely outcome of decreased hospitalizations, as well as of decreased ED and outpatient visits to offer a more complete picture of how an entire healthcare system coped. While we believe that fear of hospitals accounted for low hospitalization rates, people have offered alternative explanations. Public health measures such as physical distancing and instructing people to stay home mitigated transmission of other respiratory viruses such as influenza, rhinovirus or respiratory syncytial virus, lowered atmospheric pollution and/or led to better self-care and home management of chronic conditions. We cannot conclude that these factors did not also lower hospitalizations, but if they were the main drivers, one would expect mortality to decrease along with hospitalizations and not increase as observed.

Our findings of an initial decrease and then rebound in outpatient visits and increased virtual care use for ACSCs overall are consistent with studies focused on separate ACSCs.[50,51] Our findings are also consistent with a study demonstrating that the transition to virtual care was not associated with increased overall outpatient visit volumes.[52] Our finding of increased specialist visits toward the end of the year in individuals with mental health conditions can be potentially explained by the effects of the pandemic on exacerbating mental health problems[53] and by limited primary care and community resources for mental health.

Our study has several strengths, including its ability to examine near-complete data from a large, diverse population during the first year of the COVID-19 pandemic, its open cohort study design, its monthly level analysis, and its utilization of ARIMA modeling to project rates, which allowed us to account for seasonality and underlying trends prior to the pandemic.

However, this study has several limitations. First, it is a descriptive study that combined all ACSCs. Second, due to data availability, lack of validated algorithm and inadequate/inaccurate COVID-19 testing at the beginning of the pandemic, we were not able to identify the cause of death attributed to the COVID-19 infection; thus, we can not exclude that an increase in all-cause mortality at the beginning of the pandemic is due to unrecognized and recognized COVID-19. Next, immigrant and dementia databases were not available for the entire study period: due to database availability, we were unable to identify people who immigrated before 1985 and after May 2017. Because the dementia diagnosis algorithm involves healthcare usage over a 2-year period, prevalent dementia cases were only available from April 1996 to March 2019. Finally, we found too few PHUs with high COVID rates in our time series to report on COVID hotspots, potentially because the definition identifying high COVID rate PHUs lacked sensitivity. Finally, while our results are likely generalizable to Canada and other developed countries with public healthcare systems, this study needs to be repeated for other settings.

Shifting from hospital to family medicine-centered care, increasing primary and mental healthcare accessibility, implementing a hybrid model (a combination of virtual vs. in-person care) of patient-centered care, further education to help patients make informed decisions on when they should seek medical care within the context of public health guidelines, and to use technologies that can support the self-management of chronic conditions, such as self-management of blood glucose and blood pressure, are some potential suggestions to overcome the challenges and impacts of the COVID-19 pandemic on the management of chronic conditions.

CONCLUSION

Pandemic reductions in outpatient visits for ACSCs combined with reduced hospital admissions may have been associated with temporally increased mortality—disproportionately experienced by immigrants and those with mental health conditions—in the first year of the pandemic. Further work needs to be undertaken to understand why these trends occurred in vulnerable populations (such as individuals with mental health conditions and immigrants) to guide public health policy in future pandemics. Our findings provide insights that can be applied to avoid healthcare disruptions during future COVID-19 waves and other pandemics. Future studies should also aim to evaluate different COVID-19 variants, the impact of vaccination, and the outcomes of individual ACSCs.

ACKNOWLEDGMENT

We express sincere gratitude to Dr. J. Mark FitzGerald, who provided his knowledge and expertise for the study proposal development, the grant application that supported this study and a near-final draft of the manuscript critical appraisal. Dr. FitzGerald passed away on January 18, 2022. He has been at the forefront of shaping health outcomes for the Canadian and global respiratory community in ways that will live on for many years to come. Dr. FitzGerald's extraordinary contributions and impact on human health has made an indelible mark on the people he influenced as a clinician, researcher, colleague, mentor, and friend; he will be greatly missed. This study was supported by the Ottawa Hospital Academic Medical Organization (TOHAMO), the Ontario Health Data Platform (OHDP), a Province of Ontario initiative to support Ontario's ongoing response to COVID-19 and its related impacts, and by ICES (formerly known as the Institute for Clinical Evaluative Sciences), which is funded by an annual grant from the Ontario Ministry of Health (MOH) and the Ministry of Long-Term Care (MLTC). Parts of this material are based on data and information compiled and provided by the Canadian Institute for Health Information (CIHI). Parts or whole of this material are also based on data and/or information compiled and provided by IRCC current to May 2017. The analyses, conclusions, opinions, and statements expressed herein are solely those of the authors and do not reflect those of the funding or data sources; no endorsement is intended or should be inferred. However, the analyses, conclusions, opinions, and statements expressed herein are those of the author and not necessarily those of CIHI or IRCC. Specifically, no endorsement by the OHDP, its partners, or the Province of Ontario, and ICES, CIHI or IRCC or the Ontario MOH and/or MLTC is intended or should be inferred.

CONFLICT OF INTEREST

Tetyana Kendzerska is supported by the PSI (Physicians' Services Incorporated) foundation: The 2020 PSI Graham Farquharson Knowledge Translation Fellowship. She also received a speaker honorarium from AstraZeneca Canada Inc. and is a Clinical Consultant at Pitolisant Medical Advisory Board (Paladin Labs Inc.). Teresa To is supported by the Canadian Institutes of Health Research, Tier 1 Canada Research Chair in Asthma. Claire Kendall is supported by a Faculty of Medicine Clinical Chair Award. The funding sponsors had no role in the study design, data collection and analysis, or preparation of the manuscript. There were no other relationships or activities that could appear to have influenced the submitted work.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Kendzerska T, Zhu DT, Pugliese M, et al. Trends in all-cause mortality and inpatient and outpatient visits for ambulatory care sensitive conditions during the first year of the COVID-19 pandemic: A population-based study. *J Hosp Med*. 2022;17:726-737. doi:10.1002/jhm.12920