scientific reports

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Trends in medication use during the COVID-19 pandemic in Quebec, Canada

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The COVID-19 pandemic has disrupted health and services worldwide. We aimed to describe the changes in medication use during the COVID-19 pandemic in Quebec, Canada. Using a large healthcare database, we created weekly cohorts of all individuals ≥ 1 year old covered by the public drug plan from January 2016 to March 2022. We calculated the weekly number of prevalent and new users of different medications, including both chronic and short-term medications. We integrated the 2016–2019 weekly numbers in Quasi-Poisson regressions, with each gender and age group fitted separately. From these models, we estimated the weekly proportions of prevalent and new users expected for 2020–2021 and their 99% prediction interval [99% PI]. Results were analyzed using the ratio of the overall weekly proportion of users (observed/expected) across four periods, selected according to the different waves of the pandemic: Period 1: 1st wave (February 2020–August 2020), Period 2: 2nd wave (August 2020–March 2021), Period 3: 3rd and 4th waves (March 2021–December 2021), and Period 4: 5th and 6th waves (December 2021–March 2022). Each cohort included over 3,000,000 individuals (53% female). The proportion of new users of most medications dropped in Period 1, with exceptions like antipsychotics (ratio of adjusted overall weekly proportion observed/expected [99% PI] 1.02 [1.00–1.04]). From Period 2 onwards, the initiation of antidiabetics, lipid-lowering medications and attention deficit hyperactivity disorder (ADHD) medications, among others, exceeded expected trends, but remained below expectations notably for systemic antibiotics (Period 4: 0.71 [0.69–0.72]), nasal/oral corticosteroids (Period 4: 0.69 [0.67–0.70]/Period 4: 0.69 [0.67–0.70]) and medications for obstructive lung diseases (Period 4: 0.69 [0.68–0.71]). While the prevalent use of most chronic medications remained relatively close to expectations, observed immediate and long-term variations in medication use should be considered in studies including pandemic years and anticipated in public health planning in case of future pandemics.

Keywords Medication use, Drug utilization, COVID-19, Pandemic, Quebec, Canada

Abbreviations

ATC	Anatomical Therapeutic Chemical
ADHD	Attention deficit hyperactivity disorder
BPH	Benign prostatic hyperplasia
CDC	Centers for Disease Control and Prevention
COPD	Chronic obstructive pulmonary disease
GLP-1	Glucagon-like peptide-1
HIV	Human immunodeficiency virus
IUD	Intrauterine device
NSAID	Nonsteroidal anti-inflammatory drug
QICDSS	Quebec Integrated Chronic Disease Surveillance System
SGLT2i	Sodium-glucose co-transporter 2 inhibitors
99% PI	99% Prediction interval

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Background

The COVID-19 pandemic has drastically disrupted social, economic, and health services worldwide[1]. The threat of the disease itself, along with the sanitary measures implemented by authorities (e.g., social distancing, school closures, non-emergency health services postponed) contributed to impacting everyday life. More specifically, the province of Quebec entered a state of health emergency on March 13th, 2020, which lasted until June 1st, 2022. Quebec experienced a challenging onset of the COVID-19 pandemic, with a considerable increase in the number of early cases compared to other Canadian provinces[2]. The province also appears to stand out for the stringency of the restrictions imposed and the tendency to keep them restrictive for a longer period compared to British Columbia or Alberta[2,3].

These changes likely impacted medication use[4–10]. Health measures may have reduced the transmission of contagious diseases and associated antibiotic use[10–12]. They also heightened mental health risks[13], foreshadowing increased use of medications such as antidepressants[14]. Medications for preventing or treating COVID-19, including vaccinations[15,16], were added to therapies. Suggested harmful or beneficial associations between certain medications and COVID-19 might have influenced their avoidance or preference during the pandemic[17]. Disrupted access to health services[18,19] likely contributed to delayed diagnoses and initiation of treatments, and complicated the continuity of those administered solely by health professionals[20]. The exceptional circumstances also led to stockpiling medications, similar to other consumer products like toilet paper[17,21]. Drug supply shortages were feared and momentarily increased during the early pandemic[22]. Mitigating measures were implemented, including in Canada, where pharmacists were prompted to limit medication dispense to 30-day supplies[22].

Numerous studies have examined changes in medication use during COVID-19 pandemic[4–10,23]. However, many studies have focused on selected medications, have not differentiated between new treatments and those already in use, or have analyzed only short-term changes. None provided a complete overview of the situation in the province of Quebec. Understanding medication use during the pandemic is essential to assess the representativeness of this period and the possible need to exclude it from subsequent analyses. It also allows sound interpretation of surveillance data to inform decision-makers and resource planning. Accordingly, we aimed to compare the use of medications during the pandemic in 2020–2022 to the one expected from predictions based on historical trends from 2016 to 2019 in the province of Quebec, Canada.

Methods

Data source

We used the Quebec Integrated Chronic Disease Surveillance System (QICDSS) operated by the *Institut national de santé publique du Québec*[24]. This database identifies individuals with a unique code linking data across several medico-administrative databases. The QICDSS includes the health insurance database, providing demographic data and public drug/health insurance eligibility; the hospitalization database, collecting inpatient discharge data; the physician claims database, listing fee-for-service medical procedures; and the pharmaceutical services database, detailing medications dispensed in community pharmacy (e.g., medication, treatment duration, dose, dosage form). The pharmaceutical database covers about 30% of individuals aged 1–64[25] and approximately 90% of those ≥ 65 years[24]. The use of QICDSS for surveillance purposes has been approved by the Quebec *Commission d'accès à l'information* and the provincial Public Health Research Ethics Board[26]. The need for informed consent from participants is waived by provincial Public Health Research Ethics Board in accordance with the *Act respecting Access to documents held by public bodies and the Protection of personal information*. All methods were performed in accordance with the relevant guidelines and regulations associated with the use of the database. Data is de-identified, protected by privacy safeguards and not publicly available.

Medications analysed

We analyzed prescribed medications potentially affected by the pandemic, covering a range of chronic (e.g., antidepressants, antihypertensives, antidiabetics, contraceptives, thyroid hormones) and short-term medications (e.g., antibiotics, benzodiazepines, corticosteroids). These medication categories were selected because they include relatively common medications and cover a wide range of therapeutic indications. Medications were grouped into categories using Anatomical Therapeutic Chemical (ATC) codes (Supplementary Table S1). The ATC codes used for each category were chosen based on a general analysis of the classification tree and clinical practice in Quebec (29). Of note, treatment indication is not available within the QICDSS, and ATC codes do not necessarily indicate the purpose for which a medication is used (e.g., an antidiabetic may be used for indications other than diabetes, such as weight loss). Some ATC codes could theoretically have been included in more than one category (e.g., medications with both antihypertensive and antiarrhythmic activities), but they were ultimately assigned to only one category to maintain mutual exclusivity.

Cohort study and outcomes

We created weekly cohorts from January 2016 to March 2022, using Centers for Disease Control and Prevention (CDC) weeks. Each cohort included individuals aged ≥ 1 year covered by the public health plan in the year of interest and by the public drug plan throughout the entire CDC week and the previous year, forming our analysis denominator. We differentiated new medication use (also referred to as initiation of medication or incidence) and active use (prevalence):

(1) *Weekly number of new users* New users were defined as individuals claiming a medication in the evaluated category during the CDC week without claims for the same category in the past 365 days. For instance, an individual claiming a long-acting insulin (ATC A10AE) was not reported as a new user if they had claimed any insulin (ATC A10A) or any other antidiabetics (ATC A10) in the previous year, such as metformin

(ATC A10BA02). This method identified treatment initiation but not treatment intensification or substitution. New users of "all medications for chronic conditions" were those who first initiated any chronic medications in this study without prior claims in the previous year. Only claim dates were used to measure this outcome.

(2) *Weekly number of prevalent users* Prevalent users were defined as individuals with an active prescription for ≥ 1 day during the week in the evaluated category, regardless of previous use. We determined the active prescription period using claim dates and treatment duration (specified by the pharmacist in the pharmaceutical software when the medication is dispensed), adding a grace period of 50% of the treatment duration to account for non-adherence. For example, a 30-day medication dispensed on January 1st, 2020, was considered active until mid-February. Given the known unreliability in the recorded treatment duration for insulins, as-needed bronchodilators, and warfarin, we used a fixed duration of 90, 90, and 60 days, respectively, while removing any grace period (Supplementary Table S2). In addition to specific medication categories, we also estimated the weekly number of polypharmacy users (5 active medications or more during the week). For the polypharmacy count, we included all dosage forms (e.g., tablet, inhaler, cream) but excluded aid devices, diagnostic agents, vaccines and irrelevant products (e.g., bandages).

Statistical analysis

Weekly numbers of new users measured in 2016–2019 were integrated into Quasi-Poisson regression models to estimate expected numbers for 2020–2022 without the pandemic. Separate models were fitted for each sex and age group (generally, 1–19, 20–34, 35–49, 50–64, 65–74, 75 +), with totals of expected users obtained by summing across categories. A spline function including natural cubic bases with six equidistant nodes smoothed trends and accounted for seasonal fluctuations. Models included the CDC year as a continuous variable to consider annual trends and a holiday season dichotomous variable (weeks including the period from December 25th to January 1st). Cohort size variations were included as an offset variable. A 99% prediction interval (99%PI) was estimated using a 2-stage bootstrap simulation (Supplementary methods). Ratios with prediction interval not encompassing 1 reflected a statistically significant increase or decrease in medication use, compared to expected use. Expected numbers of prevalent users were calculated the same way as described above, except that seven nodes were used for antihypertensives and "All medications for chronic conditions" to address covariance matrix issues when calculating prediction intervals. Furthermore, in some models of prevalent users, specific adjustments were made to improve fit following visual inspection (e.g., natural logarithm of the CDC year, interaction term such as CDC year logarithm*spline function).

The expected weekly proportion of new/prevalent users corresponds to the expected weekly number of new/prevalent users divided by the total cohort size. Both observed and expected proportions were age- and sex-adjusted with direct standardization using the first 2020 CDC week cohort as a reference. Proportions of prevalent users are presented as percentages (/100 people), for ease of interpretation. Proportions of new users are presented per 100,000 people, as keeping the denominator as a percentage made interpretation of the results more challenging (numerator < 1).

We also analyzed results by pandemic periods: Period 1 (1st wave, February 23, 2020-August 1, 2020), Period 2 (2nd wave, August 2, 2020-March 20, 2021), Period 3 (3rd and 4th waves, March 21, 2021-December 4, 2021), and Period 4 (5th and 6th waves, December 5, 2021-March 26, 2022). To calculate the overall weekly proportion of new/prevalent users for each period, we summed the numerators (number of users) and divided them by the cumulative denominators for the weeks within each period.

We described the first cohort of each financial year (14th CDC week) using sociodemographic variables, including the material and social deprivation index as an ecological socioeconomic proxy[24] and the conditions included in the Charlson-Elixhauser Combined Comorbidity Index Score[27]. All statistical analyses were performed with SAS version 9.4 (SAS Institute, Cary, NC) using the GLIMMIX procedure for regression models.

Results

Each cohort included over 3,000,000 individuals, representing over a third of Quebec's total population during the study period[28]. Nearly 53% of individuals were female, 78% resided in urban areas, and approximately a quarter had at least two chronic conditions (Table 1).

The overall weekly proportion of new users declined across most medication categories during the first COVID-19 wave (Fig. 1). However, initiation remained close to expectations for antiepileptics (ratio of adjusted weekly proportions observed/expected [99% PI] = 1.01 [0.98–1.04]), antipsychotics (1.02 [1.00–1.04]), benzodiazepines (0.99 [0.97–1.00]), and medications for opioid dependence (0.90 [0.80–1.01]). From the second wave onwards, trends differed by medication category. For instance, chronic obstructive pulmonary disease (COPD)/asthma medications, systemic antibiotics, oral corticosteroids and nasal corticosteroids continued to show statistically significant declines, with initiation remaining approximately 30% lower than expected in Period 4 (i.e., ratio = 0.69 [0.68–0.71], 0.71 [0.69–0.72], 0.69 [0.67–0.70], and 0.69 [0.67–0.70], respectively). Systemic antibiotics specifically sustained a statistically significant 32%, 34%, 12% and 29% relative decline in initiation from the first to the last period, respectively (Figs. 1 and 2). Other medications had lower initiation up to 2022, such as treatments for human immunodeficiency virus (HIV), glaucoma, or opioid/tobacco dependence. Conversely, antidiabetics initially decreased by 21% (Period 1 = 0.79 [0.77–0.82]), and subsequently increased thereafter by 12% (Period 2 = 1.12 [1.07–1.15]), 9% (Period 3 = 1.09 [1.04–1.13]), and 20% (Period 4 = 1.20 [1.14–1.26]). While this initial decrease in Period 1 appears more prominent among older age groups (e.g., 65–74 years old = 0.78 [0.74–0.82]; 75 years old or more = 0.70 [0.65–0.74]) than among younger age groups (e.g., 1–34 years old = 0.95 [0.84–1.08]; 35–49 years old = 0.92 [0.85–1.03]), all age groups showed a statistically significant increase in initiation in at least one period from Period 2 onwards (Supplementary Fig. S2). Similar patterns of increased initiation were observed for antipsychotics (+ 8%, + 4%, + 4%), lipid-lowering medications (+ 9%, + 13%, + 26%),

	Financial year					
	2016	2017	2018	2019	2020	2021
Population size	3,128,970	3,187,517	3,240,392	3,297,558	3,355,347	3,440,466
Female sex, n (%)	1,658,999 (53.0)	1,687,262 (52.9)	1,712,685 (52.9)	1,740,394 (52.8)	1,768,928 (52.7)	1,811,736 (52.7)
Age, n (%)						
1–18	359,519 (11.5)	362,135 (11.4)	364,264 (11.2)	366,056 (11.1)	369,608 (11.0)	380,820 (11.1)
19–34	459,528 (14.7)	463,492 (14.5)	466,567 (14.4)	469,649 (14.2)	472,798 (14.1)	480,856 (14.0)
35–49	423,620 (13.5)	427,437 (13.4)	431,287 (13.3)	437,433 (13.3)	445,117 (13.3)	459,388 (13.4)
50–64	625,709 (20.0)	630,464 (19.8)	630,769 (19.5)	629,001 (19.1)	623,224 (18.6)	624,189 (18.1)
65–74	709,295 (22.7)	733,724 (23.0)	757,359 (23.4)	782,289 (23.7)	806,520 (24.0)	830,955 (24.2)
75+	551,299 (17.6)	570,265 (17.9)	590,146 (18.2)	613,130 (18.6)	638,080 (19.0)	664,258 (19.3)
Material deprivation index quintile, n (%)						
1st (least deprived)	457,273 (14.6)	472,879 (14.8)	489,916 (15.1)	507,610 (15.4)	524,471 (15.6)	542,271 (15.8)
2nd	488,384 (15.6)	502,740 (15.8)	516,018 (15.9)	529,289 (16.1)	542,902 (16.2)	560,473 (16.3)
3rd	567,525 (18.1)	579,019 (18.2)	588,206 (18.2)	598,081 (18.1)	608,819 (18.1)	624,730 (18.2)
4th	635,306 (20.3)	643,736 (20.2)	649,498 (20.0)	656,308 (19.9)	663,426 (19.8)	677,187 (19.7)
5th (most deprived)	753,094 (24.1)	758,012 (23.8)	759,430 (23.4)	762,142 (23.1)	765,902 (22.8)	775,134 (22.5)
Missing data	227,388 (7.3)	231,131 (7.3)	237,324 (7.3)	244,128 (7.4)	249,827 (7.4)	260,671 (7.6)
Social deprivation index quintile, n (%)						
1st (least deprived)	500,236 (16.0)	510,686 (16.0)	520,353 (16.1)	529,820 (16.1)	541,979 (16.2)	559,625 (16.3)
2nd	540,912 (17.3)	552,968 (17.3)	562,218 (17.4)	573,838 (17.4)	587,525 (17.5)	605,665 (17.6)
3rd	560,563 (17.9)	574,158 (18.0)	585,161 (18.1)	596,406 (18.1)	608,945 (18.1)	627,544 (18.2)
4th	612,086 (19.6)	622,735 (19.5)	633,391 (19.5)	645,435 (19.6)	654,299 (19.5)	666,812 (19.4)
5th (most deprived)	687,785 (22.0)	695,839 (21.8)	701,945 (21.7)	707,931 (21.5)	712,772 (21.2)	720,149 (20.9)
Missing data	227,388 (7.3)	231,131 (7.3)	237,324 (7.3)	244,128 (7.4)	249,827 (7.4)	260,671 (7.6)
Place of residence, n (%)						
Rural	677,689 (21.7)	686,105 (21.5)	693,094 (21.4)	700,727 (21.2)	711,907 (21.2)	732,741 (21.3)
Urban	2,438,317 (77.9)	2,488,347 (78.1)	2,531,046 (78.1)	2,577,283 (78.2)	2,618,870 (78.1)	2,672,570 (77.7)
Missing data	12,964 (0.4)	13,065 (0.4)	16,252 (0.5)	19,548 (0.6)	24,570 (0.7)	35,155 (1.0)
Number of chronic conditions, n (%)[a]						
0	1,593,202 (50.9)	1,637,537 (51.4)	1,689,979 (52.2)	1,753,039 (53.2)	1,841,054 (54.9)	1,907,375 (55.4)
1	706,314 (22.6)	710,850 (22.3)	709,732 (21.9)	706,264 (21.4)	694,045 (20.7)	709,222 (20.6)
2–4	586,972 (18.8)	588,180 (18.5)	584,743 (18.0)	579,101 (17.6)	563,809 (16.8)	567,155 (16.5)
≥ 5	242,482 (7.7)	250,950 (7.9)	255,938 (7.9)	259,154 (7.9)	256,439 (7.6)	256,714 (7.5)
Chronic conditions, n (%)[b]						
Diabetes	432,146 (13.8)	444,036 (13.9)	453,053 (14.0)	462,838 (14.0)	471,244 (14.0)	485,535 (14.1)
Hypertension	1,043,410 (33.3)	1,061,137 (33.3)	1,075,633 (33.2)	1,090,811 (33.1)	1,100,347 (32.8)	1,117,221 (32.5)
Coronary artery disease	454,167 (14.5)	463,014 (14.5)	468,259 (14.5)	473,689 (14.4)	478,172 (14.3)	484,519 (14.1)
Cerebrovascular disease and transient ischemic attack	133,719 (4.3)	137,860 (4.3)	141,828 (4.4)	146,348 (4.4)	149,497 (4.5)	154,040 (4.5)
Asthma	356,142 (11.4)	367,183 (11.5)	377,177 (11.6)	387,356 (11.7)	395,123 (11.8)	407,705 (11.9)
COPD	345,361 (11.0)	357,982 (11.2)	368,442 (11.4)	378,093 (11.5)	378,570 (11.3)	384,167 (11.2)
Heart failure	132,163 (4.2)	136,497 (4.3)	140,403 (4.3)	143,811 (4.4)	145,626 (4.3)	149,822 (4.4)
Anxiety and depressive disorders	249,937 (8.0)	215,939 (6.8)	214,437 (6.6)	223,040 (6.8)	227,241 (6.8)	263,527 (7.7)
Schizophrenia	26,017 (0.8)	22,630 (0.7)	21,538 (0.7)	21,021 (0.6)	18,829 (0.6)	20,763 (0.6)
Fractures (all sites)	32,166 (1.0)	31,273 (1.0)	32,998 (1.0)	30,849 (0.9)	23,370 (0.7)	25,753 (0.7)
Alzheimer and related diseases	82,651 (2.6)	85,227 (2.7)	88,093 (2.7)	91,030 (2.8)	91,314 (2.7)	93,227 (2.7)
Number of medications, n (%)[c]						
0–4	1,591,881 (54.4)	1,610,730 (54.1)	1,651,061 (54.4)	1,693,402 (54.7)	1,822,479 (57.4)	1,843,604 (56.6)
5–9	744,711 (25.5)	757,315 (25.4)	766,124 (25.3)	776,672 (25.1)	774,474 (24.4)	795,097 (24.4)
10–14	362,905 (12.4)	374,613 (12.6)	380,550 (12.5)	387,211 (12.5)	367,531 (11.6)	385,870 (11.9)
15+	226,462 (7.7)	234,462 (7.9)	235,227 (7.8)	239,466 (7.7)	212,001 (6.7)	230,575 (7.1)

Table 1. Characteristics of eligible individuals of the 14th CDC week (late March-early April) of each year. *COPD* Chronic obstructive pulmonary disease. [a]Using a 5-year lookback period, including the current financial year. [b]The lookback periods varied based on the chronic condition, ranging from lifetime (starting from 1996, e.g., diabetes) to a 1-year period (e.g., anxiety and depressive disorders), including the current financial year. [c]The number of medications claimed during each financial year was calculated exclusively for individuals who were eligible throughout the entire financial year. Denominators of the percentages for each year from 2016 to 2021 are as follows: 2,925,959; 2,977,120; 3,032,962; 3,096,751; 3,176,485 and 3,255,146 individuals.

and attention deficit hyperactivity disorder (ADHD) medications (+12%, +12%, +16%) from Periods 2 to 4, respectively. Antiarrhythmics/digoxin and thyroid hormones also showed increases in initiation after the first period, but did not appear statistically significant for all periods. Antidepressants experienced a 12% decrease in initiation during the first period (0.88 [0.87–0.89]), followed by a 10% increase in Period 2 (1.10 [1.08–1.12]), returning to expected levels in Period 3 (1.01 [1.00–1.03]) and 4 (1.00 [0.98–1.03]).

In contrast, prevalent use of chronic medications generally remained close to expected levels across periods, with minor fluctuations observed (Fig. 3). Most chronic medication categories (15/17, 88.2%) showed less than a 5% difference in overall weekly proportion of active users compared to expectations across periods. Half of these categories (9/17, 52.9%) had differences of less than 2% across periods, such as antidepressants with minor increases (≈ 1%) from Period 2 onwards (Figs. 2 and 3), while 3 categories showed (> 2%) increases. Overall, prevalent use of "All medications for chronic conditions" (Period 1 = 1.00 [1.00–1.00], Period 4 = 1.00 [1.00–1.00]) and polypharmacy (5 medications or more) (Period 1 = 0.99 [0.99–1.00], Period 4 = 1.00 [1.00–1.01]) closely corresponded with expectations. However, notable declines were observed in COPD/asthma medications and several medications for short-term conditions, such as nasal/oral corticosteroids, tobacco/opioid dependence medications, antibiotics for systemic use, and antibiotic and anti-inflammatory eye drops. This latter category saw a statistically significant 29% decline in prevalent use during the first period (0.71 [0.70–0.71]). Regarding antibiotics for systemic use, a decline in prevalent use was observed across all age groups (Supplementary Fig. S3), which generally persisted throughout the entire period under review. Conversely, prevalent use of antiarrhythmics/digoxin increased, reaching + 8% in the last period (1.08 [1.08–1.09]), a pattern specific to older age groups (e.g., Period 4, 75 years old or more = 1.08 [1.07–1.08]) compared to younger age groups (e.g., Period 4, 20–34 years old = 0.81 [0.74–0.88]) (Supplementary Fig. S3). Specific trends also included a potential decline in antineoplastic use despite consistent initiation rates from the second period onwards.

More information regarding each medication category, including ratios (99%PI) for each period, can be found in the Supplementary analysis (Supplementary Fig. S1, Supplementary Tables S3–S6). Models with poor fit in pre-pandemic years, such as those analyzing prevalent use of ADHD, gastric acidity and HIV medications, are presented in the Supplementary analysis only, and for information purposes.

Discussion

Initiation of most medications decreased during the first COVID-19 wave. Some, like medications for COPD/asthma, antibiotics for systemic use, and corticosteroids, continued to show lower initiation rates through March 2022. Others, like antidiabetics, lipid-lowering, and ADHD medications, exhibited sustained increases post-first wave. Prevalent use of many chronic medications remained close to expectations until March 2022. However, antibiotics for systemic use, corticosteroids, asthma/COPD medications, medication for tobacco/opioid dependence, and anti-infectious/anti-inflammatory eye drops saw more substantial declines across periods.

Others have reported lower medication initiation rates during the first COVID-19 wave. Aboulatta et al. noted a 46% immediate decline ($p = 0.002$) in incident use of medications between the first and second quarter of 2020 in Manitoba, Canada[4]. Other studies observed reduced initiation of chronic medications (e.g., antihypertensives, antidiabetics, antidepressants) during the pandemic's early months across different countries[29,30]. Potential explanations include reduced access to or use of healthcare services[31], with 30% of adult Canadians in need of health care services delaying medical contact during the first year of the pandemic due to reasons including COVID-19 concerns[19].

From the second wave onwards, initiation patterns varied by medication. For instance, our results indicate a statistically significant decline in new systemic antibiotic use during the first wave (− 32%), continuing until the last period (− 29%). This trend is supported by studies in Europe, the United States and Canada[4,10,29,32–35], some of which reported declines persisting into 2021[4,34,35]. In Canada, an ecological study found a 26.5% average decline in antibiotic dispensing during the first 8 months of the pandemic, primarily driven by a reduction in antibiotics for respiratory infections[10]. COVID-19 mitigation measures like face masks, social distancing, and lockdowns likely contributed to reducing infection transmission[12]. Similarly, the use of medications for obstructive respiratory diseases and corticosteroids, which treat complications of respiratory infections, also declined[4,32,36–38]. Our study suggested this decline persisted until 2022. The decline in the initiation of medications for obstructive respiratory diseases is also probably due to the decline in new diagnostics of asthma/COPD in the province of Quebec during the first 2 years of the pandemic[39]. The lower initiation of medications for HIV, glaucoma, or opioid/tobacco dependence may reflect delays in diagnosis and treatment (or preventive treatment, e.g., pre- or post-HIV exposure prophylaxis), although this hypothesis cannot be confirmed based solely on our data.

Conversely, some chronic medications saw a statistically significant increase in initiation from the second period onwards, notably antidiabetics and lipid-lowering medications. This rise might compensate for the earlier decline in treatment initiation. Additionally, studies have reported an increased incidence of diabetes during the pandemic or a possible link between COVID-19 and a higher risk of diabetes, though this is debated[40–42]. This might explain the uptick in antidiabetic medication initiation, also observed in Ontario (Canada)[43], as well as the one for lipid-lowering medications, as Canadian guidelines recommend statins for many diabetes patients[44]. The growing use of glucagon-like Peptide-1 [GLP-1] agonists and sodium-glucose co-transporter 2 inhibitors (SGLT2i) for weight loss and heart failure may also contribute[43,45]. Other medications, such as ADHD and thyroid medications, also saw increased initiation across most periods from the second wave onwards. This contrasts with Aboulatta et al. who did not observe a notable rise in thyroid medication initiation during the pandemic up to March 2021[4]. A study of 47 countries, including Canada, found ADHD medication consumption declined in 2020 but exceeded predictions in 2021, possibly due to catching up from the 2020 decline or worsening ADHD symptoms during the pandemic[46].

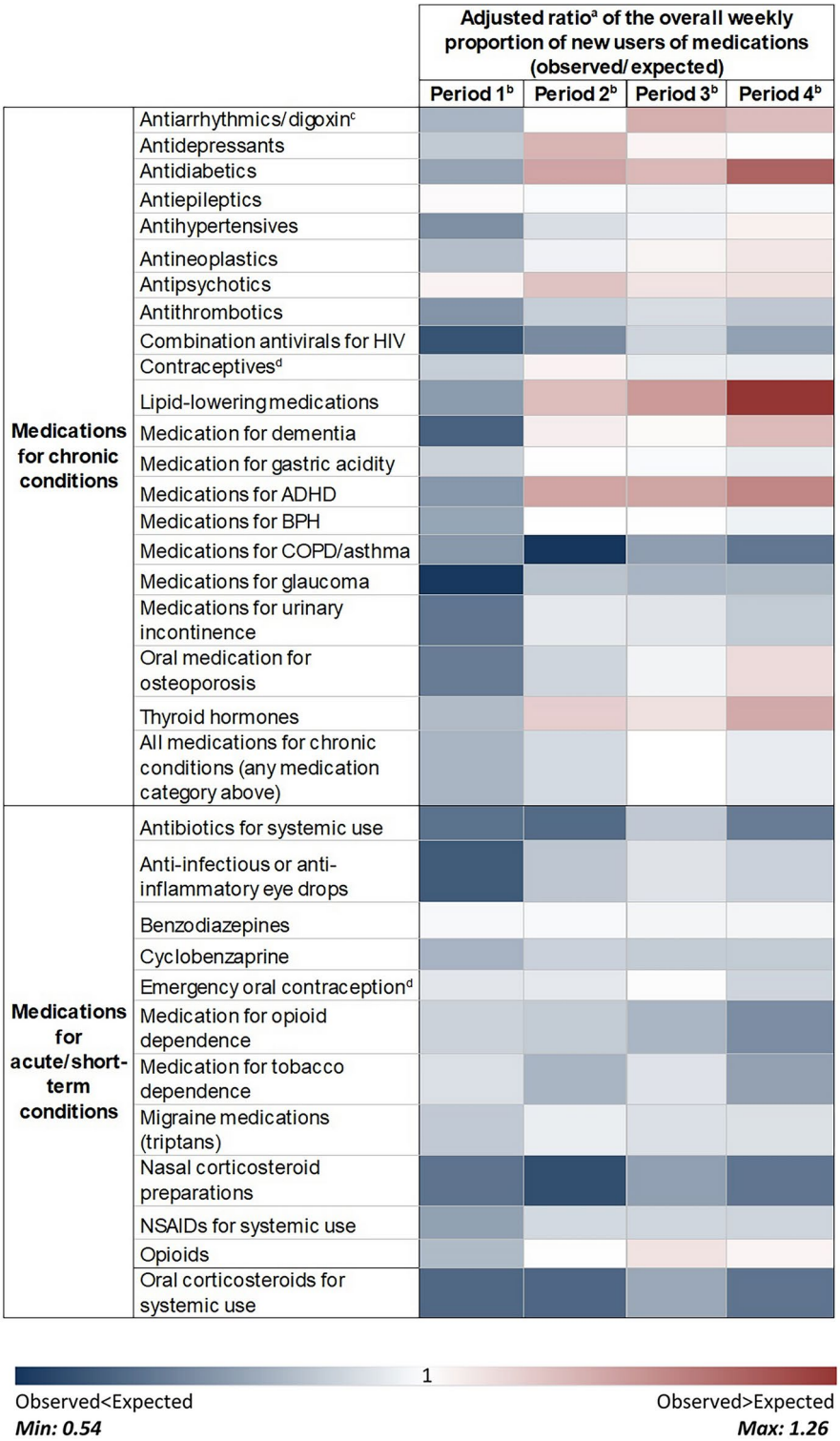

Fig. 1. Adjusted ratio (observed/expected) of the overall weekly proportion of new users, by medication category and time period. A decline in observed use, compared to expected use, is indicated by blue cells whereas an increase in use is indicated by red cells (to determine the statistical significance of these fluctuations, please refer to the Supplementary Tables). All fluctuations mentioned in the text are statistically significant, unless otherwise indicated. (**a**) Color scales used in Figs. 1 and 3 are the same. The minimum and maximum values indicated in the legend are based on the most extreme values found in both figures combined. (**b**) Period 1: 1st wave, February 23, 2020-August 1, 2020; Period 2: 2nd wave, August 2, 2020-March 20, 2021; Period 3: waves 3–4, March 21, 2021-December 4, 2021; Period 4: waves 5–6; December 5, 2021–March 26, 2022. (**c**) Excluding calcium channel blockers and beta-blockers (included in "Antihypertensives"). (**d**) Information reported for women only. Excluding IUDs and subcutaneous implants. *ADHD* attention deficit hyperactivity disorder, *BPH* Benign prostatic hyperplasia, *COPD* chronic obstructive pulmonary disease, *HIV* human immunodeficiency virus, *IUD* intrauterine device, *NSAID* nonsteroidal anti-inflammatory drug.

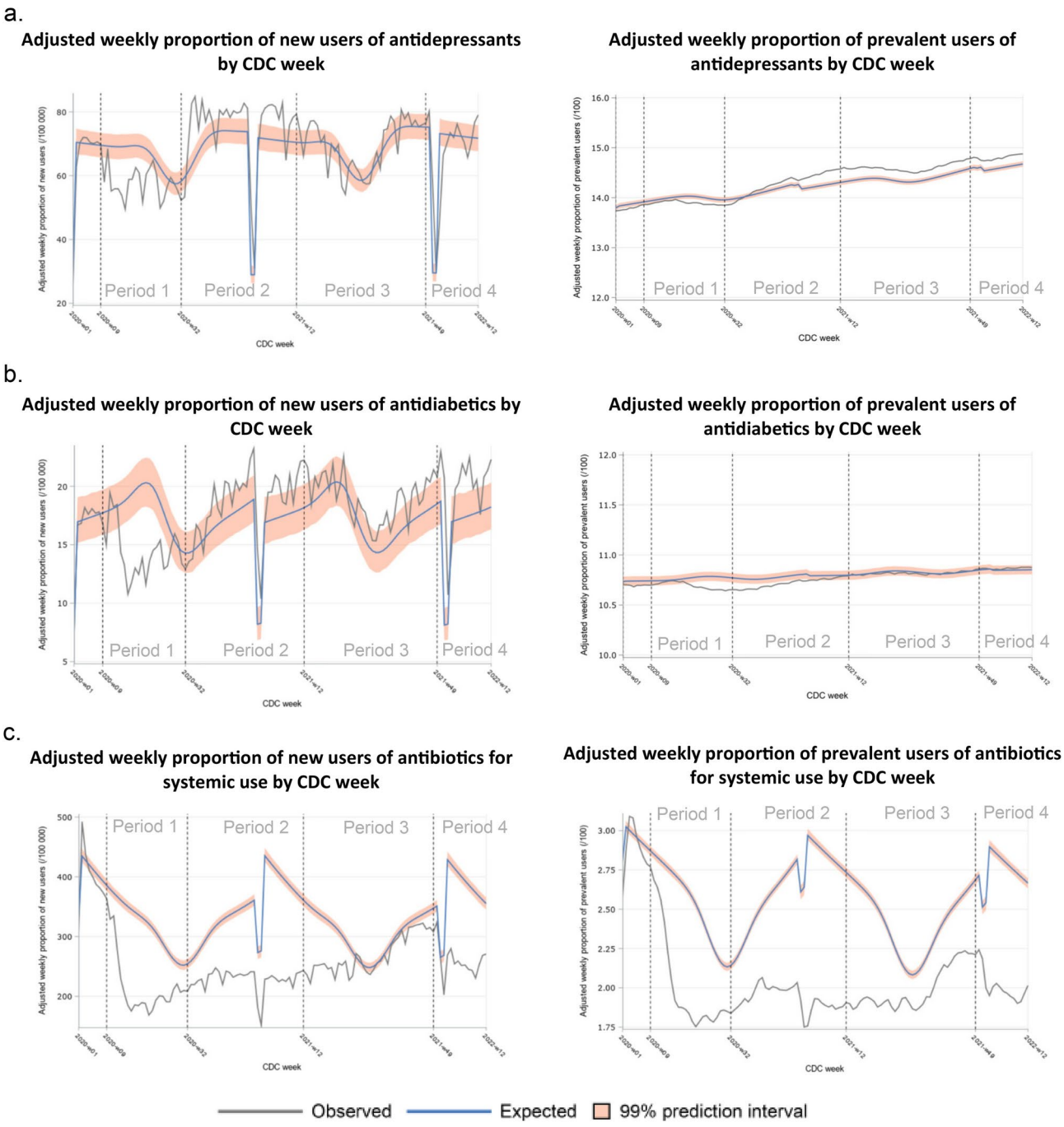

Fig. 2. Adjusted weekly proportion of news users (/100,000) and prevalent users (/100) of (**a**) antidepressants, (**b**) antidiabetics and (**c**) antibiotics for systemic use by CDC week. Observed use (grey line) compared to expected use (blue line with 99% prediction interval shown in orange).

Medications of the central nervous system are of interest. Antipsychotics initiation remained close to expected values during the first wave, then increased from the second onwards. Similarly, Leong et al. reported no statistically significant change in antipsychotics incidence rates among males or females during the second quarter of 2020, followed by an increase (among females) later in the year[47]. Our results differ from Leong et al. and Nason et al. regarding benzodiazepines, as both reported fewer anxiolytic initiations in the first months of the pandemic[47,48]. Other Canadian studies, however, suggest that the dispensing of most benzodiazepines did not change during the first year of the pandemic[14,23]. These findings are notable given the pandemic's deleterious impact on mental health[13], which might have suggested increased initiation rates of medications like benzodiazepines and antidepressants. Similar to the findings of Leong et al.[47], our analyses suggest an initial drop in antidepressant initiation during the first period, followed by an increase during the second period, potentially compensating for the initial decline. Initiation rates appeared to return to expected levels from the third period

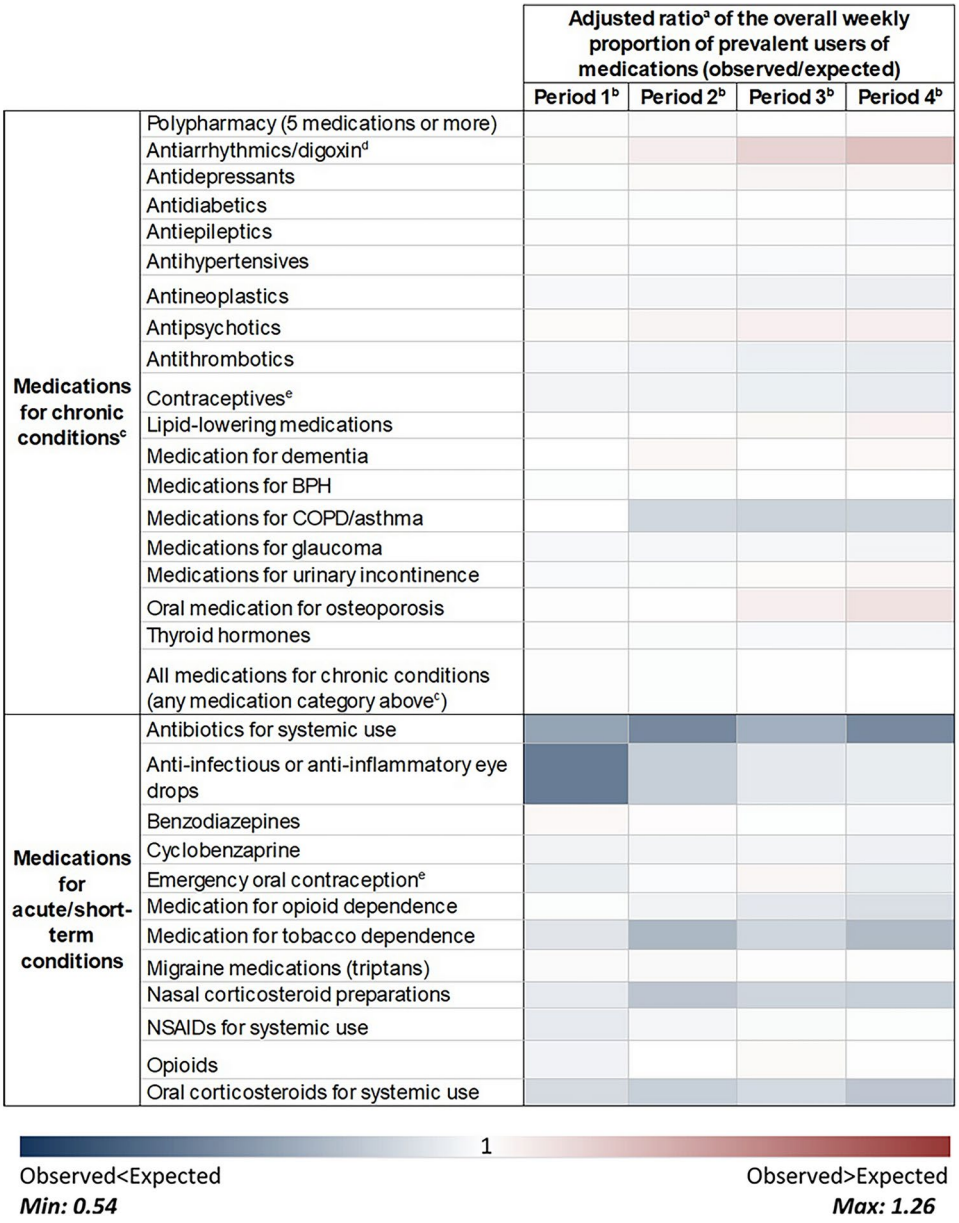

Fig. 3. Adjusted ratio (observed/expected) of the overall weekly proportion of prevalent users, by medication category and time period. A decline in observed use, compared to expected use, is indicated by blue cells whereas an increase in use is indicated by red cells (to determine the statistical significance of these fluctuations, please refer to the Supplementary Tables). All fluctuations mentioned in the text are statistically significant, unless otherwise indicated. (**a**) Color scales used in Figs. 1 and 3 are the same. The minimum and maximum values indicated in the legend are based on the most extreme values found in both figures combined. (**b**) Period 1: 1st wave, February 23, 2020–August 1, 2020; Period 2: 2nd wave, August 2, 2020-March 20, 2021; Period 3: waves 3–4, March 21, 2021–December 4, 2021; Period 4: waves 5–6; December 5, 2021–March 26, 2022. (**c**) Models for ADHD, gastric acidity and HIV medications are excluded due to poor fit, but are still included under 'All medications for chronic conditions'. 'Polypharmacy' is not included in 'All medications for chronic conditions'. (**d**) Excluding calcium channel blockers and beta-blockers (included in "Antihypertensives"). (**e**) Information reported for women only. Excluding IUDs and subcutaneous implants. *ADHD* attention deficit hyperactivity disorder, *BPH* benign prostatic hyperplasia, *COPD* chronic obstructive pulmonary disease, *HIV* human immunodeficiency virus, *IUD* intrauterine Device, *NSAID* nonsteroidal anti-inflammatory drug.

onwards. Uthayakumar et al. found that antidepressant dispensing rates fluctuated initially but returned to expected levels by August 2020[23]. Our study suggests a slight increase (≈ + 1%) in prevalent antidepressant use from the second period onwards, raising questions about whether it adequately meets the heightened demand for mental healthcare or reflects reduced treatment cessation resulting in longer therapies, intentionally or not.

The observed prevalent use of most chronic medications remained close to expected levels, suggesting that access to treatments for most patients already on medication was not compromised. More specifically, the steadiness of the prevalent use of a chronic medication category suggests continued access to at least one medication in that category. Measures such as tele-medicine and pharmacist-initiated pharmaceutical acts (e.g., medication substitutions, prescription extensions) likely contributed to continuity of care despite disruptions[49]. However, a prevalence close to expectations does not necessarily indicate all individuals needing treatment received it, particularly if disease incidence increased during the pandemic. Other studies also suggest that chronic medication use was not greatly impacted during the first year of the pandemic, despite some fluctuations[4,6,32,35,50]. For instance, Aboulatta et al. reported no statistically significant changes in the prevalent use of antidiabetics, cardiovascular medication, statins, and thyroid medication in Manitoba, Canada[4]. Conversely, some studies[7,51–53] highlighted potential impacts on dispensing or adherence, notably for medications requiring specialist consultations. Suda et al. reported statistically significant declines in purchased medication units from April through August 2020, which should be considered alongside the stockpiling surge in March 2020[54]. In general, comparing study results is challenging due to differences in medications analyzed, periods, geographic locations, methodologies for measuring medication use, and the different views of what should be considered notable changes.

Some medications, such as antibiotics for systemic use, corticosteroids, and COPD/asthma medications, saw decreased prevalent use during the pandemic, reflecting their reduced initiation. Anti-infectious or anti-inflammatory eye drops also declined during the first wave (−29%), possibly due to postponed elective cataract surgeries[55] where these medications are usually prescribed post-operatively[56]. Conversely, antiarrhythmics saw an 8% increase in prevalent use during the last period. This result might be linked to COVID-19 complications, which could have led to more arrythmias, driving up antiarrhythmic use[57]. The potential decline in the prevalent use of antineoplastics over time, despite relatively normal initiation patterns, warrants further investigation.

While our project stands out its extensive medications analysis over an extended period and its population-based approach, some limitations exist. Firstly, medication claims do not confirm actual use, as some individuals may have been non-compliant. Secondly, some medication use might be underestimated since our database does not include over-the-counter medications, unless prescribed and reimbursed nor medications dispensed in hospitals. Thirdly, our data is generalizable only to community-dwelling individuals covered by the public drug plan, excluding those in long-term care or with private insurance. Fourthly, our predictive models did not always have optimal fit during the pre-pandemic period and may not capture all short-term fluctuations. Fifthly, unlike other studies[14,32,58,59], our methods generally do not account for stockpiling as we assessed prevalence/incidence rather than the quantity dispensed or the number of claims. Lastly, our analyses cannot establish a causal link between the pandemic and medication use fluctuations, which may result from other factors.

Conclusion

In Quebec, most medication initiations decreased during the first wave of COVID-19. Subsequently, initiation patterns varied by medication category, with some, such as systemic antibiotics, showing reduced initiation through March 2022. Prevalent use of most chronic medications closely aligned with expectations, suggesting ongoing access. Our study identified acute and long-term variations in medication use relevant for future pandemics and when using medication claims data within studies encompassing pandemic years.

Data availability

The datasets generated and analyzed during the current study are not publicly available due to confidentiality reasons but are available from the corresponding author on reasonable request.

Received: 20 December 2024; Accepted: 14 April 2025
Published online: 27 April 2025

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Acknowledgements

CS was the recipient of a Junior 2 salary award from the Fonds de recherche du Québec- Santé. The project was funded by VITAM – Centre de recherche en santé durable and by the Canadian Institute of Health Research and the Natural Sciences and Engineering Research Council of Canada, grant number [CPG—170621].

Author contributions

MG participated in the conception of the project and the interpretation of data and wrote the manuscript. MD and MS participated in the conception of the project and the interpretation of data and conducted the statistical analyses. CS, NV and CL participated in the conception of the project and the interpretation of data. All authors substantively revised the work and have approved the submitted version.

Declarations

Competing interests

The authors declare no competing interests.

Ethics approval and consent to participate

The use of the QICDSS for surveillance purposes has been approved by the provincial Public Health Research Ethics Board and the Quebec *Commision d'accès à l'information*, without the need to obtain informed consent from participants.

Additional information

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1038/s41598-025-98592-x.

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