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RESEARCH REPORT

ADDICTION SSA

Changes in prenatal cannabis-related diagnosed disorders after the Cannabis Act and the COVID-19 pandemic in Quebec, Canada

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Abstract

Background and aims: Public health concerns regarding pregnant women's health after the enactment of the Cannabis Act in Canada (CAC) (a law that allowed non-medical cannabis use), and the potential impact of the COVID-19 pandemic, call for a contemporary assessment of these two events. Our study measured associations between the CAC, the COVID-19 pandemic and the monthly prevalence rates of cannabis-, all drug- and alcohol-related diagnosed disorders among pregnant women in the province of Quebec.

Design, setting and participants: This was a quasi-experimental design applying an interrupted time-series methodology in the province of Quebec, Canada. The participants were pregnant women aged 15–49 years, between January 2010 and July 2022.

Measurements: Administrative health data from the Québec Integrated Chronic Disease Surveillance System were used to classify pregnant women according to cannabis-, all drug (excluding cannabis)- and alcohol-related disorders. The CAC (October 2018) and the COVID-19 pandemic (April 2020) were evaluated as (1) slope changes and (2) level changes. Cannabis-, all drug (excluding cannabis)- and alcohol-related disorders were measured by total monthly age-standardized monthly prevalence rate of each disorder for pregnant women aged 15–49 years.

Findings: Before the CAC, the prevalence rate of cannabis-related diagnosed disorders significantly increased each month by 0.5% [95% confidence interval (CI) = 0.3–0.6] in the pregnant population. After the CAC, there were significant increases of 24% (95% CI = 1–53) of cannabis-related diagnosed disorders. No significant changes were observed for all drug (excluding cannabis)- and alcohol-related diagnosed disorders associated with the CAC. A non-significant decrease of 20% (95% CI = −38 to 3) was observed during the COVID-19 pandemic in alcohol-related disorders.

Conclusions: The monthly incidence rates of diagnosed cannabis-related disorders in pregnant women in Quebec increased significantly following the enactment of the Cannabis Act in Canada. Diagnoses of all drug (excluding cannabis)- and alcohol-related disorders remained relatively stable.

KEYWORDS
Cannabis, Cannabis Act, COVID-19, prenatal cannabis use disorder, Quebec, time-series

INTRODUCTION

Research into the impacts of non-medical cannabis laws (NMCL) on various demographics, encompassing factors such as cannabis consumption [1], cannabis use disorder [2], cannabis treatment [3, 4], traffic crashes [5] or crime [6], is rapidly accumulating. However, there is notably limited focus on understanding how these policies specifically affect pregnant women. With the enactment of the Cannabis Act in October 2018, Canada's first NMCL, many public health concerns have emerged [7, 8]. These apprehensions are based on the increase of prenatal cannabis use before the implementation of Cannabis Act in Canada (CAC), cannabis use during pregnancy being associated with negative outcomes (i.e. elevated risk of preterm birth, neonatal intensive care unit admissions, low birth weight and decreased Apgar scores) and the explicit protection of vulnerable populations outlined in the framework for the Cannabis Act, particularly children whose mothers used cannabis during pregnancy [9].

Studies assessing NMCL's associations and prenatal cannabis use and/or substance-related disorders have focused primarily upon the United States and Canada. In the United States, NCMLs throughout states were associated with 6–11% rises in the rate of cannabis use during pregnancy [10]. In Canada, from 2010 to 2018, some provinces witnessed an increase in prenatal cannabis use [11, 12]. However, despite documented instances of heightened cannabis-related hospitalizations and emergency visits within the general population following NMCL [13–15], there remains a lack of clarity regarding its association with prenatal substance-related disorders in provinces beyond Ontario [16]. More specifically, studies focusing upon NMCLs, whereby stricter measures are set in place to regulate cannabis use, should be carried out to more clearly inform the potential impact of different policy models implemented in the same country among different and similar populations.

Concerns of spillover effects of NMCLs on the use of alcohol and other substances in different populations, including pregnant women, have also been reported, with findings being inconsistent [17, 18]. In the United States NMCLs have been associated with increases in alcohol use [19], and no changes have been reported in terms of other substances, such as opiates, methamphetamine and cocaine, in the general population [20]. In Canada, one study on youth populations, in Ontario particularly, reported an absence of changes in both alcohol and other substance (opioids, amphetamines and cocaine) use after the CAC [21]. One study in the United States reported an absence of changes in alcohol use among pregnant women after NMCL [22].

The COVID-19 pandemic introduces another level of complexity when considering how substance-related disorders may vary, particularly for pregnant women. In Canada, a recent scoping review reported increases of cannabis consumption only in cannabis users, and an absence of changes in the adult population during the COVID-19 pandemic [23]. However, similar to the effects observed with NMCL's studies, there is a dearth of research examining the association between the COVID-19 pandemic and prenatal substance-related disorders. In the United States, a noteworthy 25% surge in cannabis consumption among pregnant women was associated with the pandemic [24]. Conversely, within Canada, only one study highlighted heightened cannabis usage among pregnant women experiencing financial hardships amid the pandemic; nonetheless, the overall prevalence of cannabis use within this group in Canada has exhibited some stability [25]. Nevertheless it could be expected that, during the COVID-19 pandemic, pregnant women may have experienced heightened anxiety, stress, social isolation and/or restricted access to health-care services for treating nausea. These circumstances might have prompted them to seek alternative approaches, potentially inclining them towards considering cannabis use.

Herein, we present the first population-based assessment of NMCL and the COVID-19 pandemic and their associations with three outcomes: all drug (excluding cannabis)-, cannabis- and alcohol-related disorders in pregnant women between January 2010 and July 2021. We use a population-based administrative health database in Quebec, a Canadian province with a universal public health insurance plan, to fill a threefold existing knowledge gap identified in the literature [26]. First, when considering age limit, number of dispensaries per capita and prohibition of public consumption, Quebec has one of the strictest cannabis implementation policies in Canada. More specifically, Quebec is the only province to prohibit possession and use of cannabis until age 21 years and has the lowest number of cannabis stores per 100 000 population (1.2). Conversely, in Ontario the age limit is 18 years and its number of cannabis stores is 10-fold larger than Quebec [27]. In this context, the more stringent access to cannabis in Quebec may significantly affect consumption opportunities, especially among pregnant women. This stricter access decreases the availability of cannabis, thereby shaping consumption patterns and behaviors. Thus, this setting provides an opportunity to more clearly understand if prenatal substance-related diagnosed disorders may be lower in contexts in which NMCLs are more stringent [28]. Secondly, we have considered both all drug (excluding cannabis)- and alcohol-related diagnosed disorders in pregnant women to further assess potential spillover changes of the NMCL and thus provide a more comprehensive account of potential changes in this population. Thirdly, previous studies have assessed NMCLs without teasing out the potential impact of the COVID-19 pandemic [16]. Under our design we account for the potential maternal health consequences of the COVID-19 pandemic [29], while we simultaneously assess on how Canada's NMCL may have been associated with the chosen outcomes.

METHODS

Study design

To evaluate the impact of the CAC and the COVID-19 pandemic from January 2010 to July 2021 on three outcomes—total number of drug (excluding cannabis)-, cannabis- and alcohol-related diagnosed disorders in pregnant women in Quebec—we designed a quasi-experimental study. The analysis plan of the current study was not pre-registered on a publicly available platform, with the results considered exploratory.

Data

We use data from the Québec Integrated Chronic Disease Surveillance System (QICDSS). The QICDSS offers access to annually updated and linked information from five administrative health databases, starting from 1 January 1996 [26]. Given that approximately 98% of the Quebec population is eligible and admissible to public health insurance, the QICDSS encompasses data for almost the entire population of the province [30].

Population

We identified all pregnant women aged 15–49 years who received the diagnoses of interest in Quebec health-care settings from January 2010 to July 2021 using the hospitalization and physician claims databases of the QICDSS; that is, we considered hospitalizations and outpatient visits. We considered diagnoses of all drugs (excluding cannabis)-, cannabis- and alcohol-related disorders, whether listed as primary or secondary diagnoses, in the databases that were registered with the International Classification of Diseases (ICD), ninth (ICD-9) or 10th (ICD-10) revisions following an established combination of codes. The full list of codes is provided in the Supporting information. The outcomes were monthly prevalence rates of diagnoses of these three groups of disorders per 100 000 pregnant women (aged 15–49 years).

Exposures

We defined three periods to create absence and presence of exposures: (i) the pre-intervention CAC period (January 2010–September 2018), (ii) the CAC period (October 2018–March 2020) and (iii) the COVID-19 pandemic period (April 2020–July 2021).

Lags, seasonality and time trends

As drug-related disorder-diagnosed monthly rates may be autocorrelated [31], have a seasonal shape [32] and vary consistently over time, we considered lags, Fourier terms (pairs of sine and cosine functions) and time trends to account for potential biases associated with time-series analyses and assess, respectively, their impact on the models [33].

Statistical approach

Due to the non-negative integer nature of drugs and alcohol diagnosis data, we used generalized linear models, particularly negative binomial regression. Data exploration and residual diagnostics followed the standard recommendations in the field [34]. The four steps to select the best statistical model, together with which model was chosen and the results of autocorrelation and partial correlation, are available in the Supporting information. We used the age-standardized population of pregnant women in Quebec as an offset variable to convert the outcomes into rates. This information comes from the 2011 Census [35].

We reported results from negative binomial models with estimates presented on the incidence rate ratio (IRR) with 95% confidence intervals (CI), and portmanteau tests to identify the absence of autocorrelation [36]. We applied robust standard errors. Time-series plots comparing predicted versus actual values were also produced to represent results graphically. Results from Poisson models and with cannabis sales as a metric to proxy the implementation of the CAC are available in the Supporting information, Tables S1–S4. We included cannabis sales because this variable can mirror the quantity of cannabis being consumed. Higher sales may thus signify increased consumption, potentially indicating rises in problematic use. Conversely, lower sales may suggest reduced consumption, hence indicating decreases in problematic use. All the analyses and figures were made using Stata version 17 [37].

RESULTS

From January 2010 to June 2021, there were 2695, 1920 and 833 prevalent diagnoses of all drugs (excluding cannabis)-, cannabis- and alcohol-related diagnoses disorders in the pregnant population of Quebec corresponding to a pooled mean age-standardized monthly incidence rate of 29.42 (95% CI = 27.75, 31.10), 17.42 (95% CI = 16.02, 18.82) and 10.88 (95% CI = 9.71, 12.07) diagnoses per 100 000 pregnant women, respectively. Table 1 shows data for total prevalence diagnoses for the three outcomes and monthly mean rates per 100 000 pregnant women population. Overall, monthly means of diagnoses and their rates were relatively stable over time in all drug-related disorders (excluding cannabis) (see Figure 1), increased throughout the study period for all cannabis-related disorders (see Figure 2) and decreased in alcohol-related disorders diagnosed during the pandemic (Figure 3).

Table 2 reports the ITS results (as IRRs) for the association of the CAC with the monthly incidence rates of all drug (excluding cannabis)-, cannabis- and alcohol-related disorders diagnosed per

TABLE 1 Diagnoses of all drugs (excluding cannabis)-, cannabis- and alcohol-related disorders among pregnant women in Quebec, 2010–21, per study period.

	Pre-CAC period (January 2010–September 2018)	CAC period (October 2018–March 2020)	COVID-19 pandemic period (April 2020–June 2021)	Total
All drug (excluding cannabis)-related disorders				
Total diagnoses	2074	333	288	2695
Monthly mean rate of diagnoses per 100 000 pregnant population	29.40	28.93	30.17	29.42
All cannabis-related disorders				
Total diagnoses	1259	327	334	1920
Monthly mean rate of diagnoses per 100 000 pregnant population	14.50	23.50	30.59	17.42
All alcohol-related disorders				
Total diagnoses	687	90	56	833
Monthly mean rate of diagnoses per 100 000 pregnant population	11.37	10.55	7.85	10.88

CAC = Cannabis Act, Canada.

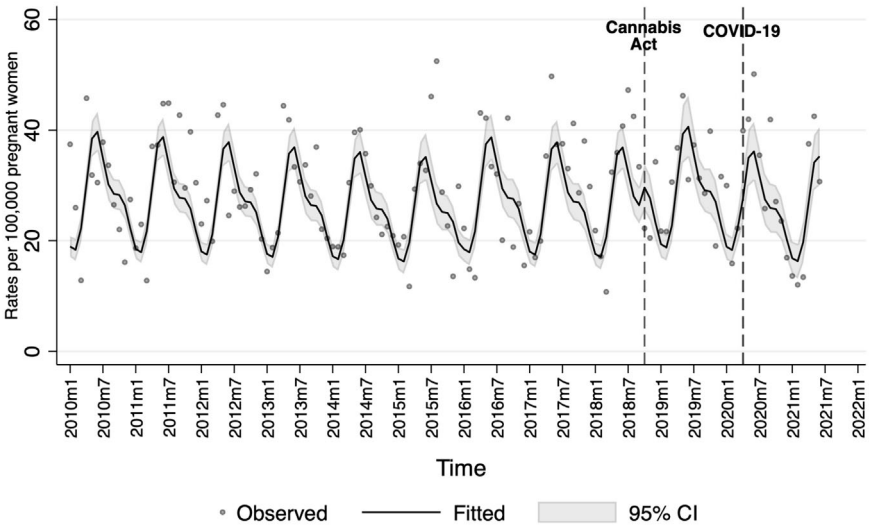

FIGURE 1 Prevalence rates of all drugs-related diagnoses disorders per 100 000 pregnant women with robust standard errors, Quebec January 2010–July 2021. The broken green line indicates the enactment of the Cannabis Act (October 2018). The broken red line indicates the beginning of the COVID-19 pandemic (March 2020).

100 000 pregnant women population in Quebec. The associations with the COVID-19 pandemic period are also reported in this table. These associations are also shown in Figures 1–3.

The CAC

In Quebec's pregnant women population, the monthly IRRs of cannabis-related diagnosed disorders increased statistically significantly every month before the CAC by 0.5% (95% CI = 0.1, 0.3) (Table 2). Conversely, no significant changes were observed in all drug (excluding cannabis)- disorders or alcohol-related disorders during the first period of analysis. After the CAC, there were statistically significant changes in the level of monthly IRRs of cannabis-related diagnoses by 24% (IRR = 1.24, 95% CI = 1.01, 1.51). There were no statistically significant differences in the level of change following the CAC for the rates of all drug (excluding cannabis)- and alcohol-related disorders. The COVID-19 pandemic was associated with a non-significant decrease in IRRs by 20% (IRR = 0.80, CI = 95% 0.62, 1.03) in of alcohol-related disorders.

The results of portmanteau tests at lags 6 and 12, each of them associated with *P*-values lower than 0.05, suggest the absence of autocorrelation in each presented model. Poisson regression analyses showed similar findings in the Cannabis Act in the selected outcomes. Additional analyses were also carried out to assess the change in legal cannabis sales during the same study period. Results are shown in the Supporting information, Tables S1–S4.

DISCUSSION

The current study highlights how, in Quebec, the monthly prevalence rates of cannabis-related diagnosed disorders in pregnant women have been rising since 2010. Notably, following enactment of the

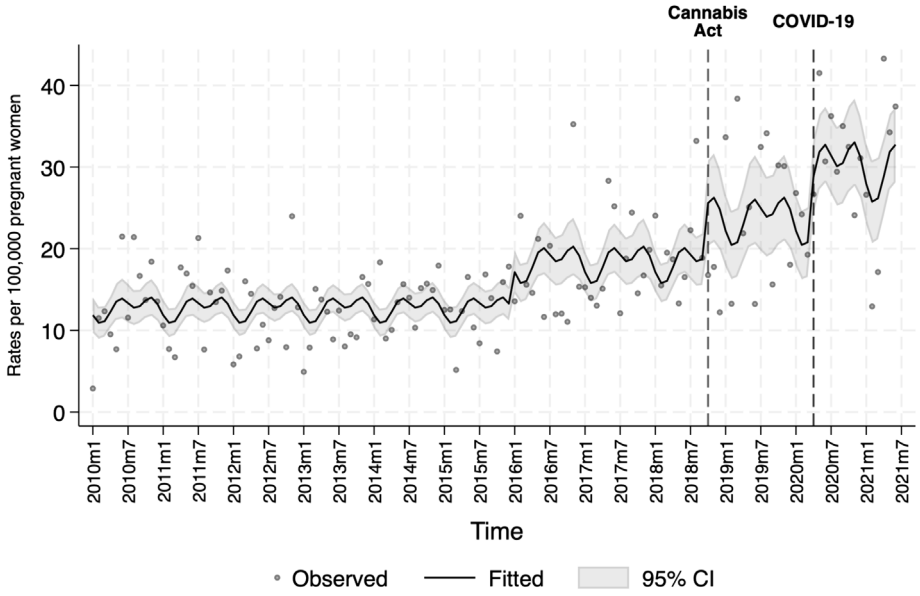

FIGURE 2 Prevalence rates of all cannabis-related diagnoses disorders per 100 000 pregnant women with robust standard errors, Quebec January 2010–July 2021. The broken green line indicates the enactment of the Cannabis Act (October 2018). The broken red line indicates the beginning of the COVID-19 pandemic (March 2020).

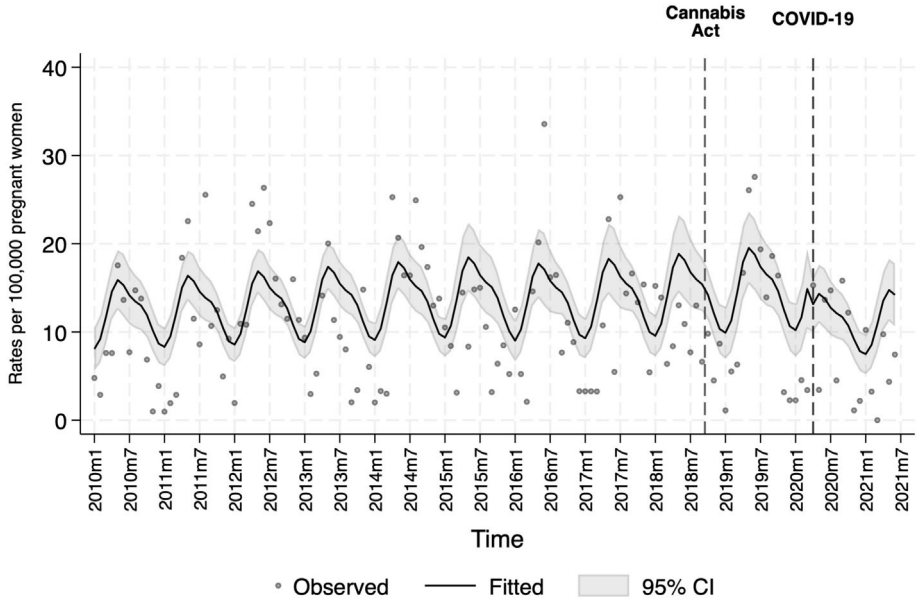

FIGURE 3 Prevalence rates of all alcohol-related diagnoses disorders per 100 000 pregnant women with robust standard errors, Quebec January 2010–July 2021. The broken green line indicates the enactment of the Cannabis Act (October 2018). The broken red line indicates the beginning of the COVID-19 pandemic (March 2020).

CAC, monthly incidence rates of diagnosed cannabis-related disorders in pregnant women continued to rise. Conversely, all drug (excluding cannabis)- and alcohol-related diagnosed disorders remained relatively stable until the COVID-19 pandemic, where a non-significant decrease was observed for alcohol-related diagnosed disorders.

While our findings generally support previous research indicating a rise in cannabis-related health outcomes following the Cannabis Act (CAC), variations persist in terms of the populations studied, the designs of the studies and the contexts in which they were conducted [13, 15, 38–40]. For instance, in Quebec, 5 months after the CAC became effective, an increase was observed in a psychiatric emergency department of one hospital [39]. Additionally, analyses of administrative health databases from emergency departments in Alberta, Ontario and Canada (excluding Quebec) also showed increases following the CAC implementation. Specifically, in Ontario and Alberta, the post-legislation period of the CAC was associated with a 12 and 45% rise, respectively, in rates of cannabis-attributable emergency visits within the general population. In Ontario, an analysis focusing on women aged 25–44 years during the post-legislation period revealed a 13% increase [15]. In terms of the effects on pregnant women's outcomes, our results are similar in direction to that reported in the United States, where increases of cannabis treatment admissions and diagnosed cannabis-related disorders were observed [41]. Results in Canada, particularly from Ontario, are also similar in direction to our findings, but different in magnitude; after the legislation an 82% increase of acute care visits for cannabis use in pregnant women was reported in Ontario versus the 25% observed in our study [16]. While differences in the reported magnitude may partly stem from the implementation practices of the CAC, particularly considering that Quebec's policy is notably stricter, variations in

TABLE 2 Negative binomial models with the associations of the Cannabis Act and the COVID-19 pandemic with rates of monthly incident diagnoses of all drug (excluding cannabis)-, cannabis- and alcohol-related disorders per 100 000 pregnant population in Quebec, 2010–21.

	All drug (excluding cannabis)-related disorders		All cannabis-related disorders		All alcohol-related disorders	
	IRR 95% CI	*P*-value	IRR 95% CI	*P*-value	IRR 95% CI	*P*-value
Time trend pre-Cannabis Act	0.99 (0.99, 1.00)	0.872	1.005 (1.003, 1.006)	0.000	1.00 (0.99, 1.00)	0.311
Change in level following CAC	1.10 (0.93, 1.29)	0.254	1.24 (1.01, 1.51)	0.039	1.02 (0,80, 1.33)	0.830
Change in level following COVID-19	0.88 (0.72, 1.07)	0.199	1.18 (0.94, 1.48)	0.132	0.80 (0.62, 1.03)	0.079
Baseline rate	26.20 (21.31, 32.21)	0.000	9.10 (8.10, 11.50)	0.000	9.74 (6.84, 13.87)	0.000
Portmanteau (Q) at lag 6	3.51	0.742	5.84	0.441	7.379	0.287
Portmanteau (Q) at lag 12	11.94	0.450	8.09	0.777	19.00	0.088

The coefficients are incidence rate ratio in the outcome with their 95% confidence interval and robust standard errors. All models consider Fourier terms (pairs of sine and cosine functions) to control for seasonality.
CAC = Cannabis Act, Canada; CI = confidence interval; IRR = incidence rate ratio.

population demographics, accessibility of health services or reporting methodologies could also account for these disparities. For instance, in Quebec, under-reporting might have occurred due to complexities regarding how cases of poly-consumption are addressed within the province's framework.

Interestingly, in terms of potential spillover effects, the CAC was not associated with increases in all drug- or alcohol-related diagnoses disorders. At least two studies have observed the absence of changes in terms of alcohol problematic use associated with NMCL [42, 43]. Our results could be partially explained by a relative consolidation of alcohol preventive policies and misuse interventions introduced, particularly those directed towards pregnant women, implemented in Quebec in the past 30 [44] and 15 years, respectively [45].

Our findings highlight the importance of universal screening and imply that pregnant women with a history of cannabis disorder may benefit from repeated screening and ad-hoc counselling during pregnancy. Our findings also show an increase in diagnosed cannabis-related disorders associated with the CAC; supplementary analyses using cannabis sales as proxy of how the CAC may have been implemented showed a similar trend. Our results may be explained in part by a number of factors, including increased health service utilization by pregnant women leading to increased diagnosis, and also increased detection by physicians following the CAC policy. Relatedly, a shift in physicians' perceptions regarding cannabis-related diagnosed disorders may have also occurred because significant public discussions on the impacts of cannabis took place during the months following the implementation of the Act. Federal and provincial efforts to protect this population, and their respective assessments, should be encouraged. For example, despite the Government of Canada mandating plain packaging on cannabis items with health warning labels, only approximately one-eighth of packages feature explicit warnings against usage during pregnancy or breastfeeding. There is a need for additional research to assess the impact of these health warnings and to determine whether mandating pregnancy warnings on all packaging is necessary [46]. This is reinforced by studies showing that knowledge of health risks associated with cannabis use during pregnancy is lacking in populations who consume cannabis more frequently [47].

Limitations and future directions should be noted. Data were not representative of the entire Canadian pregnant population. Despite the exhaustive quality controls and representativeness of the QICDSS database [30] and the use of an established combination of diagnostic codes to identify pregnant women and diagnoses [48], we cannot rule out the possibility of misclassification bias or time-related bias which future studies should address [49, 50]. Interestingly, sensitivity analyses examining how the CAC influences non-substance-related outcomes in pregnant women, such as urinary infections or gastroenteritis (available in Supporting information, Table S5), indicated no discernible effects. This indirectly underscores the potential adverse impact of this policy within this subpopulation. Similarly, while we rely upon medical health data, many other health services are provided by non-medical professional throughout the province, and therefore our cases are restricted to those with physician diagnoses. Relatedly, closures and barriers to health service use may have led to an underestimation of prevalence diagnoses during the first months of the COVID-19 pandemic, particularly for alcohol-related diagnosed disorders. Nevertheless, the direction of our findings coincides with decreases in binge drinking observed during the COVID-19 pandemic in a longitudinal survey of a female young adult population representative of Quebec [51]. Due to the limited causal inference capability derived from our single-group ITS analyses, future studies should consider including a comparable control group [52], as well as identifying more targeted interventions implemented in Quebec within the pre-legislation period. Also, the relatively low number of identified cases per month prevented us from providing further stratifications on covariates of potential interests (e.g. age, material or social deprivation or

administrative health regions of Quebec). Future studies in Quebec could use quarterly or semi-annual data, including a longer post-COVID-19 pandemic period, to consider these covariates.

Our research adds to the understanding of how cannabis-related diagnosed disorders might have shifted following the CAC in Quebec among pregnant women. Recognizing the potential for increased cannabis-related diagnosed disorders post-legalization, it is crucial to also take into account the probable effects of COVID-19 on various outcomes in pregnant women, particularly those linked with cannabis-related diagnosed disorders during the postpartum period. These concerns carry considerable weight and demand immediate attention in public health. Continual research and investment in substance use prevention and treatment are imperative to mitigate unintended harm.

AUTHOR CONTRIBUTIONS

José Ignacio Nazif-Munoz: Conceptualization (lead); formal analysis (lead); funding acquisition (lead); project administration (lead); software (lead); writing—original draft (lead); writing—review and editing (lead). **Pablo Martínez:** Formal analysis (equal); funding acquisition (equal); investigation (equal); methodology (equal); writing—review and editing (equal). **Christophe Huỳnh:** Conceptualization (equal); methodology (equal); writing—review and editing (equal). **Victoria Massamba:** Data curation (equal); investigation (equal); writing—review and editing (equal). **Isaora Zefania:** Data curation (equal); formal analysis (equal). **Louis Rochette:** Data curation (equal); formal analysis (equal); writing—review and editing (equal). **Helen-Maria Vasiliadis:** Conceptualization (equal); investigation (equal); writing—review and editing (equal).

DECLARATION OF INTERESTS

The authors declared no competing interests.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The research ethics board of the Centre intégré de santé et de services sociaux du la Montérégie-Centre approved the study protocol (FRQS-CANFEMQC2022 MP-04-2023-765).

DATA AVAILABILITY STATEMENT

In accordance with the applicable ethics regulations for the province of Quebec, the principal investigator is responsible for keeping data confidential. Data are available upon request to the Institute National de Santé Publique du Québec.

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SUPPORTING INFORMATION

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

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