

# Opioid-Related Emergency Department visits and deaths following a harm-reduction intervention: A time-series analysis

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**Short title:** Opioid-related death and ED visit intervention analysis

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**Abbreviations:**

CBN: Community-Based Naloxone

ED: Emergency Department

EMS: Emergency Medical Services

ITS: Interrupted time series

OPS: Overdose Prevention Site

SCS: Supervised Consumption Site

*Mr Matthew Yeung contributed to study design, data collection, analysis, interpretation, drafting of the initial manuscript, and subsequent revision.*

*Mr. Colin Weaver contributed to designing and executing data analysis.*

*Dr. Eddy Lang contributed to study design, interpretation, and revision of the final manuscript. All authors approved the final manuscript as submitted, and agree to be accountable for all aspects of the work.*

## Introduction:

In 2020, there were 1144 opioid overdose deaths in Alberta, highlighting the lethal and complex nature of the opioid crisis. Alberta has introduced several interventions in response, including introduction of supervised consumption sites (SCS), overdose prevention sites (OPS), and the widespread distribution of naloxone kits, through the community-based naloxone (CBN) program. Similar models of both programs have found success elsewhere, with successful trials in Canada, Australia, and the United States. SCS and OPS research has identified a decrease in overdose fatalities and increase in addiction service access in Vancouver, Canada and reduction in ambulance visits in Sydney, Australia.(1-3) CBN programs have found success in the United States, with a region in Massachusetts identifying a decrease in fatalities, while a region of North Carolina has reported reduced healthcare costs.(4, 5) However, since 2019, three out of seven SCS in the province have been closed, and implementation of two additional sites has been halted by provincial authorities. These changes come on the heels of a controversial and widely-critiqued review.(6) Given the current political climate surrounding SCS and the continuing opioid crisis with soaring opioid-related deaths to date, we sought to explore the evidence on the impact of the aforementioned interventions on opioid-related deaths, and opioid-related ED visits within Alberta.(7, 8) Our study aims to build on previous research at the local level on SCS impact by studying the impact of SCS at a municipal level.(9)

As part of a public health response to overdose deaths, Alberta scaled up and implemented both SCS and OPS beginning in 2017. SCS are locations where users can be monitored while using previously obtained drugs and may access other services such as counselling, social work, and opioid agonist treatment. They are exempted from the application of federal drug laws by Health Canada, and are designed for long-term operation. OPS are temporary SCS where individuals may be observed while using previously obtained substances, with intervention for adverse events, such as overdose. In Alberta, SCS sites currently operate in Calgary and Edmonton, while a former SCS site in Lethbridge was closed in August, 2020. An OPS site operates in Red Deer.(10) Alberta is also home to a CBN program, which began in January, 2016. With over 1 000 pharmacies participating in the CBN program, Alberta has the largest CBN program in Canada, with harm reduction agencies contributing to distribution of CBN kits to the public.(11) Through the CBN program, Alberta pharmacies are permitted to distribute naloxone free of charge to members of the public without collection of personal identifying information. Naloxone kits have been distributed by Safeworks in Edmonton since 2005.(12) Pilot projects in other regions culminated in eventual province-wide rollout in January, 2016.(13, 14) Though ample research exists demonstrating strong uptake of CBN programs and local overdose prevention via SCS sites, relatively little literature exists at the regional level comparing trends and volumes in opioid-related ED visits and deaths following intervention implementation. Further, though previous research has studied SCS site visitation and fentanyl-related deaths, there are no published studies focusing on all-opioid-related deaths and ED visits.(15) Our study thus aimed to address the overarching question of “*What is the impact of opioid-intervention strategies on local ED visits and deaths?*”. To answer our overarching research question, we established four objectives, which included 1) identifying changes in local opioid-related ED visit volume following SCS openings, 2) identifying changes in local opioid-

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3 related deaths following SCS openings, 3) identifying changes in regional opioid-related ED visit  
4 opening following implementation of the CBN program, and 4) identifying changes in regional  
5 opioid-related deaths following implementation of the CBN program.  
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## 7 **Methods:**

### 8 **Population:**

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11 ED visit data was collected from the National Ambulatory Care Reporting System, while  
12 data on opioid-related fatalities was collected from the Government of Alberta Vital Statistics  
13 Office. Data was collected from October 1<sup>st</sup>, 2013, to February 29<sup>th</sup>, 2020 for ED visits, and from  
14 October 1<sup>st</sup>, 2013 to March 31<sup>st</sup>, 2019 for deaths. Data from beyond 2020 was not included due to  
15 the potential impact of the pandemic and related public health measures on opioid-related ED  
16 visits and fatalities. Data were selected based on International Classification of Diseases (ICD),  
17 Canadian 10<sup>th</sup> Edition. ED visits included any patient with a diagnosis of F12 (opioid-use  
18 disorder) or T40.2 (accidental opioid poisoning). Opioid deaths were identified based on medical  
19 examiner data obtained via Vital Statistics, with ICD codes selected based on the Centre for  
20 Disease Control's Prescription and Drug Overdose Data and Statistics guide.(16) These codes  
21 included underlying cause of death codes X40-44, 60-64, 85, and Y10-14. Where available, we  
22 also screened for contributing causes of death which included ICD codes T40.0-40.4 and T40.6  
23 (contributing causes of death were not available post-2017). Urban areas were defined as  
24 Calgary, Edmonton, Sherwood Park, and St. Albert hospitals (with Sherwood Park and St. Albert  
25 included due to proximity to Edmonton). The urban areas include 16 EDs, four of which were  
26 located in urgent care centres offering limited service hours, but still providing emergency  
27 services to those with acute opioid intoxication. This study was approved by the University of  
28 Calgary (REB19-0238).  
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### 34 **Data Analysis:**

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36 We conducted interrupted time-series (ITS) via segmented regression for all analyses. We  
37 calculated an average slope for the pre-intervention period, and then compared the y-intercept  
38 pre- and post-intervention. Due to the presence of limited data post-intervention for the majority  
39 of interventions, we did not examine slope changes. We calculated 95% confidence intervals  
40 (CIs) to determine significance and provide a confidence estimate surrounding estimated change  
41 pre- and post-intervention. Visual data inspection identified no seasonality or serial  
42 autocorrelation for correction. Opening dates for supervised consumption sites, in addition to the  
43 beginning of province-wide CBN program were defined as the month in which the programs  
44 began. For SCS, these were defined as March, 2018 for Edmonton, October, 2017 for Calgary,  
45 October, 2018 for Red Deer, and March, 2018 in Lethbridge. The CBN program start date was  
46 defined as January, 2016. All data was adjusted to the most recent population estimates available  
47 for each municipality, or for the province in the case of province-wide analyses. All data analysis  
48 was completed in R (version 3.6.1), with Wald CIs calculated through the epiR package.  
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## 53 **Results:**

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3 Population data is available in Table 1. We identified trends of increasing opioid-related  
4 ED visits and deaths over time. The majority of visits and deaths occurred in urban areas.  
5 Though more regional deaths and ED visits were observed post-CBN program start compared to  
6 local deaths and ED visits post-SCS openings, we note less time was available in the pre-  
7 intervention period for CBN program analysis. With the exception of rural opioid-related ED  
8 visits, we observed an increasing trend in opioid-related ED visits and deaths over time in all  
9 areas.  
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12 SCS sites:

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14 Changes in opioid-related ED visits and deaths following SCS site opening can be seen in  
15 Table 2 and Figures 1-6. Changes in deaths and ED visits varied depending on municipality.  
16 Statistically significant decreases in ED visits were observed in the Calgary (absolute monthly  
17 change -22.24 (-20%); 95% CI -35.48, -8.97) and Lethbridge (absolute monthly change -8.48 (-  
18 50%); 95% CI -13.49, -3.47) areas, while a significant decrease in deaths was observed in the  
19 Edmonton area (absolute monthly change -9.23 (-55%); 95% CI -13.09, -5.37). We observed no  
20 significant changes in ED visits in Edmonton or Red Deer, and observed no significant changes  
21 in deaths in Calgary, Red Deer, or Lethbridge. It is important to note results for Lethbridge and  
22 Red Deer sites (Supplemental Figures 1 and 2) were limited by a relatively small number of  
23 deaths (n=46) across the two sites over the entire study period.  
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27 CBN program:

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29 Changes in opioid-related ED visits and deaths can be seen in Table 2 and Figures 7-10.  
30 Increases were observed in opioid-related ED visits following the initiation of the CBN program  
31 in both urban and rural areas. This included an increase by 38.09 (46%) visits per month in urban  
32 areas (95% CI 23.32, 52.86), and an increase of 15.58 (31%) visits in rural areas (95% CI 6.61,  
33 24.55). An increase in deaths was also observed in urban areas, with an additional 6.65 (27%)  
34 deaths per month (95% CI -1.35, 3.53) post-CBN program start. We observed no differences in  
35 deaths within rural areas post-program start.  
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## 38 39 **Discussion:**

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41 This is the first study to report on the regional effects of CBN programs and municipal-  
42 level effects of SCS in Alberta using a time-series analysis. Despite potentially far-reaching  
43 implications of SCS on the broader health system, including minimizing blood borne infection  
44 and complication-related costs, literature typically focuses on outcomes proximal to the SCS (i.e.  
45 overdoses reversed).(17, 18) Further, our use of ITS allowed us to account for existing trends in  
46 opioid-related ED visits and deaths at the municipal and provincial levels. The use of ITS is  
47 previously unreported in the literature with respect to opioid-related ED visits. This study is also  
48 among the first to differentiate between urban and rural opioid-related ED visits in the Canadian  
49 context.  
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### 52 *SCS Analysis*

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54 Municipality-dependent variation in ED visit and usage trends following SCS site  
55 implementation suggests differences between programs may influence SCS usage among  
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3 vulnerable population. For example, the Calgary SCS site is operated by the provincial health  
4 authority, and is located within an existing healthcare facility. The Edmonton SCS site is  
5 operated by a not-for-profit organization independent of the provincial healthcare body.  
6 Institutional differences may affect the willingness of individuals to access both services and  
7 engage in further harm reduction. We note SCS services did not appear to be correlated with any  
8 increase in deaths or opioid-related ED visits. Our study compares favourably with other studies  
9 which have identified a decline or projected decline in ED visits and deaths following SCS  
10 openings in North American cities.(19-21) Though not every municipality studied saw  
11 statistically significant change in opioid-related ED visits and deaths, we note previous research  
12 has found SCS sites may help reduce emergency medical service (EMS) use and spread of  
13 blood-borne illnesses, contributing to a reduction in healthcare system costs.(17-20) Research  
14 from Vancouver has also highlighted a reduction in all-cause deaths among substance users  
15 following SCS opening.(22) Local research focusing on the Calgary SCS site has identified 2.3-  
16 million-dollar savings over a period of 2 years and 3 months.(23) These benefits, even if small,  
17 should not be underestimated in evaluating the efficacy of SCS.  
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### 22 *CBN Analysis*

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24 Looking towards the CBN program, our findings of increasing opioid-related ED visits  
25 and deaths contrasted with existing literature focusing on CBN program initiation. Existing  
26 literature has generally identified decreased opioid-related deaths.(4, 24-26) We suspect this  
27 difference stems from a lack of data granularity, unique scope, focusing on regional CBN  
28 program impact, rather than local or population-specific impact, and because the Alberta CBN  
29 program recommends EMS use any time naloxone is used.,(24).(4) Spackman et al have  
30 conducted highly detailed analysis of the CBN program at the health zone level, and identified an  
31 inverse relationship between deaths and available naloxone kits. The contrast between Spackman  
32 et al and the current study suggest environmental variation, such as uptake frequency, should be  
33 included to have a full picture of the relationship between CBN programs, ED visits, and deaths.  
34 Further, we hypothesize because the CBN program suggests calling EMS, ED visits increased in  
35 a dose-dependent manner due to individuals having overdose reversed. This hypothesis is  
36 congruent with Spackman et al's findings of an inverse, dose-dependent relationship between  
37 deaths and kit distribution. Our observed increase in deaths may be influenced by difficult-to-  
38 measure ecological variables, including increasing opioid use in the context of a province-wide  
39 recession that took place in 2015-2016, and an increasingly toxic drug supply discussed later.(27,  
40 28)  
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46 Lack of granular data on the CBN program limited our capacity to draw concrete  
47 conclusions. In particular, we lacked data on naloxone kit use frequency, or when naloxone kit  
48 distribution began to scale up in urban and rural regions. Thus, we caution against using our  
49 findings to inform future policy, rather, our findings highlight the importance of capturing more  
50 detailed data surrounding naloxone use. However, as there is little literature commenting on  
51 opioid-related ED visits following CBN program implementation, we are confident our findings  
52 are unique.  
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### 55 *Opioid Toxicity:*

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4 Observed trends in opioid-related deaths and visits, municipally and provincially are  
5 influenced by opioid supply toxicity, particularly post-2016. National toxicity tracking has  
6 identified increasing fentanyl and fentanyl analogue frequency (particularly Carfentanil) in tested  
7 Alberta opioids.(28, 30) They now account for the majority of opioid-associated deaths in  
8 Alberta. Between 2016 and 2017, Carfentanil saw a dramatic increase in commonality, going  
9 from a near-unidentified fentanyl analogue to 2016, to the most common (at 1 in every 100  
10 samples) by 2017. Fentanyl has also seen increasing commonality, overtaking heroin among  
11 tested samples in 2015 (at 4 and 2 in every 100 samples respectively).(28) SCS are critical  
12 resources in preventing overdose fatalities through onsite overdose prevention, intervention, drug  
13 testing (in some cases), and referral to services to break the cycle of addiction.  
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### 16 *Strengths and Limitations:*

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18 Our study faced several methodological limitations, including a little post-intervention  
19 data when comparing death rates. This, combined with a low total number of reported deaths in  
20 the Lethbridge and Red Deer municipalities contributed to wide CIs when compared to the  
21 estimate, and reduced ability to identify significant differences. Further, our study relies on  
22 reported home residence for fatalities. We acknowledge individuals may have travelled from  
23 their home residence to the studied municipalities and died within the municipality as a result of  
24 opioid overdose. This may have led to over-reporting of opioid deaths in certain municipalities,  
25 and under-reporting of deaths in others. Lastly, as our study only compared individual  
26 interventions, it is highly likely other environmental factors (such as drug supply changes, the  
27 Alberta economic outlook, and other opioid treatment programs) influenced opioid-related  
28 deaths and ED visits in the time period surrounding SCS opening, and surrounding the start of  
29 the CBN program.  
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34 We hope future, multivariable analyses can account for environmental variations  
35 affecting opioid-related ED visits and deaths, and that additional data can be gleaned on other  
36 service impacts of SCS and CBN programs, such as callouts to emergency services Finally, we  
37 note publicly available CBN program data available lacked previously discussed granularity.  
38 Nonetheless, we find strength in the novelty of our study, the length of available pre-intervention  
39 data available, and in the variety of sites available. We are confident in the quality of obtained  
40 ED and Vital Statistics data, and note no identified missed data cases.  
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### 43 **Conclusion:**

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45 Overall, we conclude that the relationship between SCS introduction, deaths, and ED  
46 visitation varies depending on municipality. Further research is necessary to determine why this  
47 difference exists, and more detailed analysis and data are necessary to determine SCS  
48 effectiveness. We observed an increase in province-wide opioid-related ED visits and urban  
49 deaths associated with the CBN program. However, the generalizability of our findings is limited  
50 by insufficient data and inability to account for important contextual factors driving opioid use  
51 since 2016. Nonetheless, previous research suggests SCS and CBN programs save lives, and they  
52 are important tools for Alberta in developing a broader public health and harm-reduction  
53 response to the opioid epidemic.  
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Confidential

## GRIPP2 Short Form

Section and Topic	Item	Reported on Page Number
1: Aim	Aim was to explore evidence on the impact of safe consumption sites and a public naloxone distribution program on opioid-related deaths and opioid-related ED visits in Alberta.	1
2: Methods	We used provincial data from the National Ambulatory Care database from October 1 <sup>st</sup> , 2013, to February 29 <sup>th</sup> , 2020 for ED visits, and from October 1 <sup>st</sup> , 2013 to March 31 <sup>st</sup> , 2019 for deaths and conducted interrupted-time series analyses on the data, comparing different regions and times based on intervention introduction.	2
3: Study Results	We found highly mixed results, with decreases in ED visits in Calgary and Lethbridge, and a decrease in deaths in Edmonton. However, we saw opioid-related ED visits climb following naloxone program implementation in urban and rural areas.	3
4: Discussion and conclusions	Our results may stem from regional variability in addition to local predictors of success, such as the nature of the drug supply, timing of the intervention, and the location of the intervention.	4-6
5: Reflections/Critical Perspective	Though our study contained several limitations as described, we find our results valuable and studying previously reported data in a different light. We highlight both how there is significant regional variability in response to opiate-related interventions, and how future studies and policy should examine impacts on a more local scale.	6

**Table 2. ITS Analyses Results**

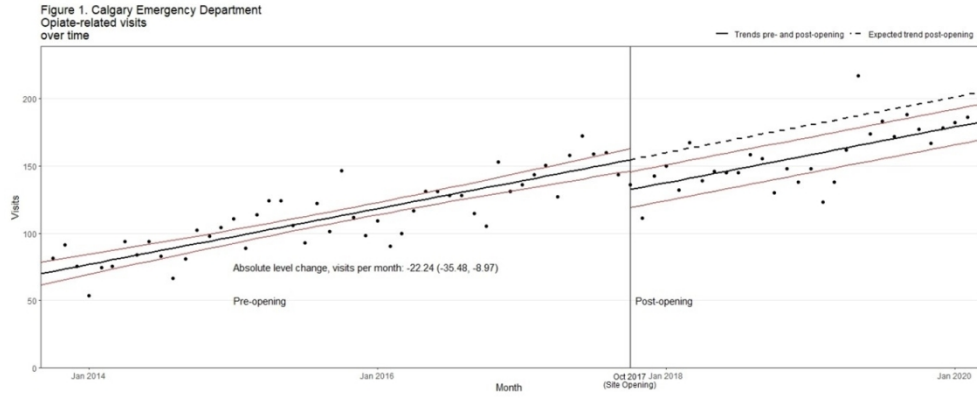
Location	Post-intervention period	Absolute level change at time of intervention, visits/deaths per month (95% CI)
<b>SCS Site Analysis</b>		
<b>ED visits</b>		
Calgary	October 2017-February 2020	-22.24 (-35.48, -8.97)
Edmonton	March 2018-February 2020	0.04 (-18.21, 18.28)
Red Deer*	October 2018-February 2020	-4.38 (-8.78, 0.02)
Lethbridge	March 2018-February 2020	-8.48 (-13.49, -3.47)
<b>Deaths</b>		
Calgary	October 2017-March 2019	-1.41 (-5.17, 2.35)
Edmonton	March 2018-March 2019	-9.23 (-13.09, -5.37)
Red Deer*	October 2018-March 2019	-0.40 (-0.92, 0.11)
Lethbridge	March 2018-March 2019	0.01 (-0.55, 0.57)
<b>CBN Program Analysis</b>		
<b>ED Visits</b>		
Urban Alberta	January 2016-February 2020	38.09 (23.32, 52.86)
Rural Alberta	January 2016-February 2020	15.58 (6.61, 24.55)
<b>Deaths</b>		
Urban Alberta	January 2016-March 2019	6.65 (0.04, 13.26)
Rural Alberta	January 2016-March 2019	1.09 (-1.35, 3.53)

\*OPS site

**Table 1. Population Data**

Location		
<b>SCS/OPS Site Analysis</b>	<b>Pre-opening</b>	<b>Post-opening</b>
<b>ED visits</b>		
Calgary	5134	4502
Edmonton	6964	4825
Red Deer*	1107	323
Lethbridge	870	382
<b>Deaths</b>		
Calgary	679	362
Edmonton	801	154
Red Deer*	19	1
Lethbridge	17	9
<b>CBN Program Analysis</b>	<b>Pre-program start</b>	<b>Post-program start</b>
<b>ED Visits</b>		
Urban Alberta	5304	16086
Rural Alberta	4260	9764
<b>Deaths</b>		
Urban Alberta	662	1334
Rural Alberta	105	312

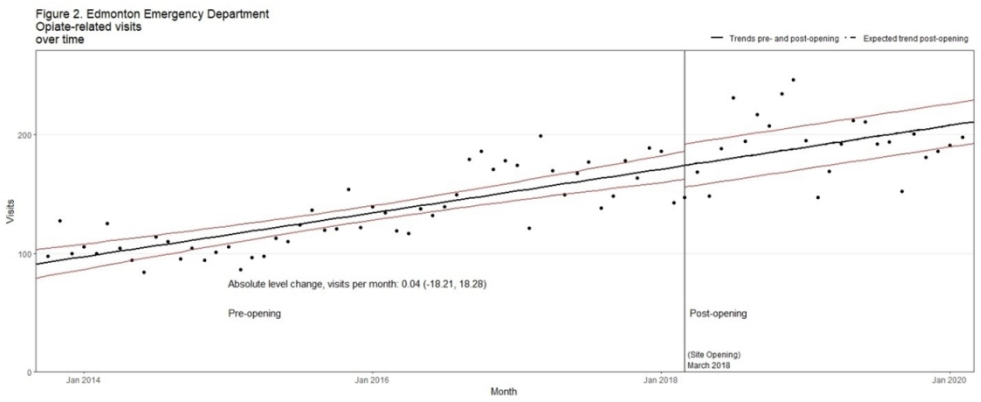
\*OPS site



Calgary Emergency Department Opiate-related Visits over time

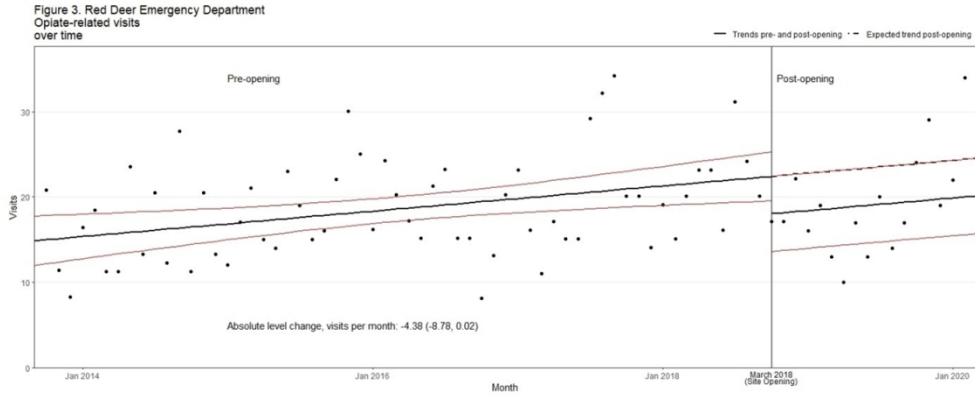
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Edmonton Emergency Department Opiate-related Visits over time

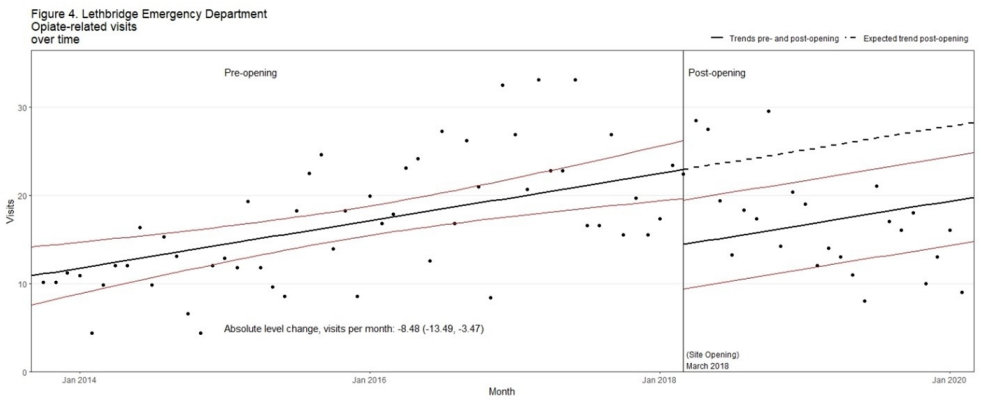
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Red Deer Emergency Department Opiate-related Visits over time

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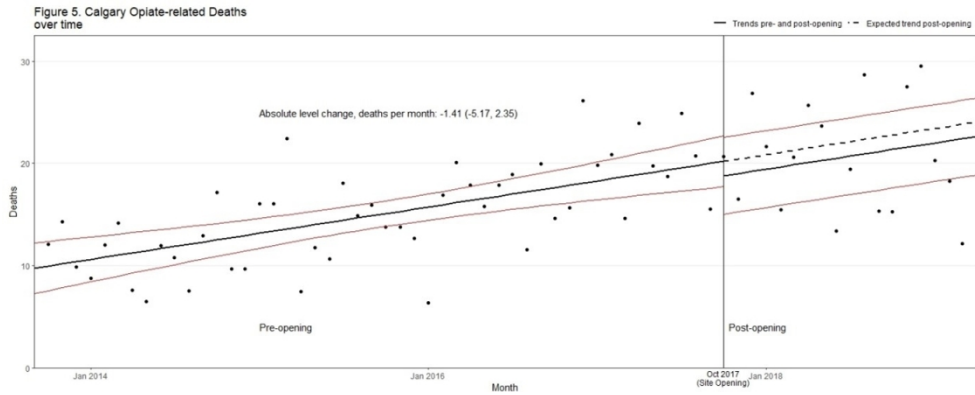
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Lethbridge Emergency Department Opiate-related visits over time

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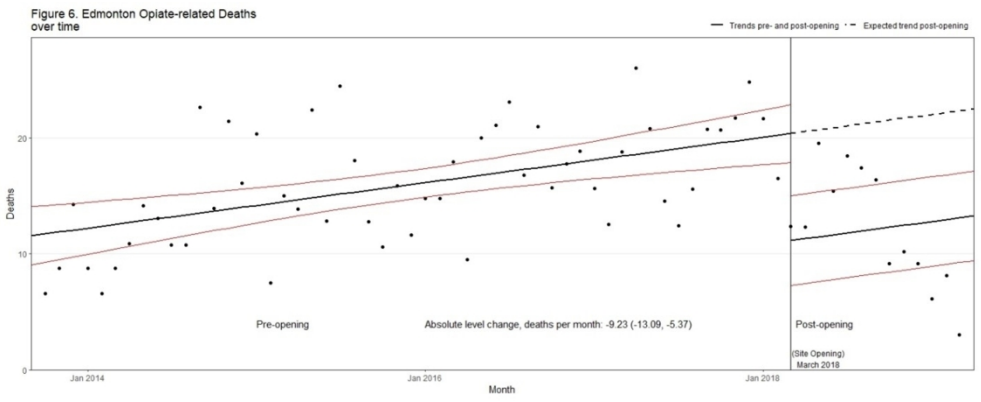




Calgary Opiate-related Deaths over time

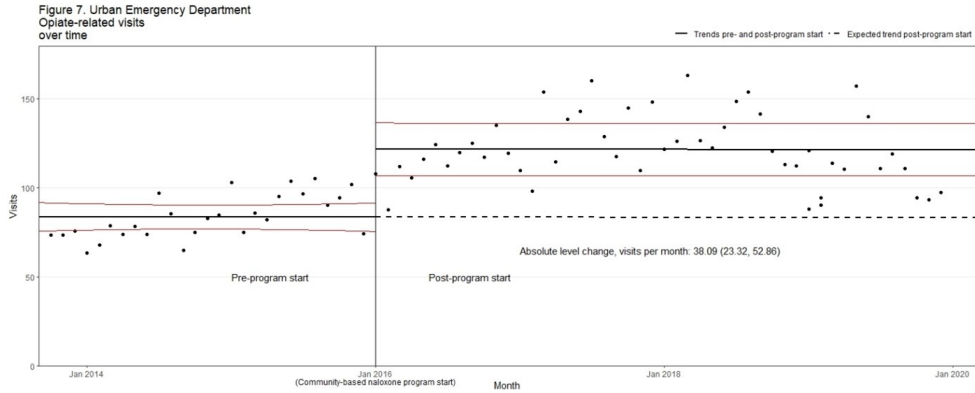
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Edmonton Opiate-related Deaths over time

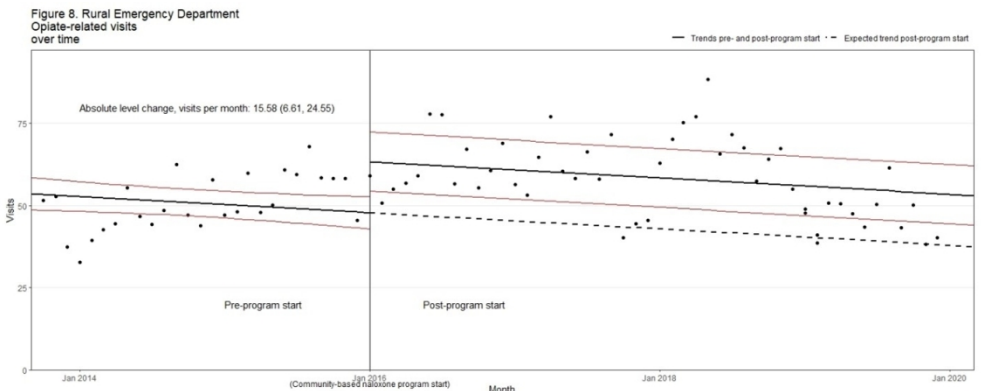
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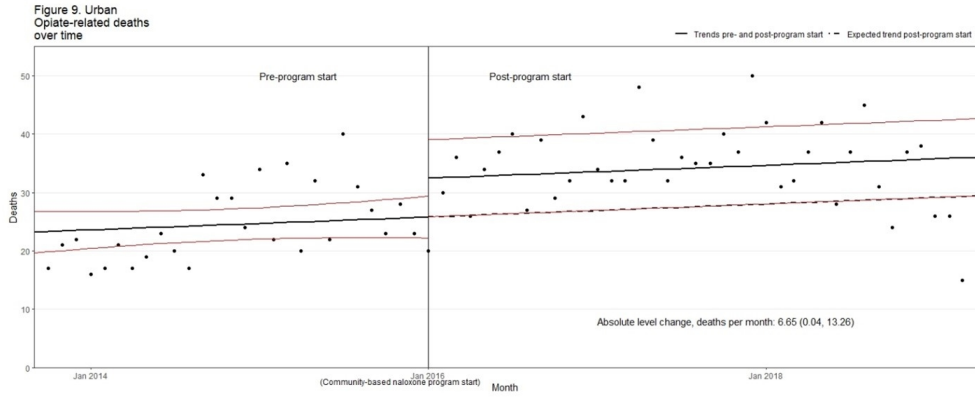
Urban Emergency Department Opiate-related visits over time

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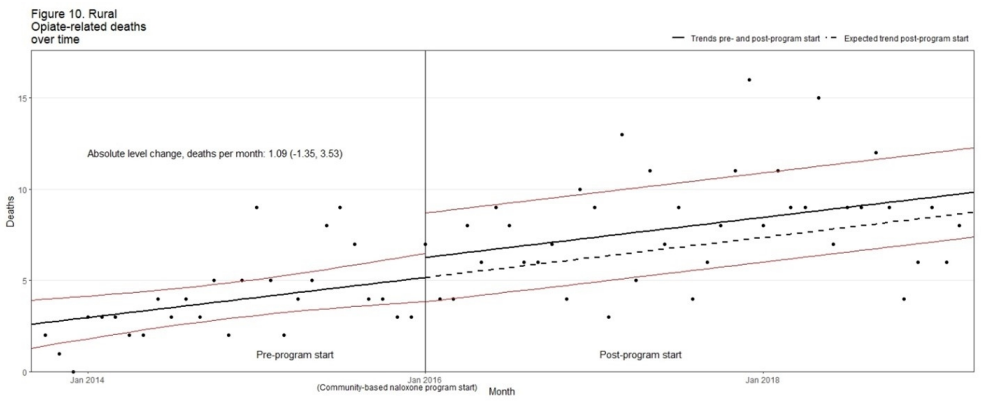
Rural Emergency Department Opiate-related visits over time  
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Urban Opiate-related deaths over time

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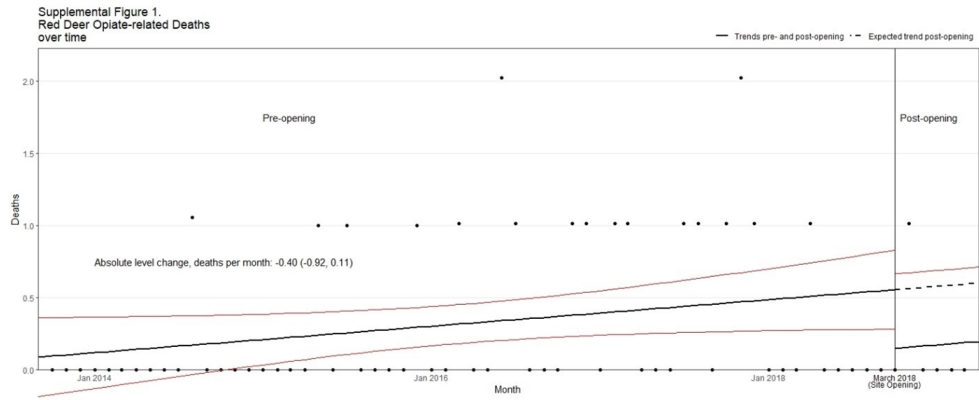
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Rural Opiate-related deaths over time

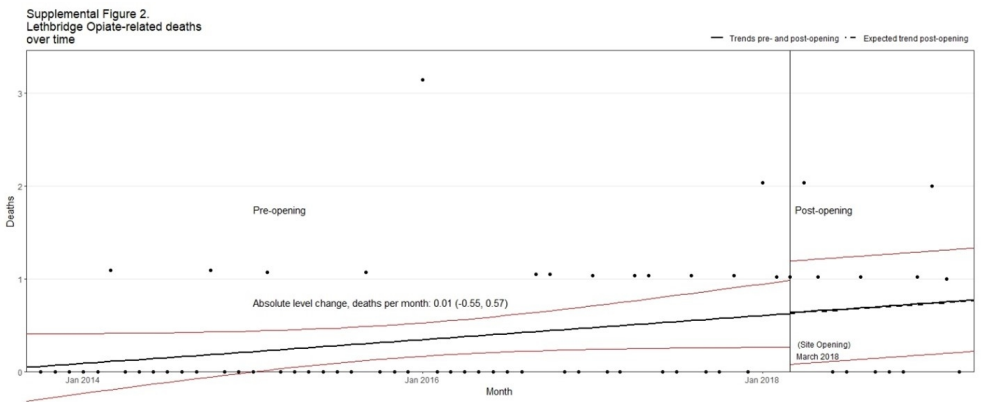
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