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RESEARCH REPORT

ADDICTION SSA

Healthcare utilization and mortality after overdose prevention site closure: A linked cohort analysis using segmented difference-in-differences time series

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Abstract

Background and aims: Evidence regarding the impacts of supervised drug consumption services (SDC) remains mixed, and few evaluations have used individual-level, linkable health data to examine service withdrawal. In September 2024, the Red Deer overdose prevention site (OPS) in Alberta, Canada, was scheduled for closure, with operations ceasing on 31 March 2025. This study examined: (1) changes in weekly opioid agonist therapy (OAT) dispensing among identifiable OPS clients associated with the closure announcement and subsequent service cessation; and (2) changes in acute healthcare utilization and mortality.

Design: Retrospective cohort study using linked provincial administrative health data from 30 June 2024 to 6 months after the Red Deer site closure (27 September 2025). A segmented difference-in-differences interrupted time-series (DID–ITS) design compared Red Deer OPS clients with clients from a continuously operating OPS in Lethbridge. Within-site interrupted time-series (ITS) models were applied for Red Deer-only analyses.

Setting: Two provincially regulated OPS programs in Alberta, Canada. The Red Deer OPS closure was publicly announced on 24 September 2024 and implemented on 31 March 2025. The Lethbridge OPS remained operational throughout.

Participants: OPS clients with a linked personal health number (PHN) and at least one consumption event at the Red Deer (n = 381) and Lethbridge sites (n = 300).

Measurements: Primary outcome: weekly proportion of clients receiving ≥1 OAT dispensing. Secondary outcomes: weekly emergency department (ED) visits, inpatient (IP) admissions, suspected opioid-related emergency medical services (EMS) events and mortality.

Findings: Prior to the closure announcement, baseline weekly OAT proportions were lower in Red Deer (9.9%) than in Lethbridge (12.0%), with broadly similar pre-announcement trends. After the closure, the proportion of clients on OAT in Red Deer

exceeded those in Lethbridge (16.1% versus 14.4%, respectively; $P < 0.021$). After closure, there was no statistically significant difference in the number of ED visits or suspected opioid-related EMS events in both the Red Deer only ITS models or in the proportion of these outcomes in the DID–ITS model comparing Red Deer and Lethbridge. Mortality events were rare during the follow-up period, and no statistically detectable increase was observed over the available follow-up.

Conclusions: The announcement and subsequent closure of the Red Deer overdose prevention site in Alberta, Canada, were associated with increased opioid agonist therapy dispensing among identifiable site users. Short-term effects on acute healthcare utilization and mortality appear stable but remain inconclusive due to the limited 26-week follow-up period and low event counts.

KEYWORDS
harm reduction, healthcare utilization, opioid agonist therapy, overdose mortality, service closure, supervised consumption services (SCS)

INTRODUCTION

Supervised drug consumption services (SDC), including supervised consumption sites (SCS) and overdose prevention sites (OPS), operate in several jurisdictions as part of broader responses to increasingly toxic and unpredictable drug markets. Early evaluations of high-volume programs in Vancouver and Sydney suggested potential benefits, such as reduced overdose-related harms and increased engagement with health and social services [1]. However, most studies rely on observational designs in which service attendance is voluntary, raising concerns that outcomes may reflect characteristics of people who choose to attend rather than the effects of the services themselves. Methodological reviews have highlighted how this endogenous exposure complicates efforts to infer service impact [2, 3].

In September 2024, the Government of Alberta announced that the Red Deer OPS, a provincially authorized service operating since 2018, would close on 31 March 2025 [4]. The announcement prompted substantial public debate, with concerns that service withdrawal would disrupt care pathways, contribute to increased healthcare utilization and increase overdose-related harms. Yet the empirical basis for these concerns is limited. Few studies have examined outcomes following SDC service withdrawal, and almost none have used linked individual-level data.

A relevant methodological precedent is the closure of an American methadone clinic studied by McGlothlin and Anglin [5], which allowed observation of changes in treatment engagement and health outcomes with reduced selection bias. Unlike methadone programs, however, OPS serve a highly transient population and function as low-threshold, episodic harm-reduction interventions rather than longitudinal clinical treatments. This distinction raises important concerns regarding survival bias, disengagement following service withdrawal and the applicability of traditional treatment evaluation frameworks. Nonetheless, exogenous service disruptions, such as site closures, remain analytically valuable, because they reduce self-selection and permit the observation of behaviour change under externally imposed conditions, even when full causal identification is not possible.

In this context, we examined weekly opioid agonist therapy (OAT) dispensing and acute healthcare utilization—including emergency department (ED) visits, in-patient (IP) admissions, suspected opioid-related emergency medical services (EMS) events and mortality—among identifiable clients of the Red Deer OPS before and after the announcement and closure of the service. To contextualize observed patterns and strengthen internal validity, we included a comparison cohort from the continuously operating Lethbridge OPS, a structurally similar provincially regulated service (Table 1). To our knowledge, this is the first Canadian study to assess the effects of OPS closure using individual-level, linkable administrative health data.

METHODS

Study design

A retrospective cohort design was used, drawing on linked provincial administrative health data to examine weekly OAT dispensing, acute healthcare utilization and mortality among identifiable clients of the Red Deer OPS before and after its announced closure. A comparison cohort from the continuously operating Lethbridge OPS, a provincially regulated site of similar scale and structure, was included to provide contextual contrast. Outcomes consisted of weekly OAT dispensing, weekly ED visits, IP admissions, suspected opioid-related EMS events and all-cause mortality. The primary research question and analysis plan were not pre-registered on a publicly available platform and the results should be considered exploratory.

Setting and participants

The Red Deer OPS served a mid-sized Alberta community until operations ceased on 31 March 2025, following a public announcement of closure on 24 September 2024 [4]. The Lethbridge OPS remained open throughout the study period under the same provincial operator.

TABLE 1 Characteristics of Lethbridge and Red Deer overdose prevention sites and regional background context.

Characteristic	Lethbridge OPS		Red Deer OPS	
N (clients with ≥1 consumption visit and valid personal health number)[a]	300 (1 June 2024 to 30 September 2025)[a]		381 (1 June 2024 to 31 March 2025)[a]	
Average % personal health number collected[a]	94.6		97.7	
Gender (female) *n* (%)[a]	153 (51.0)		155 (40.7)	
Average age (SD)[a]	36 (9)		38 (10)	
City population (2024)[b]	111 400		112 917	
City family income in Canadian dollars (2022)				
Total income (median)[b]	$102 074		$103 330	
Lone-parent family (median)[b]	$55 170		$55 670	
Closest alternative supervised drug consumption site and distance	212 km		150 km	
Service context (VODP, NTS, recovery community)	Yes/yes/yes		Yes/yes/yes	
OPS site operator	Recovery Alberta		Recovery Alberta	
Indigenous population (% of city)[c]	6.0		6.6	
Regional drug poisoning deaths in 2024 (per 100 000 person years)[†]	26.8		24.4	
Confirmed regional toxicology of decedents (%)[d]	2024	2025 to date	2024	2025 to date
Total decedents	*n* = 74	*n* = 18	*n* = 110	*n* = 56
Fentanyl	72	56	65	57
Methamphetamine	59	50	62	52
Cocaine	36	50	30	29
Alcohol	14	33	25	14
Benzodiazepine	8	0	5	2
Carfentanil	0	6	4	36

Abbreviation: OPS, overdose prevention site.
[a]Source: Consolidated Addiction and Mental Health Database, Recovery Alberta. The most recently available data for Lethbridge was provided.
[b]Source: Alberta Regional Dashboard: Alberta Regional Dashboard and Site Selector.
[c]Source: Reflect self-identified Indigenous identity from the 2021 Canadian Census: Focus on Geography Series.
[d]Source: Alberta Substance Use Surveillance System (SAS Visual Analytics). Lethbridge and Red Deer correspond to the South and Central regional zones, respectively.

Alberta requires OPS programs to request client identifiers that can be used to enable linkage across administrative datasets, including a personal health number (PHN) [6]. The analytic cohorts included individuals with at least one consumption-related visit and a linked PHN. Red Deer clients were identified from 1 June 2024 to 31 March 2025, and Lethbridge clients from 1 June 2024 to 30 September 2025, reflecting the most recent available comparator data. Individuals remained in the analytic denominator across the entire follow-up to support weekly estimation within a fixed cohort.

Data sources

Medication dispensations were obtained from the Pharmaceutical Information Network. These included all OAT medications classified under the Anatomical Therapeutic Chemical (ATC) code N07BC (buprenorphine–naloxone, buprenorphine extended-release and methadone), as well as slow-release oral morphine (drug identification numbers: 02184435, 02184443, 02184451 and 02242163). ED and IP encounters were drawn from the Connect Care provincial repository, and suspected opioid-related EMS events were obtained from the provincial EMS dataset using standardized case definitions. Mortality data were obtained through provincial vital statistics linkages available within the administrative health data environment. Site-level information on PHN collection was taken from the Consolidated Addiction and Mental Health Database. Dataset linkage was performed by the operational entity and submitted for research in an aggregated form.

Exposure periods

Exposure periods were defined according to the weekly structure of the data provided by the operational team, which was created to monitor activity in Red Deer during the site closure. Because outcomes were available only as full weekly aggregates, phase boundaries aligned with week-end dates rather than the exact calendar date of the site's final day of operation. For OAT analyses, weekly observations were grouped into a pre-announcement period from 30 June 2024 to 28 September 2024; an announcement-to-closure period

from 29 September 2024 to the week ending 29 March 2025; and a post-closure period beginning the week of 30 March 2025 through 27 September 2025. For ED, IP and EMS outcomes, the same pre-closure and post-closure week groupings were applied. Because outcomes were summarized using weekly cohort-level aggregates, individuals who died during follow-up remained in the fixed denominator, and given the low number of mortality events, any resulting denominator inflation was expected to be minimal.

Statistical analysis

Analyses combined within-site interrupted time-series (ITS) models for the Red Deer cohort with segmented difference-in-differences interrupted time-series (DID–ITS) models comparing Red Deer with Lethbridge. ITS models estimated level and slope changes associated with the announcement and closure using a weekly count data modelled with Poisson regression after evaluating dispersion (negative binomial alternatives were not required). Autocorrelation testing identified a lag-one structure for EMS models only. The DID–ITS models incorporated site indicators, phase-specific intercepts and slopes and interaction terms capturing differential level and trend changes between sites. Weekly outcomes were expressed as proportions of each fixed cohort to permit comparability despite differing cohort sizes. Ordinary least squares regression was used for DID estimation. Parallel trends were assessed during the pre-announcement interval using visual inspection and formal site-by-time interaction testing. Mortality outcomes were summarized descriptively because of low event counts.

Ethics

The study received approval from the Health Research Ethics Board of Alberta (Community Health Committee). Approval was obtained from the operational entity to release these data in an aggregated, non-identifiable form.

RESULTS

Participant characteristics

A total of 381 Red Deer OPS clients and 300 Lethbridge OPS clients with a linked valid PHN were included in the analytic cohorts. Red Deer clients were slightly older on average (mean age 38 vs. 36 years), and the proportion of female clients was higher in Lethbridge (51.0% vs. 40.7%). Capture of individual identifiers exceeded 94% at both sites. The two cities were similar in terms of population size, median income and Indigenous population proportions. However, the regional drug supply differed substantially. In Red Deer, carfentanil was detected in 4% of decedent toxicology cases in 2024, compared with 0% in Lethbridge. Public surveillance data from the Alberta Substance Use Surveillance System (SAS) further indicate that carfentanil-related deaths continued to increase in the Red Deer area during 2025. These differences represent an important contextual factor for interpreting site-level trends.

OAT

Red Deer ITS analysis

Within-site ITS models showed that weekly OAT dispensing among Red Deer clients increased significantly following the public announcement of site closure (level change, $P = 0.047$), and the trend continued throughout the post-announcement period (trend, $P < 0.0001$). During the post-closure period, the slope of OAT dispensing declined (slope change, $P < 0.0001$), however, the post-closure level of weekly OAT dispensing remained higher than during both the pre-announcement and announcement periods. Effect estimates and confidence intervals are presented in Table S1.

DID–ITS analysis

Before the closure announcement, Lethbridge exhibited a significantly higher ($P = 0.002$) baseline proportion of clients receiving OAT than Red Deer, and the two sites demonstrated broadly parallel pre-announcement trends. During the post-closure period, the proportion of Red Deer clients receiving OAT exceeded the level observed at the comparison site ($P = 0.021$).

Relative to Lethbridge, after the announcement of closure but before the actual closure of the site, there was a trend toward increased OAT use that approached, but did not reach statistical significance ($P < 0.076$). Although the post-closure slope flattened, the level effect persisted, indicating sustained weekly OAT dispensing above baseline over the available follow-up period. Full DID–ITS estimates are reported in Table S2, and fitted trends are shown in Figure 1.

ED visits, IP admissions, EMS events and mortality

Red Deer ITS analysis

Within-site ITS models identified a statistically significant increase in the post-closure trend for IP admissions among Red Deer clients ($P = 0.028$). No statistically significant changes in level or trend were observed for emergency department visits or suspected opioid-related EMS events (all P-values ≥ 0.23). Full ITS estimates are provided in Table S3.

In the 26 weeks after site closure, five all-cause mortality events were recorded (0.19 deaths per week). In the 26 weeks immediately before closure, six events occurred (0.23 deaths per week). Across the full pre-closure period, eight deaths were observed over 39 weeks, corresponding to a mean weekly mortality rate of 0.21.

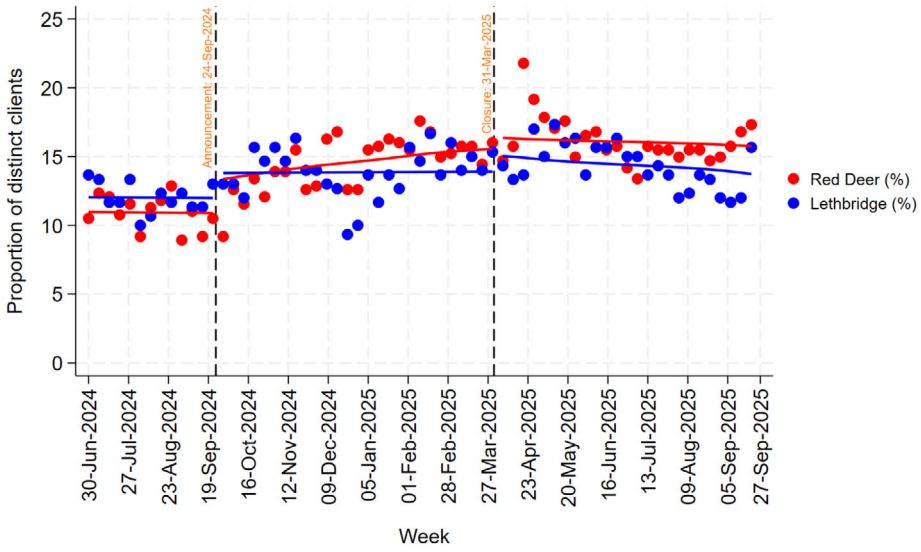

FIGURE 1 Weekly proportion of identifiable overdose prevention site (OPS) clients dispensed opioid agonist treatment (OAT) in Red Deer (intervention site) and Lethbridge (comparison site), June 2024–September 2025.*. * Vertical dashed lines indicate the public announcement of the Red Deer OPS closure (24 September 2024) and the cessation of operations (31 March 2025). Solid lines represent site-specific fitted trends from the difference-in-differences interrupted time-series (DID–ITS) model.

DID–ITS analysis

In DID–ITS analyses, no statistically significant differential post-closure changes were observed between Red Deer and Lethbridge for ED visits or suspected opioid-related EMS events. The baseline difference in IP utilization observed before closure was no longer present following closure, however, a significantly greater post-closure increase in the IP admission trend was observed in Red Deer relative to Lethbridge (P = 0.027). Full DID–ITS coefficients are reported in Table S4, and corresponding time-series plots are presented in Figure 2.

DISCUSSION

Summary of principal findings

In this linked administrative cohort study, weekly OAT dispensing increased among identifiable Red Deer OPS clients following the public announcement of the site's closure, with elevated levels persisting into the post-closure period. Across within-site ITS models and segmented DID–ITS analyses, a modest but statistically significant trend toward increased IP hospitalizations was detected. In contrast, no statistically significant changes were detected in ED visits or suspected opioid-related EMS events. Over the available follow-up interval, OAT dispensing increased and mortality rates were stable. The absence of an observed increase in mortality during the short follow-up period should not be interpreted as clear evidence of safety, particularly given rising carfentanil prevalence and limited statistical power.

Interpretation in context

The increase in OAT dispensing occurred within a provincial health system that has expanded low-barrier access through virtual pathways, same-day assessments and broad community-based supports [7–11]. These system-level changes could contribute to increased treatment uptake independent of OPS closure. Although engagement in OAT is consistently associated with reduced overdose risk and mortality in broader research [12], the present observational design does not permit attribution of the observed increase to any specific mechanism or policy change.

Interpretation of acute healthcare utilization outcomes requires caution. *Post hoc* analyses indicate that the minimum detectable effect was approximately 11% for ED visits, 23% for IP admissions and 96% for suspected opioid-related EMS events, suggesting that smaller but clinically meaningful changes may not have been reliably detected. Acute events were infrequent, the follow-up duration was limited and CI were wide. The two study communities exhibited distinct drug toxicity profiles, specifically, Red Deer demonstrated a markedly higher rate of carfentanil presence in regional decedent toxicology results during the study period. This elevated presence of carfentanil in the area where the SDC site was closed may have introduced bias toward increased rates of overdose, and subsequent increases in acute healthcare utilization, and mortality relative to the comparison site. The impact of this variable cannot be quantified with the available data. Importantly, an increase in mortality was not observed despite the closure of the SDC site and in the context of an apparently worsening local drug supply.

The increase in OAT dispensing following the closure announcement may also reflect behavioural responses to the withdrawal of supervised consumption services themselves. Although SDC programs are often described as pathways to treatment, their primary function is harm reduction, and the degree to which treatment linkage is actively prioritized varies across sites and jurisdictions. One plausible explanation is that removal of a supervised environment for ongoing illicit opioid use altered the relative attractiveness of OAT, such that pharmacotherapy became a more acceptable or necessary alternative for some individuals. Another possibility is that closure prompted intensified outreach, referral activity or administrative transitions

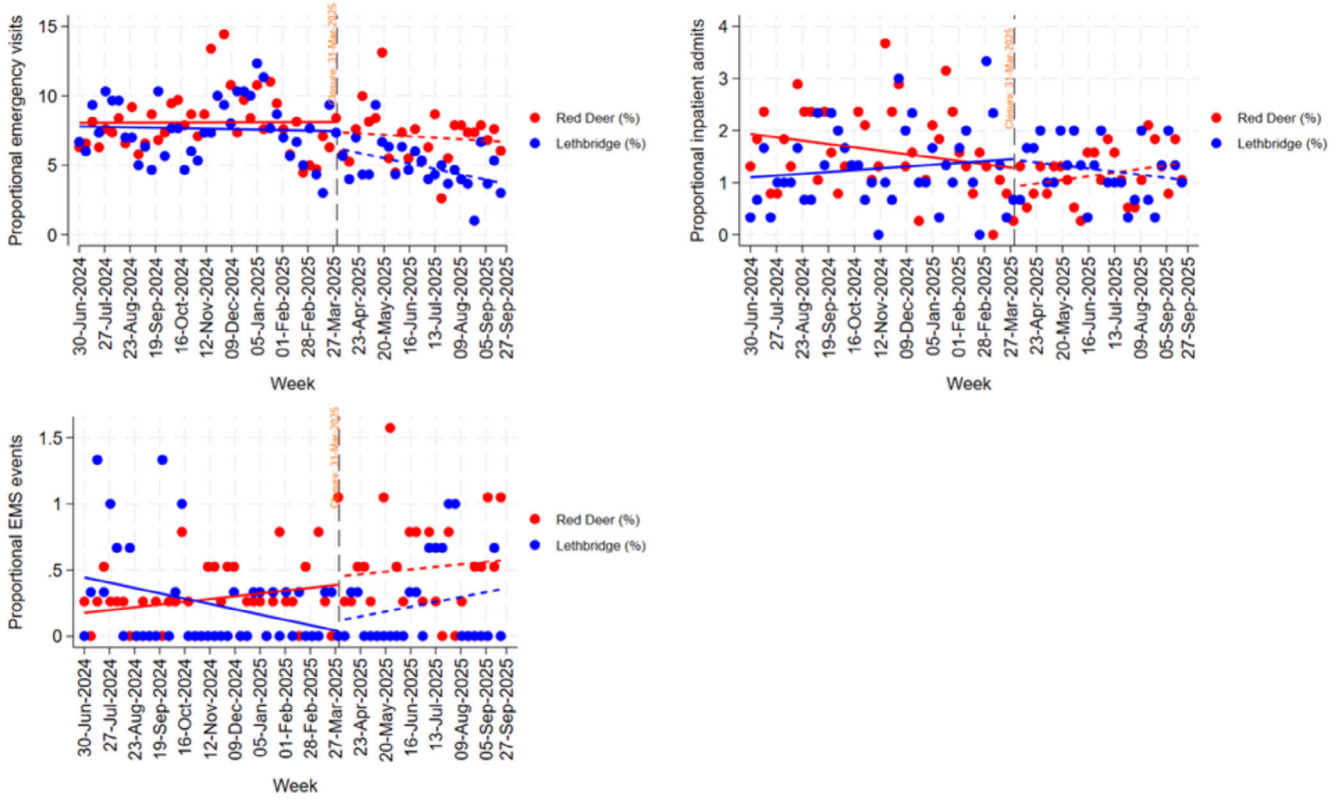

FIGURE 2 Weekly proportions of identifiable overdose prevention site OPS clients with (a) emergency department (ED) visits, (b) in-patient (IP) admissions and (c) suspected opioid-related emergency medical services (EMS) events in Red Deer (intervention site) and Lethbridge (comparison site), June 2024–September 2025.* * Vertical dashed lines mark the closure announcement (24 September 2024) and operational cessation (31 March 2025). Solid lines indicate site-specific trends fitted using DID–ITS models.

toward treatment services. Although the present study cannot distinguish among these mechanisms or establish causality, the temporal association underscores the importance of examining how changes in harm-reduction service availability may influence treatment-seeking behaviour.

By focusing on identifiable clients exposed to an externally imposed service discontinuation, this study leverages a form of exogeneity that is rarely available in evaluations of supervised consumption services, which typically rely on voluntary attendance and are, therefore, highly endogenous [1]. This methodological parallel to the classic clinic-closure analysis by McGlothlin and Anglin [5] strengthens the descriptive value of the findings, while still requiring caution and humility regarding causal inference [2].

Implications for policy and service planning

If the observed increase in OAT utilization following OPS closure persists, it may indicate shifts in engagement with evidence-based treatment in response to service withdrawal. The findings also highlight the importance of ensuring that accessible, low-barrier treatment pathways are widely available during periods of service transition. The absence of statistically detectable short-term changes in ED and EMS utilization should not be interpreted as evidence of neutrality or lack of impact, particularly in regions with heterogeneous drug toxicity. Longer-term effects—including treatment retention, delayed healthcare utilization and mortality—require continued evaluation.

Strengths and limitations

A key strength of this study is the ability to examine outcomes among identifiable clients of OPS using linked administrative health data, enabling near-complete capture of service users across multiple healthcare domains. Unlike most evaluations of supervised drug consumption services, which rely on voluntary attendance and self-reported outcomes, this design allowed longitudinal follow-up of a fixed cohort using objective measures of treatment engagement, healthcare utilization and mortality. The segmented DID–ITS approach further strengthened internal validity by evaluating changes associated with both the closure announcement and service cessation while accounting for baseline trends and incorporating a continuously operating comparison site. Inclusion of multiple outcomes—spanning treatment, acute care and mortality—provides a more comprehensive assessment of system-level impacts than single-outcome evaluations.

Several limitations warrant careful consideration. First, despite structural similarities between Red Deer and Lethbridge, the two communities differ in unmeasured ways, particularly with respect to drug

supply toxicity, polysubstance use patterns and surrounding service ecosystems. Most notably, carfentanil involvement was substantially higher in Red Deer during the study period, raising concerns about the comparability of acute-event risk between sites. To address this, we formally assessed pre-intervention parallel trends and found no statistically significant divergence before the closure announcement, supporting the use of Lethbridge as a contextual comparator. Nevertheless, residual confounding related to evolving drug toxicity cannot be fully excluded and limits causal inference.

Second, outcomes were available only as weekly aggregated data, which may obscure heterogeneity in individual service use, treatment engagement and trajectories following closure. This limitation reflects constraints of the available administrative data rather than analytic choice. Although aggregation may attenuate detection of short-term or individual-level effects, the fixed-cohort design preserves interpretability of population-level trends. It avoids bias introduced by post-closure attrition or selective follow-up. Future analyses using individual-level longitudinal data will be important for characterizing engagement and disengagement trajectories more fully.

Third, a small proportion of OPS clients (~3%–6%) could not be linked because of missing PHNs. These individuals may represent a more marginalized subgroup with different risk profiles. However, PHN capture exceeded 94% at both sites and was comparable across cohorts, reducing the likelihood of differential bias between intervention and comparison groups. Although exclusion of this subgroup may bias estimates toward more stable individuals, the high capture rate remains a notable strength relative to prior studies in this literature.

Fourth, OAT dispensing reflects medication release rather than adherence, persistence or therapeutic retention, and extended-interval formulations may be undercounted. As such, observed increases in dispensing cannot be assumed to reflect sustained engagement or clinical benefit. We addressed this limitation by interpreting OAT outcomes cautiously, avoiding claims regarding treatment effectiveness and emphasizing the need for longer-term follow-up focused on retention and outcomes beyond initial dispensing.

Fifth, acute healthcare events and mortality were relatively infrequent, limiting statistical power to detect modest or short-term changes. To address this, we estimated minimum detectable effects for each outcome, allowing readers to assess the magnitude of change the study could detect. This analysis highlights that null findings should be interpreted as inconclusive rather than evidence of no effect, particularly for rare outcomes such as EMS events and mortality. Mortality analyses further mitigated concerns regarding survival bias and strengthened interpretation in the context of elevated carfentanil prevalence.

Finally, findings reflect a provincial context characterized by extensive low-barrier opioid use disorder treatment infrastructure, including virtual care pathways and same-day OAT initiation. These system-level features may have buffered service disruption and facilitated treatment uptake following OPS closure, limiting generalizability to jurisdictions with fewer supports. At the same time, this context allows examination of service withdrawal under conditions of relatively high treatment availability, offering insight into how harm-reduction and treatment systems may interact during periods of policy transition.

Taken together, these limitations constrain causal interpretation, but do not negate the study's contribution. By leveraging an externally imposed service discontinuation, high linkage rates, objective outcomes and a quasi-experimental design, this study provides rare empirical insight into the short-term system-level effects of OPS closure and identifies key priorities for longer-term evaluation.

Future directions

Longer follow-up is needed to assess the persistence of increased OAT engagement, potential delayed changes in acute healthcare utilization and longer-term outcomes such as treatment retention and mortality. Future studies should examine the mechanisms underlying observed increases in treatment uptake following service withdrawal, including how harm-reduction service availability, outreach practices and client preferences interact over time. Given the transient nature of this population, further work should explore individual-level trajectories by frequency of OPS use, transitions between harm-reduction and treatment services, geographic access to care and associations with other health outcomes. Integration of toxicology or drug-checking data may also help contextualize findings within evolving drug supply conditions.

CONCLUSION

In this observational, quasi-experimental evaluation of OPS withdrawal, the announcement and subsequent closure of the Red Deer site coincided with a statistically significant increase in weekly OAT dispensing. Although most acute healthcare utilization indicators did not show statistically detectable short-term changes, a modest post-closure trend toward an increase in IP admissions was observed. Mortality was uncommon before and after site closure and did not increase in the early follow-up period. All outcomes warrant further evaluation over longer follow-up periods and with careful attention to contextual and methodological limitations. These findings demonstrate the value of individual-level administrative data for examining service transitions and underscore the need to continue monitoring treatment continuity and healthcare demand following changes in harm-reduction service availability.

AUTHOR CONTRIBUTIONS

Nathaniel Day: Conceptualization; investigation; writing—original draft; methodology; writing—review and editing; supervision. **Kym Kaufmann:** Conceptualization; data curation; methodology; investigation; validation; formal analysis; supervision; project administration; resources; writing—original draft; writing—review and editing. **Daniel John Alexander Devoe:** Conceptualization; investigation; writing—original draft; methodology; writing—review and editing; visualization; software; formal analysis; supervision; validation; project

administration. **Vanja Grubac:** Writing—review and editing. **Alessia DiMarzo:** Writing—review and editing. **Haisa Osmanli:** Methodology; software; formal analysis; data curation; visualization. **Vanessa Norton:** Writing—review and editing; software; visualization. **Shelly Vik:** Methodology; supervision; visualization; validation; writing—review and editing. **Nickie Mathew:** Conceptualization; writing—review and editing. **Robert Lawrence Tanguay:** Conceptualization; visualization; writing—review and editing. **Anees Bahji:** Conceptualization; writing—original draft; writing—review and editing; methodology; validation; supervision; investigation; visualization.

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DECLARATION OF INTERESTS

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DATA AVAILABILITY STATEMENT

Alberta Health and Recovery Alberta hold the data supporting this study and are not publicly available because of privacy and regulatory restrictions. These data were accessed under license for this study. Requests for data access may be submitted to Alberta Health Services through the Health System Access for Research process (Health System Access for Research | Alberta Health Services).

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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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