Essays on the Economics of Safe Consumption Sites

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I declare that this thesis is my own work and has not been submitted for the award of a higher degree elsewhere

Abstract

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In many countries, opioid overdoses are a substantial public health issue. Safe consumption sites are facilities where people who use drugs are provided with medical supervision while consuming drugs to reverse overdoses. Though safe consumption sites can reduce drug related adverse events, these facilities are not always welcomed in the communities where they are established. This public opposition can represent a barrier to the development and operation of sites. As a result, this thesis aimed to investigate current knowledge gaps that represent barriers to the establishment of safe consumption sites with respect to public opposition. Specifically, this thesis conducted a discrete choice experiment, described in **Chapter 4**, to determine the attributes of safe consumption sites that are correlated with public preferences for these facilitates. With respect to findings, the discrete choice experiment identified a set of attributes for safe consumption sites that influence public support for these facilities. Specifically, survey respondents disliked sites that increased cost to the healthcare system. Additionally, survey respondents preferred sites that were better able to reduce fatal overdoses, that could reduce improperly discarded needles, and that were accompanied by policies that provided compensation to individuals living near sites. This thesis also conducted a difference in differences analysis to assess the effectiveness of mobile versus brick & mortar safe consumption sites in preventing drug-related mortality, described in **Chapter 5**. It has been suggested that mobile sites are more acceptable to the public than brick & mortar facilities. If mobile sites are not less effective than brick & mortar facilities than mobile sites could represent a less controversial approach to safe consumption. The primary analysis of the difference in differences analysis did not find a significant association between drug related mortality and safe consumption site type, suggesting that mobile sites were not less effective than brick & mortar sites. However, several sensitivity analyses found results that conflicted with those of the primary analysis. When taken together, the findings of the primary and sensitivity analyses suggested that the optimal site type may be dependent on jurisdictional factors. As a result, policymakers who aim to develop sites should conduct jurisdictional specific research prior to implementation, to identify the optimal site type for the targeted community. To facilitate these two quantitative chapters literature reviews were conducted that are presented in **Chapters 2 & 3**.

Contents

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Author's Declaration

I declare that this thesis is my own work and has not been submitted in substantially the same form for the award of a higher degree previously or elsewhere. Parts of the following chapters were either published, presented at conference, or submitted to Lancaster University as components of various courses as is described below:

- A protocol for this thesis was submitted as a component of the course DHR.403: Principles of Research Design and Practical Research Ethics.

- Chapter 3.0 A Systematic Review of Discrete Choice Experiments of Harm Reduction Strategies for Addictive Substance Use.
    - A protocol for this chapter was submitted as a component of the course DHR.523 Systematic Approaches to Literature Reviews and Evidence Synthesis.

- Chapter 4.0 Public Preference for Safe Consumption Sites for Opioid Use: A Discrete Choice Experiment.
    - A protocol for this systematic review was submitted as a component of the course DHR.403: Principles of Research Design and Practical Research Ethics.
    - A version of this chapter was presented at conference. Berrigan, P. (November 2021). "Public Preference for Safe Consumption Sites: A Discrete Choice Experiment." Canadian Centre for Substance Use and Addiction. Issues of Substance.
    - A version of this chapter was published in the journal Drug and Alcohol Addiction. Berrigan, P., & Zucchelli, E. (2022). Public Preferences for Safe Consumption Sites for Opioid Use: A Discrete Choice Experiment. *Drug and Alcohol Dependence*, 109578.

- Chapter 5.0 Mobile versus Brick & Mortar Safe Consumption Sites: A Difference in Differences Analysis during the COVID19 Pandemic.

- A version of this chapter was presented at conference. Berrigan. P. (November 2021). “Efficacy of Mobile versus Brick & Mortar Safe Consumption Sites: A Difference in Differences Analysis in Alberta Canada.” Canadian Centre for Substance Use and Addiction. Issues of Substance.

- Finally, the present study’s author (PB) is aware of no conflicts of interest related to the conduct of this thesis. PB acknowledges that he is personally a supporter of safe consumption sites.

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1. Introduction

Addiction can be defined as a compulsive use of substances or set of behaviors that persists despite negative consequences (American Society of Addiction Medicine, 2019). Worldwide it is estimated that at least one billion people use addictive substances such as drugs, alcohol, or tobacco (Gowing et al., 2015) and the negative consequences resulting from the misuse of addictive substances are substantial. For example, globally it is estimated that approximately 8.5% of all deaths are caused by tobacco use (Gowing et al., 2015).

Of late, a substantial driver of addiction related mortality is opioid overdoses (Centers for Disease Control 2022; National Institute of Health, 2022). Opioids are psychoactive drugs that are used medicinally to manage pain but also outside the healthcare system, as an illegal narcotic. Problematic opioid use is increasingly common and it has been estimated that 16 million people have experienced opioid use disorder internationally (Huecker et al., 2019). The World Health Organization (WHO) estimated that in 2017 approximately 115,000 people died due to opioid overdose worldwide (World Health Organization, 2021). The occurrence of opioid overdoses has been an exceptionally common phenomenon in North America. For instance, in Canada, opioid overdoses caused approximately 6,500 deaths in 2020 (Government of Canada, 2021). For context, this is similar to the number of deaths in that country from common conditions such as diabetes or Alzheimer's disease over the same period (Statistics Canada, 2021). Furthermore, in the United States of America in 2020 there was an estimated 68,630 opioid related overdoses and the annual number of opioid deaths has been consistently increasing since at least the 1990s (National Institute of Health, 2022). The opioid crisis has become so acute in the United States of America that for Americans in 2020 the probability of dying from an accidental overdose exceeded that from dying in an automobile accident (National Safety Council, 2022).

Economists Anne Case and Angus Deaton have examined the root causes of the surge in drug related deaths in the United States of America (Case & Deaton, 2021). They categorized drug overdoses along with suicides and alcohol related deaths into a category that they refer to as "Deaths of Despair". They argue that changes in government policy that favour the rich, globalization, and changes in social structures such as religion and family have meant that working class whites are facing less meaningful lives than those of previous generations.

Without fulfilling work, strong family connections, or the comforts of religion this demographic has turned to drugs and alcohol to seek solace. This coupled with an ineffective healthcare system and predatory practices by the pharmaceutical industry has helped fuel the spike in opioid related deaths currently occurring. In addition to mortality, opioid use can impact healthcare utilization and workplace productivity. Overdoses may require substantial medical treatment in some instances. In serious cases, brain injury due to overdose may leave individuals permanently unable to work.

For many people, opioid addictions can be treated with approaches such as addiction treatment counselling and/or opioid agonist therapies (i.e. methadone or buprenorphine) (The Centre for Addiction and Mental Health, 2022). Unfortunately, there are few options available to those who do not respond to these therapies, leaving harm reduction as one of the few remaining options. Harm reduction is an approach to managing addiction that does not require the cessation of drug use but instead aims to curb the negative repercussions of drug use to people who use drugs and society as a whole. Safe consumptions sites (SCSs) represent a harm reduction strategy employed as a management strategy for opioid use (Bowers, 2017). Though there is heterogeneity between sites, in general, SCSs are facilities where people are provided with medical supervision while using drugs so that, should an overdose occur, medical aid can be provided (Lange & Bach-Mortensen, 2019; Bowers, 2017).

In a modern context, the use of SCS began in Bern Switzerland during the 1980s, with the goal of reducing overdose deaths and of improving the lives of people who use drugs (Beletsky, Baker, Arredondo, et al., 2018). Though the literature suggests that SCSs can reduce drug related negative outcomes, these sites are not always welcomed by the communities where they are located (Caulkins et al., 2019; Lange & Bach-Mortensen, 2019). Many residents have concerns that the establishment of SCSs will lead to increased crime and negatively impact their communities (Lange & Bach-Mortensen, 2019). This public opposition has in some cases represented a barrier to the establishment or ongoing operation of SCSs.[1] An improved understanding of the factors that influence public support for SCSs could allow policymakers

[1] Though not reported in peer reviewed literature, in Calgary, Alberta, Canada a planned safe consumption site was halted due to public concern.
The Canadian Broadcasting Corporation. (2022-09-02). Proposed overdose prevention site not proceeding at Calgary Drop-In Centre. https://www.cbc.ca/news/canada/calgary/calgary-drop-in-mike-ellis-ucp-overdose-prevention-centre-1.6571244 (Accessed 2022-11-18).

to design SCSs that would not provoke backlash from the residents of the communities where these sites are to be established. As a result, the overarching aim of this thesis was to investigate current knowledge gaps that represent barriers to the establishment of SCSs from a public preferences standpoint.

One such barrier investigated by this thesis is that we are aware of no recent studies that have used a comparative method to assess the relative importance of attributes in influencing public support for SCSs. Such an analysis could provide policymakers with an understanding of important aspects to consider when developing SCSs and thereby increase the probability that sites will be accepted within the communities where they are located. Furthermore, we are aware of no study that has estimated a willingness-to-accept (WTA) for having an SCS located in a person's community. The results of such an analysis could be used to better understand the extent to which individuals dislike the prospect of an SCS being in their community and to assess the feasibility of providing residents with financial compensation to accept the establishment of an SCS in their community.

Accordingly, this thesis first set out to conduct a discrete choice experiment (DCE) to determine a set of attributes that are significantly associated with public preferences for SCSs and to estimate a WTA for an SCS to be established in a person's neighborhood. DCEs use surveys to assess the preferences of respondents for attributes associated with a policy. Attributes refer to the components of a policy or intervention that a person may consider when deciding whether to support a policy or when choosing a preferred option from a set of policy alternatives (Bridges et al., 2011). In DCEs, attributes are assigned levels, that correspond to the values an attribute can take. To conduct a DCE, respondents are presented with a set of hypothetical alternatives for the policy being analyzed, each with a unique set of attribute/levels and are asked to choose their preferred option. This process is repeated multiple times and from this a dataset can be constructed that relates respondents' preferences to the attributes and levels that were included in the experiment. More information on the DCE methodology can be found in **Chapter 3** and **Chapter 4**.

Furthermore, this thesis aimed to assess the effectiveness of mobile versus brick & mortar SCSs in preventing drug related mortality. Briefly, a mobile SCS is an SCS that can be moved from one place to another, usually in the form of a recreational vehicle (RV) or trailer and a brick &

mortar SCS is an SCS that exists in a fixed location. Though mobile SCSs may be preferred by the public due to their smaller size and mobility, it is not clear whether these facilities are as effective at preventing mortality as brick & mortar SCSs. If it were the case that mobile sites were not less effective than brick & mortar facilities, then mobile sites could potentially provide a less controversial and equally effective alternative. Finally, it has been suggested within the literature that there is a lack of high quality evidence on the effectiveness of SCSs in reducing drug related mortality (Caulkins et al., 2019). As a result, this thesis also conducted an exploratory analysis to assess how SCS use rates impacted drug related mortality rates, across a set of five cities in Alberta, Canada.

To investigate the effectiveness of mobile SCSs versus brick & mortar SCSs in preventing drug related adverse events a difference-in-differences (DiD) approach was used. In August 2020, the city of Lethbridge, Alberta, Canada switched from a brick & mortar SCS to a mobile SCS. This change provided the opportunity to exploit a natural experiment to evaluate if a mobile SCS is as effective at preventing drug related mortality as a brick & mortar facility. DiD is a quasi-experimental research design used to assess the impacts of a policy or intervention when data are available before and after the intervention for both the treated and control groups. The difference between the outcome of interest in the treated and control groups before and after the intervention provides a measure of the average treatment effect of the intervention (Cunningham, 2021). More information on the DiD methodology can be found in **Chapter 5**. Additionally, and as a secondary analysis, this thesis also investigated the overall impact of SCS use on drug related mortality, irrespective of site type, in Alberta, Canada. During the COVID-19 pandemic, harm reduction supports in Alberta in some cases closed and if they remained open, their use declined. The reduction in SCS use that occurred during the pandemic provided an opportunity to assess the impact of the change in SCS use on the change in drug related mortality. Specifically, if cities in Alberta that experienced larger reductions in SCS use also experienced larger increases in overdose related mortality, this would suggest that SCS use is protective against drug related mortality. The base year for this analysis was 2019 and rates of change were analyzed for 2020 and 2021. This analysis was conducted to contextualize the findings of the primary analysis contained in **Chapter 5**. Correspondingly, the results of this analysis are presented in **Chapter 5**.

To conduct these two quantitative studies, literature reviews were required. Specifically, a state-of-the-art literature review was conducted to: **1)** identify drivers of public support of SCSs to serve as demographic variables in the DCE contained in **Chapter 4**; **2)** understand which parameters should be modelled as random parameters in a mixed logit model included in the DCE contained in **Chapter 4**; and **3)** determine if mobile SCSs are preferred by the public versus brick & mortar SCSs to justify the DiD analysis contained in **Chapter 5**. A state-of-the-art review approach was deemed to be the most appropriate, as public opinion on controversial topics can change quickly and older studies may not capture current trends in public attitudes. Secondly, a literature review was required that identified best practice for conducting DCEs of harm reduction strategies to inform the methodological approach used for the DCE contained in **Chapter 4**. This literature review took the form of a systematic review (SR) and systematically reviewed the literature for all English language DCEs that were conducted on topics related to harm reduction. The specific search strategies that were used to conduct these two literature reviews can be found in **Chapter 2** and **Chapter 3**.

With respect to findings, the DCE identified a set of attributes for SCS that influence public support for sites. Specifically, that survey respondents disliked sites that increased cost to the healthcare system and that survey respondents preferred sites that **1)** were better able to reduce fatal overdoses; **2)** could reduce improperly discarded needles; and **3)** were accompanied by policies that provided compensation to residents impacted by sites. The analysis estimated that the WTA for having a site located in a respondent's neighborhood was between $11,000 to $11,500 in 2021 Canadian dollars (CAD) depending on the model used. With respect to the second quantitative study contained within this thesis, the primary analysis of the DiD analysis, did not find a statistically significant association between drug related mortality and safe consumption site type, suggesting that mobile sites were not less effective than brick & mortar sites. However, several sensitivity analyses found results that conflicted with those of the primary analysis. Specifically, a time reversed DiD and a sensitivity analysis using an alterative switching time point found conflicting results. More details regarding the DiD analysis can be found in **Chapter 5**. When taken together, the findings of the primary and sensitivity analyses suggested that the optimal site type may be dependent on jurisdictional factors and that no single relationship exists between site type and drug related mortality. As a result, policymakers who aim to develop sites should conduct jurisdictional specific research prior to implementation to identify the optimal site type for the community targeted for a SCS. Finally,

the findings of the exploratory analysis suggest that SCS use is a protective factor against drug related mortality.

Findings of this thesis may be of relevance to policymakers who aim to design SCSs such that they reduce the negative response elicited from residents in the neighborhoods where sites are established. Furthermore, findings may be of relevance to those who are currently managing SCSs and would like to improve messaging with the hopes of improving public perceptions. In addition, this thesis is the first study to apply the method of DCEs to topics related to SCSs and the first to estimate a WTA for an SCS to be located in person's neighborhood. Additionally, this is the first study to investigate the comparative effectiveness of mobile versus brick & mortar SCSs. Finally, this thesis added additional information regarding the overall effectiveness of SCSs in reducing drug related mortality.

This thesis is organized into the following chapters. **Chapter 2** describes the state-of-the-art literature review that aimed to identify drivers of public support for SCSs. **Chapter 3** describes the SR of DCEs of harm reduction strategies for addictive substance use. **Chapter 4** describes the DCE that was conducted to identify attributes of SCSs that are significantly correlated with the public's preferences for SCSs and to calculate the public's WTA for an SCS to be located in their neighborhood. **Chapter 5** describes the DiD that compared brick & mortar SCSs to mobile SCSs and assessed the effectiveness of SCSs in preventing drug related mortality irrespective of site type. **Chapter 6** presents the conclusions where the findings of this thesis are summarized and contextualized. Finally, additional appendices and a list of acronyms are included following **Chapter 6**.

2 Public Perceptions of Safe Consumption Sites: A State-of-the-Art Review

2.1 Introduction

People who use drugs may rely on multiple social supports such as foodbanks, emergency housing shelters, and of specific relevance to this population SCSs. To reiterate from **Chapter 1**, SCS are facilities where people who use drugs can access medical supervision and in some cases clean paraphernalia for drug use, with the goal of preventing fatal overdoses and the spread of blood borne viruses (Lange & Bach-Mortensen, 2019; Mema et al., 2019). Though evidence suggests that SCSs are effective at reducing overdose related mortality their use remains controversial with some members of the public (Lange & Bach-Mortensen, 2019; Magwood et al., 2020; Marshall et al., 2011). Driving factors behind this controversy often include: **1)** concerns that SCSs increase crime and deviant behavior in the communities where they are located; **2)** a perception that SCSs enable drug use prolonging the negative consequences of drug use to people who use drugs and society; and **3)** a belief that addiction is a self-inflicted condition and subsequently funding for the treatment/management of addiction should not be a societal responsibility (Lange & Bach-Mortensen, 2019; Matheson et al., 2014). Of note, point 2) above was identified by the present study's author from opinion editorials published in newspapers and not from the referenced peer reviewed publication.[2]

An understanding of public preferences for policy options and their corresponding outcomes can be an important component of public policy making (Sumnall et al., 2020). This is likely of increased relevance when the public policy decision in question is related to a controversial topic such as SCSs. As a result, researchers and policymakers alike have aimed to understand the perceptions of various stakeholders for SCSs (Lange & Bach-Mortensen, 2019). For instance, in many jurisdictions public engagement is an important component of establishing SCSs (AIDS Outreach Community Harm Reduction Education & Support Society (ARCHES), 2017).

[2] An editorial by columnist and Alberta Premier Danielle Smith in the Edmonton Journal. Edmonton Journal. (2019-08-09). Drug treatment a better answer than injection sites. https://edmontonjournal.com/opinion/columnists/danielle-smith-safe-consumption-sites-arent-the-answer-to-addiction (Accessed 2022-11-21).

This chapter set out to systematically review the literature for publications that report the general public's perceptions of SCSs. This study was undertaken to gather knowledge to facilitate the conduct of research on SCSs that was subsequently presented in **Chapters 4** and **5** of this thesis. Specifically, this review sought to:

1. Identify drivers of public opinion for SCSs that served as demographic variables in a DCE (**See Chapter 4**). Briefly, it is good practice when conducting public preference surveys to compare key sociodemographic characteristics, specifically those expected to drive public support, of the sample group to those of the overall population on which the study aims to draw inference.

2. Identify literature that investigated public perceptions for mobile versus brick & mortar SCSs. Specifically, if the public preferred mobile sites to brick & mortar sites. For reference, mobile SCSs are SCSs that can be moved from one location to another and generally take the form of an RV. Brick & mortar SCSs are SCSs in a fixed location. Information related to public preferences for mobile SCSs versus brick & mortar SCSs was used to contextualize a DiD analysis (**See Chapter 5**).

3. Provide insight on which parameters should be modelled as random parameters in a mixed logit model used to analyze a DCE (**See Chapter 4**). Briefly, a mixed parameter is an independent variable in a regression model for which the relationship between the dependent and independent variable is assumed to vary across entities, in **Chapter 4** the entities were respondents. The set of parameters that were considered for modelling as random parameters were: the cost of the site to the healthcare system; the effectiveness of the site in reducing overdose deaths; financial compensation to residents if a site opens in their neighborhood; if the site is located in the respondent's neighborhood; and if the site reduces improperly discarded needles. Based on this literature review, a set of random parameters was selected from the aforementioned list.

4. Finally, the knowledge gained through the process of screening and reviewing hundreds of abstracts and dozens of full texts provided valuable insight on the state of the literature related public perceptions of SCSs. This provided a useful knowledge base from which to conduct this thesis.

Findings of this review may be of interest to both policymakers and researchers aiming to design or assess SCSs. Furthermore, findings will be of value to individuals aiming to conduct public opinion research related to SCSs. The remainder of this chapter is organized in the following manner. First there is a **Background** section that describes previous literature on this topic. This is followed by a **Methods** section that describes the databases, search terms, and search strategy. The **Results** section follows the **Methods** section and presents the results. Finally, the **Discussion** section contextualized the results and discusses limitations.

2.2 Background and Literature

At the time of analysis, the author of this study was aware of a single previous SR on public perceptions of SCSs (Lange & Bach-Mortensen, 2019). However, the SR of Lange & Bach-Mortensen (2019) is subject to limitations that warrant further investigation on this topic. Primarily, their SR was limited to qualitative studies only and as a result may have missed a substantial number of quantitative analyses reporting information on this topic. Additionally, the SR of Lange & Bach-Mortensen (2019) only included studies published prior to 2018. Given these limitations, a more comprehensive, in terms of methodical approaches included, and a more recent literature review would be of value.

2.3 Methods

Search Strategy

The present review used the approach described by Khan et al., (2003). This approach provided a concise methodology to conduct a literature review, which has been widely used in peer-reviewed literature to date (Khan et al., 2003). Khan et al., (2003) outline five components to the literature review process: **1)** Framing the review question; **2)** Identifying relevant publications; **3)** Assessing study quality; **4)** Summarizing findings; and **5)** Interpreting results.

The target databases used by the present review include PsychInfo, PubMed, Scopus, and the Cochrane Library Database. In addition, the present review also conducted a grey literature search of Google Scholar. Google Scholar has been recommended as a useful database to

identify grey literature (Simon Fraser University, 2019). The keywords used in the present review are an augmented version of those used by Lange & Bach-Mortensen, (2019) - a previous SR on public opinion related to SCSs. Keywords were stratified into three themes **1)** those related to SCSs; **2)** those related to drug addiction; and **3)** those related to public perceptions. Keywords were searched as free terms and also used to identify relevant subject headings in target databases. To be included, a study needed to include a keyword or relevant subject heading from each of the three aforementioned stratifications **(1)** to **(3)**. Keywords related to SCSs include: *supervised injection, safe injection, supervised consumption, safe consumption, consumption room*. Keywords related to addiction include: *addiction, heroin, dependence, opioids, drugs, narcotics, harm reduction*. Keywords related to public opinion include: *public opinion, public perceptions, public consultation, public outreach.* The following section details the search strategy used by this state-of-the-art review (**See Box 1**).

Box 1 Search Strategy for State-of-the-Art Review

Database: PubMed
Search Date: May 24, 2021
Filters: limited to humans, English language, and studies published on/after January 1, 2020
Articles Identified: 96

Search Code	Hits
1. ((((supervised injection) OR (safe injection)) OR (supervised consumption)) OR (safe consumption)) OR (consumption room)	41,755
2. ((((((addiction) OR (heroin)) OR (dependence)) OR (opioids)) OR (drugs)) OR (narcotics)) OR (harm reduction)	338,557
3. (((public opinion) OR (public perceptions)) OR (public consultation)) OR (public outreach)	40,946
4. #1 AND #2 AND #3 Filters: Humans, English, from 2020/1/1 - 3000/12/12	96

Database: Scopus
Search Date: May 24, 2021
Filters: limited to English language and studies published on/after January 1, 2020
Articles Identified: 14

Search Code	Hits
1. supervised injection OR safe injection OR supervised consumption OR safe consumption OR consumption AND room	622

2. addiction OR heroin OR dependence OR opioids OR drugs OR narcotics OR harm AND reduction	2,045,043
3. public AND opinion OR public AND perception OR public AND consultation OR public AND outreach	57,853
4. #1 AND #2 AND #3 (LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020)) AND (LIMIT-TO (LANGUAGE , "English"))	14

Database: Google Scholar (Grey Literature)
Search Date: March 27, 2021
Filters: limited to humans, limited to English language, limited to studies published on/after January 1, 2020
Articles Identified: 72

Search Code	Hits
1. "supervised consumption" OR "supervised injection" AND "public opinion" OR "public outreach"	72

Database: Cochrane Library Database
Search Date: May 24, 2021
Filters: limited to studies published on/after January 1, 2020
Articles Identified: 2

Search Code	Hits
1. supervised injection OR safe injection OR supervised consumption OR safe consumption OR consumption room in Title Abstract Keyword - (Word variations have been searched)	10,607
2. addiction OR heroin OR dependence OR opioids OR drugs OR narcotics OR harm reduction in Title Abstract Keyword - (Word variations have been searched)	127,106
3. public opinion OR public perception OR public consultation OR public outreach in Title Abstract Keyword - (Word variations have been searched)	4,814
4. #1 AND #2 AND #3 Limit to 2020 or later.	2

Database: PsychInfo
Search Date: May 24, 2021
Filters: limited to humans, limited to English language, limited to studies published on/after January 1, 2020
Articles Identified: 10

Search Code	Hits

(supervised injection sites or supervised injection facilities or safe injection sites or safe injection facilities or insite or drug consumption rooms or consumption room) AND (addiction or substance abuse or drug abuse or heroin or dependence or opioid or drug or narcotic or harm reduction) AND (public opinion or attitudes or beliefs or perception or stigma or outreach or consultation) **Limited to 2020 and later.**	10

Studies were first screened for relevance using titles and abstracts based on the inclusion/exclusion criteria **(See Table 1)**. The reason for rejection of rejected studies was recorded. The full texts of the remaining studies were then reviewed based on the inclusion/exclusion criteria and the reason for rejection was again recorded. Finally, studies referencing or referenced by identified studies were reviewed for inclusion by first screening titles and abstracts and then full texts. Articles citing included studies were identified with the Google Scholar "Cited by" function. Identified relevant SRs were included for the purposes of recursive searching of their references. The tiles, abstracts, full texts, and reasons for rejection of studies identified in each of the target databases for each stage of the search process were recorded.

Inclusion and Exclusion Criteria

The present review included studies that report the perceptions of the general public towards SCSs. The present review focused on the general public versus other stakeholders, as the general public represents a group whose approval may by necessary prior to the establishment of SCSs. No restrictions were placed on the jurisdictions of identified studies. However, the inclusion criteria was limited to English language studies. With respect to timeframes, inclusion was restricted to studies published on or after January 1, 2020. The purpose of this timeframe restriction was to ensure that the review captured an up-to-date reflection of public perceptions towards SCSs. As public opinion on controversial topics can change quickly, older studies may not be reflective of current trends in public attitudes. Specifically, the introduction of more toxic synthetic opioids has increased drug related mortality and as a result increased attention on this issue. The increased attention has led to increased awareness that may have impacted public perceptions of SCS. January 2020 was chosen as the starting point for this review, as it represents a point in time when data captured by identified studies is likely to be reflective of the current high mortality environment. A study conducted prior to this is more likely to reflect data in a period when mortality was comparatively lower and public awareness

regarding opioids may not have been as widespread. A limitation of this approach is that potentially relevant studies published prior to 2020 may have been missed. However, limiting the review to recent studies allowed for the identification of the "state-of-the-art" with respect to public opinion research related to SCSs (Grant & Booth, 2009; Iragorri & Spackman, 2018). Furthermore, the 17-month search period used by the present review, is similar to that of other recent state-of-the-art reviews on health economic topics (Iragorri & Spackman, 2018). Iragorri and Spackman (2018) used a 12-month search period, to identify the state-of-the-art, with respect to cost-effectiveness analysis of screening tools in healthcare. For a full list of the inclusion/exclusion criteria, PICOTS criteria can be found in **Table 1**.

Table 1 Inclusion/Exclusion Criteria

Criteria	Inclusion	Exclusion
Population	General or wider public	Studies targeting a specific segment of the population
Interventions	Studies related to SCSs	Studies not related to SCSs
Comparators	NA	NA
Outcomes	Public perceptions of SCSs	Studies not reporting public perceptions for SCSs
Study Design	Any	None
Timeframe	On or after January 1, 2020	Before January 1, 2020
Other	English Language	Non-English Language

Abbreviations: NA: Not applicable; SCS: Safe consumption site.

Data Extraction and Synthesis

The present review synthesized data from identified studies using a narrative synthesis approach with tabular data displays (Rumrill & Fitzgerald, 2001). This approach has been recognized as a valuable method for aggregating and presenting a knowledge body (Rumrill & Fitzgerald, 2001). Data was extracted related to: **1)** General Study Details; **2)** Specific Study Details: and **3)** Key Findings/Limitations. A copy of this review's extraction form can be found in **Appendix 1**.

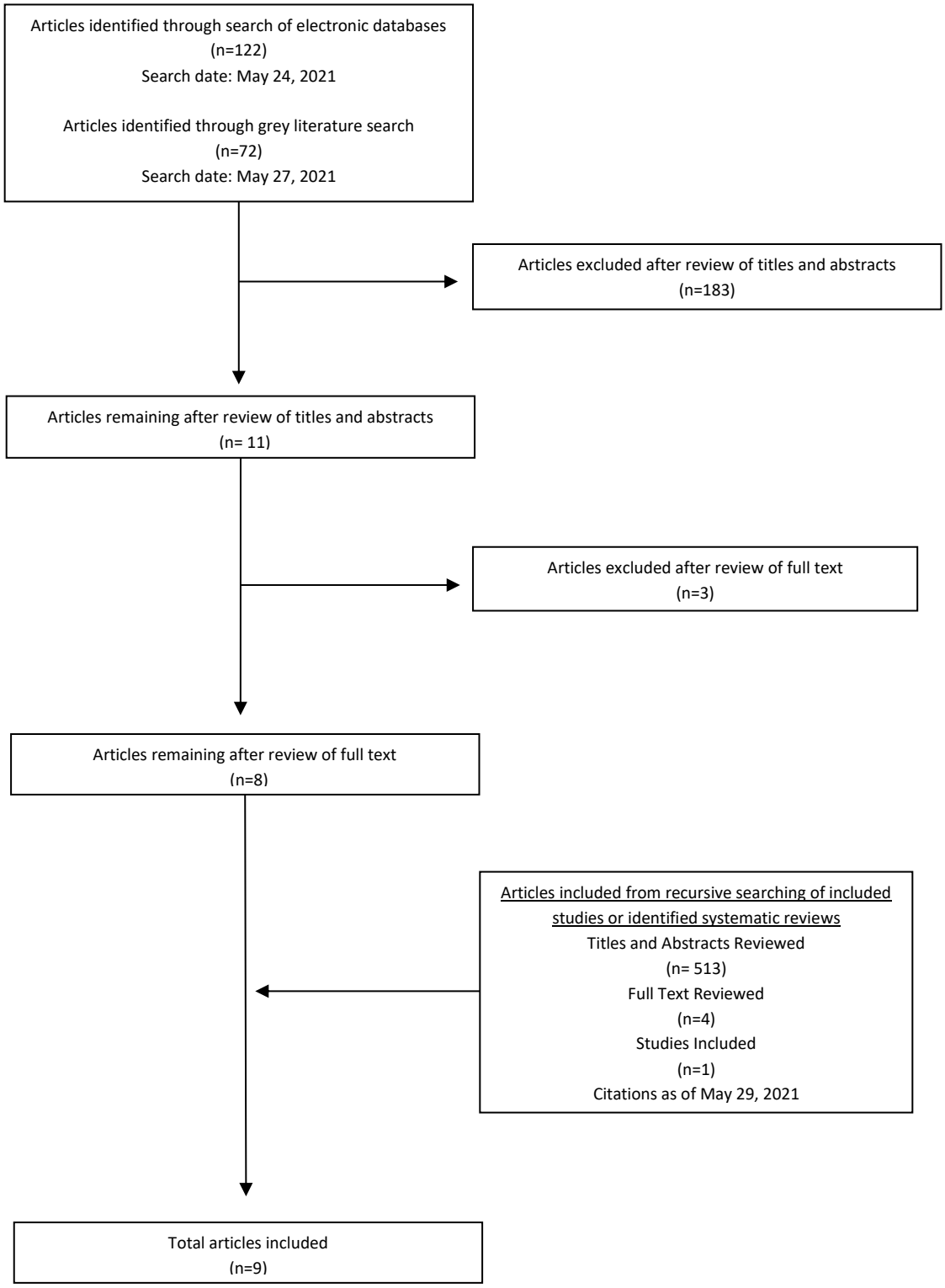
Appraisal and Validation

To assess the quality of studies included in the present review, appraisal tools provided by the Critical Appraisal Skills Program were used (https://casp-uk.net/casp-tools-checklists/). The present review used this organization's qualitative study appraisal tool to appraise qualitative studies and the cohort study appraisal tool to assess quantitative studies. Both tools were applied to mixed methods studies for appraisal. Several of the questions related to repeated measurements from the cohort study appraisal tool were omitted, as they were not applicable to the present review. The Critical Appraisal Skills Program's tools were chosen as they are efficient and easy to use, and this organization provides a wide variety of tools tailored to many study designs. This meant that a single set of tools developed by the same entity could be used to appraise all identified studies for quality regardless of study type. It was our anticipation that this would provide consistency and uniformity across the quality appraisal of studies in the present review, given the diverse range of study types that were considered. To improve the accuracy of the extracted materials, the extraction and quality appraisal were performed twice by the same reviewer and compared for accuracy. Discrepancies were revisited and corrected.

2.4 Results

Searches were conducted on May 24, 2021 (electronic database search) and May 27, 2021 (grey literature search). The electronic database search resulted in 122 hits and the grey literature search resulted in 72 hits. From these, the full texts of 11 studies were screened and eight studies were included (Bancroft & Houborg, 2020; Brooks-Russell et al., 2021; Mrazovac et al., 2020; Sastre et al., 2020; Sharp et al., 2020; Sumnall et al., 2020; Taylor et al., 2021; Wild et al., 2021). 513 studies either referenced or were referenced by included studies as of May 29, 2021. From these, four studies were selected for full text review and one was included (Alberta Health, 2020). In total, 707 titles/abstracts were screened, 15 full texts were screened, and nine studies were included (**See Figure 1**). Results reported in this section reflect the interpretation of the present study's author and are summaries of the information provided within the corresponding publications.

Figure 1 PRISMA Diagram State-of-the-Art Review



Of identified studies most were peer-reviewed publications (n=8) (Bancroft & Houborg, 2020; Brooks-Russell et al., 2021; Mrazovac et al., 2020; Sastre et al., 2020; Sharp et al., 2020; Sumnall et al., 2020; Taylor et al., 2021; Wild et al., 2021). One exception was a report by the Government of Alberta, Canada (n=1) (Alberta Health, 2020). Studies were approximately evenly distributed between methodological approaches. There were two qualitative studies (n=2) (Mrazovac et al., 2020; Sharp et al., 2020; Taylor et al., 2021), four quantitative studies (n=4) (Brooks-Russell et al., 2021; Sastre et al., 2020; Sumnall et al., 2020; Wild et al., 2021), and three mixed methods studies (n=3) (Alberta Health, 2020; Bancroft & Houborg, 2020; Mrazovac et al., 2020). Overall, surveys were the most commonly used approach (n=7) (Alberta Health, 2020; Bancroft & Houborg, 2020; Brooks-Russell et al., 2021; Mrazovac et al., 2020; Sastre et al., 2020; Sumnall et al., 2020; Wild et al., 2021). All studies took place in developed countries with three in Canada (n=3) (Alberta Health, 2020; Mrazovac et al., 2020; Wild et al., 2021), one in Denmark (n=1) (Bancroft & Houborg, 2020), one in France (n=1) (Sastre et al., 2020), one in the United Kingdom (n=1) (Sumnall et al., 2020), and three in the United States of America (n=3) (Brooks-Russell et al., 2021; Sharp et al., 2020; Taylor et al., 2021). For additional information regarding general study details see **Table 2**.

Table 2 General Study Details

Publication	Country	Publication Type	Study Approach	Study Design
1. Taylor 2021	United States	Peer Review Article	Qualitative	Interviews & Focus Groups
2. Sastre 2020	France	Peer Review Article	Quantitative	Survey
3. Mrazovac 2020	Canada	Peer Review Article	Mixed Methods	Survey & Thematic Analysis
4. Wild 2021	Canada	Peer Review Article	Quantitative	Survey
5. Bancroft 2020	Denmark	Peer Review Article	Mixed Methods	Survey & Interviews
6. Brooks-Russell 2021	United States	Peer Review Article	Quantitative	Survey
7. Sumnall 2020	United Kingdom	Peer Review Article	Quantitative	Survey
8. Sharp 2020	United States	Peer Review Article	Qualitative	Focus Group
9. Alberta Health 2020	Canada	Government Report	Mixed Methods	Surveys, Town Hall Sessions, & Other Public Outreach

All studies assessed public opinion of SCSs in a specific geographic region such as a city or country (n=9) (Alberta Health, 2020; Bancroft & Houborg, 2020; Brooks-Russell et al., 2021; Mrazovac et al., 2020; Sastre et al., 2020; Sharp et al., 2020; Sumnall et al., 2020; Taylor et al., 2021; Wild et al., 2021). Several studies assessed the impact of information and/or messaging on public support for SCSs (n=3) (Mrazovac et al., 2020; Sumnall et al., 2020; Taylor et al., 2021). Of studies that used surveys (n=7), sample sizes ranged from 318 to 14,070. For studies with qualitative components (n=5), sample sizes ranged from 26 to 115 participants. Finally, one study focused on syringe exchange programs alone (n=1) (Sharp et al., 2020). For information regarding specific study details see **Table 3**.

Table 3 Specific Study Details

Author	Sample Size	Study Objective
1. Taylor 2021	Interviews (44) & Focus Groups (115)	This study set out to investigate public opinion on safe consumption sites in communities whose opinions on these facilities have not been evaluated previously. The study took place in the counties of Ashtabula and Cuyahoga in Ohio and Carroll and Hillsborough in New Hampshire in the United States.
2. Sastre 2020	318	This study set out to perform cluster analysis on survey data to identify classes of French citizens in Toulouse and Andorra with respect to their opinions regarding safe consumptions sites.
3. Mrazovac 2020	Pilot Survey (354) & Main Survey (407)	This study set out to determine if information on the benefits of safe consumption sites can influence public support for the establishment of these facilities in the Waterloo Region of Ontario, Canada.
4. Wild 2021	4,645	This study set out to determine the level of support for a set of harm reduction programs for people who inject drugs in Canada.
5. Bancroft 2020	Survey (566) & Interviews (33)	This study set out to assess the attitudes of residents regarding drug consumption rooms in Vesterbro, Copenhagen, Denmark.
6. Brooks-Russell 2021	690	This study set out to understand public attitudes towards syringe service programs, to assess the feasibility of expanding services in eight counties in Colorado, United States (Alamosa, Arapahoe, Boulder, Denver, Jefferson, Larimer, Mesa, and Pueblo).
7. Sumnall 2020	1,591	This study set out to determine how messaging influences public support for drug consumption rooms in Scotland, United Kingdom.
8. Sharp 2020	26	This study set out to determine perceptions of residents in Manatee County Florida, United States on: awareness and acceptability; facilitating

		factors; and perceived barriers related to needle exchange programs.
9. Alberta Health 2020	14,070	This study sets out to determine the socioeconomic impacts of safe consumption sites in Alberta, Canada.

Seven studies reported key drivers associated with public support for SCSs (n=7) (Brooks-Russell et al., 2021; Mrazovac et al., 2020; Sastre et al., 2020; Sharp et al., 2020; Sumnall et al., 2020; Taylor et al., 2021; Wild et al., 2021). Key drivers refer to factors associated with SCSs that influence public opinion regarding the facilities. Individual characteristics that predicted support for SCSs included age, sex, and political affiliation with more conservative individuals being less likely to support SCSs (Brooks-Russell et al., 2021; Sastre et al., 2020; Wild et al., 2021). Several studies reported that the messaging regarding a site could influence public support (Mrazovac et al., 2020; Sumnall et al., 2020; Taylor et al., 2021). Furthermore, knowledge of or education on SCSs were generally shown to positively influence public support for SCSs (Mrazovac et al., 2020; Taylor et al., 2021; Wild et al., 2021). For a list of key determinants of public support for SCSs reported by studies see **Table 4**.

Table 4 Key Determinants of Public Support

Author	Key Determinants
1. Taylor 2021	Respondents felt that the provision of information to the public on the benefits of safe consumption sites for people who use sites and society would improve public support.
2. Sastre 2020	Males, older participants, and participants with right-wing political leanings, were less likely to support safe consumption sites. With respect to attributes of safe consumption sites, the most influential were: 1) the type of staff running sites, with healthcare providers being preferred; and 2) the mission assigned to staff members, with the promotion of abstinence being preferred.
3. Mrazovac 2020	Knowledge about safe consumption sites increased the probability that a respondent would support these facilities.
4. Wild 2021	Personal familiarity with people who use drugs, beliefs about addiction, respondent sex, household income, political views, and education were predictors of support for harm reduction services.
5. Bancroft 2020	Not reported
6. Brooks-Russell 2021	Political affiliation of participants was associated with support for syringe exchange services.
7. Sumnall 2020	Key drivers of public support included: 1) the type of message provided to participants; 2) individuals' attitudes towards drug recovery; and 3) individuals' attitudes towards homelessness.
8. Sharp 2020	Stigmatization of the drug using population was determined to be the largest barrier to the establishment of syringe exchange programs in the study's jurisdiction.
9. Alberta Health 2020	Not reported

Most studies found majority support for SCSs (n=7) with support ranging from 55% to 75.4% (Bancroft & Houborg, 2020; Brooks-Russell et al., 2021; Mrazovac et al., 2020; Sastre et al., 2020; Sharp et al., 2020; Taylor et al., 2021; Wild et al., 2021). One exception was the study by Alberta Health, which did not find wide spread support for SCSs in Alberta, Canada (Alberta Health, 2020). In another study, a definitive assessment of the level of public support was not identified (Sumnall et al., 2020). Of studies that looked at the impact of messaging on public perception, findings suggested that provision of information on the benefits of SCSs on individuals who use the facilities and/or society is likely to improve public support (Sumnall et al., 2020; Taylor et al., 2021). For a list of details regarding the findings of identified studies see **Table 5**.

Table 5 Summary of Key Findings

Author	Findings
1. Taylor 2021	Participants had concerns that safe consumption sites would enable drug use. There was also a concern that people who use drugs might not want to go to safe consumption sites for fear of being arrested. Participants felt that cultural, resource, and practical barriers inhibit acceptance of safe consumption sites where they live. Findings suggest tentative stakeholder support for safe consumption sites.
2. Sastre 2020	The study found three unique positions regarding safe consumption sites: not very acceptable (20% of respondents), depends on staff and mission (49% of respondents), and always acceptable (31% of respondents). Gender, age, and political orientation delineated these groups. A type of safe consumption facility that would be accepted by most respondents was one that was staffed by medical professionals and that encouraged site users to seek rehabilitation.
3. Mrazovac 2020	The majority of respondents (75.4%) supported the establishment of safe consumption sites in the pilot study and (82.5%) were supporters in the main study. Analyses demonstrated that education on safe consumption sites increased support for the facilities.
4. Wild 2021	64% of Canadians supported harm reduction with estimates ranging from 60% to 73% based on province. Five of the harm reduction interventions assessed received majority support: outreach (79%), naloxone (72%), drug checking (70%), needle distribution (60%) and safe consumption sites (55%). A minority of respondents supported low-threshold opioid agonist treatment and safe inhalation interventions (49% and 44%).
5. Bancroft 2020	The study found that most residents were in general supportive of drug consumption rooms.
6. Brooks-Russell 2021	More than 75% of respondents reported familiarity with syringe service programs. Only 25% of respondents were aware of the legal status of these facilities. Approximately, 33% of respondents thought syringe service programs or safe consumption sites make communities better. 57% of respondents thought safe consumption sites should be legal.

7. Sumnall 2020	Findings suggest public support for drug consumption rooms is not positively influenced by factual statements on the benefits of these facilities alone. Public engagement that addresses public concerns about the facilities and/or demonstrate the benefits of the programs in relation to the people they may indirectly help is more likely to be successful.
8. Sharp 2020	In general, there was support for syringe exchange programs amongst study participants. Respondents felt they themselves were more open towards safe consumption sites than the average person in their community.
9. Alberta Health 2020	In general, safe consumption sites had minority public support.

The most common limitation mentioned in identified studies was related to a potential lack of generalizability to the broader public (n=7) (Brooks-Russell et al., 2021; Mrazovac et al., 2020; Sastre et al., 2020; Sharp et al., 2020; Sumnall et al., 2020; Taylor et al., 2021; Wild et al., 2021) This limitation was most acutely present in studies who sampled specific populations. For example, one study sample consisted of people who use drugs or people who work with people who use drugs (n=1) (Taylor et al., 2021). Another study's sample was made entirely of public servants and focused only on the syringe exchange component of SCSs (n=1) (Sharp et al., 2020). For a list of limitations associated with identified studies see **Table 6**.

Table 6 Limitations

Author	Limitations
1. Taylor 2021	• The population of this study is likely not representative of the general public, as study participants consist of people who use drugs or people who work with people who use drugs. • The authors mention that results may be biased by site selection with interviews/focus groups having only been conducted in four counties.
2. Sastre 2020	• The authors expressed concerns about the generalizability of the study to the wider public. • The authors mention that the surveys were constructed such that they asked participants to assume that local authorities had decided to implement a supervised consumption site. This may have biased respondents by framing the scenario as coming from an authority. • The authors mention that the survey only requested participants' opinions on three types of drugs (cocaine, amphetamines, and heroin). Including more drugs may have provoked a wider variety of preferences.
3. Mrazovac 2020	• The authors mention concerns about the generalizability of the sample to the general public.

	• The authors also mention a possible lack of saturation regarding the qualitative analysis.
4. Wild 2021	• The authors mention concerns about the generalizability of the study to the general public. • The authors mention that the cross-sectional design used by the study precluded assessments of causality.
5. Bancroft 2020	Not reported
6. Brooks-Russell 2021	• The authors refer to concerns about an inability to verify if target participants filled out the survey themselves or if someone else at the address filled out the survey instead. • The authors reference a low response rate. • The authors mention concerns about the generalizability of the sample to the general public.
7. Sumnall 2020	• The authors expressed concerns about the self-reported nature of the survey. • The authors point out that personal biases could have influenced respondents' survey responses. • The authors mention concerns about the generalizability of the sample to the general public. • The authors mention that the survey included relatively long descriptions of scenarios regarding safe consumption sites. As a result, respondent attention may have waned, influencing findings.
8. Sharp 2020	• The study only explores syringe exchange programs, representing a relatively narrow definition of safe consumption sites. • The study sample only included public servants. • The authors mention that biases of the research team could have influenced respondents' answers. • The authors mention concerns about the generalizability of the sample to the general public.
9. Alberta Health 2020	• There are concerns regarding the objectivity of the report's authors. Wording and context suggested bias against safe consumption sites by authors. The extent to which this would impact results is unclear. • Author's mention some concerns regarding the reliability of data specifically regarding the impact of safe consumption sites on businesses near sites.

Table 7 and **Table 8** below show the results of the critical appraisal for the qualitative, quantitative, and mixed methods studies. In general, critical appraisal suggested that studies were conducted in a rigorous fashion. One study that performed relatively poorer in critical appraisal was the Alberta Health study (Alberta Health, 2020). Of note, concerns regarding the

scientific rigor of this study have been raised elsewhere in the literature (Livingston, 2021). The present study's author was familiar with this literature and the corresponding concerns at the time of quality appraisal, potentially biasing the appraisal of the Alberta Health study.

Table 7 Appraisal of Studies with Qualitative Components

	Section A: Are the results valid?						**Section B: What are the results?**			**Section C: Will the results help locally?**
Study	1. Was there a clear statement of the aims of the research? (Y/N/U)	2. Is a qualitative methodology appropriate? (Y/N/U)	3. Was the research design appropriate to address the aims of the research? (Y/N/U)	4. Was the recruitment strategy appropriate to the aims of the research? (Y/N/U)	5. Was the data collected in a way that addressed the research issue? (Y/N/U)	6. Has the relationship between researcher and participants been adequately considered? (Y/N/U)	7. Have ethical issues been taken into consideration ?	8. Was the data analysis sufficiently rigorous? (Y/N/U)	9. Is there a clear statement of findings? (Y/N/U)	10. How valuable is the research?
1. Taylor 2021	Y	Y	Y	Y	Y	Y	Y	Y	Y	Results will be useful to policymakers assessing whether to establish SCSs in Ohio and New Hampshire as well as other comparable jurisdictions.
2. Mrazovac 2020	Y	Y	Y	Y	Y	Y	U	Y	Y	Results will be useful to policymakers assessing whether to establish SCSs in Ontario as well as other comparable jurisdictions.
3. Bancroft 2020	Y	Y	Y	Y	Y	Y	U	Y	Y	Findings will be useful for the development and/or continuation of harm reduction services in Denmark
4. Sharp 2020	Y	Y	Y	Y	Y	Y	U	Y	Y	The study's findings contributed to the adoption of a syringe exchange program is the study's jurisdiction.
5. Alberta Health 2020	Y	Y	N	Y	N	Y	U	N	U	Wording and context suggested bias against SCSs by authors. The extent to which this would impact results of the qualitative portion of the project is unclear.

Abbreviations: N: No; SCS: Safe Consumption Sites; U: Unsure; Y: Yes.

Table 8 Appraisal of Studies with Quantitative Components

	Section A: Are the results valid?						**Section B: What are the results?**			**Section C: Will the results help locally?**
Study	1. Did the study address a clearly focused issue? (Y/N/U)	2. Was the cohort recruited in an acceptable way? (Y/N/U)	4. Was the outcome accurately measured to minimise bias? (Y/N/U)	5. (a) Have the authors identified all important confounding factors? (Y/N/U)	5. (b) Have they taken account of the confounding factors in the design and/or analysis? (Y/N/U)	7. What are the results of this study? (Text Response)	9. Do you believe the results? (Y/N/U)	10. Can the results be applied to the local population? (Y/N/U)	11. Do the results of this study fit with other available evidence? (Y/N/U)	12. What are the implications of this study for practice?
1. Sastre 2020	Y	Y	Y	U	Y	†	Y	Y	Y	Findings will be of value to policymakers assessing whether to develop SCSs in their jurisdiction.
2. Mrazovac 2020	Y	N	Y	U	Y	†	Y	Y	Y	Findings will be of value to policymakers assessing whether to develop SCSs in their jurisdiction.
3. Wild 2021	Y	Y	Y	U	Y	†	Y	Y	Y	Findings will be of value to policymakers assessing whether to implement harm reduction programs in their jurisdiction.
4. Bancroft 2020	Y	Y	Y	U	U	†	Y	Y	Y	Findings will be of value to policymakers assessing whether to implement harm reduction programs in their jurisdiction.
5. Brooks-Russell 2021	Y	Y	Y	Y	Y	†	Y	Y	Y	Findings will be of value to policymakers assessing whether to implement harm reduction programs, with a particular relevance to syringe exchange, in their jurisdiction.
6. Sumnall	Y	Y	Y	Y	Y	†	Y	Y	Y	Findings will be of value to policymakers assessing whether to develop SCSs in their jurisdiction.
7. Alberta Health 2020	Y	Y	N	N	N	†	N	U	N	Findings were used to justify a revamp of Alberta Canada's drug rehabilitation programs.

Abbreviations: N: No; SCS: Safe Consumption Sites; U: Unclear; Y: Yes.
† See Table 5 for results.

2.5 Discussion

In total, 707 titles/abstracts were screened, 15 full texts were screened, and nine studies were included. Searches were conducted on May 24, 2021 (electronic database search) and May 27, 2021 (grey literature search). The electronic database search resulted in 122 hits and the grey literature search resulted in 72 hits. From these, the full texts of 11 studies were screened and eight studies were included (Bancroft & Houborg, 2020; Brooks-Russell et al., 2021; Mrazovac et al., 2020; Sastre et al., 2020; Sharp et al., 2020; Sumnall et al., 2020; Taylor et al., 2021; Wild et al., 2021). 513 studies either referenced or were referenced by included studies as of May 29, 2021. From these, four studies were selected for full text review and one was included (Alberta Health, 2020).

Identified studies were exclusively from high-income countries. This suggest that at present there is a lack of understanding regarding public perceptions of harm reduction interventions in developing countries and highlights an area where further research is needed. Among identified studies there was primarily two unique objectives: studies that primarily set out to assess public opinion of SCSs in a geographic region such as a city or country (Alberta Health, 2020; Bancroft & Houborg, 2020; Brooks-Russell et al., 2021; Mrazovac et al., 2020; Sharp et al., 2020; Wild et al., 2021) and studies that aimed to assess the impact of information and/or messaging on public support for SCSs (Mrazovac et al., 2020; Sumnall et al., 2020; Taylor et al., 2021). Though drivers of public support were identified to facilitate the subsequent DCE, no studies investigated public perceptions of mobile versus brick & mortar SCSs. Though anecdotally it has been suggested that the public prefers mobile SCSs, no recent scientific literature could be found confirming this (Mema et al., 2019).

Most studies found majority support for SCSs (n=7) with support ranging from 55% to 75.4% An exception was the Alberta Health study, which when considering the totality of its findings suggested a lack of public support for SCSs in Alberta, Canada (Alberta Health, 2020). It is unclear whether the discrepancy between the Alberta Health study and other identified studies is the result of methodological differences, differences in the attitudes of the surveyed populations, or both. Overall, findings suggest that within developed countries there is support for the development of SCSs. Policymakers should be cognizant of this when contemplating the development of SCSs in their jurisdictions.

Of studies that looked at the impact of messaging on public perception, findings suggested that provision of information on the benefits of SCSs on individuals who use the facilities and/or society is likely to improve public support (Sumnall et al., 2020; Taylor et al., 2021). This is also of value to policymakers who hope to improve public support or alleviate concerns about the establishment of SCSs. Findings suggest that providing education on the benefits of SCSs is likely to ease concerns regarding the development of facilities. Individual characteristics that predicted support for SCSs included age, sex, and political affiliation with more conservative individuals being less likely to support SCSs (Brooks-Russell et al., 2021; Sastre et al., 2020; Wild et al., 2021).

With respect to study methodology there was an approximately even distribution of study types between qualitative, quantitative, and mixed methods designs. This suggests that previous literature reviews may have excluded relevant publications by focusing on studies with qualitative components alone (Lange & Bach-Mortensen, 2019). Given the diversity of methodological approaches identified by the present review, it is interesting that most studies found majority support amongst their study populations (n=7). This finding provides further credibility to the assessment that there tends to be support for SCSs in high-income countries.

Overall, there was substantial heterogeneity in the limitations reported by identified studies. The most common limitation reported by identified studies was issues regarding generalizability of findings to the broader population (n=7) (Brooks-Russell et al., 2021; Mrazovac et al., 2020; Sastre et al., 2020; Sharp et al., 2020; Sumnall et al., 2020; Taylor et al., 2021; Wild et al., 2021). Several studies were in sub-populations that were sufficiently specific that it is unclear if their results would be reflective of the general public. There was a study whose sample consisted of people who use drugs or people who work with people who use drugs (Taylor et al., 2021). Another study's sample consisted of public employees and also focused on syringe exchange programs alone (Sharp et al., 2020). Though syringe exchange represents an important component of some SCSs, syringe exchange alone represents a narrow definition of SCSs. The extent to which the findings of these studies could be extrapolated to SCSs more broadly is not clear.

With respect to the predefined information that this study aimed to identify to support subsequent research, identified drivers of public opinion for SCSs to be used as sociodemographic variables in the subsequent DCE (**See Chapter 4**) were age, sex, income, education, if a person has children in their care, overall support for SCSs, and

geographic area. Two drivers that were identified but ultimately not included were political affiliation and personal experience with people who use drugs. These two characteristics were not included as sociodemographic variables in the DCE due to concerns that they could possibly cause selection bias. A portion of individuals may not feel comfortable providing information regarding political leanings or affiliations and subsequently not participate in a study asking for this information. Similarly, individuals may not have felt comfortable providing details on their own use of drugs or the use of drugs by those they know. Given that in most cases drug use is an illegal activity, potentially respondents may prefer to avoid the study rather than provide information that involves admitting to an illegal activity.

Furthermore, this literature review did not identify studies that determined if the type of SCS, mobile versus brick & mortar, was a driver of public support. As a result, a supplemental review using a non reproducible search strategy was conducted using Google Scholar. This supplemental review did not follow the original search strategy highlighted in **Table 1**. The review did use combinations of the search terms listed in **Section 2.3 Methods,** however no date restrictions were applied. The use of this supplementary search approach was chosen to determine if mobile SCS are preferred by the public over brick & mortar SCS, versus conducting an additional structured review, due to limitations on the scope of the distance learning doctoral thesis at Lancaster University (i.e. a 35,000 word count target with a hard cap of 40,000 words). Based on these limitations, reporting an additional structured review with sufficient detail would not have been feasible. As a result, a structured review on this topic was deemed out of scope and left for future research. With respect to findings, this supplemental review identified a degree of anecdotal evidence suggesting that mobile sites were preferred. Specifically, a previously published report that documented the public consultation process for the development of a brick & mortar SCS in Lethbridge, Alberta, Canada (ARCHES, 2017). In this report, members of the public who attended a public engagement event hosted by the developers of the Lethbridge SCS, questioned if a mobile SCS had been considered instead of the planed brick & mortar SCS. This suggested that mobile SCSs may be preferred by the general public versus brick & mortar SCSs. Furthermore, the literature review of Mema et al., (2019) suggested that mobile sites may represent a way of mitigating public apprehension regarding SCS development (Mema et al., 2019). Based on the results of this supplemental review, we do not believe that any study has been conducted to date demonstrating that mobile sites are preferred to brick & mortar facilities. As a result, this represents an interesting area for future research.

Finally, this review was unable to establish insight on which parameters should be modelled as random effects from a predefined set of parameters, described previously, included in the mixed logit model used to analyze a DCE (**See Chapter 4**). As a result, a supplemental review was again conducted using Google Scholar. As a result of this supplemental review, two studies were identified that suggested the possibility of random parameters for two of the attributes to be included in the subsequent DCE (Matheson et al., 2014; Lange & Bach-Mortensen, 2019). Matheson et al., (2014) presented qualitative responses regarding the opinions of individuals in Scotland towards drug treatment programs. There existed heterogeneity in the responses obtained by Matheson et al., (2014), suggesting possible preference heterogeneity for the parameter related to the effectiveness of the site in preventing overdose related mortality. Some respondents gave responses that were companionate towards people who use drugs while the responses of others seemed hostile towards people who use drugs. As a result, the present study felt there could be possible preference heterogeneity for the attribute for the effectiveness of the SCS in preventing overdose related mortality. Additionally, Lange & Bach-Mortensen, (2019) in an SR of qualitive studies regarding the opinions of stakeholders towards SCSs reported multiple benefits and concerns associated with SCSs that lead the present study to suspect possible preference heterogeneity related to if the SCS is located in a respondent's neighborhood. Specifically, SCSs may be able to reduce improperly discarded needles, a positive for a person in a neighborhood that struggles with this issue, but there is also a belief that these facilities will lead to increased crime in the area where the site is established. The juxtaposition of these two characteristics of SCSs, lead the present study to model if the site is located in a respondent's neighborhood as a random parameter. The present study did not identify literature to suggest the existence of substantial preference heterogeneity for the other parameters to be included in the subsequent DCE. Please note a version of this paragraph is presented in **Chapter 4** and was also published in the journal Drug and Alcohol Dependence.[3]

The most substantial limitation associated with the present review is that it was conducted by a single reviewer. Due to this, the present review may be susceptible to inclusion bias and extraction errors to a greater extent than a review that included dual review and extraction (McDonagh et al., 2008). An additional limitation regarding the present review

[3] Berrigan, P., & Zucchelli, E. (2022). Public preferences for safe consumption sites for opioid use: A discrete choice experiment. *Drug and Alcohol Dependence*, *238*, 109578. https://doi.org/10.1016/j.drugalcdep.2022.109578

is that it only considers English language studies (Khan et al., 2003). Only considering English language studies may potentially bias results if there are jurisdictional correlations in study outcomes. It should be noted that several of the identified studies took place in non-English speaking countries. As a result, the extent to which the use of English language only impacted findings may be minimal. Identified studies were exclusively from high-income countries. As a result, it is unclear the extent to which the findings of the present review can be applied to low-income countries.

3. A Systematic Review of Discrete Choice Experiments of Harm Reduction Strategies for Addictive Substance Use

3.1 Introduction

Though research suggests that harm reduction strategies can reduce the negative consequences resulting from the use of some addictive substance, they tend to be controversial (Lange & Bach-Mortensen, 2019; Matheson et al., 2014). Many individuals report being apprehensive about such services due to a perception that these facilities increase crime and deviant behavior in the area in which they are located (Lange & Bach-Mortensen, 2019). Furthermore, some individuals do not believe that treatment for addiction should be the responsibility of the health or social systems, viewing addiction as a self-inflicted illness and consequently not a societal responsibility (Matheson et al., 2014).

In response to this controversy, researchers and policymakers have endeavoured to understand societal preferences for harm reduction strategies for addictive substances (Berrigan, 2018; Lange & Bach-Mortensen, 2019). This information is important for the design of harm reduction strategies that are both palatable to the public and also effective in reducing harm to people with addiction. A useful approach for assessing societal preferences for policy options are DCEs. DCEs ask participants to rank their preferences for policy options based on the underlying characteristics of the policy option. A more in-depth explanation of DCEs can be found in **Section 3.2 Background and Literature** of this chapter.

The present chapter set out to systematically review the literature for DCEs of harm reduction strategies for addictive substances. The purpose of this review was to identify and characterize the methods and approaches that have been used to date as they relate to DCEs of harm reduction strategies for addictive substances. Findings aimed to identify the state-of-the-art with respect to conducting DCEs on this topic and will be of use to researchers who aim to conduct DCEs related to harm reduction for addictive substances. Furthermore, findings were used to facilitate the conduct of a DCE that was conducted by the present study's author related to SCSs (see **Chapter 4)**.

The remainder of this chapter takes the following form. First there is a **Background** section that describes previous literature on this topic. This is followed by a **Methods** section that

describes the databases, search terms, and search strategy. The **Results** section follows the **Methods** section and presents the results. Finally, the **Discussion** section contextualized the results and discusses limitations.

3.2 Background and Literature

In the context of health research, DCEs investigate the preferences of survey respondents for attributes associated with healthcare interventions and policies (Bridges et al., 2011). Attributes refer to the characteristics of a policy or intervention that individuals consider when making choices about their preferred alternative. Examples of attributes that may influence preferences for healthcare treatments are the cost associated with the treatment, the effectiveness of the treatment, and the severity of side-effects associated with a treatment (Soekhai et al., 2019). DCEs are implemented using surveys that vary the attributes of one or more alternatives over a range of possible levels. Levels refer to the values an attribute can take. For example, the attribute treatment effectiveness may take levels corresponding to low effectiveness, moderate effectiveness, and high effectiveness in treating a given condition. DCEs ask study participants to choose their preferred alternative from a set of hypothetical alternatives, each having a unique set of attribute-level combinations. The set of hypothetical profiles participants are asked to choose from is called a choice set. Findings from DCEs can be used to estimate utility scores, respondents' WTA for attributes associated with an alternative, and the relative importance of attributes in influencing respondents preferences for alternatives (Clark et al., 2014; de Bekker-Grob et al., 2012; Soekhai et al., 2019).

Several SRs have been conducted on DCEs (Clark et al., 2014; de Bekker-Grob et al., 2012; Soekhai et al., 2019). However, these reviews have focused on DCEs in general. To the best of the author's knowledge, no literature review has been conducted of DCEs for harm reduction strategies in addictive substances in general. Though the previous literature reviews of DCEs were comprehensive and well done, they have limitations that justify a targeted investigation with respect to harm reduction. For example, each of the aforementioned literature reviews searched only a single database. Two searching PubMed (Clark et al., 2014; Soekhai et al., 2019) and one searching Medline (de Bekker-Grob et al., 2012). Furthermore, the most recent of these reviews only included studies published before 2018 (Soekhai et al., 2019). Finally, a more focused review would allow for targeted data extraction with more relevance to harm reduction compared to a review that aims to report on DCEs in general.

Information this study hopes to obtain includes but is not limited to the attributes included in DCEs of harm reduction strategies, the populations who are asked to complete surveys (i.e. general public, people who use addictive substances, healthcare workers, etc.), and also the statistical techniques used such as sample size calculations and approaches to statistical analysis.

3.3 Methods

Inclusion and Exclusion Criteria

The present SR aims to identify the state-of-the-art regarding DCEs of harm reduction for addictive substances, to aid in the development of future research. In accordance with this objective, the present SR has outlined the following inclusion/exclusion criteria (**See Table 9**).

Table 9 Inclusion/Exclusion Criteria

	Criteria
1)	To be included, studies must be DCEs;
2)	To be included, DCEs must be of harm reduction strategies;
3)	To be included, the harm reduction strategy must be for an addictive substance. Addictive substances to be considered include drugs (prescription or otherwise), alcohol, and tobacco;
4)	To be included, full texts must be available to the reviewer in English;
5)	There are no date restrictions other than those imposed by the electronic databases (i.e. Embase provided content from 1947 to present at the time of analysis);
6)	There are no jurisdictional restrictions (i.e. only high income countries);

Abbreviations: DCE : Discrete Choice Experiment; i.e : id est.

To be considered a DCE, studies must ask survey respondents to rank their preferences for one or more policy alternatives while varying the levels of the attributes associated with the policy alternatives (Bridges et al., 2011). To be considered harm reduction, an intervention must focus on reducing negative impacts to people who use addictive

substances or society without focusing on abstinence. Finally, addictive substances to be considered are drugs (prescription or otherwise), alcohol, or tobacco (Ritter & Cameron, 2006).

Search Strategy

To identify relevant keywords, a preliminary literature search was conducted for SRs relating to DCEs and harm reduction for addictive substances respectively. The preliminary review identified three SRs of DCEs (Clark et al., 2014; de Bekker-Grob et al., 2012; Soekhai et al., 2019) and one SR of harm reduction for addictive substances (Ritter & Cameron, 2006). The keywords used in the present study are based on, but not necessarily identical to, those used by these SRs. Keywords were searched as free terms and also used to identify relevant subject headings in target databases. To be considered for inclusion, studies had to contain at least one keyword or corresponding subject heading from the DCE list and one keyword or corresponding subject heading from the harm reduction list. The databases searched by the present review are: Medline, PubMed, Embase, PsychINFO, and Cochrane Database of Systematic Reviews. Cochrane was included such that the reference lists of relevant SRs could be recursively checked. Finally, a grey literature search of Google Scholar was conducted using combinations of the identified keywords (Simon Fraser University, 2019).

DCE related keywords include: *discrete choice experiment, discrete choice experiments, discrete choice modeling, discrete choice modelling, discrete choice conjoint experiment, stated preference, part-worth utilities, functional measurement, paired comparisons, pairwise choices, conjoint analysis, conjoint measurement, conjoint studies, conjoint choice experiment, and conjoint choice experiments*. Harm reduction related keywords include: *harm reduction, alcohol, heroin, tobacco, cannabis, illicit drug, drug use, dependence, abuse, needle exchange, syringe exchange, supervised injection, safe injection, safe consumption, naloxone, overdose, outreach, blood-borne virus, brief intervention, HIV, HIV testing, counselling, HCV, and hepatitis*. The following details the Embase search (**See Box 2**). Given the substantial length associated with each of these searches the search strategies and code used for each of the target databases was reported in **Appendix 2**.

Box 2 Embase Search Strategy

Database: Embase
Date: December 30, 2019

Search Software: Ovid
Filters: Limited to Humans, Limited to English Language, Limited to Articles – to deal with a large amount of conference abstracts.
Hits: 403

Search Term		Search Code
1. discrete choice experiment	→	discrete choice experiment.mp. (2035)
2. discrete choice experiments	→	discrete choice experiments.mp. (597)
3. discrete choice modeling	→	discrete choice modeling.mp. (25)
4. discrete choice modelling	→	discrete choice modelling.mp. (30)
5. discrete choice conjoint experiment	→	discrete choice conjoint experiment.mp. (22)
6. stated preference	→	stated preference.mp. (602)
7. part-worth utilities	→	part-worth utilities.mp. (56)
8. functional measurement	→	functional measurement.mp. (290)
9. paired comparisons	→	paired comparisons.mp. (1467)
10. pairwise choices	→	pairwise choices.mp. (28)
11. conjoint analysis	→	conjoint analysis.mp. (1043)
12. conjoint measurement	→	conjoint measurement.mp. (71)
13. conjoint studies	→	conjoint studies.mp. (4)
14. conjoint choice experiment	→	conjoint choice experiment.mp. (3)
15. conjoint choice experiments	→	conjoint choice experiments.mp. (3)
16. combine DCE related searches	→	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 (5494)
17. harm reduction	→	exp addiction/ or harm reduction.mp. or exp methadone/ or exp diamorphine/ or exp drinking behavior/ or exp Human immunodeficiency virus infection/ or exp drug abuse/ or exp harm reduction/ or exp drug dependence/ or exp acquired immune deficiency syndrome/ (764065)
18. alcohol	→	exp alcohol withdrawal syndrome/ or alcohol.mp. or exp "Alcohol Use Disorders Identification Test"/ or exp alcohol abuse/ or exp alcohol intoxication/ or exp alcohol consumption/ or exp alcohol/ or exp drug alcohol interaction/ or exp alcohol rehabilitation/ (552716)
19. heroin	→	heroin.mp. or exp diamorphine/ (31759)
20. tobacco	→	exp chewing tobacco/ or tobacco.mp. or exp tobacco dependence/ or exp tobacco snuff/ or exp dipping tobacco/ or exp smokeless tobacco/ or exp tobacco smoke/ or exp tobacco consumption/ or exp tobacco/ or exp waterpipe tobacco/ or exp "tobacco use"/ (456265)

21. cannabis	→	cannabis.mp. or exp cannabis derivative/ or exp medical cannabis/ or exp "cannabis use"/ or exp cannabis smoking/ or exp "Cannabis (genus)"/ or exp cannabis addiction/ or exp cannabis/ (47743)
22. illicit drug	→	illicit drug.mp. or exp illicit drug/ (19198)
23. drug use	→	exp "drug use"/ or drug-use.mp. or exp drug overdose/ (353130)
24. dependence	→	dependence.mp. or exp dependent personality disorder/ (340499)
25. abuse	→	abuse.mp. or exp amphetamine abuse/ or exp intravenous drug abuse/ or exp drug abuse/ or exp analgesic agent abuse/ or exp "drug of abuse test kit"/ or exp inhalant abuse/ or exp multiple drug abuse/ or exp alcohol abuse/ or exp phencyclidine abuse/ or exp drug abuse pattern/ (280735)
26. needle exchange	→	exp intravenous drug abuse/ or exp needle/ or exp Human immunodeficiency virus infection/ or exp acquired immune deficiency syndrome/ or needle exchange.mp. or exp preventive health service/ or exp drug abuse/ (544853)
27. syringe exchange	→	exp health program/ or exp syringe/ or exp preventive health service/ or syringe exchange.mp. or exp intravenous drug abuse/ or exp Human immunodeficiency virus infection/ (531848)
28. supervised injection	→	exp substance abuse/ or supervised injection.mp. or exp preventive health service/ (79119)
29. safe injection	→	exp substance abuse/ or safe injection.mp. (53094)
30 safe consumption	→	safe consumption.mp. (180)
31. naloxone	→	exp naloxone plus tilidine/ or exp methadone plus naloxone/ or exp hydromorphone plus naloxone/ or naloxone.mp. or exp naloxone plus oxycodone/ or exp naloxone 6 spirohydantoin/ or exp naloxone benzoylhydrazone/ or exp naloxone/ or exp buprenorphine plus naloxone/ or exp naloxone plus pentazocine/ (46609)
32. overdose	→	overdose.mp. or exp intoxication/ (370098)
33. outreach	→	outreach.mp. (18559)
34. blood-borne virus	→	blood-borne virus.mp. (489)
35. brief intervention	→	exp alcohol consumption/ or exp alcohol/ or exp alcoholism/ or brief intervention.mp. (403639)
36. hiv	→	hiv.mp. or exp Human immunodeficiency virus/ (421520)
37. hiv testing	→	hiv testing.mp. or exp HIV test/ (19045)
38. counselling	→	counselling.mp. or exp counseling/ (173404)
39. hepatitis	→	exp hepatitis/ or hepatitis.mp. (383665)
40. combine hr related searches	→	17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 (3127014)
41. identify studies related to both DCE and HR	→	16 and 40 (692)

42. limit studies to English language	→	limit 41 to english language (683)
43. limit studies to humans	→	limit 42 to human (628)
44. limit studies to articles.	→	limit 43 to article (403)

Studies were first screened for relevance using titles and abstracts based on the inclusion/exclusion criteria. The full texts of the studies that could not be rejected based on titles or abstracts were then reviewed. Based on full text reviews, studies were either included or rejected. Finally, studies referencing or referenced by included studies were reviewed by first screening titles and abstracts and then full texts. Articles citing included studies were identified with the Google Scholar cited by function. No formal quality appraisal tool was applied. Reviews of DCEs do not often implement quality screening tools due to a lack of validated instruments or reporting guidelines (Soekhai et al., 2019; Whitty et al., 2014).

To assess the comprehensiveness of our search strategy, we searched the reference list of studies reported by a previous SR of DCEs by Soekhai et al., (2019) for DCEs related to addictive substances, not necessarily harm reduction strategies. These included (Czoli et al., 2016; Kotnowski et al., 2016; Salloum, Abbyad, et al., 2015; Salloum, Maziak, et al., 2015; Van Minh et al., 2016). We checked that the DCEs related to addictive substances identified by Soekhai et al., (2019) were also identified by the present review's search strategy and all were.

Data Extraction and Synthesis

The extracted data focused on three categories general study details, experimental design details, and outcomes/findings. For an example of the data extraction form see **Appendix 3**. Data was synthesized using a narrative synthesis approach with tabular data displays. In line with the objective of the present SR, previous research providing methodological guidance on literature review suggests that narrative synthesis is a useful approach for "advancing best practice" (Rumrill & Fitzgerald, 2001). From this information, overall trends were identified. To improve the accuracy of reported information, data extraction was performed twice by the same reviewer and compared for accuracy.

3.4 Results

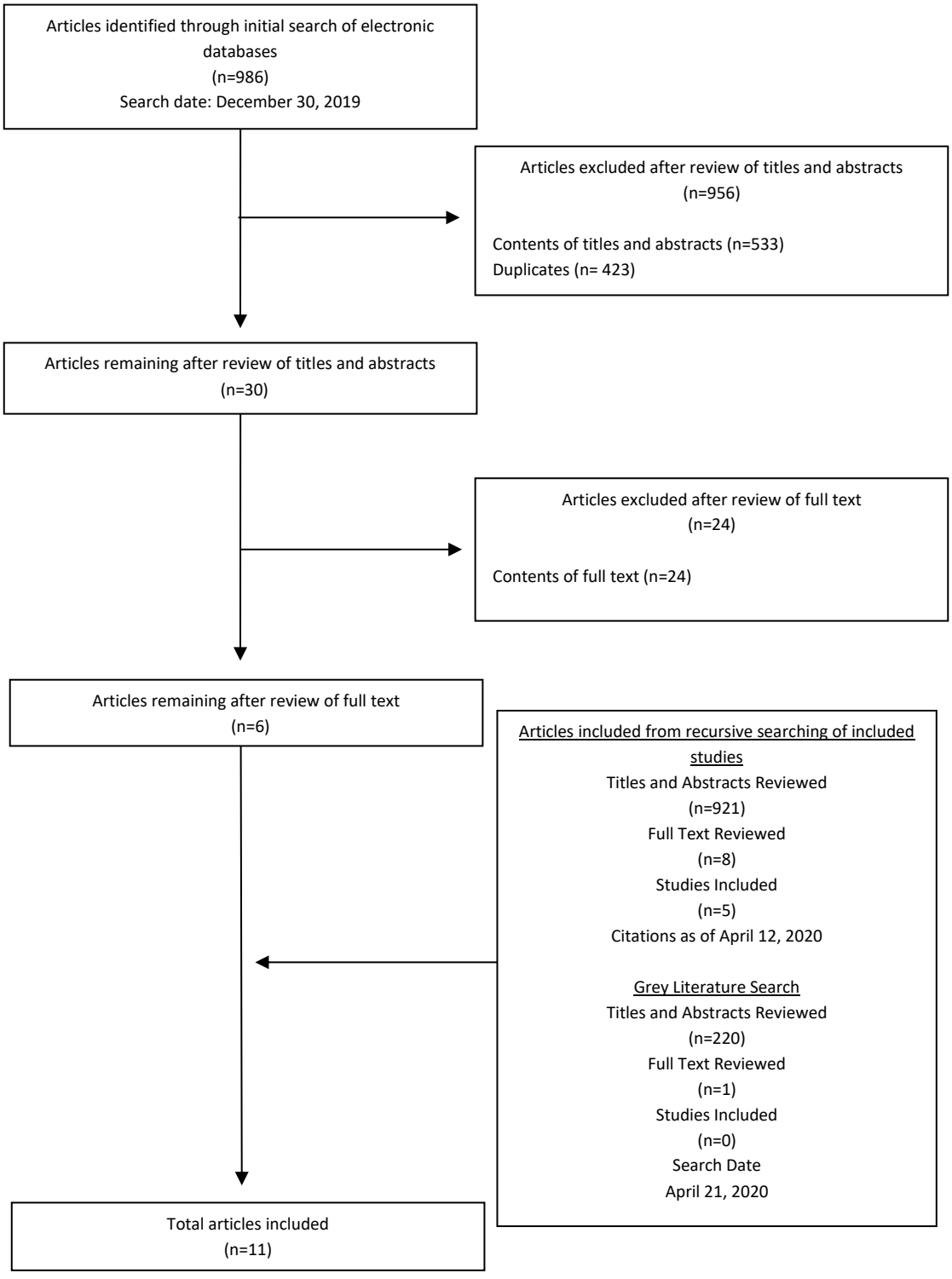
Searches were conducted in each of the target databases on December 30, 2019. This resulted in 986 hits. From these 986, the full texts of 30 studies were screened. From these 30, six studies met criteria and were selected for inclusion (Buckell & Sindelar, 2019; Eisingerich et al., 2012; Knudsen et al., 2018, 2019; Pesko et al., 2016; Shrestha et al., 2018).

In total, 921 studies either referenced or were referenced by included studies based on reference lists and the Google Scholar cited by function as of April 12, 2020. From these 921, eight were selected for full text review. Of these eight, five were included (Buckell et al., 2017, 2019; Marti et al., 2016, 2019; Shang et al., 2020). The grey literature search conducted on April 21, 2020 resulted in 220 hits. From these, one study was selected for full text review and none were included.

For context, one of the five included studies that either cited or was cited by an included study was published after our extraction date of December 30, 2019 (Shang et al., 2020). Two were published in grey literature and were consequently not identified by our search of electronic databases (Buckell et al., 2017; Marti et al., 2016). Finally, two of the included studies were not identified by our electronic database search (Buckell et al., 2019; Marti et al., 2019).

Two sets of the included studies were companions, meaning they reported essentially the same results using the same data (Marti et al., 2016, 2019) and (Buckell et al., 2017, 2019). To avoid potentially overstating trends, only one of the two sets of companion studies is presented in the **Results** section (Buckell et al., 2017; Marti et al., 2019). In the Tables below, blank table cells indicate that the corresponding information could not be identified in the corresponding study. If a study touched on a relevant piece of information but did not provide sufficient details to be reported in the tables below this was marked as "Unclear". If a study explicitly stated that a component was not included, this was designated in the tables with "Not Included". In total, 2,127 titles and abstracts were screened (including duplicates), 39 full texts were screened, and 11 studies were included (**See Figure 2**).

Figure 2 PRISMA Diagram Systematic Review



General study details reveal little heterogeneity in geographic region. All but one study took place in the United States of America (Eisingerich et al., 2012). With respect to how studies self-identified, five studies identified as DCEs (Buckell et al., 2017, 2019; Buckell

& Sindelar, 2019; Marti et al., 2016, 2019; Pesko et al., 2016; Shang et al., 2020) and four studies identified as conjoint analyses (Eisingerich et al., 2012; Knudsen et al., 2018, 2019; Shrestha et al., 2018). With respect to who was sampled, the target populations of included studies were people who use addictive substances, with the exception of two which surveyed physicians on their approaches to treating patients with drug addiction (Knudsen et al., 2018, 2019). Studies tended to be recent, as all studies were published after 2015 with the exception of one (Eisingerich et al., 2012). Finally, sample sizes tended to be large compared to those that would be predicted via standard sample size calculations for DCEs, ranging from 400 to 2,031 (de Bekker-Grob et al., 2015) (**See Table 10**).

Table 10 General Study Details

Publication	Country	Study Type	Sample Size	Population
(Shang et al., 2020)	USA	Discrete Choice Experiment	1,154	Adult smokers who were also using electronic nicotine devices or had not ruled out electronic nicotine devices.
(Buckell & Sindelar, 2019)	USA	Discrete Choice Experiment	2,003	Young adults who had tried cigarettes or e-cigarettes.
(Knudsen et al., 2019)	USA	Conjoint Analysis	776	Physicians who prescribe buprenorphine.
(Marti et al., 2019)	USA	Discrete Choice Experiment	1,669	Current tobacco smokers.
(Knudsen et al., 2018)	USA	Conjoint Analysis	1,174	Physicians who prescribe buprenorphine.
(Shrestha et al., 2018)	USA	Conjoint Analysis	400	HIV-negative people who use drugs, who reported drug and/or sex-related risky behaviors
(Buckell et al., 2017)	USA	Discrete Choice Experiment	2,031	Adult smokers and recent quitters.
(Pesko et al., 2016)	USA	Discrete Choice Experiment	1,200	Adult Smokers.

(Eisingerich et al., 2012)	Peru, Ukraine, India, Kenya, Botswana, Uganda and South Africa. People who use drugs were from Ukraine	Conjoint Analysis	1,790	People who may benefit from using PREP. People who use drugs intravenously were included among other high-risk groups.

United States of America = USA. Pre-exposure Prophylaxis = PREP.

Interestingly, though there was heterogeneity in the study objectives of included studies, none focused on the preferences of the general public. Specifically, the study objectives of included studies focused on three areas: **1)** physicians' approaches to treating drug addiction (Knudsen et al., 2018, 2019); **2)** people who use drugs' willingness to take pre-exposure prophylaxis (PREP) (Eisingerich et al., 2012; Shrestha et al., 2018); and **3)** individuals' choice to use electronic cigarettes versus tobacco cigarettes (Buckell et al., 2017, 2019; Buckell & Sindelar, 2019; Marti et al., 2016, 2019; Pesko et al., 2016; Shang et al., 2020) (**See Table 11**). For context, people who inject drugs are at increased risk to acquire human immunodeficiency virus (HIV) and other blood borne viruses. PREP is a pharmaceutical that reduces the risk of contracting HIV and is often prescribed to individuals at high-risk of contracting the virus.

Table 11 Study Objective

Publication	Study Objective
(Shang et al., 2020)	Determine adult smokers' preferences for electronic nicotine delivery systems.
(Buckell & Sindelar, 2019)	To estimate young adults' preferences for attributes related to cigarettes and e-cigarettes. Then estimate how policy changes could impact young adults' preferences for cigarettes and e-cigarettes.
(Knudsen et al., 2019)	Determine the relative importance of attributes to physicians' decision to adjustment dosage and office visit frequency during buprenorphine-naloxone treatment.
(Marti et al., 2019)	Determine what influences tobacco smokers' preferences for tobacco cigarettes and e-cigarettes.
(Knudsen et al., 2018)	Determine the relative importance of attributes to physicians' decision to prescribe buprenorphine-naloxone treatment.
(Shrestha et al., 2018)	Determine the preferences of people who use drugs and report high-risk drug/sex behavior towards attributes associated with PREP.
(Buckell et al., 2017)	Determine attributes, with a particular emphasis on flavours, that influence smokers' and recent quitters' preferences for e-cigarettes, cigarettes, and smoking in general.

(Pesko et al., 2016)	Determine attributes that influence smokers' preferences for e-cigarettes with a particular emphasis on regulatory approaches.
(Eisingerich et al., 2012)	Determine the attributes that influence willingness to take PREP.

Pre-exposure Prophylaxis = PREP.

Selecting the attributes to be included in a DCE is of paramount importance to experimental development and this process requires careful consideration. The number of attributes used by included studies ranged from three to seven. Among studies that investigated preferences of people who use addictive substances, two common attributes were **1)** cost of the strategy/intervention (Buckell et al., 2017, 2019; Buckell & Sindelar, 2019; Marti et al., 2016, 2019; Pesko et al., 2016; Shang et al., 2020; Shrestha et al., 2018) and **2)** effectiveness in reducing harm.(Buckell et al., 2017, 2019; Buckell & Sindelar, 2019; Marti et al., 2016, 2019; Shang et al., 2020; Shrestha et al., 2018). Of included studies that reported how attributes were selected: all used literature (Buckell et al., 2017, 2019; Eisingerich et al., 2012; Knudsen et al., 2018, 2019; Marti et al., 2019; Shang et al., 2020; Shrestha et al., 2018); five used expert opinion (Buckell et al., 2017, 2019; Eisingerich et al., 2012; Knudsen et al., 2018, 2019; Shrestha et al., 2018); and four used qualitative interviews (Knudsen et al., 2018, 2019; Marti et al., 2016, 2019; Shrestha et al., 2018) (**See Table 12**).

Table 12 Attributes Included

Publication	Attributes	Method to Determine Attributes
(Shang et al., 2020)	1) Relative harm, 2) effectiveness for helping smokers quit, 3) nicotine strength, 4) flavor, and 5) price.	Attributes were based on literature.
(Buckell & Sindelar, 2019)	1) Flavors, 2) short-term health risks to self, 3) second-hand smoke risks, and 4) price.	
(Knudsen et al., 2019)	1) Current dose, 2) urine drug test results and opioid blockade, 3) recent intravenous use, 4) visit attendance, 5) counseling adherence, 6) payment, and 7) visit schedule.	Attributes were based on clinical practice guidelines, qualitative interviews, and the team's clinical expertise,
(Marti et al., 2019)	1) Health impact relative to combustible cigarettes, 2) potential to help smokers quit using combustible cigarettes, 3) bans in public places, and 4) price.	Attributes were selected using qualitative interviews and literature.
(Knudsen et al., 2018)	1) Risky substance use, 2) method of payment, 3) spousal involvement	Attributes were based on literature review, qualitative

	in treatment, 4) type of opioid/route, 5) treatment history, 6) co-occurring infections, and 7) employment status.	interviews, and clinical expertise within the investigative team.
(Shrestha et al., 2018)	1) Cost, 2) dosing, 3) efficacy, 4) side-effects, 5) treatment setting, and 6) frequency of HIV testing.	Attributes were based on qualitative interviews, literature review, and expert opinion.
(Buckell et al., 2017)	1) Flavours, 2) price, 3) health impact, and 4) nicotine level in cigarettes and e-cigarettes.	Attributes were based on literature and authors experience.
(Pesko et al., 2016)	1) Warning labels, 2) flavor regulations and 3) prices.	
(Eisingerich et al., 2012)	1) Route of administration, 2) dispensing site, 3) time spent obtaining PREP, 4) frequency of pick up, and 5) Frequency of HIV testing associated with PREP.	Attributes were based on expert consultation and literature review.

Pre-exposure Prophylaxis = PREP. Human Immunodeficiency Virus = HIV.

The number of possible attribute level combinations in DCEs is often large. As a result, researchers frequently use fractional designs which include only a subset of possible profiles. To determine which profiles to include in the fractional design, efficiency criteria was most commonly used by included studies (Buckell et al., 2017, 2019; Buckell & Sindelar, 2019; Eisingerich et al., 2012; Marti et al., 2016, 2019; Pesko et al., 2016; Shang et al., 2020). An efficient design is one that maximizes the precession associated with parameter estimates from the regression model to be used to analyze the data (Bridges et al., 2011). To obtain an efficient design, software is required. The software used by included studies was SPSS (n=3) (Knudsen et al., 2018, 2019; Shrestha et al., 2018), NGENE (n=3) (Buckell et al., 2017, 2019; Buckell & Sindelar, 2019; Marti et al., 2016, 2019), and SAS (n=2) (Eisingerich et al., 2012; Shang et al., 2020). Of note, SPSS was used to determine orthogonal designs which are not necessarily efficient. Orthogonal designs are those in which all attribute level combinations vary independently between profiles (Bridges et al., 2011). Most of the included studies did not report details regarding sample size calculations. Of included studies that reported this information one used a sample group that was recruited for a different study (Shrestha et al., 2018) and another used a rule of thumb approach (Marti et al., 2016, 2019). (**See Table 13**). Of note, a rule of thumb approach to sample size calculation is generally a simple formula that can be applied to an experiment that does not take into account specific information on expected distributions or effect sizes. Generally, rule of thumb calculations are considered to be less rigorous than calculations that incorporate specific distributional information (de Bekker-Grob et al., 2015).

Table 13 Experimental Design Details

Publication	Design	Design Criteria	Design Software	Sample Size Calculation
(Shang et al., 2020)	Fractional	D-optimal	SAS	Unclear
(Buckell & Sindelar, 2019)	Fractional	D-optimal	NGENE	Unclear
(Knudsen et al., 2019)	Fractional	Orthogonal	SPSS	
(Marti et al., 2019)	Fractional	D-efficient	NGENE	Rule of Thumb approach.
(Knudsen et al., 2018)	Fractional	Orthogonal	SPSS	
(Shrestha et al., 2018)	Fractional	Orthogonal	SPSS	This analysis was applied to an ongoing study. The sample size was chosen to inform the ongoing study.
(Buckell et al., 2017)	Fractional	D-efficient	NGENE	Unclear
(Pesko et al., 2016)	Fractional	D-efficient		
(Eisingerich et al., 2012)	Fractional	Efficient	SAS	

Choosing the number of choice sets to display to respondents and the number of profiles to include in each choice set is an important consideration in DCEs. Exposing respondents to higher amounts of both will increase the amount of data a researcher can collect in an experiment but can also lead to survey fatigue in respondents and complicated surveys. The number of choice sets given to respondents ranged from one to 18 in included studies and the number of profiles in each choice set ranged from one to eight (**See Table 14**). The most profiles exposed to participants was 72 (Buckell et al., 2017, 2019) and the fewest was eight (Shrestha et al., 2018). Most studies included an opt-out option in surveys allowing respondents to choose none of the profiles included in a choice set. Of note, the opt-out option was included as a profile in the profiles per choice set column of **Table 14**. Most studies took place online with the exception of two that took place through mail (Knudsen et al., 2018, 2019) and two that took place in-person (Eisingerich et al., 2012; Shrestha et al., 2018). Studies taking place in person were conducted in patients recruited from SCSs, potentially representing a more appropriate approach in this group, given a potential lack of internet access and/or fixed addresses.

Table 14 Experimental Design Details Extended

Publication	Choice Sets per Respondent	Profiles per Choice Set	Opt-out Option Provided	Data Collection Method
(Shang et al., 2020)	12	4	Y	Online
(Buckell & Sindelar, 2019)	8	4	Y	Online
(Knudsen et al., 2019)	16	1	Y	Mail
(Marti et al., 2019)	6	3	Y	Online
(Knudsen et al., 2018)	18	1		Mail
(Shrestha et al., 2018)	1	8		In person
(Buckell et al., 2017)	12	6	Y	Online
(Pesko et al., 2016)	12	3	Y	Online
(Eisingerich et al., 2012)	10	4	Y	In person

The choice of statistical analysis should align with the study objective (Bridges et al., 2011; Hauber et al., 2016). In included studies, a variety of model types were used however, variations of logit models were most commonly applied (n=5) (Buckell et al., 2017, 2019; Buckell & Sindelar, 2019; Marti et al., 2016, 2019; Pesko et al., 2016; Shang et al., 2020). Additionally, four studies incorporated multiple models in their analyses (Buckell & Sindelar, 2019; Marti et al., 2016, 2019; Pesko et al., 2016; Shang et al., 2020) (**See Table 15**). Incorporating multiple modelling approaches can be beneficial, as they can serve to validate findings if each model is in agreement. Furthermore, if a study tests multiple hypothesis multiple models may be necessary to accurately assess the different hypotheses. Key Results presented in **Table 15** represent the interpretations of the present study's author and were not taken verbatim from the corresponding manuscripts.

Table 15 Outcomes and Findings

Publication	Statistical Approach	Key Results
(Shang et al., 2020)	- Multinomial logit model, - Nested logit model, - Mixed logit model.	Attributes associated with e-cigarettes will influence people's choice to use e-cigarettes, cigarettes, and smoke in general.
(Buckell & Sindelar, 2019)	- Multinomial logit model, - Latent class multinomial logit model.	Attributes associated with cigarettes and e-cigarettes influence if people use e-cigarettes. Policymakers should consider how e-cigarette policy will impact the likelihood that cigarette smokers switch

			to e-cigarettes and also that e-cigarette users quit.
(Knudsen et al., 2019)	-	SPSS Conjoint	Patient attributes influenced physicians' decisions to modify treatment for patients receiving buprenorphine-naloxone for drug addiction.
(Marti et al., 2019)	- -	Conditional logit model, Latent class logit model.	Smokers' demand for electronic nicotine devices are for the most part motivated by health concerns associated with cigarette smoking.
(Knudsen et al., 2018)	-	SPSS Conjoint	Patient attributes influenced physicians' decisions to prescribe buprenorphine to patients for drug addiction.
(Shrestha et al., 2018)	-	SPSS Conjoint	Cost and effectiveness in preventing HIV infection were the most important attributes associated with people who use drugs' willingness to take PREP.
(Buckell et al., 2017)	-	Exploded multinomial logit model.	Flavours associated with e-cigarettes will influence people's choice to use e-cigarettes, cigarettes, and smoke in general.
(Pesko et al., 2016)	- - -	Linear probability model, Logit model. Conditional logit model.	Increased regulation of electronic nicotine delivery systems may inhibit cigarette smokers from switching to electronic devices. Additionally, regulating flavours may reduce the number of youths who try electronic nicotine devices.
(Eisingerich et al., 2012)	-	Hierarchical Bayes estimation.	If effective and affordable many people in high-risk populations for contradicting HIV would be willing to take PREP.

Pre-exposure Prophylaxis = PREP. Human Immunodeficiency Virus = HIV.

3.5 Discussion

In total, 2,127 titles and abstracts were screened (including duplicates), 39 full texts were screened, and 11 studies were included. Most studies aimed to determine which attributes of harm reduction strategies most influenced respondents' preferences for using a harm reduction strategy with the exception of two (Knudsen et al., 2018, 2019). Included studies focused on three areas: **1)** physicians' approaches to treating drug addiction (Knudsen et al., 2018, 2019); **2)** people who use drugs' willingness to take PREP (Eisingerich et al., 2012; Shrestha et al., 2018); and **3)** individuals' choice to use electronic cigarettes versus tobacco cigarettes (Buckell et al., 2017, 2019; Buckell & Sindelar, 2019; Marti et al., 2016, 2019; Pesko et al., 2016; Shang et al., 2020). Interestingly, most studies set out to understand the preferences of people who use addictive substances. Understanding, the preferences of people who use addictive substances is important, as without this perspective it is difficult to develop policies that serve the needs of those who use addictive substances (Lancaster et al., 2013, 2014). Interestingly, no studies targeted the general public.

Understanding the general public's preferences for harm reduction strategies can help policymakers develop policies that will be well received and less controversial.

The number of attributes used by included studies ranged from three to seven. Of included studies that reported how attributes were selected: all used literature; five used expert opinion; and four used qualitative interviews. Commonly included attributes were the cost of the intervention and also the intervention's effectiveness in reducing harm. Given how commonly these attributes were included, these attributes are likely of high importance with respect to DCEs of harm reduction strategies.

The number of choice sets presented to respondents ranged from one to 18 and the number of profiles included in each choice set ranged from one to eight. Most studies included an opt-out option in surveys. Most studies utilized fractional designs and efficiency criteria was commonly used to determine the fractional design. The use of efficiency criteria to determine choice sets is not unique to DCEs of harm reduction strategies. Soekhai et al., (2019) found that D-efficient criteria was commonly used across DCEs in all fields. The specifics of experimental design used by included studies show reasonably good accordance with the International Society for Pharmacoeconomic Research (ISPOR) guidelines for conjoint analyses (Bridges et al., 2011).

Few studies reported their approaches to sample size calculation. Included studies did not appear to be underpowered and were more likely overpowered. Overpowering studies cannot always be viewed as an appropriate strategy, as sampling more respondents than is required to gain the necessary information can be inefficient with respect to resource allocation and the use of respondents' time. The use of various specifications of logit models observed in included studies is in line with DCEs in other areas. The SR of Soekhai et al., (2019) that reviewed DCEs in general found that multinomial logit and mixed logit models were the most common statistical approaches in recent DCEs (Soekhai et al., 2019).

Though the primary focus of the present review was to identify methodological approaches to DCEs of harm reduction strategies for addictive substances, this SR also provides a brief review of the findings of included studies. Of studies that investigated physicians' approaches to treating drug addiction (Knudsen et al., 2018, 2019) both found that patient attributes influence the approaches physicians take. For example, a patient with a spouse who uses drugs would be less likely to receive a buprenorphine prescription. Studies that investigated people who use drugs' willingness to take PREP found that people who use

drugs would be willing to take PREP providing it is effective and affordable (Eisingerich et al., 2012; Shrestha et al., 2018). Finally, if policymakers regulate e-cigarettes with things such as taxes, it is likely that fewer non-smokers will try e-cigarettes, a good outcome. However, fewer tobacco cigarette smokers may switch to the potentially less harmful e-cigarettes, an overall less desirable outcome (Buckell et al., 2017, 2019; Buckell & Sindelar, 2019; Marti et al., 2016, 2019; Pesko et al., 2016; Shang et al., 2020). As a result, careful consideration is required with respect to e-cigarette regulation.

Several studies were identified that investigated the impacts of warning labels on cigarette packages. These studies were not included as they were deemed to primarily focus on abstinence and subsequently did not meet the definition of harm reduction in the present review. Additionally, many studies investigated attributes associated with e-cigarettes (Czoli et al., 2016). However, only studies that presented e-cigarettes as a harm reduction alternative to tobacco cigarettes were included. Finally, studies that focused on policy and did not evaluate a specific program or approach were not included (Shanahan et al., 2014).

This SR was subject to limitations. Potentially, the most impactful is that the SR's screening and data extraction were conducted by a single reviewer. Due to this limitation, this SR may be susceptible to bias and/or error to a greater extent than a review that used multiple reviewers (McDonagh et al., 2008). Additionally, this SR only considered English language literature and as a result this may have led to selection bias.

In summary, study designs did not differ greatly from DCEs on other topics (Soekhai et al., 2019). Most DCEs of harm reduction strategies for addictive substances aimed to solicit the preferences of people who use addictive substances. The present review identified that cost and effectiveness in reducing harm are important attributes to include in DCEs of harm reduction strategies for addictive substances. Furthermore, the literature would benefit from more rigorous approaches to and/or better reporting of sample size calculations. Finally, all studies used fractional research designs and most used efficiency criteria, such as D-efficiency, to design experiments. The information identified by this SR used to develop the subsequent DCE (**See Chapter 4**) included the following:

1. The methods document "Conjoint Analysis Applications in Health—a Checklist: A Report of the International Society for Pharmacoeconomics and Outcomes Research Good Research Practices for Conjoint Analysis Task Force" was a frequently sited

document regarding the design of DCEs related to harm reduction. As a result, this document was used to plan the subsequent DCE (Bridges et al., 2011).

2. The use of D-efficient or similar designs to develop the choice sets to be incorporated in DCEs was reasonably common. Also, the use of Statistics for Social Sciences (SAS) software to develop the D-efficient design was also identified by this SR. As a result, these two approaches were incorporated in the subsequent DCE.

3. The use of logit and mixed logit regression models, to analyze the data obtained through DCEs was noted by this SR. This assessment was substantiated by the work of Soekhai et al., (2019) who also found these to be commonly used regression approaches in DCEs. As a result, these regression approaches were incorporated into the subseuqent DCE.

4. The attributes for the effectiveness of the SCS in reducing harm and also the cost of the SCS to payers were noted in identified sutdies. As a result, these two attributes were considered for incorporation in the subseuqnet DCE.

5. Additionally, and as was the case in **Chapter 2**, the knowledge gained through the process of screening and reviewing more than two thousand abstracts and dozens of full texts provided valuable insight on the state of the literature related to DCE of harm reduction for addictive substances.

6. Finally, studies identified in this SR were used to compare the findings of the subsequent DCE to, to assess the validity of results (**See Chapter 4**).

4. Public Preference for Safe Consumption Sites for Opioid Use: A Discrete Choice Experiment

4.1 Introduction

The impact of opioid overdose is substantial, as mentioned in previous chapters, it is estimated that 16 million people experience opioid use disorders globally and in many jurisdictions the number of opioid related overdoses is reaching crisis levels (Government of Canada, 2021; Azadfard et al., 2021). Though SCSs are effective in preventing overdose related mortality, they are controversial (Behrends et al., 2019; Lange & Bach-Mortensen, 2019). Some are not comfortable having SCSs in their communities due to a belief that these facilities may increase crime (Lange & Bach-Mortensen, 2019). However, it is important to acknowledge that previous research appears to suggest that SCSs should not increase crime (Fitzgerald, 2010; Livingston, 2021).

Given the controversial nature of SCSs, identifying the characteristics of SCSs that influence public perceptions of these facilities will aid policymakers in developing SCSs that both meet the needs of people who use drugs and are acceptable to the general public. An approach commonly used within the literature to identify attributes of a policy that influence public perceptions are DCEs. DCEs use surveys to assess the preferences of individuals for attributes associated with a good or service by asking survey respondents to choose their preferred option from a set of hypothetical alternatives for that good or service. Additional details on DCEs can be found in **Section 4.3 Materials and Methods** of this chapter.

To the best of our knowledge, no DCE has been conducted to identify the preferences of the general public towards attributes associated with SCSs, to date. As a result, this study employed a specifically designed DCE to assess the preferences of the Canadian public for SCSs. This study sets out to: **1)** identify a set of attributes that are significantly associated with the general Canadian public's preferences for SCSs and **2)** estimate a value for the general Canadian public's WTA for an SCS to be located in their neighborhood. WTA refers to the amount an individual would need to be compensated, in currency, such that they would be indifferent to having an SCS located in their own neighborhood or in another neighborhood. WTA estimates can provide additional information to policymakers on public perceptions of policies. Specifically, policymakers can use WTA estimates to

understand the extent to which individuals dislike a policy option that will impact them. Higher WTA suggest that a policy is less acceptable to the public.

To meet these objectives, this study designed a DCE and collected data from respondents using an online platform. Data were then analyzed using logit and mixed logit regression models. Given that SCSs are frequently used both in Canada and internationally, findings will be of value to policymakers aiming to design SCSs and/or SCS related policies that both meet the needs of people who use drugs and are more positively received by the public. SCSs that can achieve these two objectives could help reduce both mortality and possible hesitance by people living near sites.

The rest of the chapter is organized as follows. The **Background and Literature Review** section provides further background to the analysis together with a brief summary of the literature review presented in **Chapter 3**, while the **Methods** section presents survey design, data collection and the statistical methods used in the analysis. The **Results** section presents the main results, and the **Discussion** section contextualizes the results and makes recommendations for policymakers. Please note, a version of this chapter was published in the journal Drug and Alcohol Dependence.[4]

4.2 Background and Literature Review

As a recap of **Chapter 3,** though we are aware of no DCEs on SCSs to date, there have been several DCEs conducted on reducing the harm associated with the use of addictive substances. For instance, two studies have looked at the willingness of people who use drugs intravenously to take PREP to prevent the acquisition of HIV (Eisingerich et al., 2012; Shrestha et al., 2018). These studies found that people who inject drugs would be willing to take PREP providing it is effective and affordable. Additionally, seven studies have investigated smokers' willingness to switch from tobacco cigarettes to e-cigarettes (Buckell et al., 2017, 2019; Buckell & Sindelar, 2019; Czoli et al., 2016; Marti et al., 2016, 2019; Shang et al., 2020). In general, these studies found that stricter regulation of e-cigarettes with policies such as price controls or warning labels may cause fewer non-smokers to try e-cigarettes, an overall good outcome. However, fewer tobacco cigarette smokers may switch to the potentially less harmful e-cigarettes in the presence of such

[4] Berrigan, P., & Zucchelli, E. (2022). Public preferences for safe consumption sites for opioid use: A discrete choice experiment. *Drug and Alcohol Dependence*, *238*, 109578. https://doi.org/10.1016/j.drugalcdep.2022.109578

regulations. As a result, careful consideration of the consequences is required when regulating e-cigarette use.

As described in **Chapter 2**, though there have been no DCEs on SCSs, there have been several studies that have investigated public perceptions of SCSs using qualitative, quantitative, or mixed methods approaches. Since January 1, 2020 we are aware of nine studies that investigated public support for SCSs, internationally (Alberta Health, 2020; Bancroft & Houborg, 2020; Brooks-Russell et al., 2021; Mrazovac et al., 2020; Sastre et al., 2020; Sharp et al., 2020; Sumnall et al., 2020; Taylor et al., 2021; Wild et al., 2021). Parameters that have been shown to influence preferences for SCSs in these studies included age, sex, and political affiliation with older, male, and more conservative individuals generally being less likely to support SCSs (Brooks-Russell et al., 2021; Sastre et al., 2020; Wild et al., 2021). Several of these studies reported that the messaging provided to the public with respect to an SCS can influence public support (Mrazovac et al., 2020; Sumnall et al., 2020; Taylor et al., 2021). For instance, sites that aim to recruit site-users into abstinence-based rehabilitation programs and sites that emphasize the benefits of SCSs to society were more likely to be preferred by the public. Additionally, knowledge of or education on SCSs were generally shown to positively influence public support for SCSs (Mrazovac et al., 2020; Taylor et al., 2021; Wild et al., 2021).

4.3 Materials and Methods

Discrete Choice Experiments

To reiterate what was described in **Chapter 3**, in the context of health research, DCEs investigate the preferences of survey respondents for attributes associated with healthcare interventions and policies. Attributes being the characteristics of a policy or intervention that individuals consider when making choices about their preferred alternative. Examples of attributes that may influence preferences for healthcare treatments are the cost associated with the treatment, the effectiveness of the treatment, and the severity of side-effects associated with a treatment. DCEs are implemented using surveys that vary the attributes of one or more alternatives over a range of possible levels. Levels refer to the values an attribute can take. DCEs ask respondents to choose their preferred alternative from a set of hypothetical alternatives, each having a unique set of attribute-level combinations. An example of a choice set from the present study can be found in **Appendix 4**. Of relevance to this study, DCEs can be used to estimate respondents' WTA for attributes associated

with a good or service and the relative importance of attributes in influencing respondents' preferences for a good or service.

An advantage of using DCEs to assess public preferences for goods or services versus a simpler survey design is that DCEs require respondents to make trade-offs between attributes associated with the good or service. By necessitating trade-offs DCEs, may provide researchers with a greater understanding of the relative value of attributes and therefore a better understanding of respondents' preferences for the good or service being evaluated. As the present study is the first to apply the DCE method to SCSs, it provides useful information on the relative preferences of respondents towards attributes associated with SCSs.

Attribute and Level Selection

An unlabeled and forced-choice DCE approach was used. In this case, a forced-choice approach was used to more appropriately reflect the decision problem, given that SCSs are a public policy and not a consumer good that individuals can choose to purchase or not purchase. Furthermore, if an opt-out option was provided then respondents who disagreed with SCS may choose to opt out rather than consider which option they preferred from the choice set. However, even if respondents disagree with SCS, we still believe that they can prefer one option over another. For instance, an individual may disagree with SCS but still value the fact that an SCS may reduce improperly discarded needles in a community. As a result, we hypothesize not providing an opt-out option may have led to increased importance for attributes that benefit society and less importance for those that benefit people who use drugs alone. Of note, literature that has investigated the impact of adding an opt out option to DCE suggest that there are small differences in outcomes that result from the choice of experimental design (Veldwijk et al., 2014). Given the desire to include the preferences of those who do not support SCS, the forced choice option was chosen in the present study, to increase the likelihood that these individuals provided responses.

To determine the set of attributes associated with public preference for SCSs, literature on public perceptions of SCSs was used. From the literature, a list of attributes was compiled. This list was then presented to staff at an SCS for feedback. The final set of attributes consisted of: **1)** the cost of the SCS to the healthcare system (Cruz et al., 2007); **2)** the effectiveness of the SCS in reducing mortality (Cruz et al., 2007); **3)** the ability of the SCS to reduce improperly discarded needles in its neighborhood (Cruz et al., 2007; Lange &

Bach-Mortensen, 2019); **4)** if the SCS is located within the respondent's neighborhood (Lange & Bach-Mortensen, 2019); and **5)** compensation to residents if an SCS is located in their neighborhood. Of note, the attribute for compensation was not identified from literature but added to facilitate WTA calculations.

Attribute levels were limited to a maximum of three (Bridges et al., 2011). The levels were informed by the literature where possible. The attribute cost of the site had three levels: cost-saving, cost-neutral, and higher cost. The literature has suggested that SCSs can offset expenditure in other areas of the economy by reducing disease transmission, the need for policing, and the number of overdoses managed in the emergency setting (Cohen, 2018). The attribute for reduction in overdose mortality has three levels: 25%, 50%, and 75%. These values represent the approximate range of reduction in overdose related mortality in the area where an SCS is located (Kaplan, 2018). The attribute for the location of the SCS has two levels: located within the respondent's neighborhood or located outside of the respondent's neighborhood. To define neighborhood, respondents were asked to consider the area where they live. The attribute for the ability of SCSs to reduce improperly discarded drug paraphernalia has two levels: the SCS reduces the amount of improperly discarded needles in its neighborhood or the SCS does not reduce the amount of improperly discarded needles in its neighborhood.

Levels for the attribute for compensation to individuals if an SCS is located in their neighborhood were determined using a convenience sample of individuals from across Canada. Initially, the literature was searched but no relevant studies providing estimates for this value were identified so a convenience sample approach was used. The convenience sample consisted of 23 individuals recruited from one of the study author's (PB) contacts. Individuals were asked about the amount of compensation they would require such that they would be indifferent between an SCS located in their neighborhood or another neighborhood. They were told that the value could be any amount but that they could not use the compensation to then move to a new neighborhood. Of the 23 individuals sampled, nine reported that there was no amount that they could be compensated such that they would be indifferent between having an SCS located in their neighborhood or not. These individuals were not considered, as Bridges et al., (2011) suggested not incorporating extreme values for levels (Bridges et al., 2011). Of the remaining 14 individuals, the compensations for all but one fell between $0 and $50,000. As a result, compensation values were chosen to reflect this range. The responses derived from the convivence sample are presented in **Box 3** below. Note that the use of non-random samples of available

individuals for the development of DCEs has been used previously (e.g. Livingstone et al., 2020). However, it is possible that by using a convenience sample instead of a random sample, values did not reflect those of the wider public.

Box 3 Survey on Willingness to Accept for Discrete Choice Experiment

A convenience sample of individuals were asked about the amount of compensation they would require such that they would be indifferent between an SCS being located in their neighborhood or not. They were told the value could be any amount but that they could not use this money to then move to a new neighborhood. *Zero dollars* represents people who were indifferent to having an SCS in their neighborhood and *No amount* refers to people who could be compensated no amount such that they would be indifferent to having an SCS in their neighborhood.

Location	Sex	Age	Compensation
1. Nova Scotia	M	50 and over	No amount
2. Nova Scotia	F	50 and over	No amount
3. Nova Scotia	M	25-49	No amount
4. Nova Scotia	F	25-49	$0
5. Nova Scotia	F	25-49	$50,000
6. Alberta	M	25-49	$50,000
7. Alberta	F	25-49	$10,000
8. Ontario	M	25-49	$0
9. Nunavut	M	25-49	$50,000
10. New Brunswick	M	25-49	$100,000
11. Alberta	F	25-49	No amount
12. Alberta	M	25-49	$21,000
13. Alberta	F	25-49	$0
14. Nova Scotia	M	25-49	$50,000
15. British Columbia	F	25-49	No amount
16. Ontario	M	50 and over	$0
17. Ontario	F	25-49	$0
18. Ontario	F	25-49	No amount
19. Ontario	M	25-49	No amount
20. Ontario	F	50 and over	No amount
21. Ontario	M	50 and over	No amount
22. Ontario	F	25-49	$1,000
23. Ontario	M	25-49	$10,000

Abbreviations: F: Female; M: Male. SCS: Safe Consumption Sites

Table 16 below contains a list of the attribute/level combinations used in the present DCE.

Table 16 Attributes and Levels

Attribute/Level	Level 1	Level 2	Level 3
Cost of the SCS to the healthcare system	Cost-saving	Cost-neutral	Higher cost
Effectiveness of the SCS in decreasing overdose related mortality	25% reduction in overdose deaths	50% reduction in overdose deaths	75% reduction in overdose deaths
Compensation to residents if an SCS is located in their neighborhood.	$0	$25,000	$50,000
If the SCS is located within the respondent's neighborhood	In your neighborhood	Not in your neighborhood	**NA**
Ability of the SCS to reduce improperly discarded needles in its neighborhood	No change	Reduces improperly discarded needles	**NA**

Abbreviations: NA: Not Applicable; SCS: Safe Consumption Site.

To contextualize concepts that needed to be considered to complete the survey, such as what is meant by "neighborhood", respondents were provided with background information prior to starting the survey. With respect to the decision context of the study, the type of SCS was not included as an attribute. Furthermore, respondents were not provided with any background information on the condition of the neighborhood where the site would be opened prior to the opening of the SCS. Finally, a do-nothing choice set was not included where no SCS was built. The rationale for not providing such hypothetical details was so that WTA estimates would reflect that of the general public, given their current personal situations. If too much additional information was provided, WTA estimates would no longer be reflective of the general public's current realities and more reflective of the general public's WTA given the hypothetical scenario provided. Adding too many hypothetical details, would pose a limitation for informing policy, as WTA may be over or underestimated. The following is a copy of the information that survey respondents were provided with prior to beginning (See **Box 4**).

Box 4 Instructions Provided to Participants Before Beginning the Survey

Instructions

- This survey asks you to choose between possible safe consumption sites. Safe consumption sites are facilities where people are provided with medical supervision and clean needles for drug use. These facilities aim to reduce overdoses and improperly discarded needles. The purpose of this survey is to determine what matters most to you when it comes to safe consumption sites.

- In this study, you will be asked to think about your neighborhood. By your neighborhood, we would like you to think of the place where you live. This area can be as big or small as you would like.

- This survey will refer to the cost of safe consumption sites to the healthcare system. Though safe consumption sites cost money to operate they may save money in other areas of the economy by reducing the spread of diseases like HIV and reducing the number of overdoses requiring emergency rooms. Therefore, safe consumption sites may cost money in some cases, be cost neutral in others, or save money by operating.

- Finally, this survey asks your opinion on compensation to people living near safe consumption sites. This question refers to a onetime cash payment made to all individuals living in the neighborhood where the site is located on the day the site opens. People who move to the neighborhood after the site opens would not receive this payment.

Abbreviations: HIV: Human Immunodeficiency Virus

Data Collection and Experimental Design

The online platform Conjoint.ly was used to display and collect information from a sample of the Canadian Public (https://conjointly.com/). For the main study, participants were recruited from Conjoint.ly using a sample available through the website for the "Canadian General population". This sample included adults only, was split approximately evenly by gender, and approximately reflects census data for household income and geographic area. Although key characteristics of the individuals in the sample are close to those of the Canadian population (**See Table 17**), this should not be considered a statistically representative sample of the Canadian population. Conjoint.ly works with partner market research agencies to recruit individuals for their predefined panels (Personal Correspondence, July 25, 2023). Individuals voluntarily agree to join these market research panels. If they join, the partner market research agency will administer screening questions and these screening questions are used to identify

individuals for inclusion in panels. In general, respondents are not financially compensated for participation. Instead, respondents are usually awarded points for completing surveys by the partner market research agency and these points can be redeemed for vouchers or gift cards.[5]

A preliminary version of the DCE was piloted between April 26, 2021, and May 2, 2021. The results of the pilot were used to assess/improve the functionality/clarity of the survey and to provide the research team with experience using the Conjoint.ly platform. The pilot was conducted using Conjoint.ly's quick feedback function. For the pilot, a balanced and orthogonal set of nine choice sets were developed each containing two profiles. Additional conditions were applied including: **1)** each attribute's levels were required to be compared to all other levels for that attribute at least once and **2)** each of the 18 profiles had to be unique, meaning that the same profile was not repeated. To design the pilot experiment, an algorithm was developed in Microsoft Excel using Visual Basic for Applications (VBA) that would assign attribute level combinations at random based on the criteria described above. To identify the attributes and levels that were included in the pilot the same approach was used as was used in the main study. Specifically, literature was used to identify attributes and levels. Attributes were presented to staff at an existing SCS for feedback. For more detail on this process see **Section 4.3 Materials and Methods** sub section **Attribute and Level Selection**. To assess quality, an opened ended text question was included that asked respondents for feedback. This text suggested that some respondents felt that the survey's instructions were too complicated. As a result, the respondent instructions were simplified for clarity. Additionally, as no complaints about the number of choice sets were received, a design with more choice sets was used in the main study, to increase the amount of data that was collected. Originally, it had been planned to use coefficients obtained from the pilot as priors for experimental design. However, Conjoint.ly's quick feedback function does not limit respondents to any specific geographic location and due to this upon inspection, it was felt that the coefficients obtained from the pilot may not be reflective of the Canadian public. Given that inappropriate priors can negatively impact study design this was not done (Johnson et al., 2013).[6]

[5] This information was obtained from a personal correspondence between PB and a Conjoint.ly representative.

[6] Specifically, the sign on some coefficients did not conform with expectations.

The main study used 12 choice sets each with two profiles and no blocking. The use of 12 choice sets was chosen, as it was the largest candidate fractional design between the eight and sixteen choice sets suggested by Bridges et al., (2011). Efficiency criteria was used to determine the attribute/level combinations to include in the choice sets presented to respondents based on the SAS macro "%choiceff". The %chioceff macro generates the set of experimental designs that could result from a set of input criteria provided by the user. These include the number of attributes, the number of levels, the number of choice sets, and estimates for the beta coefficients that would result from the model. The macro identifies the design that would generate the model with the smallest value when summing the standard errors for coefficients assuming a logit model was run, which is referred to as the D-efficient design.[7] The final design was associated with an absolute D-efficiency of 1.898 and a D-error of 0.527.

To improve data quality the following steps were included. Respondents were required to view each choice set for at least two seconds. If respondents did not, they would be warned that they were proceeding too quickly and if they continued, they would be removed from the survey. Additionally, respondents were required to view the entire screen prior to making their choice. Similarly, if respondents did not, they would be warned that they may not be reviewing all relevant information and if they continued, they would be removed from the survey. Furthermore, responses were checked to make sure respondents did not choose the same option for each choice set. Finally, data for respondents who closed their browsers before completing the survey were not included in the analysis, as it was deemed that these individuals likely had not sufficiently engaged with the survey such that they provided well thought out responses on their preferences.

Statistical Analysis

Sample size was chosen using a formula-based approach (de Bekker-Grob et al., 2015). This formula states that the minimum sample size required to conduct a main effects analysis of a DCE is given by:

[7] This was taken from the SAS %ChoicEff Macro's User Manual. https://support.sas.com/rnd/app/macros/ChoicEff/ChoicEff.pdf (Accessed July 26, 2023)

$$\textbf{\textit{Minimum Sample Size}} = \frac{500 * C}{(T * A)} \quad \textbf{(1)}$$

Note: 500 is a constant that represents the minimum number of times each attribute level combination should be presented in the experiment to produce stable results, *C* is the number of levels for the attribute with the highest number of levels, *T* is the number of choice sets, and *A* is the number of alternatives included in choice sets. When the equation above is evaluated with this experiment's corresponding values the suggested sample size is 63. However, Conjoint.ly recommends a minimum sample size for all experiments of 200 when using their platform.

Binomial logit and mixed logit models from the mlogit package in "R" were used (Croissant, 2020). A logit model is a category of generalized linear models (GLM) parametrized by a logit link function, that describes how a set of independent variables correlate with a dependent categorical variable (Croissant, 2020; Wooldridge, 2010). The mixed logit model is a flexible extension of the standard logit model allowing for preference heterogeneity via the inclusion of random taste parameters. Another advantage of these models is that they are compatible with random utility maximization (McFadden & Train, 2000). The included models are reflected by **Equation 2**.

$$Utility_{ijk} = \beta 1_{ijk} * Lower\ Cost_{ijk} + \beta 2_{ijk} * Higher\ Cost_{ijk} + \beta 3_{ijk} * Effectiveness_{ijk} + \beta 4_{ijk} * Compensation_{ijk} + \beta 5_{ijk} * Neighborhood_{ijk} + \beta 6_{ijk} * Needles_{ijk} + E_{ijk} \quad \textbf{(2)}$$

Note: Lower Cost indicates that the SCS is cost saving to the healthcare system; Higher Cost indicates that the SCS is higher cost to the healthcare system; Effectiveness indicates the ability of the SCS to reduce overdose deaths; Compensation indicates compensation to individuals living in the neighborhood where the SCS is located; Neighborhood indicates whether or not the SCS is located in the respondents' own neighborhood; and Needles indicates if the SCS reduces the amount improperly discarded needles in the area where it is located. E is an error term. Subscript i indicates the respondent, j represents the alternative, and k represents the choice set.

For the mixed logit model, random parameters were assigned to **1)** *the effectiveness of the SCS in decreasing overdose related mortality* and **2)** *if the SCS is located in the respondents' neighborhood*. As was described in **Chapter 2**, these were chosen based on literature. Specifically, Matheson et al., (2014) provided qualitative responses of the opinions of individuals in Scotland, United Kingdom towards people who use drugs. Though overall responses were negative, responses ranged from compassionate to hostile, suggesting possible preference heterogeneity in the attribute for effectiveness in preventing overdose related

mortality. Lange & Bach-Mortensen, (2019) in their SR of qualitive studies on the opinions of stakeholders towards SCSs reported benefits and concerns that suggested possible preference heterogeneity for having an SCS located in a person's neighborhood. Specifically, the ability of SCSs to reduce improperly discarded needles could be a positive for a neighborhood impacted by drug use. Conversely, Lange & Bach-Mortensen, (2019) also report the belief amongst some stakeholders that SCSs increase crime. We were not aware of convincing literature to suggest preference heterogeneity for the other parameters included in the analysis. A set of models with different combinations of random parameters were also run, including the model with all parameters modelled as random, however none of these alternative models appeared to improve fit based on Akaike or Log-likelihood criteria. For the mixed logit model, all random parameters were assigned normal distributions.

The WTA for an SCS to be located in a respondent's neighborhood was calculated by dividing the coefficient for *if the SCS is located in the respondents' neighborhood* by the coefficient for *compensation to residents if an SCS is located in their neighborhood*. Random parameters were not correlated in the mixed logit model. Data on respondents': sex; age; income; educational attainment; location (Canadian province); if respondents had children in their care; and overall support for SCSs was collected. As it is possible that the relationship between compensation and choice may be dependent on whether or not the site is located in the respondent's neighborhood an additional mixed logit model was run that included an interaction term between *if the SCS is located in the respondent's neighborhood* and *compensation to residents if the SCS is located in their neighborhood.*

Attributes were coded as categorical variables except for *the effectiveness of the SCS in decreasing overdose related mortality* and *compensation to residents if an SCS is located in their neighborhood*. These attributes were coded as continuous variables. In an exploratory analysis that investigated how respondent preferences varied with demographic variables, sex was coded as a binary variable for male = 1, 0 otherwise, as previous research suggests that individuals who identify as male tend to be less accepting of SCSs than other segments of the population (Sastre et al., 2020); age was coded as a continuous variable; income was coded as a binary variable for above medium household income of study sample = 1, 0 otherwise; children in care was coded as a binary variable for a respondent having children in their care = 1, 0 otherwise; and whether the respondent supports the development of SCSs was coded as a

binary variable with supports = 1, 0 otherwise. Jurisdiction was coded as a binary variable with if the respondent lived in British Columbia or Atlantic Canada = 1 versus if the respondent lived elsewhere in the country = 0. Jurisdictions were coded in this fashion, as previous research suggests that opinions towards harm reduction may vary based on these geographic regions (Wild et al., 2021).

4.4 Results

Data were collected between May 30, 2021, and June 1, 2021. Data was collected on 203 individuals of the 363 who began the survey. 82 individuals began the survey but did not complete it. The data for 76 individuals were removed for either proceeding too quickly or not reviewing the full screen. The demographic characteristics of respondents can be found in **Table 17**. **Table 17** also shows values for Canada for comparison that were primarily taken from Canada's national statistics agency.

Table 17 Demographic Characteristics of Participants

Demographic Variable	Study Value (N = 203)	Value for Canada	Details of Value for Canada
Age in Years (Mean SD)	44.7 (15.2)	41.7	The average age of Canadians on July 1, 2021 (Statistics Canada, 2021a).
Male (%, SD)	48.8% (3.5%)	49.7%	The percentage of Canadians who identify as male on July 1, 2021 (Statistics Canada 2021b)
Household Income (Median Range Respondents)	$50,000-$75,000	$75,400	The median total income for economic families and persons not in economic families in Canada for 2020 (Statistics Canada, 2022a).
Education (% Post-secondary, SD)	71.9% (3.2%)	64.8%	An estimate of the educational attainment of individuals in Canada (Statistics Canada, 2017).
Children in Care (% with children in care, SD)	35.0% (3.3%)	38.6%[a]	Households with children in care (Statistics Canada, 2021c).
Support for SCSs (% who supported, SD)	73.9% (3.1%)	55%-82.5%	Range of public support for SCSs reported in recent Canadian literature (Mrazovac et al., 2020; Wild et al., 2021).

Jurisdiction (%) - Ontario - Quebec - Prairies - British Columbia - Atlantic Canada	 38.4% 23.2% 17.7% 12.8% 7.9%	 38.8% 22.5% 18.3% 13.7% 6.5%	Population distribution of Canadians in last quarter of 2021 (Statistics Canada, 2022).

Abbreviations: N: Sample Size; SCS: Safe Consumption Site; SD: Standard Deviation.

[a] This value represents the number of Canadian households with children divided by the total number of Canadian households.

Table 3 shows the results of the binomial and mixed logit regression models investigated in this analysis. When examining a logit model a positive coefficient indicates that there is a positive correlation between the dependent and independent variables and a negative coefficient suggests a negative correlation. The values of coefficients are not directly interpretable and cannot be used to quantify the relationship between the dependent and independent variables. As a result, coefficients of logit models are often converted into odds ratios. Odds ratios represent the odds of an event occurring if a condition is true divided by the odds of an event occurring if that same condition is false. Odds ratios greater than one indicate an increased probability of an event occurring if the condition is true and odds ratios of less than one indicate a decreased probability of an event occurring if the condition is true. In each of the two models the same four attributes were statistically significant at the 1% level: *if the SCS was higher cost to the healthcare system; the effectiveness of the SCS in decreasing overdose related mortality; compensation to residents if an SCS is located in their neighborhood;* and *if the SCS reduces the amount of improperly discarded needles in its neighborhood* **(See Table 18)**. The variable for *if the SCS is located in the respondents' neighborhood* and the variable reflecting *if the SCS was cost saving to the healthcare system* were not significantly correlated with respondents' choices in any model. The direction of the relationship between attributes and respondents' preferences were as expected with *if the SCS was higher cost to the healthcare system* and *if the SCS is located in the respondents' neighborhood*, having negative associations and all other attributes having positive associations. Finally, the predicted WTA for having an SCS located in a respondent's neighborhood ranged from $11,109 to $11,447 in 2021 Canadian dollars. Overall, both models provided similar results with the significant independent variables and their level of significance being identical between models. Furthermore, the odds ratios that resulted from the coefficients were of similar values. In general, the same policy conclusions would be

reached from examining either model. However, the mixed logit model provided a better fit for the data based on the Akaike Information Criterion (AIC) and Log-likelihood criteria and as a result would be the preferred model.

The categorical attributes with the largest influence on respondents' preferences based on the odds ratios presented in **Table 18** were*: if the SCS reduces the amount of improperly discarded needles in its neighborhood* followed by *if the SCS was higher cost to the healthcare system.* Of note, *the effectiveness of the SCS in decreasing overdose related mortality* and *compensation to residents if an SCS is located in their neighborhood* attributes were modelled as continuous variables and are not directly comparable, with respect to magnitude of impact, to the attributes modelled as categorical variables. In **Table 18, Model 3** reflects a mixed logit sensitivity analysis that included an interaction term between *if the SCS is located in the respondent's neighborhood* and *compensation to residents if the SCS is located in their neighborhood.* The interaction term was not significant and the inclusion of the interaction term did not improve fit based on the AIC and log-likelihood criteria. Overall, the results appear to suggest that the relationship between compensation and choice does not depend on whether or not the site is located in the respondent's neighborhood.

Table 18 Results of Binomial Logit and Mixed Logit Regression Models

Coefficient	Model 1 Binomial Logit Model Coefficient (Standard Error) [P-Value] {95% Confidence Interval}	Model 1 Odds Ratios	Model 2 Mixed Logit Model Coefficient (Standard Error) [P-Value] {95% Confidence Interval}	Model 2 Odds Ratios	Model 3 Mixed Logit Model Coefficient Interaction Term (Standard Error) [P-Value] {95% Confidence Interval}	Model 3 Odds Ratios
The SCS is Cost Saving to Healthcare system	0.062 (0.063) [0.322] {-0.061–0.185}	1.064	0.053 (0.074) [0.471] {-0.092–0.198}	1.055	0.065 (0.078) [0.405] {-0.088–0.218}	1.067
The SCS is Higher Cost to the Healthcare system	- 0.186 *** (0.063) [0.003] {-0.309– -0.063}	0.830	- 0.235 *** (0.075) [0.002] {-0.382– -0.088}	0.791	-0.214** (0.087) [0.014] {-0.385– -0.043}	0.807
Effectiveness in Decreasing Overdose Related Mortality	0.017 *** (0.001) [<0.001] {0.015–0.019}	1.017	0.024 *** (0.002) [<0.001] {0.020–0.028}	1.025	0.024*** (0.002) [0.000] {0.020–0.028}	1.024
Compensation to Residents if an SCS is Located in their Neighborhood	0.007 *** (0.001) [<0.001] {0.005–0.009}	1.007	0.008 *** (0.002) [<0.001] {0.004–0.012}	1.008	0.010*** (0.003) [0.005] {0.004–0.016}	1.010
The SCS is Located in the Respondent's Neighborhood	- 0.078 (0.044) [0.076] {-0.164–0.008}	0.925	- 0.093 (0.052) [0.072] {-0.195–0.009}	0.911	-0.023 (0.159) [0.884] {-0.335–0.289}	0.977
The SCS Reduces the Amount of Improperly Discarded Needles in its Neighborhood	0.231 *** (0.047) [<0.001] {0.139–0.323}	1.260	0.327 *** (0.056) [<0.001] {0.217–0.437}	1.387	0.327*** (0.056) [0.000] {0.217–0.437}	1.387
Interaction Term	-	-	-		-0.003 (0.006) [0.642] {-0.015–0.009}	0.997
WTA	$11,447		$11,109		$2,354	
AIC	3,130		2,952		2,953	
Log likelihood	-1,559	NA	-1,468	NA	-1,468	NA
Observations	203		203		203	
K	2		2		2	

Abbreviations: AIC: Akaike Information Criterion; K: Parameter in Akaike Criterion Calculation; NA: Not Applicable; SCS: Safe Consumption Site; WTA: willingness-to-accept.

*** = 0.01; ** = 0.05.

Note: The coefficients for Effectiveness in Decreasing Mortality is per one percent and the coefficients for Compensation to Residents if an SCS is Located in their Neighborhood is per $1,000 dollars.

Note: Values in this table were rounded to three decimal places to increase the readability of the table. As a result, any values reported as zeros may have been rounded.

Note: For the analysis presented in this table 5% was used to indicate a statistically significant difference based on a predefined level.

Note: Interaction Term refers to *Compensation to Residents if an SCS is Located in their Neighborhood * The SCS is Located in the Respondent's Neighborhood*

As an exploratory analysis, this study assessed how respondents' preferences vary based on demographic characteristics. To do this, mixed logit models were run including interactions between each of the attributes presented in **Table 16** and the demographic variables highlighted in **Table 17**. The mixed logit model was chosen for the exploratory analysis, as it appeared to provide a better fit for the data than the binomial logit model based on the AIC and log likelihood criteria. **Table 19** shows the coefficients for each of the interaction terms between the attribute corresponding to the row and the demographic variable corresponding to the column. Though not presented in **Table 19** the main effects were also included in the models in this exploratory analysis. Statistically significant interaction terms suggest that respondents' preferences may vary based on demographic characteristics. Of note, the sample size was not selected to conduct hypothesis tests for interactions and consequently results for the interaction terms presented in **Table 19** should be viewed as exploratory. However, these results may still provide policymakers with additional information regarding how preferences may vary by sociodemographic factors.

Table 19 Results of Mixed Logit Regression with Interaction Terms for Demographic Variables

Coefficient	Model 3 Interaction with Age Coefficient (Standard Error) [P-Value]	Model 4 Interaction with Sex Coefficient (Standard Error) [P-Value]	Model 5 Interaction with Geographic Location Coefficient (Standard Error) [P-Value]	Model 6 Interaction with Income Coefficient (Standard Error) [P-Value]	Model 7 Interaction with Education Coefficient (Standard Error) [P-Value]	Model 8 Interaction with Children in Care Coefficient (Standard Error) [P-Value]	Model 9 Interaction with Support for SCSs Coefficient (Standard Error) [P-Value]
The SCS is Cost Saving to the Healthcare system	0.004 (0.005) [0.454]	0.004 (0.149) [0.976]	0.314 (0.184) [0.088]	0.177 (0.159) [0.266]	-0.149 (0.165) [0.366]	0.037 (0.155) [0.811]	-0.019 (0.168) [0.911]
The SCS is Higher Cost to the Healthcare system	-0.004 (0.005) [0.384]	-0.104 (0.150) [0.489]	-0.207 (0.183) [0.257]	0.118 (0.161) [0.464]	-0.109 (0.168) [0.517]	0.223 (0.156) [0.151]	-0.022 (0.172) [0.897]
Effectiveness in Decreasing Overdose Related Mortality	0.000** (0.000) [0.018]	-0.005 (0.003) [0.155]	-0.002 (0.004) [0.657]	0.002 (0.003) [0.563]	0.002 (0.004) [0.631]	-0.001 (0.003) [0.754]	0.015*** (0.004) [<0.001]
Compensation to Residents if an SCS is Located in their Neighborhood	-0.000** (0.000) [0.016]	-0.003 (0.003) [0.344]	0.004 (0.004) [0.233]	-0.001 (0.003) [0.697]	-0.010*** (0.003) [0.003]	0.001 (0.003) [0.708]	-0.003 (0.003) [0.363]
The SCS is Located in the Respondent's Neighborhood	-0.005 (0.003) [0.131]	0.231** (0.104) [0.026]	-0.156 (0.128) [0.223]	-0.171 (0.111) [0.124]	-0.041 (0.115) [0.724]	-0.122 (0.108) [0.260]	0.462*** (0.119) [<0.001]
The SCS Reduces the Amount of Improperly Discarded Needles in its Neighborhood	0.007 (0.004) [0.060]	-0.185 (0.112) [0.098]	-0.200 (0.136) [0.142]	-0.089 (0.120) [0.458]	-0.061 (0.125) [0.627]	-0.026 (0.116) [0.825]	0.061 (0.128) [0.631]
AIC	2,946	2,955	2,949	2,960	2,952	2,961	2,961
Log likelihood	-1,459	-1,464	-1,461	-1,466	-1,462	-1,466	-1,459
Observations	203	203	203	203	203	203	203
K	2	2	2	2	2	2	2

Abbreviations: AIC: Akaike Information Criterion; K: Parameter in Akaike Criterion Calculation; SCS: Safe Consumption Site.

*** = 0.01; ** = 0.05

Note: Not presented here but the regression equations above also included the attributes as coefficients as well as the interaction terms above.

Note: Values in this table were rounded to three decimal places to increase the readability of the table. As a result, any values reported as zeros may have been rounded.

Note: For the analysis presented in this table 5% was used to indicate a statistically significant difference based on a predefined level.

4.5 Discussion

To date, we are aware of DCEs that have been conducted on topics related to harm reduction such as the use of electronic cigarettes versus tobacco cigarettes and the willingness of people who use drugs intravenously or engage in high-risk sexual behaviors to take PREP to prevent HIV transmission (Buckell et al., 2019; Buckell & Sindelar, 2019; Eisingerich et al., 2012; Shang et al., 2020; Shrestha et al., 2018). However, we are aware of no DCEs on the topic of SCSs. Furthermore, we are aware of no studies that have aimed to estimate the WTA of residents for the establishment of an SCS in their neighborhoods.

In the primary analysis, all attributes were significantly correlated with respondents' preferences for SCSs, apart from two (**See Table 18**). Interestingly, the variable for *if the SCS was cost saving to the healthcare system* was not significantly associated with respondents' preferences, and this appears to differ from previous research. For instance, when investigating heroin assisted treatment (HAT) Cruz et al. (2007) found that public support for the intervention was higher if it could reduce costs to society. HAT is a harm reduction strategy where untainted heroin is provided to people with addiction to provide a safe supply. This discrepancy could potentially be the result of changes in preferences over time or the result of differences in survey design, as Cruz et al., (2007) did not use a DCE.

Conversely, *if the SCS was higher cost to the healthcare system* there was a statistically significant negative association with respondents' preferences. Overall, this suggests that respondents had a stronger negative preference towards SCSs increasing costs to the healthcare system than they had a positive preference for SCSs reducing costs to the healthcare system. As a result, when communicating with the public regarding planned or established SCSs, policymakers should provide details on how these facilities could reduce or offset their own operational costs and, in the net, not increase costs to the healthcare system. If policymakers

provide this information, there may be a higher chance that the public would react positively to SCSs.

Another attribute significantly correlated with respondents' preferences that policymakers should consider when developing SCSs is *the effectiveness of the SCS in decreasing overdose related mortality* – with more effective SCSs being preferred. This finding aligns with expectations, as harm prevention is a primary objective of SCSs. Similarly, Cruz et al. (2007) found that individuals would be more likely to support SCSs, if it could be shown that they reduce overdose deaths and disease transmission. Furthermore, in two previous DCEs that investigated the attributes that influence the willingness of individuals who use drugs and/or engage in high-risk sexual behaviors to take PREP, effectiveness in preventing harm was a driver of choice (Eisingerich et al., 2012; Shrestha et al., 2018). An important consideration is that these two previous DCEs investigated the preferences of individuals engaging in the high-risk activities and not the general public. Therefore, results may not be directly comparable. Based on these findings, it would be valuable for SCS administrators to conduct evaluations of the harm prevented by the SCSs they manage. These could then be presented to community members and other stakeholders, to improve public perceptions. Additionally, administrators could also rely on the existing body of literature on the effectiveness of SCSs in reducing harm, to inform messaging.

The attribute *for if the SCS reduces the amount of improperly discarded needles in its neighborhood* – with a reduction preferred influenced choice. In fact, of the odds ratios presented for categorical variables in **Table 18** this attribute had the largest impact on respondents' preferences. Considering this information, SCSs could be developed with programs where trained staff and/or properly trained people who use the site would actively engage in the cleanup of improperly discarded drug paraphernalia in the neighborhoods where sites are located. Such programs may have multiple benefits as they could improve public acceptability and help make neighborhoods safer. It should be noted that reducing the amount of improperly discarded needles is a primary objective of SCSs and that similar programs, aimed at cleaning the area around sites, have been implemented previously (ARCHES, 2017).

We found that the attribute for *compensation to residents if an SCS is located in their neighborhood* was significantly and positively associated with respondents' preferences. We

are aware of no studies that investigated compensations to individuals if an SCS opens in their neighborhood. Of note, this attribute was added to facilitate WTA calculations. However, results were in accordance with expectations prior to the analysis. Surprisingly, the attribute for *If the SCS was located in the respondents' neighborhood* was not significantly associated with choice. This ran counter to expectation, given that literature has discussed the "not in my backyard" phenomenon associated with harm reduction site development (Sharp et al., 2020). We suspect that this may be a consequence of the hypothetical nature of a DCE. If in the real-world respondents had been presented with an SCS opening in their neighborhood, it is possible that more negative preferences would be observed.

Relevant to this study, a previous report that documented the public consultation process associated with the development of an SCS in Lethbridge, Alberta, Canada highlighted the public's concerns with facility development (ARCHES, 2017). In this report, members of the community wanted reassurance that SCSs can reduce harm. Furthermore, community members were apprehensive about SCSs being in residential neighborhoods. Interestingly, we did not find a statistically significant association between choice of site and the SCSs being in a respondent's neighborhood. Potentially, there are systematic differences between individuals who were sampled by the present study and individuals who would choose to voluntarily attend a public consultation event for a proposed SCS. Additionally, community members queried what other services could be offered at an SCS to help people with addiction such as referral to detox programs or addiction counselling. Such an attribute was not included in the present study. If the survey discussed possible referrals to addiction treatment programs this could lead to the confusion of respondents. Specifically, causing confusion between rehabilitation programs versus harm reduction programs. The report suggested that community members also questioned how the police would interact with people who use the site. Specifically, would drug dealers be tolerated, would people who use drugs be targeted when going to or from the site, and whether the SCS would limit the drug quantities for people who use the site.

The predicted WTA for having an SCS located in a person's neighborhood ranged from $11,109 in Model 2 to $11,447 in Model 1. An understanding of these values may help policymakers understand the extent to which individuals are amendable to having a SCS located in their neighborhoods. For context, when compared to other literature the results of this study suggest that SCSs are less desirable than electrical infrastructure developments but

more desirable than nuclear waste related projects. For instance, Groothuis et al., (2008) investigated the WTA required for residents in North Carolina, United States of America to accept the establishment of windmills and found a WTA of approximately $40/year (exchange rate: 1 CAD = 0.80 USD) in 2021 CAD (Groothuis et al., 2008). Riddle and Schwer (2006) investigated the WTA of individuals in Nevada, United States of America living near a rail line to accept the transport of nuclear waste and found a WTA for those living within one mile of the rail line of approximately $128,873 (exchange rate: 1 CAD = 0.80 USD) in 2021 CAD over the project's anticipated 24-year lifespan (Riddel & Schwer, 2006).

Based on the findings of **Chapter 2** most Canadians support SCS. Specifically, of the two recent studies on the topic that were identified in the state-of-the-art review conducted in **Chapter 2** public support ranged from 55%-82.5% (Mrazovac et al., 2020; Wild et al., 2021). The support for SCS indicated by respondents of the present study of 73.9% fell within this range. For context and as was reported previously in **Chapter 2** State of the Art Review, Mrazovac et al., (2020) set out to determine if information on the benefits of safe consumption sites can influence public support for the establishment of these facilities in the Waterloo Region of Ontario, Canada using a mixed methods approach. Wild et al., (2020) set out to determine the level of support for a set of harm reduction programs for people who inject drugs in Canada via a survey.

The exploratory analysis that investigated interactions between respondents' demographic characteristics and attributes, suggested that respondents' preferences for attributes may vary based on sociodemographic characteristics. With respect to key results from the exploratory analysis, individuals identifying as men were more likely to choose alternatives with SCSs located in the neighborhood where they lived. Additionally, individuals who support SCSs were more likely to be influenced by the attribute for effectiveness in preventing mortality and more likely to choose SCSs that were located in the neighborhood where they lived than other respondents. As a result, using neighborhoods with higher overall support for SCSs as site locations when establishing SCSs may represent a strategy to reduce public opposition. Public opinion surveys could be used prior to a site's establishment to identify candidate locations. Additionally, if a site is established in a neighborhood with relatively higher support for SCSs, the messaging around the development and operation of these sites could highlight harm prevented. With respect to the interaction terms including support for SCSs, it is possible that

support for SCSs mediates instead of interacts with respondent's preferences in this DCE. However, the above information is likely still to be of use to policymakers. It is important to point out that this study's sample size was not determined to test hypotheses related to the interaction terms. Although these findings should be viewed with caution, they may provide policymakers with additional insights on how preferences vary between individuals and may also provide context for future research.

The present study is subject to several potential limitations. As with any survey there exists the possibility that survey participants may not truly represent the target population. More specifically, it might be the case that the preferences expressed by individuals in our sample may not accurately reflect those of the general Canadian public, and this may have implications for the external validity of the findings. Yet, we compared participant demographic information to those of the general Canadian public, to assess potential deviations and in most cases results appeared reasonable. As a second limitation, the survey was conducted in English only. As a result, Canadians who do not speak English were not surveyed. Furthermore, it is possible that respondents had preconceived notions of SCSs and completed the survey based on personal biases and not the information provided. This problem is present in all DCEs but is likely to be more prominent in DCEs of controversial topics such as harm reduction. It should be noted that we did not collect information on respondents' previous use of drugs. The study was concerned that this may have introduced potential selection issues, as individuals who have used opioids illegally may not choose to participate, if asked to admit to previous or current drug use. Furthermore, the study did not collect information on ethnicity. As a result, this study is not capable of identifying the specific role played by ethnicity in influencing respondents' preferences for SCSs. Of note, Roth et al. (2019) in interviews of the public in Philadelphia, Pennsylvania, United States of America found that ethnicity was a driver of public opinion towards SCSs (Roth et al., 2019). Additionally, the levels for the attribute for the change in cost that would result from the SCS were not assigned numeric values. This could have potentially led to respondents disregarding this attribute. Finally, we did not include an opt-out option. This might have influenced findings, as individuals who were indifferent between alternatives and those who do not support SCSs under any circumstances were forced to choose a preferred alternative.

Finally, findings suggest that there is a set of attributes associated with SCSs that influence the public's preferences for these facilities. Policymakers aiming to develop SCSs that are positively received by the public should consider these attributes when developing SCSs and communicating with the public. In doing so, policymakers can improve the acceptability of SCSs to residents while also offering harm reduction services that could save lives.

5. Mobile versus Brick-and-Mortar Safe Consumption Sites: A Difference in Differences Analysis During the COVID-19 Pandemic

5.1 Introduction

Opioids are psychoactive drugs that are used medicinally to manage pain and are generally considered controlled substances in developed countries requiring a prescription from a physician (Preuss et al., 2019). Despite their benefits in pain management, these drugs can be misused for recreational purposes outside the healthcare system. As has been stated in previous chapters, deaths from opioids are becoming increasingly common around the world (World Health Organization, 2021; Government of Canada, 2021; National Institute of Health 2022). Though research has demonstrated that SCSs are effective in preventing deaths due to overdose, these facilities are sometimes viewed negatively by the public (Lange & Bach-Mortensen, 2019). Some are concerned that the establishment of an SCS may negatively impact the communities where they are located (Lange & Bach-Mortensen, 2019). This public opposition has, in the past, led to the cancelation of planned SCS development.[8]

A possible solution to improve public acceptability of SCSs are mobile SCSs. Mobile SCSs are SCSs that can be moved from one location to another and generally take the form of an RV or trailer (Mema et al., 2019). The portability of mobile SCSs means that no community is likely to be permanently impacted by the establishment of a site, potentially ameliorating the concerns of individuals living in the vicinity of proposed sites. To date, there has been anecdotally evidence suggesting that mobile sites are more palatable to the public than brick & mortar facilities (Mema et al., 2019). Though mobile SCSs may be preferred by community members, it is not clear whether these facilities are as effective at preventing adverse events as brick & mortar SCSs. At present, we are aware of no studies that have compared the effectiveness of mobile SCSs to brick & mortar SCSs in terms of their ability to reduce overdose related mortality. To reiterate what was stated in **Chapter 1**, in this chapter the term brick & mortar SCS refers to a building or a structure in a fixed location serving as an SCS.

[8] Though not reported in peer reviewed literature, in Calgary, Alberta, Canada a planned safe consumption site was halted due to public concern.
The Canadian Broadcasting Corporation. (2022-09-02). Proposed overdose prevention site not proceeding at Calgary Drop-In Centre. https://www.cbc.ca/news/canada/calgary/calgary-drop-in-mike-ellis-ucp-overdose-prevention-centre-1.6571244 (Accessed 2022-11-18).

Some limitations associated with mobile SCSs are that: **1)** they often cannot always serve as many clients as brick & mortar facilities; **2)** if the location of the mobile SCS is changed, people who would use the site may not know where to find it; **3)** mobile SCSs have less space and may be regarded as less comfortable than brick & mortar facilities; and **4)** mobile SCSs may not be suited to cold or hot climates.

As a result, this study set out to investigate the effectiveness of mobile versus brick & mortar SCSs in terms of their ability to prevent drug related mortality using a natural experiment that occurred in Alberta, Canada in 2020. In August 2020, the city of Lethbridge, Alberta, Canada switched from a brick & mortar SCS to a mobile SCS. This change provided the opportunity to exploit a policy experiment to evaluate whether a mobile SCS is as effective at preventing drug related mortality as a brick & mortar facility. Specifically, a DiD analysis using monthly data for a set of five cities in Alberta, Canada over the period September 2019 to May 2021. In this DiD, Lethbridge served as the treatment group and the other four cities served as controls. This set of jurisdictions represents all cities in Alberta that used SCSs during the study period. The dependent variables investigated were the monthly number of deaths from overdose from **1)** any drug; and **2)** opioids. The model controlled for a range of independent variables. All data informing the analysis were taken from provincial and federal government datasets and are described below in **Section 5.2 Methods** of this chapter.

Several studies have applied the method of DiD to questions related to opioid use in recent years. Venkataramani et al., (2020) investigated the impact of auto factory closures on opioid overdose mortality in the United States of America and found that closures of auto factories were responsible for an increase in opioid related overdose deaths (Venkataramani et al., 2020). Rogeberg et al., (2021) used a Poison DiD model to assess the effect of opioid agonist programs in reducing fatal overdoses in Norway. Briefly, opioid agonist programs provide people who use opioids with medications that reduce drug cravings and lessen the symptoms of withdraw to help reduce drug use (Rogeberg et al., 2021). This study found that opioid agonist programs were associated with a reduction in drug related mortality. Finally, several studies have investigated the impact of the adoption or expansion of publicly funded prescription drug programs on opioid agonist use (Hongdilokkul et al., 2021; Knudsen et al., 2022). Yet, to the best of our knowledge, no previous studies have used the inference method of DiD to compare

the effectiveness of mobile to brick & mortar SCSs in preventing drug related adverse events such as mortality.

As a secondary analysis, this chapter investigated the overall impact of SCS use on drug related mortality, irrespective of site type, in Alberta, Canada. To date, most studies that have investigated the impact of SCSs have found that sites are effective in reducing drug related adverse events (Caulkins et al., 2019). Though Caulkins et al., (2019) highlight that the studies that have assessed questions regarding the efficacy of SCSs to date have had limitations. As a result, it is difficult to make definitive assessments of causality. During the COVID-19 pandemic harm reduction supports in Alberta for people who use drugs in some cases closed and when these facilities did remain open, their use declined. The reduction in SCS use that occurred during the pandemic provided an opportunity to assess the impact of the change in SCS use on the change in drug related mortality. Specifically, if cities in Alberta that observed greater reductions in SCS use also experienced greater increases in drug related mortality, this would suggest that access to SCSs might be a protective factor against drug related mortality. This secondary analysis used pooled ordinary least squares (OLS) and random effects regression analysis, the base year for this analysis was 2019, and rates of change were analyzed for 2020 and 2021.

The main contribution of this chapter is to provide policymakers with information regarding the relative effectiveness of mobile SCSs versus brick & mortar facilities in preventing drug related mortality. Additionally, this chapter adds evidence regarding the effectiveness of SCSs in preventing drug related mortality, irrespective of site type. Prior to these analyses the present study hypothesised that brick & mortar SCSs would be more effective than mobile sites and that overall SCS use would be a protective factor against drug related mortality. Findings of the present study may be of interest to policymakers evaluating the merits of mobile SCSs versus brick & mortar SCSs and SCS use in general. This chapter used the following structure. The **Methods Section** discusses the statistical approaches used in this analysis with a particular emphasis on the regression approaches, DiD method, and data sources. The **Results Section** presents results. Finally, **The Discussion Section** contextualizes findings and discusses limitations.

5.2 Methods

Econometric Analysis

Primary Analysis

The primary analysis used a DiD design. DiD is a quasi-experimental research method used to assess the causal impact of a policy or intervention by exploiting a change in policy (Wooldridge, 2010). Quasi-experimental research designs differ from experimental research designs, as quasi-experimental designs use processes other than randomization to assign entities to treatment groups. DiD mimics a natural experiment and is therefore applicable when there is quantitative data on an outcome of interest for at least two groups, one that receives the intervention and one that does not and the data spans the pre and post introduction of the intervention for both groups (Cunningham, 2021; Card & Krueger, 1993). It is necessary that the dependent variables included in DiD satisfy the parallel trends assumption. The parallel trends assumption requires that the change in trends for the outcome of interest in the treated group over time would be equivalent to that of the control group had the intervention not been implemented. Since this cannot be directly observed, an analysis of preintervention trends is usually conducted, to assess this assumption. The assessment of pretends aims to provide the reader with a degree of certainty that changes in the dependent variable after the intervention were the result of the switch and not the result of other factors that may cause differences in the outcome variable between the control and treatment groups.

The primary analysis focused on the impact of site type on drug related mortality and used a two-period DiD design. To conduct DiD in the two-period scenario, binary variables are used to identify the pre versus post policy implementation periods as well as the treated versus control groups. An interaction term is then created between these two variables. Values for the dependent variable that is being used to assess the policy impact are regressed on the binary variables denoting **1)** the pre versus post implementation period, **2)** the treatment versus control group, and **3)** their interaction term. The coefficient for the interaction term is interpreted as the average treatment effect of the policy, where a statistically significant value is taken to indicate the presence of a treatment effect. Additional independent variables can be included in the regression equation to adjust for heterogeneity in observable characteristics between the control and treatment groups. More complex analytical techniques can be applied when there

is variation in treatment timing amongst the entities included in the analysis (Cunningham, 2021).

The primary analysis used OLS regression. To account for unobserved heterogeneity, the panel level regression technique of fixed effects was used. Fixed effects are a statistical technique that is used to account for time invariant idiosyncrasies that exist across entities, in this case cities, in an analysis. Time fixed effects for months were also included to account for heterogeneity across time.

The primary analysis used **1)** *opioid related overdose death rates per month* and **2)** *the rate of overdose deaths from any drug per month as dependent variables*. The assumption being that if mobile SCSs are as effective as brick & mortar SCSs, the rates of overdose deaths in cities should not be impacted by the type of SCS used. In the primary analysis, all dependent variables included in regression models were expressed as per 100,000 adults to account for variation in the size of cities.[9] Covariates considered for inclusion were chosen from a previous study that investigated the characteristics of individuals who overdosed and a government report (Alberta Government, 2020a; Fischer et al., 2004). Fischer et al., (2004) reported that homelessness was a predictor of individuals who would experience overdose. The report by the Alberta Government suggested that working age males were more likely to die of overdose. These were further supplemented with additional covariates deemed to be of potential relevance such as the employment rate and drug toxicity. Including the employment rate aligns with the assertions of Case & Deaton (2021) who suggested that opioid deaths are "deaths of despair" in part driven by a lack of fulfilling employment. Furthermore, as the toxicity of the opioid supply may vary over time and between cities, a control for drug toxicity was sought.

In total, the model considered the following covariates: **1)** *the percentage of the population 15 and over who are prime working age males (24-55 years)*; **2)** *the employment rate*; **3)** *homelessness* – which was proxied by emergency shelter use per 100,000 adults; and **4)** *drug toxicity* – which was proxied by overdoses responded to by emergency personnel per 100,000 adults (**See Equation 3)**. Due to concerns of possible endogeneity between drug related

[9] For the purposes of this study adults were defined using Statistics Canada's age of inclusion in the Labour Force survey 15.
Statistics Canada. (2020). *Labour force characteristics by economic region, three-month moving average, unadjusted for seasonality*.
https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1410029302. (Accessed, August 20, 2022).

mortality and the proxy for drug toxicity, sensitivity analyses were run not including the variable for drug toxicity.

$$Y_{jt} = \beta_0 + \beta_1 \lambda_{tj} + \beta_2 \theta_{jt} + \beta_3 \lambda_{jt} * \theta_{jt} + \beta_4 \text{Employment Rate}_{jt} + \beta_5 \%\text{Working Age Males}_{jt} + \beta_6 * \text{Homelessness}_{jt} + \beta_7 * \text{Drug Toxicity}_{jt} + e_{jt} \quad \textbf{(3)}$$

Where λ indicates if the city used a mobile SCS. θ indicates if the month is before or after the switch from brick & mortar to mobile SCS in Lethbridge. Employment Rate is the employment rate in cities. %Working Age Males is the percentage of the population 15 and over who are prime working age males in cities. Homelessness is homeless shelter use per 100,000 adults in cities. Drug Toxicity is the rate of emergency responses for overdose per 100,000 adults in cities. Y represents the dependent variables described above expressed as per 100,000 adults in cities. The subscript t indicates the time component of the analysis, and the subscript j indicates the city. The coefficient β_3 is the outcome of interest.

Sensitivity Analysis

Several sensitivity analyses were conducted on the primary analysis. For instance, as drug related mortality is included as a monthly rate in the present study, a Poisson regression was conducted for a scenario representing a two-period DiD design including month and city fixed effects. The Poisson regression was conducted to assess the degree to which results were sensitive to the regression approach. Poisson regression models are a type of generalized linear model that are used for dependent variables that are expressed as counts or rates. Whereas the more general linear model assumes the dependent variable follows a normal distribution, the Poisson model assumes that the dependent variable follows a Poisson distribution (Wooldridge 2010). Notable features of the Poisson distribution are that it assumes that the mean and variance are equal and it cannot have negative values. As a result, it may produce more reasonable values, then other regression approaches, when these properties are exhibited by the dependent variable. In this analysis, coefficients for the Poisson regression are presented as incidence rate ratios (IRRs). An IRR reflects the ratio of incidence rates between two groups. The Poisson regression used the same variables and timeframe as the primary analysis (See **Equation 3**).

Furthermore, when evaluating the data, two possible outliers were identified. For the city of Lethbridge in November of 2020 no drug related deaths were recorded for either of the dependent variables in the primary analysis (i.e. opioid related mortality and mortality from

any drug). The present study hypothesized that these low values were driven by concerned citizens independently operating unsanctioned SCSs. For context, after the closure of the Lethbridge brick & mortar SCS, concerned citizens began operating their own SCSs and offering services to people who use drugs.[10] The present study hypothesized that this may have driven the reduction in drug related mortality observed directly after the switch in Lethbridge between September and November of 2020 **(See Figure 3)**. As a result, two alternative versions of the primary analysis were run to investigate the impact of these low values on results. In the first, the zeros observed in Lethbridge in November 2020 were substituted with the mean values for Lethbridge over the 21-month dataset, to assess the extent to which approaches to handling these values influenced results. In the second, an alternative version of the primary analysis was run that assumed that the low drug related mortality observed in Lethbridge between September and November 2020 were due to the unsanctioned SCSs. As a result, a DiD was conducted where December 2020 was used as the first month of the post-switch period. The idea being that it was not until this point that the true impact of the mobile SCS was reflected in the data. It is important to point out that we could not verify the exact dates and specifics of the unsanctioned SCSs and as a result this analysis should be viewed as exploratory in nature.

An additional sensitivity analysis was conducted for the primary analysis. In Lethbridge, the mobile SCS opened on August 14, 2020 and the brick & mortar SCS closed at the end of August 2020. The primary analysis in the present study classified September 2020 as the first month of the post-switch period. To assess the impact of this assumption, an alternative version of the analysis was run assuming August 2020 as the first month of the post-switch period instead of September 2020.

Finally, given that the present study's dataset included an *"Always Treated Group*" (Grand Prairie), and a *"Switching Group*" (Lethbridge), a time reversed DiD is possible. This involved conducting a DiD analysis comparing the switching group to the always treated group. A time reversed DiD is conducted in a similar manner as a DiD. From a technical standpoint the "*Always Treated Group*" was coded as D = 0 and the *"Switching Group*" is coded as D = 1.

[10] Though not reported in peer reviewed literature, this was documented in popular media.
The Canadian Broadcasting Corporation. (September 26, 2020). 3 weeks after province ends funding for injection site, unsanctioned space opens in Lethbridge.
https://www.cbc.ca/news/canada/calgary/lethbridge-supervised-injection-site-unsanctioned-1.5737627
(Accessed 2022-11-27).

Then the pre-switch period is coded as D = 1 and the post-switch period is coded as D = 0. From here, the time reversed DiD followed the same approach as the general DiD. The results of the time reversed DiD can be compared to the results of the general DiD. If results are in alignment than this provides further evidence of a causal relationship. The time reversed DiD used the same coefficients as the primary analysis with one exception. As the time reversed DiD only contained a total of 42 datapoints (21 for Grand Prairie and 21 for Lethbridge) and of these only 18 reflected the post intervention period, time fixed effects were not included in the model. This was to preserve degrees of freedom.

Secondary Analysis

The secondary analysis assessed the impact of SCS use on drug related mortality exploiting variation in SCS use that occurred during the COVID-19 pandemic in Alberta, Canada. During the pandemic, harm reduction supports for people who use drugs in some cases closed and when these facilities did remain open, their use declined. The reduction in SCS use that occurred during the pandemic provided an opportunity, to assess the impact of the change in SCS use on the change in drug related mortality. Specifically, if cities in Alberta that observed greater reductions in SCS use experienced greater increases in drug related mortality, this would suggest that access to SCSs might be a protective factor against drug related mortality.

The base year for the secondary analysis was 2019 and rates of change were analyzed for 2020 and 2021. First a pooled OLS regression was estimated **(See Equation 4)**. Additionally, panel regression was also conducted. A Hausman test was run that suggested that a random effects model was reasonable. A time dummy delineating 2021 from 2020 was also considered for each of the models presented in the secondary analysis.

$$\Delta Y_{jt} = \beta_0 + \beta_1 \delta \text{Site Use}_{tj} + \beta_3 D_{jt} + e_{jt} \quad \textbf{(4)}$$

Where site use is the change in SCS use in cities from baseline, which was 2019. Y represents the change in drug related mortality in cities from baseline. D represents a time dummy delineating 2021. The subscript t indicates the time component of the analysis, and the subscript j indicates the city.

Data Sources

Primary Analysis and Subsequent Sensitivity Analysis

All data are publicly available and were collected and linked based on city. In Alberta, three cities used brick & mortar SCSs (Calgary, Edmonton, and Red Deer), one city used a mobile SCS only (Grand Prairie), and one city switched from a brick & mortar to a mobile SCS (Lethbridge). Accordingly, cities with brick & mortar SCSs were coded as = 0 and those with mobile SCSs as = 1. See **Table 20** for a list of cities and the type of site they used. Of note, a city is characterized as Brick & Mortar in **Table 20** if there is at least one brick & mortar SCS in the city. This dataset included all cities in Alberta that operated SCSs over the study period.

Table 20 Type and Location of Safe Consumption Sites in Alberta

Location	Pre-intervention Period	Post-intervention Period
Calgary	Brick & Mortar	Brick & Mortar
Edmonton	Brick & Mortar	Brick & Mortar
Grand Prairie	Mobile	Mobile
Lethbridge	Brick & Mortar	Mobile[†]
Red Deer	Brick & Mortar	Brick & Mortar

[†] Brick & mortar location was replaced with a mobile site on August 14, 2020.
Note: If a city had access to at least one brick & mortar facility the city was classified as brick & mortar, even if there were also mobile sites operating in the city.

With respect to the primary analysis and subsequent sensitivity analyses data for: *the monthly number of opioid related deaths***;** *the monthly number of overdose deaths from any drug*; and the monthly number of overdoses responded to by emergency personnel were obtained from Alberta's Substance Use Surveillance Data (Alberta Government, 2020c). Data for drug related adverse events was obtained four months after the end of the study period. As data on the cause of death can require additional time to be confirmed, the longer the duration after this data is made publicly available, the more accurate the data will be.[11] Drug related adverse events were converted to rates per 100,000 adult residents per month using population data from Statistic Canada's Labour Force Survey (Statistics Canada, 2020). Data for independent variables including: *the monthly adult population who are prime working age males* and *the monthly employment rate* were taken from Statistics Canada's Labour Force Survey (Statistics Canada,

[11] At the time of data collection, the Alberta Government did not provide a timeline for when data is considered final. As a result, the dataset is subject to change.

2020). Data on emergency shelter use, was obtained from the Alberta Government (Alberta Government, 2020b).

Secondary Analysis

With respect to the secondary analysis, data for **1)** SCS use and **2)** drug related mortality were taken from Alberta's Substance Use Surveillance Data (Alberta Government, 2020c). This was the same data source used for the primary analysis. Unlike data related to mortality, at the time of analysis, data for SCS use is only made available through Alberta's Substance Use Surveillance Data on a quarterly basis.

Time Period

Primary Analysis & Subsequent Sensitivity Analysis

The time period used in the primary and subsequent sensitivity analyses spanned September 2019 to May 2021. Nine months post the switch in Lethbridge was chosen for the primary analysis, as in the spring of 2021 the Alberta Government stated that they would restructure Alberta's drug treatment approach. The new system increased the importance of abstinence-based programs and reduced the role of harm reduction. Important changes included **1)** increasing the profile of inpatient rehabilitation; **2)** the need for people who use SCSs to provide identification prior to use; and **3)** the relocation of some SCSs.[12], [13] Though the changes did not take effect immediately there were concerns that by stating their intention to make these changes, the Alberta Government may have impacted the behavior of people who use SCSs,

Though not reported in peer reviewed literature, this was documented in popular media.

[12] The Globe and Mail. (December 21, 2021). Alberta's new rules requiring health-care number at supervised injection sites will only exacerbate barriers to supports. https://www.theglobeandmail.com/opinion/article-albertas-new-rules-requiring-id-at-supervised-injection-sites-will/ (Accessed: February 24, 2023).

[13] The Canadian Broadcasting Corporation. (May 27, 2021). Alberta government to close Calgary's supervised consumption site, replace it with new locations. https://www.cbc.ca/news/canada/calgary/sheldon-chumir-supervised-consumption-site-closing-replaced-new-facilities-1.6043680#:~:text=CBC%20News%20Loaded-,Alberta%20government%20to%20close%20Calgary's%20supervised%20consumption%20site%2C%20replace%20it,it%20with%20two%20new%20sites. (Accessed: February 24, 2022).

creating an anticipation effect. For instance, messaging related to the plan to collect personal information from people who use SCSs could confuse site users and potentially result in some individuals not using the site due to an erroneous belief that the change had already taken place. Furthermore, it was unclear how these changes were implemented or if they were implemented consistently between cities. It was possible that this could impact findings by impacting data in a heterogenous fashion across cities in the post-intervention period. Therefore, in the primary analysis the nine-month post-switch period was used versus a full year of data.

Secondary Analysis

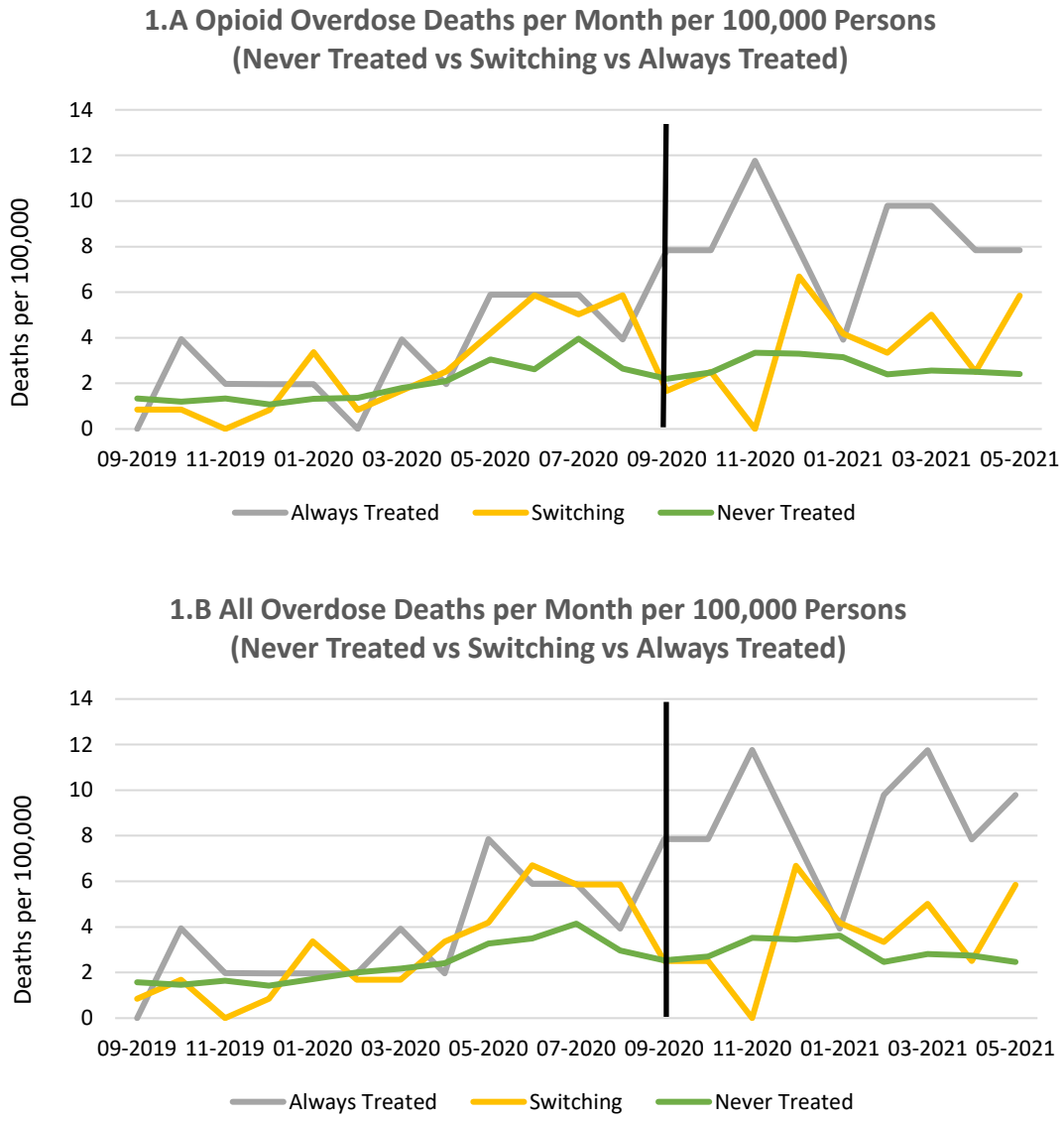
The secondary analysis investigating the effectiveness of SCSs, irrespective of site type, used rates of change from a baseline of 2019 for the years 2020 and 2021.

Parallel Trends Assumption

The parallel trends assumption was first evaluated via visual inspection. **Figure 3** shows the time trend for the *"Switching Group"* (Lethbridge), the *"Always Treated Group"* (Grand Prairie) and the average value of the *"Never Treated Group"* (Calgary, Edmonton, and Red Deer) over the 21-month time series. The values for the *"Never Treated Group"* were averaged to improve the readability of **Figure 3**. As visual inspection suggested the possibility of parallel trends between cities, the present study plotted time trends for each of the dependent variables for each city, over the pre-intervention period for the primary analysis and the post-intervention period for the time reversed DiD (**See Table 21**). A dummy variable was added to the time trends to account for the pre versus post pandemic periods and robust standard errors were used. As the 95% confidence intervals (CIs) for all trends for each city overlapped, DiD and the time reversed DiD were conducted. Of note, the relatively small sample size for the time reversed DiD may have led to a type 1 error when comparing trends. Furthermore, if the time dummy delineating the first versus second year of the pandemic is not included, not all of the 95% CI overlap for the DiD or the time reversed DiD. Taken together this suggested possible violations of the parallel trends assumption. Due to potential concerns with the parallel trends assumption, as a sensitivity analysis, models were run using simple OLS regression and DiD models were run matching based on pre-trends. Specifically, the cities whose coefficients were least like Lethbridge in **Table 21** were removed from the analysis, for each of the dependent

variables. The matched DiD model used one to one matching and time and entity fixed effects were not used given, the smaller sample size.

Figure 3 Trend Analysis of Dependent Variables in Primary Analysis



Note: The vertical line indicates approximately when the intervention was implemented (August 2020).

Note: Switching group includes Lethbridge, the Always Treated group includes Grand Prairie, and Never Treated includes Calgary, Edmonton, Red Deer.

Table 21 Preintervention trend Analysis of Slope Coefficients

City	Preintervention trend beta	Preintervention trend beta SE	Preintervention trend beta 95% Confidence Interval
1. Opioid Overdose Deaths per Month per 100,000 Persons			
Calgary	0.126	0.097	-0.094–- 0.346
Edmonton	0.139	0.130	-0.154–- 0.433
Lethbridge	0.550	0.211	0.073–- 1.027
Red Deer	0.146	0.063	0.003–- 0.289
2. All Overdose Deaths per Month per 100,000 Persons			
Calgary	0.094	0.107	-0.148–- 0.336
Edmonton	0.882	0.696	-0.692–- 2.456
Lethbridge	0.165	0.127	-0.122 - 0.453
Red Deer	0.586	0.196	0.143–- 1.029
3. Opioid Overdose Deaths per Month per 100,000 Persons (Time Reversed DiD)			
Lethbridge	0.390	0.188	-0.056–- 0.835
Grande Prairie	-0.035	0.158	-0.407–- 0.338
4. All Overdose Deaths per Month per 100,000 Persons (Time Reversed DiD)			
Lethbridge	0.334	0.192	-0.120–- 0.787
Grande Prairie	0.161	0.187	-0.282–- 0.604

Note: For the analysis presented in this table, 5% was used to indicate a statistically significant difference based on a predefined level.

5.3 Results

The tables below **(22-28)** reflect the results of the primary analysis and the subsequent sensitivity analyses. In the primary analysis, the coefficient on the interaction term $\lambda_{ij}*\theta_{jt}$ reflects the change in the monthly rate of drug related mortality per 100,000 adults that resulted from using a mobile SCS versus a brick & mortar SCS. When interpretating results, a positive association between the dependent variable and $\lambda_{ij}*\theta_{jt}$ suggests mobile SCSs were less effective at preventing adverse events, and a negative association suggests mobile SCSs are more effective. Though *homelessness* had originally been considered as a covariate in the primary analysis, it was not included in any of the final models, as preliminary analysis suggested that it had a negligible and non statistically significant association with the dependent variables. As a result, it was removed to preserve degrees of freedom. For the time reversed DiD (See **Table 27**), the interpretation is different than in the general DiD. In this case, a positive association between the dependent variable and $\lambda_{ij}*\theta_{jt}$ suggests mobile SCSs were more effective at preventing adverse events, and a negative association suggests mobile SCSs are less effective. Given possible concerns with the parallel trends assumption and the dip in mortality that occurred in Lethbridge after the switch from a brick & mortar to a mobile SCS – that may have been caused by the actions of concerned citizens, attributing causality to any findings from this analysis would not be advisable. This is because the DiD approach assesses changes in trends before versus after an intervention comparing control and treatment groups. DiD analysis assumes that the values for the dependent variable for the control and treatment groups would follow the same trend over time if not for the introduction of the intervention and therefore any deviations between trends in the dependent variable between the groups after the intervention is the result of the treatment. In this study, it is not clear that this holds.

Primary Analysis

Table 22 reflects the results of the primary analysis. Overall, none of the models presented in **Table 22** showed a statistically significantly association between drug related mortality and SCS type. The association was negative in four of the six models presented in **Table 22** (**Model 1, Model 2, Model 4, and Model 5**) and positive in two **(Model 3 and Model 6)**. This suggests that the direction of association may at least in part be dependent on which covariates were included in the analysis. The *employment rate* was only significantly associated with drug related mortality in one of the models that it was included in (**Model 1**). However, in all models that included the employment rate the direction of the association was negative as expected. The *percentage of the population that were prime working age males* was negatively associated with drug related mortality and the association was significant in two of the four models it was included in

(**Model 2 and Model 5**). Here the direction of association was counter to what was expected. *Drug toxicity* was significant and positively correlated with drug related mortality in all models in which it was included (**Model 1 and Model 4**). The direction of association was as expected.

Sensitivity Analysis

Table 23 depicts each of the models presented in **Table 22**, but instead assuming that the first month of the post intervention period was August 2020 versus the September 2020 used in the primary analysis. The findings of these sensitivity analyses were in accordance with the results of the primary analysis. **Table 24** depicts each of the models contained in **Table 22** after conducting a mean substitution for the low values observed in Lethbridge in November of 2020. As was the case in **Table 23**, this did not change the interpretation of the results versus the primary analysis. Of note, the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) suggested that the models presented in **Table 24** provided the best fit of any analyses. However, this is to be expected as extreme values were replaced using mean substitution. **Table 25** depicts the results of a DiD when it is assumed that the first month of the post-switch period was December 2020. When this change was made the model suggested that there is a statistically significant and positive association between mobile SCSs and drug related mortality. It should be noted that this analysis was conducted to explain an unusually low period of drug related mortality observed directly after the switch from a brick & mortar to mobile SCS in Lethbridge. A possible explanation for this period of low mortality was that it was due to the operation of unsanctioned SCSs in Lethbridge. However, as we were unable to confirm the details regarding these sites, this analysis should be treated as exploratory in nature. **Table 26** shows the results of the Poison regressions. These models are analogues to the models presented in **Table 22** but instead of using an OLS regression model, Poison regression was used. When using Poison regression, the association between SCS type and drug related mortality was not statistically significant at conventional thresholds, conforming with the primary analysis.

Table 27 shows the results of the time reversed DiD. The time reversed DiD suggested that mobile SCSs were associated with a statistically significant reduction in drug related mortality. Interestingly, this ran counter to expectation prior to the analysis and did not align with the models included in the primary analysis. In the time reversed DiD, the *employment rate* was significantly associated with drug related mortality in all the models where it was included and the direction of association was negative. The *percentage of the population that were prime working age males* was not significantly associated with drug

related mortality in any of the models presented in **Table 27.** *Drug toxicity* was significant and positively correlated with drug related mortality in all models in which it was included (**Model 31 and Model 34**).

Table 28 shows the results of the simple OLS models, and the matching DiD models that were run as sensitivity analyses to address potential issues with the parallel trends assumption. These models assumed that the switch from brick & mortar to mobile occurred in September 2020 and no mean substitution was used to deal with extreme values. In the simple OLS model, though the coefficient for SCS type, denoted as *treatment* in **Models 37** and **38** of **Table 28**, did increase in significance versus the DiD models run in the primary analysis, it did not reach the 5% threshold for significance prespecified for this study. For the matched-on pre-trend DiD models, results were little changed from the non-matched DiD models run in the primary analysis and not significant.

Secondary Analysis

The impact of SCS use, regardless of site type, on drug related mortality appeared to be significant in all models presented in **Table 29**. This finding has implications for the interpretation of the results from the primary study. As the switch from a brick & mortar to mobile SCS in Lethbridge occurred during the COVID-19 pandemic, if the SCS would have resulted in less use of sites this may not have been detected by the DiD analysis because SCS use was already suppressed by the pandemic. A binary variable distinguishing 2021 from 2020 in the pooled OLS regressions in **Table 29** was explored but not included, as it did not improve fit based on the AIC or BIC criterion. Of note, if this time dummy is included the coefficient for SCS use in **Model 41** would no longer be significant at a 5% level. Similarly, if a fixed effects model was run, results would no longer be significant. In both instances, we have hypothesized that this may be the result of the relatively small sample size used in this analysis. As there are five cities each with two datapoints there may not be enough variation to include covariates in this analysis. Of note, this was not a prespecified analysis but instead an analysis that was added post-hoc to fill a noted gap in the literature. As a result, this analysis should be viewed as exploratory in nature. **Figure 4** plots the change in SCS use versus the change in drug related mortality for each of the cities in Alberta with SCS from 2019 to 2020 and 2021.

Table 22 Primary Analysis, Mortality per Month per 100,000 Residents

Variable	Model 1 Opioid Deaths (SE)[P-value]	Model 2 Opioid Deaths Restricted Model (SE)[P-value]	Model 3 Opioid Deaths No Covariates (SE)[P-value]	Model 4 Any Overdose Deaths (SE)[P-value]	Model 5 Any Overdose Restricted Model (SE)[P-value]	Model 6 Any Overdose Deaths No Covariates (SE)[P-value]
Treatment*Post	-0.155 (0.495) [0.755]	-0.038 (0.541) [0.945]	0.157 (0.505) [0.757]	-0.193 (0.511) [0.707]	-0.060 (0.568) [0.916]	0.054 (0.521) [0.918]
Post	0.751 (0.711) [0.295]	1.611** (0.729) [0.031]	2.015*** (0.713) [0.006]	0.630 (0.732) [0.393]	1.604** (0.766) [0.041]	1.908** (0.736) [0.012]
Treatment	-	-	-	-	-	-
Employment Rate	-0.191** (0.091) [0.041]	-0.143 (0.098) [0.151]	-	-0.166 (0.094) [0.083]	-0.112 (0.103) [0.283]	-
% Working Age Males	-0.088 (0.098) [0.374]	-0.205** (0.100) [0.045]	-	-0.083 (0.101) [0.416]	-0.216** (0.105) [0.045]	-
Drug Toxicity	0.094*** (0.027) [0.001]	-	-	0.107*** (0.028) [0.000]	-	-
Constant	15.119*** (5.135) [0.005]	15.800*** (5.615) (0.007)	1.218** (0.496) [0.017]	13.437** (5.293) [0.014]	14.208** (5.893) [0.019]	1.391*** (0.512) [0.009]
Overall R^2	0.611	0.532	0.556	0.589	0.494	0.536
AIC	224.456	239.051	251.337	229.530	247.172	256.723
BIC	285.226	297.391	304.815	290.300	305.512	310.201

Abbreviations: DiD: difference-in-differences; SE: Standard Error. AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion.

*** = 0.01; ** = 0.05.

Note: The variable differentiating between treatment and control was omitted due to multicollinearity with the entity fixed effects.

Note: " – " indicates that the variable was not included in the model.

Note: Values in this table were rounded to three decimal places to increase the readability of the table. As a result, any values reported as zeros may have been rounded.

Note: For the analysis presented in this table 5% was used to indicate a statistically significant difference based on a predefined level.

Table 23 Primary Analysis Assuming August is the First Post-switch Month, Mortality per Month per 100,000 Residents

Variable	Model 7 Opioid Deaths (SE)[P-value]	Model 8 Opioid Deaths Restricted Model (SE)[P-value]	Model 9 Opioid Deaths No Covariates (SE)[P-value]	Model 10 Any Overdose Deaths (SE)[P-value]	Model 11 Any Overdose Restricted Model (SE)[P-value]	Model 12 Any Overdose Deaths No Covariates (SE)[P-value]
Treatment*Post	0.324 (0.476) [0.500]	0.532 (0.513) [0.304]	0.627 (0.494) [0.209]	0.204 (0.492) [0.680]	0.443 (0.541) [0.416]	0.478 (0.513) [0.356]
Post	0.817 (0.708) [0.253]	1.654** (0.721) [0.026]	1.897*** (0.703) [0.009]	0.685 (0.732) [0.353]	1.642** (0.760) [0.035]	1.802** (0.730) [0.17]
Treatment	-	-	-	-	-	-
Employment Rate	-0.149 (0.088) [0.098]	-0.096 (0.095) [0.314]	-	-0.131 (0.091) [0.159]	-0.070 (0.100) [0.484]	-
% Working Age Males	-0.118 (0.096) [0.224]	-0.236** (0.097) [0.019]	-	-0.108 (0.099) [0.281]	-0.243** (0.102) [0.021]	-
Drug Toxicity	0.091*** (0.027) [0.001]	-	-	0.105*** (0.028) [0.000]	-	-
Constant	13.217** (5.038) [0.011]	13.526** (5.478) [0.017]	1.218** (0.490) [0.016]	11.843** (5.208) [0.027]	12.197** (5.770) [0.039]	1.391*** (0.508) [0.008]
Overall R^2	0.606	0.539	0.592	0.584	0.500	0.564
AIC	223.913	237.489	249.211	229.486	246.207	255.513
BIC	284.683	295.829	302.689	290.257	304.546	308.991

Abbreviations: DiD: difference-in-differences; SE: Standard Error. AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion.

*** = 0.01; ** = 0.05.

Note: The variable differentiating between treatment and control was omitted due to multicollinearity with the entity fixed effects.

Note: " – " indicates that the variable was not included in the model.

Note: Values in this table were rounded to three decimal places to increase the readability of the table. As a result, any values reported as zeros may have been rounded.

Note: For the analysis presented in this table 5% was used to indicate a statistically significant difference based on a predefined level.

Table 24 Primary Analysis Replacing Zeros Observed in November 2021 with Means, Mortality per Month per 100,000 Residents

Variable	Model 13 Opioid Deaths (SE)[P-value]	Model 14 Opioid Deaths Restricted Model (SE)[P-value]	Model 15 Opioid Deaths No Covariates (SE)[P-value]	Model 16 Any Overdose Deaths (SE)[P-value]	Model 17 Any Overdose Restricted Model (SE)[P-value]	Model 18 Any Overdose Deaths No Covariates (SE)[P-value]
Treatment*Post	0.320 (0.426) [0.456]	0.431 (0.474) [0.367]	0.494 (0.446) [0.273]	0.320 (0.439) [0.468]	0.446 (0.498) [0.374]	0.417 (0.461) [0.369]
Post	0.878 (0.611) [0.156]	1.689** (0.639) [0.011]	1.930*** (0.629) [0.003]	0.767 (0.629) [0.228]	1.688** (0.672) [0.015]	1.817*** (0.650) [0.007]
Treatment	-	-	-	-	-	-
Employment Rate	-0.137 (0.078) [0.087]	-0.092 (0.086) [0.290]	-	-0.107 (0.081) [0.189]	-0.057 (0.091) [0.535]	-
% Working Age Males	-0.110 (0.084) [0.196]	-0.221** (0.088) [0.015]	-	-0.107 (0.086) [0.223]	-0.232** (0.092) [0.015]	-
Drug Toxicity	0.089*** (0.023) [0.000]	-	-	0.101*** (0.024) [0.000]	-	-
Constant	12.224*** (4.418) [0.008]	12.866** (4.916) [0.011]	1.218*** (0.438) [0.007]	10.313** (4.547) [0.027]	11.041** (5.172) [0.037]	1.391*** (0.453) [0.003]
Overall R^2	0.690	0.602	0.625	0.672	0.566	0.604
AIC	199.187	216.736	230.386	203.997	225.243	235.954
BIC	259.958	275.075	283.864	264.768	283.583	289.432

Abbreviations: DiD: difference-in-differences; SE: Standard Error. AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion.

*** = 0.01; ** = 0.05.

Note: The variable differentiating between treatment and control was omitted due to multicollinearity with the entity fixed effects.

Note: " – " indicates that the variable was not included in the model.

Note: Values in this table were rounded to three decimal places to increase the readability of the table. As a result, any values reported as zeros may have been rounded.

Note: For the analysis presented in this table 5% was used to indicate a statistically significant difference based on a predefined level.

Table 25 Primary Analysis Assuming December is the First Post-switch Month, Mortality per Month per 100,000 Residents

Variable	Model 19 Opioid Deaths (SE)[P-value]	Model 20 Opioid Deaths Restricted Model (SE)[P-value]	Model 21 Opioid Deaths No Covariates (SE)[P-value]	Model 22 Any Overdose Deaths (SE)[P-value]	Model 23 Any Overdose Restricted Model (SE)[P-value]	Model 24 Any Overdose Deaths No Covariates (SE)[P-value]
Treatment*Post	1.633*** (0.567) [0.006]	2.008*** (0.590) [0.001]	1.598*** (0.513) [0.003]	1.443** (0.596) [0.019]	1.887*** (0.632) [0.004]	1.404** (0.541) [0.012]
Post	1.159 (0.674) [0.091]	1.910*** (0.669) [0.006]	1.654** (0.663) [0.015]	0.999 (0.709) [0.164]	1.887** (0.716) [0.011]	1.571** (0.699) [0.028]
Treatment	-	-	-	-	-	-
Employment Rate	-0.004 (0.095) [0.965]	0.064 (0.098) [0.518]	-	0.004 (0.100) [0.966]	0.085 (0.105) [0.423]	-
% Working Age Males	-0.217** (0.095) [0.026]	-0.331*** (0.093) [0.001]	-	-0.201** (0.100) [0.049]	-0.335*** (0.010) [0.001]	-
Drug Toxicity	0.077*** (0.026) [0.004]	-	-	0.092*** (0.027) [0.001]	-	-
Constant	6.476 (5.195) [0.218]	5.555 (5.539) [0.320]	1.218*** (0.460) [0.010]	5.567 (5.461) [0.312]	4.478 (5.930) [0.453]	1.391*** (0.485) {0.006]
Overall R^2	0.657	0.601	0.647	0.628	0.557	0.611
AIC	212.985	223.527	238.695	221.370	234.975	247.673
BIC	273.755	281.866	292.173	282.141	293.315	301.151

Abbreviations: DiD: difference-in-differences; SE: Standard Error. AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion.

*** = 0.01; ** = 0.05.

Note: The variable differentiating between treatment and control was omitted due to multicollinearity with the entity fixed effects.

Note: " – " indicates that the variable was not included in the model.

Note: Values in this table were rounded to three decimal places to increase the readability of the table. As a result, any values reported as zeros may have been rounded.

Note: For the analysis presented in this table 5% was used to indicate a statistically significant difference based on a predefined level.

Table 26 Poisson Regression, Mortality per Month per 100,000 Residents

Variable	Model 25 Opioid Deaths (SE)[P-value]	Model 26 Opioid Deaths Restricted Model (SE)[P-value]	Model 27 Opioid Deaths No Covariates (SE)[P-value]	Model 28 Any Overdose Deaths (SE)[P-value]	Model 29 Any Overdose Restricted Model (SE)[P-value]	Model 30 Any Overdose Deaths No Covariates (SE)[P-value]
Treatment*Post	0.954 (0.376) [0.905]	0.942 (0.366) [0.877]	0.976 (0.294) [0.937]	0.965 (0.360) [0.924]	0.959 (0.352) [0.910]	0.973 (0.280) [0.925]
Post	1.774 (1.084) [0.348]	2.261 (1.313) [0.160]	2.705 (1.457) [0.065]	1.598 (0.929) 0.420]	2.100 (1.159) [0.179]	2.401 (1.230) [0.087]
Treatment	-	-	-	-	-	-
Employment Rate	0.935 (0.065) [0.333]	0.950 (0.064) [0.452]	-	0.945 (0.062) [0.388]	0.963 (0.062) [0.556]	-
% Working Age Males	0.958 (0.083) [0.616]	0.927 (0.076) [0.351]	-	0.971 (0.078) [0.716]	0.935 (0.070) [0.373]	-
Drug Toxicity	1.023 (0.018) [0.205]	-	-	1.025 (0.017) [0.137]	-	-
AIC	266.107	265.704	264.745	277.265	277.461	275.801
BIC	324.447	321.613	315.793	335.605	333.370	326.848

Abbreviations: DiD: difference-in-differences; SE: Standard Error. AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion.

*** = 0.01; ** = 0.05.

Note: The variable differentiating between treatment and control was omitted due to multicollinearity with the entity fixed effects.

Note: " – " indicates that the variable was not included in the model.

Note: Coefficients in Table 26 are Incidence Rate Ratios.

Note: Values in this table were rounded to three decimal places to increase the readability of the table. As a result, any values reported as zeros may have been rounded.

Note: For the analysis presented in this table 5% was used to indicate a statistically significant difference based on a predefined level.

Table 27 Time Reversed DiD, Mortality per Month per 100,000 Residents

Variable	Model 31 Opioid Deaths (SE)[P-value]	Model 32 Opioid Deaths Restricted Model (SE)[P-value]	Model 33 Opioid Deaths No Covariates (SE)[P-value]	Model 34 Any Overdose Deaths (SE)[P-value]	Model 35 Any Overdose Restricted Model (SE)[P-value]	Model 36 Any Overdose Deaths No Covariates (SE)[P-value]
Treatment*Post	2.881** (1.094) [0.012]	4.270*** (1.224) [0.001]	4.290*** (1.330) [0.003]	2.981** (1.130) [0.012]	4.443*** (1.272) [0.001]	4.654*** (1.397) [0.002]
Post	-3.314*** (0.864) [0.001]	-4.713*** (0.931) [0.000]	-5.163*** (0.940) [0.000]	-3.017*** (0.893) [0.002]	-4.489*** (0.967) [0.000]	-5.271*** (0.988) [0.000]
Treatment	-	-	-	-	-	-
Employment Rate	-0.080** (0.0389) [0.047]	-0.133*** (0.043) [0.004]	-	-0.095** (0.040) [0.024]	-0.151*** (0.045) [0.002]	-
% Working Age Males	0.038 (0.086) [0.658]	0.049 (0.102) [0.633]	-	0.129 (0.089) [0.155]	0.140 (0.106) [0.193]	-
Drug Toxicity	0.120*** (0.031) [0.000]	-	-	0.126*** (0.032) [0.000]	-	-
Constant	12.984 (6.758) [0.063]	23.416*** (7.351) [0.003]	5.903*** (0.503) [0.000]	9.368 (6.983) [0.188]	20.336** (7.636) [0.012]	6.167*** (0.528) [0.000]
AIC	164.722	178.132	184.595	167.470	181.321	188.734
BIC	175.148	186.720	189.808	177.896	189.919	193.947

Abbreviations: DiD: difference-in-differences; SE: Standard Error. AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion.

*** = 0.01; ** = 0.05.

Note: The variable differentiating between treatment and control was omitted due to multicollinearity with the entity fixed effects.

Note: " – " indicates that the variable was not included in the model.

Note: Values in this table were rounded to three decimal places to increase the readability of the table. As a result, any values reported as zeros may have been rounded.

Note: For the analysis presented in this table 5% was used to indicate a statistically significant difference based on a predefined level

Table 28 OLS without DiD and OLS Matched Based on Pre-trends with DiD, Mortality per Month per 100,000 Residents

Variable	Model 37 Opioid Deaths Without DiD (SE)[P-value]	Model 38 Any Overdose Deaths Without Did (SE)[P-value]	Model 39 Opioid Deaths Matched with DiD (SE)[P-value]	Model 40 Any Overdose Deaths Matched with DiD (SE)[P-value]
Treatment*Post	-	-	-0.081 (0.692) [0.908]	-0.543 (0.810) [0.507]
Post	-	-	0.112 (0.519) [0.830]	0.548 (0.481) [0.263]
Treatment	-0.595 (0.360) [0.101]	-0.639 (0.362) [0.081]	-0.429 (0.489) [0.386]	-1.812 (1.107) [0.111]
Employment Rate	-0.050** (0.019) [0.011]	-0.069*** (0.019) [0.001]	-0.291*** (0.087) [0.002]	-0.208** (0.079) [0.012]
% Working Age Males	0.145*** (0.047) [0.002]	0.192*** (0.047) [0.000]	-0.126 (0.111) [0.266]	-0.145 (0.268) [0.592]
Drug Toxicity	0.167*** (0.019) [0.000]	0.165*** (0.189) [0.000]	0.087*** (0.027) [0.003]	0.108*** (0.027) [0.000]
Constant	-0.160 (0.267) [0.551]	0.086 (0.268) [0.749]	21.718*** (6.142) [0.001]	18.594 (8.240) [0.030]**
R^2	0.683	0.698	0.632	0.640

Abbreviations: DiD: difference-in-differences; SE: Standard Error. AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion.

*** = 0.01; ** = 0.05.

Note: The variable differentiating between treatment and control was omitted due to multicollinearity with the entity fixed effects.

Note: " – " indicates that the variable was not included in the model.

Note: Values in this table were rounded to three decimal places to increase the readability of the table. As a result, any values reported as zeros may have been rounded.

Note: For the analysis presented in this table 5% was used to indicate a statistically significant difference based on a predefined level.

Table 29 Results Secondary Analysis, Mortality per Quarter per 100,000 Residents

Variable	Model 41 Pooled OLS Opioid Deaths (SE)[P-value]	Model 42 Random Effects Opioid Deaths (SE)[P-value]	Model 43 Pooled OLS Any Overdose Death (SE) [P-value]	Model 44 Random Effects Any Overdose Death (SE) [P-value]
ΔSCS Use	1.953** (0.837) [0.048]	1.775** (0.855) [0.038]	2.000** (0.649) [0.015]	1.909*** (0.654) [0.003]
Time Dummy 2021	-	0.456 (0.354) [0.198]	-	0.300 (0.293) [0.307]
Constant	0.616 (0.331) [0.100]	0.446 (0.362) [0.218]	0.499 (0.257) [0.088]	0.379 (0.282) [0.179]
Overall R^2	NA	0.512	NA	0.602
AIC	19.717	NA	14.647	NA
BIC	20.322	NA	15.252	NA

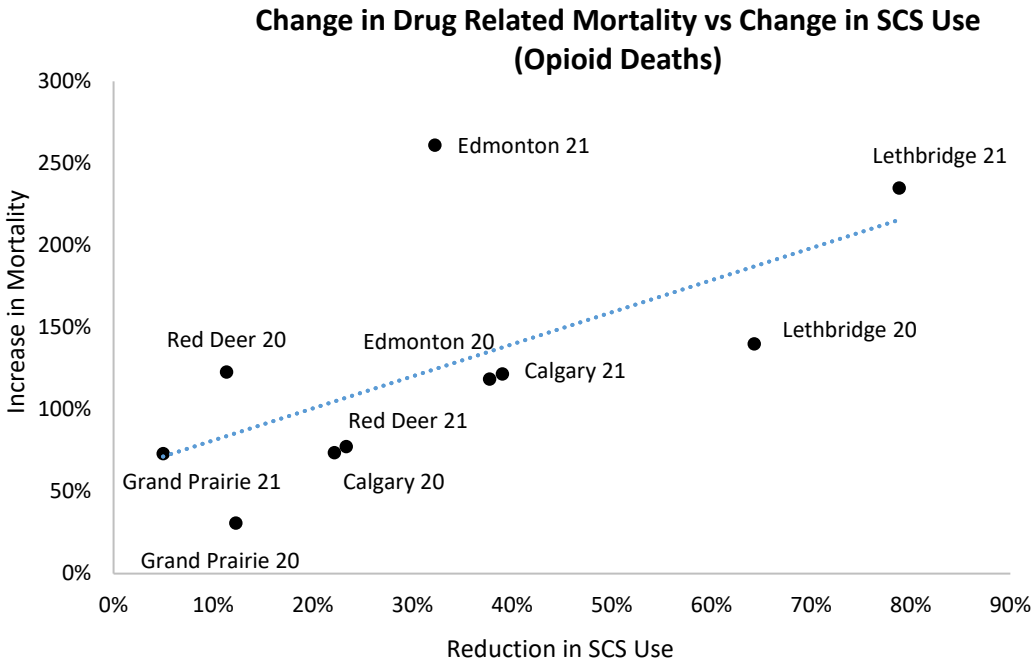
Abbreviations: DiD: difference-in-differences; OLS: Ordinary Least Squares; SCS: Safe Consumption Site; SE: Standard Error. AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion.

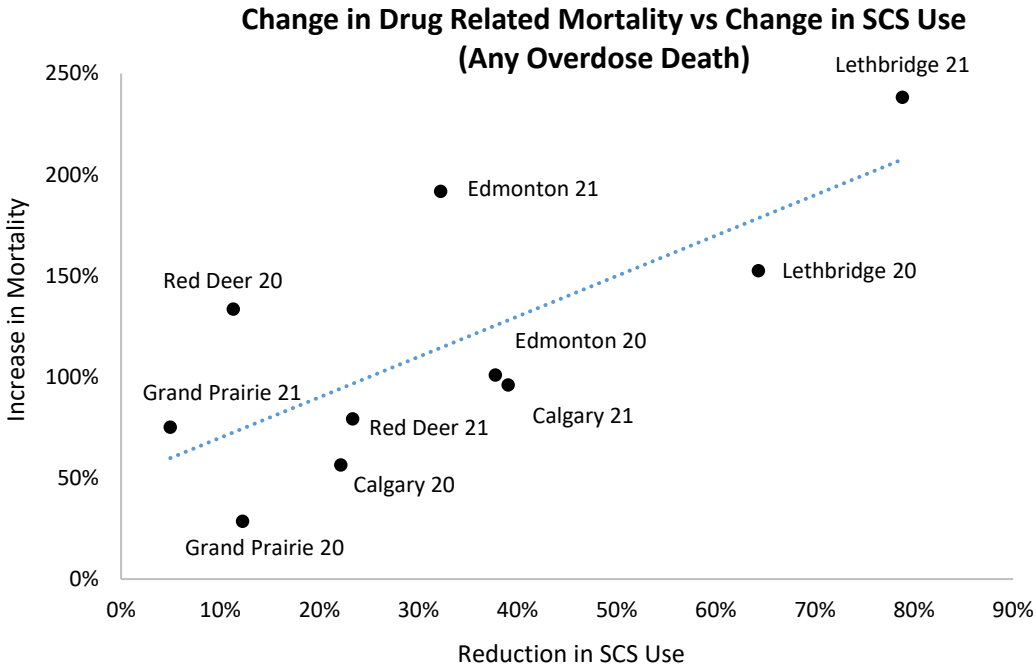
*** = 0.01; ** = 0.05

Note: Values in this table were rounded to three decimal places to increase the readability of the table. As a result, any values reported as zeros may have been rounded.

Note: For the analysis presented in this table 5% was used to indicate a statistically significant difference based on a predefined level.

Figure 4 Change in SCS Use versus Change in Drug Related Mortality





Note: Each data point in Figure 4 is labeled based on the city and the corresponding year the change from 2019 was measured to.

5.4 Discussion

This chapter investigated the effectiveness of mobile versus brick & mortar SCSs in preventing drug related mortality. Specifically, a DiD analysis was employed to take advantage of a natural experiment that occurred in Alberta, Canada in 2020. If these two site types were equally effective, then mobile SCSs may represent a less controversial alternative to brick & mortar facilities. Additionally, this chapter investigated a possible relationship between SCS use rates and drug related mortality rates, in five cities in Alberta, Canada using variation resulting from the COVID-19 pandemic. This analysis provided additional information on this topic and addressed a noted gap within the literature.

The primary analysis of the present study did not find a statistically significant association between drug related mortality and SCS type. This suggested that mobile SCSs were not less effective than brick & mortar SCSs. Results of the primary analysis did not change in several sensitivity analyses including if August 2020 was assigned as the first month of the post-switch period; if zeros observed in Lethbridge in November of 2020 were replaced using mean substitution; and if an alternative regression approach was used. The results did change when the post-switch period was assumed to start in December 2020. This change resulted in a statistically significant and positive association between mobile SCSs and drug related mortality, suggesting that mobile SCS were associated with increased mortality. It should be noted that the sensitivity analysis using December 2020 as the first month of the post-switch period was conducted to explain an unusually low period of drug related mortality observed directly after the switch from a brick & mortar to mobile SCS in Lethbridge (See **Figure 3**). A possible explanation for this observation was that this period of low mortality was due to the operation of unsanctioned SCSs in Lethbridge. However, we were unable to confirm the details regarding these sites.

With respect to covariates included in the primary analysis (**Table 22**), the direction of the association between *drug toxicity*, which was proxied by overdoses responded to by emergency personnel, and drug related mortality was negative and statistically significant. This conformed with expectations. The direction of the association between the *employment rate* and drug related mortality was as expected but only significant in one model presented in **Table 22 (Model 1).** This result, to an extent, aligns with the work of Case & Deaton (2021) who suggested that overdose deaths are "deaths of despair" caused in part by a lack of fulfilling

employment resulting in less life satisfaction. The direction of the association between drug related mortality and the *percentage of the population that were prime working age males* was negative, which ran counter to expectation and the association was significant in two of the four models presented in **Table 22** (**Model 2 and Model 5**). As it is known that most fatal overdoses in Alberta occur in working aged men, this observation was paradoxical. A potential interpretation of this result is that there is a fixed number of men who are at elevated risk for overdose deaths per capita and the size of this group does not vary substantially between cities. *Homelessness*, which was proxied by homeless shelter use rates was not significantly associated with drug related mortality and its influence on the dependent variables was negligible. As a result, this variable was excluded from the analysis. Potentially, homeless shelter use, might not be an appropriate proxy for homelessness rates or may not reflect the portion of the homeless population that are at greatest risk for overdose deaths.

In the primary analysis and the corresponding sensitivity analysis, the effect of drug toxicity was proxied using the rate of overdoses responded to by emergency personnel per month per 100,000 residents. However, it is likely that if mobile SCSs are less effective at preventing drug related mortality, switching to a mobile SCS would also increase rates of overdoses responded to by emergency personnel. Due to concerns of endogeneity, models were run excluding covariates for *drug toxicity* **(See Table 22, Table 23, Table 24, Table 25, Table 26, and Table 27)**. When *drug toxicity* was excluded from the models, the association between SCS type and drug related mortality was still not significant, apart from the sensitivity analysis presented in **Table 25**. This result suggested that the possible multicollinearity between drug related mortality and the variable for drug toxicity was not obscuring a potential correlation between SCS type and drug related mortality.

Contrary to the primary analysis, a time reversed DiD suggested that that mobile SCSs are associated with a statistically significant reduction in drug related mortality. Interestingly, this ran counter to expectation prior to the analysis and did not align with other models included in the primary analysis. It should be noted that the unsanctioned SCSs that were operated in Lethbridge after the closure of the brick & mortar SCS may have confounded the results of the time reversed DiD, as was the case in the other DiD. Furthermore, the city that constituted the control group in the time reversed DiD, Grand Prairie, was not included in the DiD in the primary analysis, suggesting that results may be dependent on which control group is used.

Consequent to this and given the conflicting findings between the primary analysis and the time reversed DiD, it is possible that the relationship between SCS type and drug related mortality could vary geographically without a single or consistent relationship across all cities. As a result, policymakers may consider the following during the planning of SCSs. Prior to designing or adopting a mobile SCS, policymakers could assess if a mobile SCSs will have the capacity to meet the demand placed upon it in the community where it will be located. Furthermore, it would be useful to understand if the people who would use the site, in a given jurisdiction, would be willing to use a mobile site. Qualitative research that investigates factors that influence the choices of people who use drugs to use SCSs would help establish if there exists a willingness to use a mobile facility amongst possible site users. Finally, research that provides insight on which type of SCS is likely to be most beneficial from a value for money standpoint given the characteristics of a given jurisdiction would be of value. It is reasonable that the SCS type that offers the best value for money may be dependent on city specific factors. For instance, mobile SCSs may be a better alternative in small or rural communities.

In the secondary analysis, SCS use appeared to have a significant and negative relationship with drug related mortality, suggesting that SCS use is a protective factor against drug related mortality. This finding aligns with existing, though limited research, that has investigated the impact of SCS on drug related adverse events and found that these sites are an effective preventative measure (Caulkins et al., 2019). For context, Marshall et al., (2011) found that after the opening of an SCS in Vancouver, British Columbia, Canada the reduction in overdose related mortality was larger in the vicinity of the SCS than in the rest of the city (Marshall et al., 2011). Conversely, Salmon et al., (2010) did not find that SCS significantly reduced overdose deaths but did find a significant reduction in ambulance calls due to overdose (Salmon et al., 2010). Though the method used by the present study for this analysis precludes statements regarding causality the identification of an apparent dose response by this thesis provides further evidence on the effectiveness of SCSs.

In light of the findings of the secondary analysis, the impact of the COVID-19 pandemic on the results of the primary analysis should be considered. As the switch from a brick & mortar to mobile SCS in Lethbridge occurred during the COVID-19 pandemic, it is possible that the pandemic confounded a relationship between SCS type and drug related mortality, resulting in the null findings of the primary analysis. If the switch to the mobile SCS in Lethbridge would

have resulted in less use, the subsequent impact on mortality may not have been detected by the DiD used in the primary analysis because SCS use was already suppressed by the pandemic. As a result, this study cannot conclude that SCS type does not influence drug related mortality, as was identified in the primary analysis (See **Table 22**). In fact, when taken together, the results of the primary analysis and time reversed DiD suggest that the relationship between drug related mortality and site type may be dependent on jurisdiction-specific factors.

This analysis is subject to several limitations. For the primary analysis and subsequent sensitivity analysis, after the closure of the brick & mortar SCS in Lethbridge, concerned citizens operated SCSs to offset any potential gaps in service availability caused by the closure of the Lethbridge brick & mortar SCS.[14] This may have confounded results, as the present study hypothesized that the actions of these individuals lead, at least in part, to the reduction in mortality observed between September and November 2020 in Lethbridge. Additionally, this study used a relatively short follow-up length. Due to policy changes implemented by the Alberta Government, the authors chose to limit the post-implementation period in the primary analysis to less than one year. Furthermore, Statistics Canada's labor force data, which was used to inform the dependent and independent variables included in the primary analysis, reports data for the cities of Lethbridge and Medicine Hat, Alberta, Canada together. As a result, the present study assumed that 50% of the reported population were citizens of Lethbridge for analysis. As these cities are reasonably close by Canadian standards (167km) and Lethbridge has SCS facilities and Medicine Hat does not, it was unclear whether individuals from Medicine Hat would use the SCS facility. Thus, we assumed that half of those within the area would be able to take advantage of the Lethbridge SCS. Additionally, the study period coincided with the COVID-19 pandemic. This had the potential to confound results, if the COVID-19 pandemic did not influence drug related mortality in a similar fashion across cities. Furthermore, this may have masked a possible relationship between SCS type and drug related mortality in the primary analysis by suppressing SCS use across all cities. As a result, it is unclear if the results from this analysis can be extrapolated to time periods outside the pandemic. The brick & mortar site in Lethbridge was closed because of concerns by the

[14] Though not reported in peer reviewed literature, this was documented in popular media.
The Canadian Broadcasting Corporation. (September 26, 2020). 3 weeks after province ends funding for injection site, unsanctioned space opens in Lethbridge.
https://www.cbc.ca/news/canada/calgary/lethbridge-supervised-injection-site-unsanctioned-1.5737627
(Accessed 2022-11-27).

provincial government of financial mismanagement and due to public opposition.[15] Though speculative, it is possible that the financial mismanagement led to inefficiencies at the brick & mortar facility. As a result, this site may have prevented fewer deaths than would have been prevented by a more fiscally responsible run facility. This could have potentially obscured a relationship between site type and mortality. A consideration when interpreting the results of this data is that there may be differences in how overdoses are categorized between jurisdictions, and this could potentially impact findings.

Finally, there may have been some concerns with the parallel trends assumption, as the test conducted in the present study was sensitive to the covariates included in the model. The secondary analysis conducted by the present study that investigated if SCS use irrespective of site type was a protective factor against drug related mortality was also subject to limitations. Notably, this analysis had a small sample size and this analysis was not prespecified, as it was added in a post-hoc fashion to address an identified gap in the literature.

In summary, the primary analysis performed as part of this chapter found that the use of mobile SCSs did not result in increased mortality relative to brick & mortar facilities, in Lethbridge, Alberta. However, the present study hypothesized that the null findings observed are at least in part driven by the COVID-19 pandemic and the actions of concerned individuals in the Lethbridge area who operated their own SCSs after the closure of the brick & mortar site. When the results of the primary analysis are taken together with results of sensitivity analyses, it is possible that the correlation between site type and drug related mortality may be dependent on jurisdictional factors. Jurisdictional factors may include the attitudes and preferences of people who inject drugs in a given city. If these people were unwilling to use a mobile site than it is unlikely that a mobile site will be effective in preventing mortality. Based on the totality of findings, the present study believes that more research is necessary before definitive assessments of the association between SCS type and mortality can be made. Furthermore, policymakers who plan to design SCSs should conduct jurisdictional specific research to assess if a mobile or brick & mortar site would be more beneficial in the targeted jurisdiction.

[15] The Canadian Broadcasting Corporation. (August 31, 2020). Lethbridge braces for closure of Canada's busiest supervised consumption site. https://www.cbc.ca/news/canada/calgary/lethbridge-arches-supervised-consumption-site-closure-1.4434070 (Accessed August 5, 2023)

6. Conclusions

This thesis investigated current knowledge gaps that represent barriers to the establishment of SCSs from a public preferences standpoint. This thesis first assessed the relative importance of a set of attributes in influencing public support for SCSs. The findings from this analysis aimed to provide policymakers with information regarding which components of SCSs are most important in influencing public opinion towards these facilities. Furthermore, this study estimated the WTA for having an SCS located in a person's community. By having an estimate of the WTA, this analysis aimed to better understand the degree to which people oppose SCSs in their community. The WTA could also be used to assess if it would be feasible to placate the concerns of residents that stem from an SCS being developed in their community with financial compensation. To investigate these two questions, a DCE was conducted, which was described in **Chapter 4**.

Secondly, this thesis aimed to assess the effectiveness of mobile versus brick & mortar SCSs in preventing drug related mortality. If it were the case that mobile sites were comparable in terms of effectiveness to brick & mortar facilities, then mobile sites may represent a less controversial alternative to brick & mortar facilities. To assess this knowledge gap, a DiD analysis was conducted to exploit a natural experiment that occurred in Alberta, Canada in the summer of 2020, which was described in **Chapter 5**. Finally, it has been suggested that there is a lack of high quality studies investigating the effectiveness of SCSs in preventing drug-related adverse events (Caulkins et al., 2019). To assess this knowledge gap, this thesis conducted an analysis to assess how SCS use rates impacted drug related mortality rates, across a set of five cities in Alberta, Canada using variation in use rates that resulted from the COVID-19 pandemic. Results from this analysis are described in **Chapter 5**.

To facilitate the two quantitative chapters (**Chapters 4 and 5**) described previously two literature reviews were required. The state-of-the-art review described in **Chapter 2**, set out to systematically review the literature for recent (since January 1, 2020) public opinion research on SCSs. The databases searched by the state-of-the-art review included: PsychInfo, PubMed, Scopus, and the Cochrane Library Database. Additionally, a grey literature search of Google Scholar was conducted. Searches were conducted on May 24, 2021 (electronic database search) and May 27, 2021 (grey literature search). The electronic database search resulted in 122 hits

and the grey literature search resulted in 72 hits. From these, the full texts of 11 studies were screened and eight studies were included. 513 studies either referenced or were referenced by the included 8 studies as of May 29, 2021. From these, four studies were selected for full text review and one was included. In total, 707 titles/abstracts were screened, 15 full texts were screened, and nine studies were included. The findings of the state-of-the-art review were used to inform both quantitative chapters included within this thesis (**Chapter 4** and **Chapter 5**).

The second literature review was an SR, which was described in **Chapter 3**. The SR set out to systematically review the literature for DCEs of harm reduction strategies for addictive substances. The purpose of this review was to identify and characterize the methods and approaches that have been used to date as they relate to DCEs related to harm reduction strategies. The databases searched were: Medline, PubMed, Embase, PsychINFO, and Cochrane Database of Systematic Reviews. Additionally, a grey literature search of Google Scholar was conducted. Searches were conducted on December 30, 2019 and resulted in 986 hits. From these, the full texts of 30 studies were screened and six studies were included. In total, 921 studies either referenced or were referenced by included studies as of April 12, 2020. From these, eight were selected for full text review and five were included. The grey literature search conducted on April 21, 2020 resulted in 220 hits. From these, one study was selected for full text review, and none were included. In total, 2,127 titles/abstracts were screened, 39 full texts were screened, and 11 studies were included. The findings of the SR were used to inform **Chapter 5** of this thesis.

A limitation associated with both literature reviews conducted by this thesis is that they were conducted by a single reviewer. As a result, these reviews may have been impacted by error or selection bias to a greater extent than would have been the case had multiple reviewers conducted the analyses. Additionally, both literature reviews were limited to English only studies, representing a possible limitation.

The DCE presented in **Chapter 4** identified a set of attributes for SCSs that influence public support for these facilities. Specifically, this study found that respondents disliked sites that increased cost to the healthcare system. Conversely, respondents preferred sites that were better able to reduce fatal overdoses, that could reduce improperly discarded needles, and that were accompanied by policies that provided compensation to those impacted by sites. The study

found the WTA for having a site opened in a respondent's neighborhood ranged from $11,109 to $11,447 in 2021 Canadian dollars.

Findings of the DCE suggested that respondents had a stronger negative preference towards SCSs increasing costs to the healthcare system than they had a positive preference for SCSs reducing costs to the healthcare system. As a result, when communicating with the public regarding SCSs, policymakers should provide details on how these facilities could reduce or offset their own operational costs and, in the net, not increase healthcare system costs. If policymakers provide this information, it may be less likely that the public would oppose SCSs. Furthermore, it would be of value for SCS administrators to conduct evaluations of the harm prevented by the SCSs they manage. These could then be presented to community members and other stakeholders. This could have the effect of improving public opinion related to sites. Finally, SCSs could be developed such that staff and people who use SCSs would cleanup improperly discarded drug paraphernalia in the neighborhoods surrounding sites. This could both improve public acceptability of SCSs and help make neighborhoods safer by removing hazardous materials. In summary, findings suggest that there are attributes associated with SCSs that impact public preferences for sites. Policymakers aiming to develop SCSs that provoke less opposition from the public should consider these attributes when developing and communicating about SCSs. In doing so, policymakers may improve the acceptability of SCSs without compromising the ability of SCSs to save lives.

The DCE was subject to several limitations. Briefly, there is the possibility that survey participants may not be representative of the target population. The demographic information of participants was compared to values for the Canadian public and results were similar. Additionally, the survey was conducted in English only. Finally, given the controversial nature of this topic, it is possible that respondents answered surveys based on personal biases and not the information provided.

Chapter 5 presented a DiD analysis, to assess the change in drug related mortality that occurred in Lethbridge, Alberta relative to other cities in Alberta using SCSs after Lethbridge switched from a brick & mortar SCS to a mobile SCS. The primary analysis of this DiD, did not find a significant association between drug related mortality and SCS type, suggesting that mobile sites were not less effective than brick & mortar sites. However, the present study

hypothesized that the null findings may at least in part be driven by the COVID-19 pandemic, as it suppressed SCS use throughout the province. Additionally, the actions of concerned citizens in the Lethbridge area who operated their own SCSs after the closure of the brick & mortar site may also have confounded results. Contrary to the primary analysis, a time reversed DiD, conducted as a sensitivity analysis, indicated that mobile SCSs were more effective than brick & mortar facilities with respect to preventing drug related mortality. When considering the results of the primary analysis together with the results of sensitivity analyses including the time reversed DiD, findings suggested that the optimal site type may be dependent on idiosyncrasies within a given jurisdiction and that there is no single relationship that exists between SCS type and drug related mortality. As a result, policymakers who aim to develop SCSs should conduct jurisdictional specific research prior to implementation to identify the optimal site type for the target community. In a secondary analysis presented in **Chapter 5**, SCS use appeared to have a significant and negative relationship with drug related mortality, suggesting that SCS use, independent of site type, might be a protective factor against drug related mortality. Though the study design of the secondary analysis precluded assessments of causality, the dose response identified between the change in SCS use and the change in mortality provides additional information regarding the effectiveness of SCS.

There were limitations associated with the DiDs presented in **Chapter 5**. Of note, the study period coincided with the COVID-19 pandemic. This had the potential to confound results, if the COVID-19 pandemic did not influence drug related mortality equivalently in all cities. Additionally, the pandemic may have confounded a possible relationship between SCS type and drug related mortality in the primary analysis by suppressing SCS use across all cities. Given these limitations, it is unclear if the findings from **Chapter 5** can be extrapolated to time periods outside of the pandemic. Additionally, after the closure of the brick & mortar facility in Lethbridge, concerned citizens and members of the First Nations community in the Lethbridge area operated their own SCSs, to address potential service gaps that may have arisen from the closure of the brick & mortar site. Furthermore, there may have been concerns with the parallel trends assumption, as the test conducted in the present study was sensitive to which covariates were included. With respect to the data used, there exists concerns regarding how Statistics Canada reports Labour Force Survey data that required the authors to make assumptions regarding the population that would use the Lethbridge SCSs. Finally, the result of policy changes by the Alberta Government, the timeframe of the analysis was limited to 21

months. With respect to the findings of the secondary analysis conducted to assess if SCSs are effective in preventing drug related mortality, the most substantial limitation associated with this analysis is its small sample size. The analysis contained five cities and had data for each city across two years. Furthermore, this analysis was not prespecified but instead was added in a post-hoc fashion to address a gap in the literature and provide context for the primary DiD analysis contained in **Chapter 5**.

While conducting this thesis several opportunities for future research were identified. For instance, there has been no use of DCE to date, to better understand public preferences of harm reduction strategies for drug addiction. As harm reduction strategies for drug addiction tend to be controversial, extending this methodology to investigate public preferences for HAT (See **Chapter 4** for a description of HAT) could provide decision-makers with useful information on public preferences for this harm reduction strategy. Furthermore, replication studies of the present DCE would also be of value. Additionally, at present there is only anecdotal evidence to suggest that mobile SCSs are preferred by residents versus brick & mortar SCSs. A study that investigated this question would make a valuable contribution to the literature. Given that the DiD analysis conducted within this thesis took place within the COVID-19 pandemic, additional research taking place outside of the pandemic would help alleviate concerns that the pandemic biased the results of the DiD analyses. At present we are aware of no studies that have investigated how far people will travel to use SCS services. A study that assessed this would be of value. Understanding this information would have given the present study a better understanding of the population that would likely be willing to use the site in Lethbridge. Finally, and as previously mentioned by Caulkins et al., (2019) causal studies on the effectiveness of SCSs in preventing drug related mortality, irrespective of site type, would be of value to the literature. As it would likely be impractical to use randomization to answer this question, a DiD or a study that looked for a dose response using a larger sample size than used in the present study may represent feasible methodologies.

An important consideration when investigating life-saving interventions related to drug use is the value of a statistical life. The value of statistical life refers to the amount that an entity (i.e. an individual, a decision-maker, a funder, society, etc.) would be willing to pay for a reduced probability of mortality (Trautmann et al., 2021). Of note, these values are usually calculated for an anonymous person and not a loved one or oneself. Some research suggests that for some

individuals, willingness-to-pay to save a life through harm reduction interventions may be less than for other life-threatening conditions. For instance, when Matheson et al., (2014) investigated willingness-to-pay for drug treatment programs they received some responses from participants that could be interpreted to suggest respondents would preferif individuals experiencing addiction died. Or, in other words these individuals would not be willing to pay any money to reduce the probability of overdose death. This could mean that should a decision-maker invest substantially in harm reduction programs for drug addiction, they could face public backlash.

Overall, this thesis made several contributions to the economic literature related to SCSs. To our knowledge, the DCE contained within this thesis was the first to use a comparative method to assess the relative importance of a set of key attributes in influencing public support for SCSs. Additionally, this thesis was the first to estimate a WTA for an SCS to be established in a person's neighborhood. Furthermore, the authors are aware of no other DCEs that have been conducted in relation to harm reduction strategies for opioids. As a result, this thesis may spur additional use of the DCE method for controversial topics related to opioid addiction. The DiD included in this thesis was the first to compare the effectiveness of mobile versus brick & mortar SCSs in preventing drug related mortality. Though results of the DiD analysis were not conclusive, it is the authors' hope that this study will inspire additional research on this topic. Finally, the present study added additional research to the body of literature suggesting that SCSs are effective in preventing drug related mortality. In summary, this study identified information that could help decisionmakers design SCSs that can prevent drug related adverse events and reduce public opposition to the establishment of these facilities.

Research Ethics

Consent was obtained from all participants where relevant. The studies contained in **Chapter 4** and **Chapter 5** were approved by the Research Ethics Board at Lancaster University (Bailrigg, Lancashire, United Kingdom). Research ethics approval was not sought for the literature reviews contained in **Chapter 2** and **Chapter 3**.

Appendix 1 Extraction Sheet State-of-the-Art Review

Extraction Element	Value	Page #
General Study Details		
5. Lead Author		
6. Year of Publication		
7. Jurisdiction		
8. Study Approach *(Qual, Quant, Mixed)*		
9. *Publication Type*		
10. Study Design		
11. Sample Size		
12. Primary Research Question		
Specific Study Details		
13. Study Objective		
Key Findings/Limitations		
14. Drivers of Public Opinion		
15. Summary of Key findings		
16. Limitations		

Appendix 2 Search Strategy for Systematic Review

Database: Medline
Date: December 30, 2019
Search Software: Ovid
Filters: Limited to Humans, Limited to English Language.
Articles Identified: 186

Search Code

Keyword		Search Code (Hits)
1. discrete choice experiment	→	discrete choice experiment.mp. (1331)
2. discrete choice experiments	→	discrete choice experiments.mp. (412)
3. discrete choice modeling	→	discrete choice modeling.mp. (16)
4. discrete choice modelling	→	discrete choice modelling.mp. (23)
5. discrete choice conjoint experiment	→	discrete choice conjoint experiment.mp. (22)
6. stated preference	→	stated preference.mp. (457)
7. part-worth utilities	→	part-worth utilities.mp. (30)
8. functional measurement	→	functional measurement.mp. (206)
9. paired comparisons	→	paired comparisons.mp. (1120)
10. pairwise choice	→	pairwise choice.mp. (20)
11. conjoint analysis	→	conjoint analysis.mp. (741)
12. conjoint measurement	→	conjoint measurement.mp. (64)
13. conjoint studies	→	conjoint studies.mp. (3)
14. conjoint choice experiment	→	conjoint choice experiment.mp. (2)
15. conjoint choice experiments	→	conjoint choice experiments.mp. (2)
16. combine DCE related searches	→	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 (3955)
17. harm reduction	→	harm reduction.mp. or exp Substance Abuse, Intravenous/ or exp Harm Reduction/ or exp Substance-Related Disorders/ or exp Methadone/ or exp Heroin Dependence/
18. alcohol	→	alcohol.mp. (294603)
19. heroin	→	exp Heroin Dependence/ or exp Heroin/ or heroin.mp. (18934)
20. tobacco	→	exp Tobacco/ or tobacco.mp. (124384)
21. cannabis	→	cannabis.mp. or exp Cannabis/ (21279)
22. illicit drug	→	illicit drug.mp. or exp Street Drugs/ (17341)
23. drug use	→	exp Substance Abuse, Intravenous/ or exp Substance-Related Disorders/ or drug-use.mp.
24. dependence	→	exp Morphine Dependence/ or exp Heroin Dependence/ or dependence.mp. (230016)

25. abuse	→	exp Substance Abuse Detection/ or exp Substance Abuse Treatment Centers/ or exp Marijuana Abuse/ or exp Substance Abuse, Intravenous/ or abuse.mp. (166193)
26. needle exchange	→	exp Substance-Related Disorders/ or exp Substance Abuse, Intravenous/ or exp Needle-Exchange Programs/ or needle exchange.mp. or exp Drug Users/ (274057)
27. syringe exchange	→	exp Needle Sharing/ or exp Substance Abuse, Intravenous/ or syringe exchange.mp. or exp Needle-Exchange Programs/ (15802)
28. supervised injection	→	exp Drug Overdose/ or exp Substance Abuse, Intravenous/ or exp Harm Reduction/ or supervised injection.mp. or exp Substance Abuse Treatment Centers/ or exp Needle-Exchange Programs/ (32733)
29. safe injection	→	safe injection.mp. or exp Substance Abuse, Intravenous/ (15056)
30 safe consumption	→	safe consumption.mp. (163)
31. naloxone	→	exp Naloxone/ or exp Buprenorphine, Naloxone Drug Combination/ or naloxone.mp. (32997)
32. overdose	→	exp Analgesics, Opioid/ or exp Opioid-Related Disorders/ or exp Drug Overdose/ or overdose.mp. or exp Substance-Related Disorders/ (370037)
33. outreach	→	outreach.mp. (13018)
34. blood-borne virus	→	exp Substance Abuse, Intravenous/ or blood-borne virus.mp. (15097)
35. brief intervention	→	exp Substance-Related Disorders/ or exp Alcoholism/ or exp Alcohol Drinking/ or brief intervention.mp. or exp Alcohol-Related Disorders/ (317502)
36. hiv	→	exp HIV/ or HIV.mp. (350234)
37. hiv testing	→	HIV testing.mp. (11243)
38. counselling	→	counselling.mp. (26099)
39. hepatitis	→	exp Hepatitis/ or hepatitis.mp. (250086)
40. combine hr related searches	→	17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 (1547944)
41. identify studies related to both DCE and HR	→	16 and 40 (253)
42. limit studies to English language	→	limit 41 to122nglishh language (248)
43. limit studies to humans	→	limit 42 to humans (186)

Database: Embase
Date: December 30, 2019
Search Software: Ovid
Filters: Limited to Humans, Limited to English Language, Limited to Articles – to deal with a large amount of conference abstracts.
Hits: 403

Search Code

Search Term		Search Code
1. discrete choice experiment	→	discrete choice experiment.mp. (2035)
2. discrete choice experiments	→	discrete choice experiments.mp. (597)
3. discrete choice modeling	→	discrete choice modeling.mp. (25)
4. discrete choice modelling	→	discrete choice modelling.mp. (30)
5. discrete choice conjoint experiment	→	discrete choice conjoint experiment.mp. (22)
6. stated preference	→	stated preference.mp. (602)
7. part-worth utilities	→	part-worth utilities.mp. (56)
8. functional measurement	→	functional measurement.mp. (290)
9. paired comparisons	→	paired comparisons.mp. (1467)
10. pairwise choices	→	pairwise choices.mp. (28)
11. conjoint analysis	→	conjoint analysis.mp. (1043)
12. conjoint measurement	→	conjoint measurement.mp. (71)
13. conjoint studies	→	conjoint studies.mp. (4)
14. conjoint choice experiment	→	conjoint choice experiment.mp. (3)
15. conjoint choice experiments	→	conjoint choice experiments.mp. (3)
16. combine DCE related searches	→	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 (5494)
17. harm reduction	→	exp addiction/ or harm reduction.mp. or exp methadone/ or exp diamorphine/ or exp drinking behavior/ or exp Human immunodeficiency virus infection/ or exp drug abuse/ or exp harm reduction/ or exp drug dependence/ or exp acquired immune deficiency syndrome/ (764065)
18. alcohol	→	exp alcohol withdrawal syndrome/ or alcohol.mp. or exp“"Alcohol Use Disorders Identification Tes”"/ or exp alcohol abuse/ or exp alcohol intoxication/ or exp alcohol consumption/ or exp alcohol/ or exp drug alcohol interaction/ or exp alcohol rehabilitation/ (552716)
19. heroin	→	heroin.mp. or exp diamorphine/ (31759)
20. tobacco	→	exp chewing tobacco/ or tobacco.mp. or exp tobacco dependence/ or exp tobacco snuff/ or exp dipping tobacco/ or exp smokeless tobacco/ or exp tobacco smoke/ or exp tobacco consumption/ or exp tobacco/ or exp waterpipe tobacco/ or exp“"tobacco us”"/ (456265)
21. cannabis	→	cannabis.mp. or exp cannabis derivative/ or exp medical cannabis/ or exp“"cannabis us”"/ or exp cannabis

		smoking/ or exp“"Cannabis (genus”"/ or exp cannabis addiction/ or exp cannabis/ (47743)
22. illicit drug	→	illicit drug.mp. or exp illicit drug/ (19198)
23. drug use	→	exp“"drug us”"/ or drug-use.mp. or exp drug overdose/ (353130)
24. dependence	→	dependence.mp. or exp dependent personality disorder/ (340499)
25. abuse	→	abuse.mp. or exp amphetamine abuse/ or exp intravenous drug abuse/ or exp drug abuse/ or exp analgesic agent abuse/ or exp“"drug of abuse test ki”"/ or exp inhalant abuse/ or exp multiple drug abuse/ or exp alcohol abuse/ or exp phencyclidine abuse/ or exp drug abuse pattern/ (280735)
26. needle exchange	→	exp intravenous drug abuse/ or exp needle/ or exp Human immunodeficiency virus infection/ or exp acquired immune deficiency syndrome/ or needle exchange.mp. or exp preventive health service/ or exp drug abuse/ (544853)
27. syringe exchange	→	exp health program/ or exp syringe/ or exp preventive health service/ or syringe exchange.mp. or exp intravenous drug abuse/ or exp Human immunodeficiency virus infection/ (531848)
28. supervised injection	→	exp substance abuse/ or supervised injection.mp. or exp preventive health service/ (79119)
29. safe injection	→	exp substance abuse/ or safe injection.mp. (53094)
30 safe consumption	→	safe consumption.mp. (180)
31. naloxone	→	exp naloxone plus tilidine/ or exp methadone plus naloxone/ or exp hydromorphone plus naloxone/ or naloxone.mp. or exp naloxone plus oxycodone/ or exp naloxone 6 spirohydantoin/ or exp naloxone benzoylhydrazone/ or exp naloxone/ or exp buprenorphine plus naloxone/ or exp naloxone plus pentazocine/ (46609)
32. overdose	→	overdose.mp. or exp intoxication/ (370098)
33. outreach	→	outreach.mp. (18559)
34. blood-borne virus	→	blood-borne virus.mp. (489)
35. brief intervention	→	exp alcohol consumption/ or exp alcohol/ or exp alcoholism/ or brief intervention.mp. (403639)
36. hiv	→	hiv.mp. or exp Human immunodeficiency virus/ (421520)
37. hiv testing	→	hiv testing.mp. or exp HIV test/ (19045)
38. counselling	→	counselling.mp. or exp counseling/ (173404)
39. hepatitis	→	exp hepatitis/ or hepatitis.mp. (383665)
40. combine hr related searches	→	17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 (3127014)
41. identify studies related to both DCE and HR	→	16 and 40 (692)

42. limit studies to English language	→	limit 41 to125nglishh language (683)
43. limit studies to humans	→	limit 42 to human (628)
44. limit studies to articles.	→	limit 43 to article (403)

Database: PsychInfo
Search Software: Ovid
Date: December 30, 2019
Filters: Limited to Humans, Limited to English Language
Hits: 205

Search Code

Search Term		Search Code
1. discrete choice experiment	→	discrete choice experiment.mp. (410)
2. discrete choice experiments	→	discrete choice experiments.mp. (211)
3. discrete choice modeling	→	discrete choice modeling.mp. (31)
4. discrete choice modelling	→	discrete choice modelling.mp. (12)
5. discrete choice conjoint experiment	→	exp Conjoint Measurement/ or discrete choice conjoint experiment.mp. (180)
6. stated preference	→	stated preference.mp. (327)
7. part-worth utilities	→	part-worth utilities.mp. (21)
8. functional measurement	→	paired comparisons.mp. (928)
9. paired comparisons	→	pairwise choices.mp. (25)
10. pairwise choices	→	exp Conjoint Measurement/ or conjoint analysis.mp. (755)
11. conjoint analysis	→	conjoint measurement.mp. or exp Conjoint Measurement/ (359)
12. conjoint measurement	→	exp Conjoint Measurement/ or conjoint studies.mp. (178)
13. conjoint studies	→	conjoint choice experiment.mp. (9)
14. conjoint choice experiment	→	conjoint choice experiments.mp. (8)
15. conjoint choice experiments	→	functional measurement.mp. (204)
16. combine DCE related searches	→	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 (2899)
17. harm reduction	→	harm reduction.mp. or exp Harm Reduction/ (5796)
18. alcohol	→	alcohol.mp. or exp Alcohols/ (124990)
19. heroin	→	exp Heroin Addiction/ or exp Heroin/ or heroin.mp. (9484)
20. tobacco	→	exp Tobacco Smoking/ or tobacco.mp. or exp Smokeless Tobacco/ or exp“"Tobacco Use Disorde”"/ (40963)
21. cannabis	→	exp“"Cannabis Use Disorde”"/ or exp Cannabis/ or cannabis.mp. (13755)
22. illicit drug	→	exp Drugs/ or exp Tobacco Smoking/ or exp Alcohol Abuse/ or illicit drug.mp. or exp Cocaine/ or exp Alcohol Drinking Patterns/ or exp Drug Usage/ or exp Drug Abuse/ or exp Drug Dependency/ or exp Cannabis/ (440039)

23. drug use	→	exp Alcohol Abuse/ or exp Intravenous Drug Usage/ or drug-use.mp. or exp Tobacco Smoking/ or exp Alcoholism/ or exp Alcohol Drinking Patterns/ or exp Drug Abuse/ or exp Drug Usage/ or exp Drug Therapy/ (307985)
24. dependence	→	exp Morphine Dependence/ or dependence.mp. (60063)
25. abuse	→	abuse.mp. or exp Drug Abuse Prevention/ or exp Inhalant Abuse/ or exp“"Substance Abuse and Addiction Measure”"/ or exp Alcohol Abuse/ or exp Drug Abuse/ (189867)
26. needle exchange	→	exp Opiates/ or exp Drug Abuse/ or exp Needle Sharing/ or needle exchange.mp. or exp Drug Usage/ or exp Harm Reduction/ or exp Intravenous Drug Usage/ or exp Needle Exchange Programs/ or exp“"Substance Use Treatmen”"/ or exp AIDS Prevention/ (177040)
27. syringe exchange	→	exp Needle Sharing/ or exp AIDS Prevention/ or exp“"Substance Use Treatmen”"/ or syringe exchange.mp. or exp Drug Abuse/ or exp Intravenous Drug Usage/ or exp Needle Exchange Programs/ or exp Harm Reduction/ (80119)
28. supervised injection	→	exp Opiates/ or exp Drug Abuse/ or exp“"Substance Use Treatmen”"/ or exp Harm Reduction/ or supervised injection.mp. or exp Drug Overdoses/ or exp Intravenous Drug Usage/ or exp Drug Abuse Prevention/ (95815)
29. safe injection	→	exp“"Substance Use Treatmen”"/ or exp Drug Abuse/ or exp Needle Exchange Programs/ or safe injection.mp. or exp Drug Usage/ or exp Harm Reduction/ or exp Intravenous Drug Usage/ or exp AIDS Prevention/ or exp Drug Therapy/ (289960)
30 safe consumption	→	exp Drug Therapy/ or exp Alcoholism/ or exp Cannabis/ or exp Alcohol Drinking Patterns/ or exp Alcohol Drinking Attitudes/ or exp Ethanol/ or safe consumption.mp. (209577)
31. naloxone	→	naloxone.mp. or exp Naloxone/ (6108)
32. overdose	→	exp Drug Abuse/ or exp Heroin/ or exp Naloxone/ or exp Drug Therapy/ or exp Intravenous Drug Usage/ or overdose.mp. or exp Opiates/ or exp Drug Overdoses/ or exp Drug Abuse Prevention/ (212240)
33. outreach	→	outreach.mp. (7600)
34. blood-borne virus	→	exp Drug Abuse/ or exp Hepatitis/ or exp HIV/ or exp Drug Dependency/ or exp Intravenous Drug Usage/ or exp Needle Sharing/ or blood-borne virus.mp. (100798)
35. brief intervention	→	exp Alcoholism/ or exp Alcohol Abuse/ or exp Alcohol Drinking Patterns/ or exp Alcohol Treatment/ or brief intervention.mp. or exp Drug Abuse/ (109310)
36. hiv	→	exp HIV Testing/ or exp HIV/ or hiv.mp. (55616)
37. hiv testing	→	hiv testing.mp. or exp HIV Testing/ (4083)
38. counselling	→	counselling.mp. (11590)

39. hepatitis	→	exp Drug Usage/ or HCV.mp. or exp Drug Abuse/ or exp Opiates/ (154961)
40. combine hr related searches	→	exp Hepatitis/ or hepatitis.mp. (4541)
41. identify studies related to both DCE and HR	→	17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 (686031)
42. limit studies to English language	→	16 and 41 (222)
43. limit studies to humans	→	limit 42 to human (207)
44. limit studies to articles.	→	limit 43 to127nglishh language (205)

Database: PubMed
Date: December 30, 2019
Filters: Limited to Humans
Hits: 188

Search Code
“"discrete choice experimen”"[All Fields] OR“"discrete choice experiment”"[All Fields] OR“"discrete choice modelin”"[All Fields] OR“"discrete choice modellin”"[All Fields] OR“"discrete choice conjoint experimen”"[All Fields] OR“"stated preferenc”"[All Fields] OR“"part-worth utilitie”"[All Fields] OR“"functional measuremen”"[All Fields] OR“"paired comparison”"[All Fields] OR“"pairwise choice”"[All Fields] OR“"conjoint analysi”"[All Fields] OR“"conjoint measuremen”"[All Fields] OR“"conjoint studie”"[All Fields] OR“"conjoint choice experimen”"[All Fields] OR“"conjoint choice experiment”"[All Fields])
AND
“"harm reductio”"[All Fields] OR“"alcoho”"[All Fields] OR“"heroi”"[All Fields] OR“"tobacc”"[All Fields] OR“"cannabi”"[All Fields] OR“"illicit dru”"[All Fields] OR“"drug us”"[All Fields] OR“"dependenc”"[All Fields] OR“"abus”"[All Fields] OR“"needle exchang”"[All Fields] OR“"syringe exchang”"[All Fields] OR“"supervised injectio”"[All Fields] OR“"safe injectio”"[All Fields] OR“"safe consumptio”"[All Fields] OR“"naloxon”"[All Fields] OR“"overdos”"[All Fields] OR“"outreac”"[All Fields] OR“"blood-borne viru”"[All Fields] OR“"brief interventio”"[All Fields] OR“"HI”"[All Fields] OR“"HIV testin”"[All Fields] OR“"counsellin”"[All Fields] OR“"HC”"[All Fields] OR“"hepatiti”"[All Fields])
AND “"human”"[MeSH Terms]

Database: Cochrane Library of Systematic Reviews
Search Software: Ovid
Date: December 30, 2019
Filters: Limited to Humans, Limited to English Language
Hits: 4
Search Code
Search code was the same as Medline.

Appendix 3 Data Extraction Sheet Systematic Review

Data Element	Value	Location (ex. pg. #)
General Study Details		
Title		
Author(s)		
Year of Publication		
Country(ies) of Sample		
Sample Size		
Sample population (patients, policy-makers, general public, etc.)		
Study objective(s)		
DCE Specific Details		
List of attributes included		
# of choice sets per respondent		
Data collection method (in-person, online, etc.)		
# of alternatives per choice set		
Opt out option provided? (Y/N)		
Experimental Design Details		
Design type (full factorial, fractional, etc.)		
Design plan (Main effects, interactions, etc.)		
Blocking approach used? (Y/N)		
Type of software used to develop experimental design		
Method to develop task sets (Orthogonal, D-efficient, etc.)		
How were attributes selected?		
How were levels selected?		
Sample size calculation		
Statistical Modelling and Validity Testing		
Statistical modelling approach		
Validity tests conducted		
Outcomes and Limitations		
Outcomes included		
Findings		

What did they find?

Appendix 4. Survey Example Discrete Choice Experiment

Which of of the following safe consumption sites would you choose (please choose one)?

Cost of Operating the Safe Consumption Site to Healthcare System	A1: Cost neutral (neither costs nor saves money by operating)	A1: Higher cost (costs more money by operating)
Effectiveness of Safe Consumption Site in Reducing Overdose Deaths	A2: 25% Fewer deaths	A2: 50% Fewer deaths
Financial Compensation to Residents if a Safe Consumption Site Opens in Their Neighborhood	A3: $50,000 given to residents living near site	A3: $0 given to residents living near site
Location of the Safe Consumption Site (Your Neighborhood vs Another Neighborhood)	A4: Please assume the site is NOT in the neighborhood where you live	A4: Please assume the site is in the neighborhood where YOU live
Does the Safe Consumption Site Reduce Improperly Discarded Needles?	A5: There is No change in the amount of improperly discarded needles	A5: The site Reduces the amount of improperly discarded needles

Go back

Appendix 5 All Choice sets Included in the Discrete Choice Experiment

The values A1 to A5 in the table below correspond to the attributes in Table 16 reading from top to bottom in Table 16. The levels for attributes below follow Table 16 in the manuscript reading from left to right.

Choiceset 1	A1	A2	A3	A4	A5
Profile 1	2	2	2	2	2
Profile 2	3	3	3	1	1

Choiceset 2	A1	A2	A3	A4	A5
Profile 1	1	2	3	1	2
Profile 2	2	3	1	2	1

Choiceset 3	A1	A2	A3	A4	A5
Profile 1	2	1	3	1	1
Profile 2	1	3	2	2	2

Choiceset 4	A1	A2	A3	A4	A5
Profile 1	1	1	1	2	2
Profile 2	2	2	2	1	1

Choiceset 5	A1	A2	A3	A4	A5
Profile 1	1	2	3	2	1
Profile 2	3	1	2	1	2

Choiceset 6	A1	A2	A3	A4	A5
Profile 1	3	3	3	2	2
Profile 2	1	1	1	1	1

Choiceset 7	A1	A2	A3	A4	A5
Profile 1	3	2	1	2	2
Profile 2	1	3	2	1	1

Choiceset 8	A1	A2	A3	A4	A5
Profile 1	3	2	1	2	1
Profile 2	2	1	3	1	2

Choiceset 9	A1	A2	A3	A4	A5
Profile 1	3	1	2	2	1
Profile 2	2	3	1	1	2

Choiceset 10	A1	A2	A3	A4	A5
Profile 1	2	1	3	2	2
Profile 2	1	3	2	1	1

Choiceset 11	A1	A2	A3	A4	A5
Profile 1	2	1	3	2	1
Profile 2	3	2	1	1	2

Choiceset 12	A1	A2	A3	A4	A5
Profile 1	1	3	2	2	2
Profile 2	3	2	1	1	1

List of Acronyms and Abbreviations

Abbreviation	Definition
AB	Alberta
AIC	Akaike Information Criterion
AIDS	Acquired Immunodeficiency Syndrome
ARCHES	AIDS Outreach Community Harm Reduction, Education, & Support Society
BIC	Bayesian Information Criterion
CAD	Canadian Dollars
CI	Confidence Interval
COVID-19	Coronavirus Disease of 2019
DCE	Discrete Choice Experiment
DiD	Difference in Differences
HIV	Human Immunodeficiency Virus
HR	Harm Reduction
i.e.	Id Est
IRR	Incidence Rate Ratios
ISPOR	International Society for Pharmacoeconomic Research
NA	Not Applicable
PICOTS	Population, Intervention, Comparators, Outcomes, Time-Period, & Study Type
PREP	Preexposure Prophylaxis
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RV	Recreational Vehicle
SAS	Statistics for Social Sciences
SCS	Safe Consumption Site
SR	Systematic Review
USA	United States of America
USD	United States of America Dollars
VBA	Visual Basic for Applications
WTA	Willingness to Accept

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