



# Attributable fractions for substance use in relation to crime

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## ABSTRACT

**Aims** Building upon an existing methodology and conceptual framework for estimating the association between the use of substances and crime, we calculated attributable fractions that estimate the proportion of crimes explained by alcohol and six other categories of psychoactive substances. **Design** Cross-sectional surveys. **Setting** Canadian federal correctional institutions. **Participants** Canadian men ( $n = 27\,803$ ) and women ( $n = 13\,355$ ) offenders who began serving a custodial sentence in a Canadian federal correctional institution between 2006 and 2016. **Measurements** Offenders completed the computerized assessment of substance abuse, a self-report tool designed to assess (1) whether the offence for which they were convicted would have occurred had they not been intoxicated from alcohol or another substance, (2) whether they committed the offence to support their alcohol or other substance use and (3) whether they were dependent on alcohol (alcohol dependence scale) or another substance (drug abuse screening test). Offences were grouped into four mutually exclusive categories: violent crimes, non-violent crimes, impaired driving and substance-defined crimes. This study focused on violent and non-violent crime categories. Substances assessed were: alcohol, cannabis, opioids, other central nervous system (CNS) depressants, cocaine, other CNS stimulants and other substances. **Findings** According to offender self-report, 42% of all violent and non-violent crime would probably not have occurred if the perpetrator had not been under the influence of, or seeking, alcohol or other substances. Between 2006 and 2016, 20% of violent crimes and 7% of non-violent crimes in Canada were considered attributable to alcohol. In contrast, all other psychoactive substance categories combined were associated with 26% of all violent crime and 25% of non-violent crime during the same time-frame. **Conclusions** Attributable fraction analyses show that more than 42% of Canadian crime resulting in a custodial sentence between 2006 and 2016 would probably not have occurred if the perpetrator had not been under the influence of or seeking alcohol or other drugs. Attributable fractions for alcohol and substance-related crime are a potentially useful resource for estimating the impact of alcohol and other substances on crime.

**Keywords** Attributable fractions, criminal justice costs, substance harms, substance use, crime, alcohol.

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## INTRODUCTION

In 2002, Pernanen *et al.* developed a methodology and conceptual framework for estimating the association between substance use (SU) and crime in Canada [1], based on a model originally proposed by Goldstein [2]. Using samples of Canadian provincial offenders, federal offenders and arrestees, the authors estimated the proportion of crimes committed in Canada that were a result of alcohol or illicit

drug use. In 2006, Rehm *et al.* [3] applied these proportions, or attributable fractions (AFs), to estimate the cost of crime attributable to SU in Canada.

Since 2002, more comprehensive survey data have been collected that permit calculation of improved estimates of SU related AFs for crime. In addition, since 2002 there is a need to develop AF for more categories of substances. Pernanen *et al.* developed AFs for alcohol and a large, non-specific, category they called 'illicit drugs'.

This category included cannabis, opioids and cocaine as well as other psychoactive substances. In 2020, the Canadian Substance Use Costs and Harms (CSUCH) Scientific Working Group released a full assessment of the costs and harms associated with SU in Canada spanning 2015 to 2017 [4]. To conduct this assessment, the association between more categories of substances and crime was assessed for a number of reasons. First, the non-medical use of cannabis was legalized in Canada as of October 2018. Determining the association between cannabis and crime is important, so that the contribution of cannabis to crime can be monitored before and after legalization. Next, in 2017 there were almost 4000 opioid-related deaths in Canada [5] and 47 600 in the United States [6]. Therefore, it is also important to monitor the unique contribution of opioids to crime.

### Causal relationship between substance use and crime

There are four causal models that have been used to estimate the proportion of crimes attributable to SU [7,8]. They are the intoxication model, the economic–compulsive model, the systemic model and the substance-defined model. Briefly, these models are as follows.

#### *The intoxication model (IM)*

The IM, also variously referred to as the ‘pharmacological model’ or the ‘disinhibition model’, posits that substance intoxication has a direct, causal relationship with criminal behaviour. Criminal acts that are explained via the IM would not have occurred if the individual was not under the influence of alcohol or other substances [1,8].

#### *The economic–compulsive model (ECM)*

According to the ECM, some crimes are motivated by the desire to acquire a substance(s) or resources to purchase a substance and would not have occurred if the individual committing the crime did not have a substance use disorder (SUD) [1,8].

#### *The substance-defined model (SDM)*

Also referred to as the ‘illegal system’ model, the SDM includes crimes which are defined as being criminal as a direct result of laws regulating the production, sale and possession of controlled substances. As Pernaenen *et al.* [1] noted, this model is not a causal one, but instead represents a tautological connection between crime and substance use. In other words, these crimes are a direct result of drug prohibition laws. Thus, when drug laws change the number of substance-defined crimes change accordingly. Crimes explained via this model are considered 100% attributable to SU.

#### *The systemic model (SM)*

Crimes that are explained by the SM include criminal acts that would not have occurred if the individual had not been involved with the illicit substance-related economy, but are illegal regardless of the legal status of the drug. For example, assault is illegal regardless of whether or not a controlled substance is involved. However, assault associated with the collection of drug-related debts would be considered a crime explained by the SM. Examples include crimes committed while selling drugs, collecting drug debts or fighting over drug territory. AFs associated with the SM are challenging to calculate, as the data sources that can be used to determine them are difficult to acquire.

To estimate the proportion of crimes that can be considered causally associated with crime according to the IM and the ECM, Pernaenen *et al.* [1] obtained response data from the computerized lifestyle assessment instrument (CLAI), a survey used by the Correctional Service of Canada (CSC) from 1990 to 1999 to assess offenders’ need for substance use treatment. However, since Pernaenen *et al.*’s report, new assessment instruments have been implemented within the CSC. Building upon the methodology developed by Pernaenen *et al.* [1], we describe the calculation of new SU-related AFs for a greater number of substances.

This paper describes the development of fractions that estimate the proportion of violent and non-violent crimes attributable to seven substance use categories: (1) alcohol, (2) cannabis, (3) opioids, (4) other central nervous system (CNS) depressants (including benzodiazepines, barbiturates, etc.), (5) cocaine, (6) other CNS stimulants (including amphetamine, methamphetamine and ecstasy) and (7) other substances (including hallucinogens and inhalants).

## METHODS

### Participants

Between 2006 and 2016, approximately 59% ( $n = 27\ 803$ ) of all male offenders who entered federal correctional institutions in Canada completed the substance use supplementary intake assessment within 2 weeks of intake to assess whether they required treatment for substance use-related problems. Between 2011 and 2016, 81% ( $n = 1335$ ) of female federal offenders completed the assessment (described below).

### Measures

#### *Computerized assessment of substance abuse (CASA)*

The CASA [9] is a component of the federal offender intake assessment process. The men’s CASA (M-CASA) is a 171-item questionnaire designed to explore the nature

and seriousness of an offender's substance use problems. Items included in the M-CASA are grouped to form 16 content areas including patterns and severity of alcohol and drug use and the relationship between substance use and crime. The M-CASA was nationally implemented in 2006 and continues to be administered in 2020. The questionnaire administered to women offenders is referred to the Women's CASA (W-CASA [10]). It was modelled from the M-CASA and is a 221-item computerized assessment tool designed to assess substance use-related issues, especially those salient to women. The W-CASA was nationally implemented in 2011 and continues to be administered in 2020. In the event that an offender had been administered the M-CASA or W-CASA on more than one occasion (approximately 5% of men and 2% of women), response information corresponding to their most serious offence was used.

#### *The alcohol dependence scale (ADS)*

The ADS [11,12] is a 25-item self-report measure that provides a quantitative assessment of the severity of alcohol dependence. The ADS groups respondents based on level of severity during the 12-month period prior to assessment and has been widely used as a research and clinical tool [11–14]. Sensitivity and specificity have been found to be assessed at 74 and 92%, respectively [15]. The ADS is embedded within both versions of the CASA ( $\alpha = 0.98$  for both men and women).

#### *The drug abuse screening test (DAST)*

The DAST [15] is a self-report measure designed to assess severity of drug abuse. Comprised of 20 items with a 'yes' or 'no' response format, the DAST yields a total score (ranging from 0 to 15) representing the severity of psychosocial impairment resulting from drug use. The scale demonstrated excellent reliability ( $\alpha = 0.91$  for men and 0.98 for women). Specificity and sensitivity have been found to be 79 and 96%, respectively [14]. The DAST is embedded within both versions of the CASA.

#### *Offence category*

Offences were grouped into four offence categories: violent crimes, non-violent crimes, impaired driving and substance-defined crimes. Violent crimes included convictions for murder (homicide), assault, robbery with violence, sexual assault and kidnapping. Non-violent crimes included convictions for theft, break and enter, fraud, possession of a weapon, escape, arson, obstruction of justice and major driving offences (other than driving while intoxicated). Impaired driving and substance-defined crimes (i.e. incarceration for the possession, trafficking or manufacturing of controlled substances) are considered 100% attributable to substances and were therefore excluded ( $n = 8649$ ).

#### **Calculating the proportion of crimes committed due to intoxication (IM)**

In order to determine the proportion of crimes that can be identified as IM crimes, we calculated the number of offenders reporting that the offence for which they were convicted would not have occurred had they not been intoxicated at the time of their offence. Among men offenders, this was determined by a positive response to M-CASA items: 'Were you under the influence of alcohol on the day of the offence?' and 'Do you think you still would have committed this offence had you not been drinking?'. For other substances this was determined by a positive response on another two items: 'Were you under the influence of drugs on the day of your current offence?' and 'Do you think you still would have committed this offence if you had not been using drugs?'. Then, using the question: 'What drug(s) were you under the influence of on the day you committed your current offence?', we were able to determine which substance(s) the offender reported was associated with the crime for which they were incarcerated. When respondents indicated more than one substance, a weight of 1.0 was equally distributed between the reported substances. Therefore, although some respondents indicated more than one substance, the count still sums to the number of respondents who indicated that one or more substances were associated with the crime for which they were incarcerated. For women, although the wording of the questions on the W-CASA was slightly different (i.e. 'Were you under the influence of alcohol or drugs the time of your current offence(s)?', 'Do you believe you would have committed this offence if you were not using?' and 'Which substance(s) were you using at the time of the offence?'), the same method was applied. Please note that this analysis was not pre-registered and therefore the results should be considered exploratory

#### **Calculating the proportion of crimes committed to acquire substances (ECM)**

The proportion of crimes explained by the ECM is the second key piece of information required to calculate the overall SU-associated AFs. In order to determine the proportion of crimes that can be explained by the ECM, we first determined the number of crimes that were committed in order to support the offender's alcohol or drug use [1,8]. Among men offenders, this was determined using the following M-CASA items: 'Did you commit current offence(s) to support your drinking?' and 'Did you commit current offence(s) to support your drug use?'. In order to ensure that we did not count individuals more than once when deriving the final AFs, we also calculated the number of individuals responding positively to one of these two questions if they did not indicate that they attributed their crime to

intoxication. Finally, only crimes committed by those with a SUD are considered to be explained by the ECM which satisfies the 'compulsive' portion of the model [8]. In order to determine the proportion of offenders with a SUD, we then only selected those individuals who were identified by CSC assessment practices as having a moderate, substantial or severe alcohol or substance use disorder (SUD). Included on the M-CASA and W-CASA is a question asking offenders to identify the drug used most often during the past 12 months prior to incarceration. This question was used to categorize SUD offenders by drug category. When respondents were identified as both alcohol- and substance-dependent, the count was equally distributed between alcohol and the reported substance (i.e. 0.5 and 0.5).

### AFs for the systemic model

As noted above, AFs associated with the systemic model are challenging to calculate, as data sources that can be used to determine them are difficult to acquire. Pernanen *et al.* [8] argued that most crimes identified in the systemic model will have already been taken into account via the IM and the ECM. Pernanen *et al.* [1] found that when adding the systemic component to their two-factor model (i.e. AFs incorporating the IM and the ECM) it increased the overall AF from 0.57 to 0.58. In the CSUCH report [4], in order to include the systemic model in the AFs used to calculate the number of violent and non-violent crimes that could be attributable to SU, this difference of 0.01 was divided over six drug categories (not including alcohol), two offence categories and two sexes by adding 0.0004 to each of the 24 AFs (calculated by dividing 0.01 by  $6 \times 2 \times 2$ ). However, systemic crimes are not incorporated into the AFs presented below.

## RESULTS

### Sample characteristics

Table 1 lists the number of incarcerated offenders who completed the M-CASA or W-CASA between 2006 and

**Table 1** Total number of incarcerated offenders who completed the CASA or WCASA between 2006 and 2016 by offence category.

Offence category	Total
Violent crimes	15 132
Non-violent offences	5357
Impaired driving	1209
Substance defined offences	7440
Total	29 138

CASA = Computerized Assessment of Substance Abuse; WCASA = Women's CASA.

2016 by offence category. As noted, those entering federal custody for impaired driving or substance-defined offences were excluded. Therefore, AFs were calculated using 20 489 responses: 15 132 responses among those incarcerated for violent offences and 5357 responses among those incarcerated for non-violent offences.

### Proportion of crimes explained by the IM

The number of offenders who reported that their conviction and subsequent incarceration was due to being intoxicated at the time of their most serious offence by substance are presented in Table 2. To calculate the proportion of crime attributable to SU according to the IM model, we then calculated the proportion of offenders incarcerated for intoxication-caused offences out of the total number of offenders incarcerated for either violent or non-violent offences. For example, according to Table 2, 2915.4 offenders indicated that they would not have committed violent offences had they not been intoxicated from alcohol. Dividing this number by the total number offenders incarcerated due to a violent crime and who completed the M-CASA or W-CASA between 2006 and 2016 (15 132, see Table 1) we get 0.1927.

### Proportion of crimes explained by the ECM

The proportions of crimes explained by the ECM are presented in Table 3. To calculate, similar to the IM proportions, we first counted all those who reported committing the offence to support their alcohol or SU and were alcohol- ( $n = 688$ ) or substance-dependent ( $n = 4025.5$ ) (fractions due to missing data). Among those with an SUD, we attributed the crime to the substance they reported using most often in the past 12 months. If both alcohol- and substance-dependent, the offender was allocated 0.5 to alcohol and 0.5 to the substance. To calculate the proportion of crime attributable to SU according to the ECM, we then simply divided counts of alcohol- and substance-dependent offenders whose crime was explained by the ECM by all offenders incarcerated for violent and non-violent crimes. We also performed the same calculation after those whose crimes were accounted for by the IM model were subtracted from the numerator. This permitted us to add the resulting proportion to the IM proportion and calculate AFs for the full model without counting offenders more than once.

### Proportion of violent and non-violent crimes attributable to substance use

To obtain the overall substance-use AFs for both violent and non-violent crime we simply summed  $AF_{IM}$  and  $AF_{ECM}$  for each substance by offence category combination. The results are presented in Table 4.



**Table 2** Number of offenders self-reporting that the offence for which they were convicted would not have occurred had they not been intoxicated by a substance and attributable fractions for substance use attributable crime according to the intoxication model.

Substance	Violent offences		Non-violent offences	
	Total number of offenders	AF <sub>IM</sub> <sup>a</sup>	Total number of offenders	AF <sub>IM</sub> <sup>a</sup>
Alcohol	2915.4	0.1927	369.1	0.0689
Cannabis	733.6	0.0485	140.8	0.0263
Opioids	641.7	0.0424	305.6	0.0570
Other CNS depressants	167.8	0.0111	50.6	0.0094
Cocaine	1469.3	0.0971	547.9	0.1023
Other CNS stimulants	454.7	0.0301	146.9	0.0274
Other substances	129.4	0.0086	31.3	0.0058
Total, <i>n</i>	6512.0	0.4303	1592.1	0.2972
All offenders in sample	15 132		5357	

<sup>a</sup>AF<sub>IM</sub> = attributable fraction explained by the intoxication model (IM). CNS = central nervous system. The total number of offenders do not add up to whole numbers due to weighting method applied when participants indicated that they were under the influence of more than one substance.

**Table 3** Number of substance dependent offenders self-reporting they committed the offence they were incarcerated for in order to support their substance use. Numbers in parentheses exclude those indicating that intoxication caused them to commit the offence (in order to avoid double counting when calculating fractions in the full model).

Categories of substance dependents	Violent offences		Non-violent offences	
	Total	AF <sub>ECM</sub> <sup>a</sup>	Total	AF <sub>ECM</sub> <sup>a</sup>
Alcohol-dependent (ADS)	577.5 (96.5)	0.0382 (0.0064)	110.5 (16.0)	0.0206 (0.0030)
Drug-dependent (DAST)	2659.0 (322.0)	0.1757 (0.0213)	1366.5 (138.0)	0.2551 (0.0258)
All offenders in sample	15 132		5357	
Among those drug-dependent, substance used most often in 12 months prior to incarceration				
Cannabis	514.5 (93.0)	0.0340 (0.0061)	213.5 (25.5)	0.0399 (0.0048)
Opioids	692.5 (64.0)	0.0458 (0.0042)	358.0 (30.0)	0.0668 (0.0056)
Other CNS depressants	27.0 (4.5)	0.0018 (0.0003)	10.5 (1.0)	0.0020 (0.0002)
Cocaine	1201.0 (133.0)	0.0794 (0.0088)	657.0 (66.5)	0.1226 (0.0124)
Other CNS stimulants	188.0 (22.5)	0.0124 (0.0015)	110.0 (13.0)	0.0205 (0.0024)
Other substances	36.0 (5.0)	0.0024 (0.0003)	17.5 (2.0)	0.0033 (0.0004)
Total, <i>n</i>	3236.5 (418.5)	0.2139 (0.0277)	1477.0 (154.0)	0.2757 (0.0287)

<sup>a</sup>AF<sub>ECM</sub> = attributable fraction explained by the economic compulsive model (ECM). IM = intoxication model; CNS = central nervous system. There were 2678.5 participants incarcerated for violent crime (322.5 excluding crimes explained by the IM) and 1378.5 (138.0) incarcerated for non-violent crime that were classified as drug-dependent. However, data on substances used most often in the year prior to incarceration were only available for 2659.0 (322.0) and 1366.5 (138.0); thus, 0.73% and 0.87% of the data (respectively) were missing. These missing data were due to survey administration errors and not systematically associated with the variables under examination. The total number of offenders does not add up to whole numbers due to weighting method applied to responses when participants indicated that when they committed the offence they were incarcerated to support both alcohol and drug use.

## DISCUSSION

According to our newly generated AFs, just over 42% of crime would probably not have occurred if the perpetrator had not been under the influence of or seeking alcohol or other drugs. It is important to note that this percentage excludes crimes considered 100% attributable to substances—specifically, impaired driving and substance-defined crimes (i.e. possession, trafficking and manufacturing of controlled substances defined by the Canadian Controlled Drugs and Substances Act). Interestingly, our total SU AFs are very similar to those reported by Pernanen and colleagues using federal offender data from the CLAI [1].

In their study, published in 2002 using data from the 1990s, the authors reported that 47% of all crimes (excluding those considered wholly attributable to drugs) were attributable to alcohol and drug use; this provides evidence, in Canada, showing that the association between crime and SU has remained broadly stable over time.

In our AFs alcohol, the legal, most available and widely marketed substance, was associated with the greatest proportion of crimes (approximately 17%) compared to other substances such as cocaine (11%) and opioids (5%). Alcohol was also disproportionately associated with violent versus non-violent offences (approximately 20 versus 7%, respectively). In contrast, all other psychoactive substance

**Table 4** Attributable fractions for substance use related crime (including the IM and ECM models).

Substance	Attributable fractions		
	Violent offences	Non-violent offences	All offences <sup>a</sup>
Alcohol	0.1991	0.0719	0.1658
Cannabis	0.0546	0.0311	0.0485
Opioids	0.0466	0.0626	0.0508
Other CNS depressants	0.0114	0.0096	0.0109
Cocaine	0.1059	0.1147	0.1082
Other CNS stimulants	0.0315	0.0298	0.0311
Other substances	0.0089	0.0062	0.0822
All substances combined	0.4581	0.3259	0.4235

<sup>a</sup>Excludes impaired driving and drug-defined offences. ECM = economic compulsive model; IM = intoxication model; CNS = central nervous system.

categories combined were associated with 26% of all violent crime and 25% of non-violent crime. Specifically, cocaine was associated with a similar proportion of violent and non-violent crime (approximately 11%) whereas opioids were associated with a higher proportion of non-violent crimes (approximately 6%) than violent crimes (approximately 5%). These findings suggest that interventions aimed at increasing public safety by targeting the link between substance use and crime may achieve greater impact by investing more resources into interventions aimed at reducing alcohol consumption. This could be accomplished by investing in individually directed interventions such as promoting low-risk drinking guidelines [16] or implementing public policy interventions demonstrated to reduce alcohol consumption such as alcohol minimum unit pricing, limiting availability, placing restrictions on the marketing of alcohol [17,18] or other high-impact strategies recommended by the World Health Organization SAFER initiative [19].

#### Possible uses of new crime-related attributable fractions

As noted, the calculated AFs were used to estimate the criminal justice costs of SU in Canada from 2015 to 2017 [4]. To do so, the attributable fractions presented were adjusted to be sensitive to geographical or temporal fluctuations in SU prevalence and applied to counts of partially attributable criminal code incidents (to estimate policing costs), charges (to estimate court costs) and admissions to correctional facilities (to estimate correctional costs). The result was then added to the number of fully attributable incidents, charges or admissions and divided by the total to assess the proportion of SU attributable counts. The resulting proportions were then applied to the total cost associated with policing, court and correction costs by year and province/territory.

The results indicated that in 2017, more than \$9 billion was spent on SU-attributable criminal justice costs.

Alcohol accounted for almost one-third of these costs at \$2.8 billion. Following alcohol, cocaine was the substance responsible for the highest costs to the criminal justice system (\$2.6 billion), followed closely by cannabis (\$1.6 billion), despite past-year prevalence rates of less than 2% in the Canadian general population. Cocaine was associated with 10.7% of all violent crime and 10.5% of all non-violent offences (not including 100% SU-attributable crimes).

#### Limitations

The AFs presented here offer improvements over those produced previously. For example, self-report surveys were administered to offenders within the first 2 weeks of their incarceration and included questions about the influence of alcohol [20]. Nonetheless, there are several limitations.

First, only federal offenders were administered the survey instruments. In Canada, federal and provincial offender populations differ, as offences committed by federal offenders are typically more severe and exclude non-violent or drug-related offences receiving alternative sanctions to incarceration (i.e. diversion, community service, etc.). The result is that serious crime categories may be overrepresented, perhaps overestimating the proportion of violent crime associated with SU. However, the magnitude of this possible overestimation is unknown, as we are unaware of any data describing the number of offenders receiving alternative sanctions to incarceration.

A second limitation of the study involves the reliance upon offender self-report data. Specifically, offenders may not be truthful or be subject to recall bias in reporting the details of their criminal behaviour or the extent of their SU. Further, delays between the offences in question and admission to federal institutions can increase the probability of recall bias. In Canada, court processing times from arrest to incarceration can be upwards of 1 year [21]. Although offender self-report has been used extensively to measure criminal behaviour [22–25], the AFs developed

here are subject to biases associated with this method of data collection (e.g. memory or recall errors, concealment or exaggeration, etc.). However, given that we were unable to directly observe the crimes for which they were incarcerated or obtain any other direct data, self-report represents the next best source of information regarding the role of substances in their crime. A third limitation of this work involves polysubstance use and the IM. In the present study when this occurred, responsibility was ascribed to each substance equally. Future research should focus upon developing a method for ascribing responsibility differentially for criminal acts explained via the IM when more than one substance is involved. Finally, it is important to note that the costs of substance use attributable crime to the criminal justice system represent a small fraction of the true social costs of crime and do not include victim costs, lost productivity costs due to incarceration or other intangible costs [26].

## CONCLUSIONS

By drawing upon a rich data set of more than 29 000 offenders incarcerated for a variety of violent and non-violent crimes, we were able to estimate the proportions of these crimes that would not have occurred had an individual not been under the influence of or seeking alcohol or other drugs.

In Canada, we have been able to use the AFs presented here to conduct a comprehensive assessment of the costs associated with crime in Canada from 2007 to 2014 ([www.csuch.ca](http://www.csuch.ca)). It is hoped that others interested in estimating the impact of SU on their criminal justice system will be able to use the AFs described in this paper.

## Declaration of interests

T.S., J.S. and A.S. have each received travel expenses from Scandinavian government alcohol retail monopolies (Systembolaget and/or Alko) to take part in a project to assess the public health impacts of their policies. T.S. also received a consulting fee for this work, and A.S. and J.S. received salary contributions. The other authors have no conflicts to declare.

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## Author contributions

**Matthew Young:** Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology;

project administration; supervision. **Chealsea DeMoor:** Conceptualization; formal analysis; investigation; methodology. **Pamela Kent:** Conceptualization; formal analysis; funding acquisition; investigation; methodology; project administration. **Tim Stockwell:** Conceptualization; methodology. **Adam Sherk:** Conceptualization; methodology. **Jinhui Zhao:** Conceptualization; formal analysis; methodology. **Justin Sorge:** Conceptualization; methodology. **Shanna Farrell MacDonald:** Data curation; formal analysis; methodology. **John Weekes:** Conceptualization; investigation. **Bridget Maloney-Hall:** Methodology. **Emily Biggar:** conceptualization; methodology.

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