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Constructing Historical Cannabis Consumption Volume Estimates for Canada, 1960 to 2015

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Release date: February 21, 2018

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.   not available for any reference period
..   not available for a specific reference period
...   not applicable
0   true zero or a value rounded to zero
0^s value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
^{p} preliminary
^{r} revised
x   suppressed to meet the confidentiality requirements of the *Statistics Act*
^{E} use with caution
F   too unreliable to be published
*   significantly different from reference category (p < 0.05)

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by

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Economic Analysis Division and Health Analysis Division
Statistics Canada

February 2018

Analytical Studies: Methods and References

Papers in this series provide background discussions of the methods used to develop data for economic, health, and social analytical studies at Statistics Canada. They are intended to provide readers with information on the statistical methods, standards and definitions used to develop databases for research purposes. All papers in this series have undergone peer and institutional review to ensure that they conform to Statistics Canada's mandate and adhere to generally accepted standards of good professional practice.

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Abstract

This paper discusses the process for estimating the volume of cannabis consumption in Canada by age group from 1960 to 2015. Cannabis consumption is estimated using a model that first estimates the number of cannabis consumers among 15- to 17-year-olds, 18- to 24-year-olds, 25- to 44-year-olds and 45- to 64-year-olds. This is accomplished by estimating cannabis consumption prevalence based on multiple survey data sources. For each age group, consumers are divided into categories based on annual frequency of consumption: once in the past year, less than once a month, one to three times a month, weekly (excluding daily) and daily. Each category of frequency of consumption is then associated with a quantity of cannabis consumed.

1   Introduction

On April 13, 2017, the Government of Canada tabled legislation to legalize the recreational use of cannabis in Canada. As a result, it will be necessary to adjust statistical measures of economic activity in the Canadian System of Macroeconomic Accounts (CSMA) to include the volume, price and value of cannabis produced, distributed and consumed by Canadians (Statistics Canada 2017, Tebrake 2017). To do so, Statistics Canada has been releasing a sequence of reports and data sets to help inform about the size and composition of the cannabis market. The first estimates for the volume of cannabis consumption were published in December 2017 (Macdonald and Rotermann 2017). These estimates documented the progression of cannabis consumption by age group in Canada from 1960 to 2015. The Cannabis Stats Hub subsequently incorporated these estimates by basing its trend estimates for cannabis consumption on them, and extending the data up to 2017. A detailed discussion of available survey data sources and an examination of recent trends in the prevalence of cannabis use in Canada can be found in Rotermann and Macdonald (2018). This paper provides a detailed methodology for how the time series for cannabis consumption between 1960 and 2015 are estimated.

Cannabis consumption presents an unusual challenge for integration into the CSMA because national accounts estimates do not include illegal activity.[1] And, while the recent development of a medicinal cannabis market is captured in some national accounts statistics, there is no formal designation for the medical cannabis market. Moreover, cannabis has been widely available in Canada despite its prohibition, and many people regularly consume it recreationally. Consequentially, a fully formed market for recreational cannabis exists outside the boundaries of what is measured as economic activity. Additionally, existing data sources for consumption do not permit a disaggregation between the legal medical market and the illegal, recreational market. As a result, including cannabis consumption in the CSMA requires integrating an estimate for the entire cannabis market. This may create a discontinuity through time if the market value of cannabis consumption is simply added to current consumption estimates once recreational cannabis consumption is legalized.

Some policy questions also require information on the shares of activity in the black market and the legal market. For example, information about total market size and composition is important for evaluating the degree to which the legal market is replacing the black market.

To address these challenges, modern and historical data sources are integrated to estimate the volume of cannabis consumption from 1960 to 2015. This period covers the illegal market and the legal market as it has developed. It also allows for the creation of a time series long enough that including it, or portions of it, will maintain the time series consistency of the CSMA.

It is critical to recognize explicitly at the outset that estimating cannabis consumption involves considerable uncertainty. This uncertainty increases the further into the past one goes because sources of information are more limited and data sources are less consistent. This occurs because cannabis consumption was illegal during these periods, so limited information exists about the size and composition of the cannabis market in Canada. Moreover, the information that does exist exhibits a tendency towards underreporting because of the legal penalties and social stigma associated with cannabis consumption (Rotermann and Macdonald 2018). As a result, strong assumptions must be used to construct estimates. These assumptions are difficult to test, and their validity can affect the estimate of the volume of consumption.

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1. However, the CSMA does include an estimate for grey market, or "underground", activity, such as cash payments to a contractor.

Two main types of data sources can be used to estimate the volume of consumption of illegal narcotics in Canada: health, addiction, and drug/tobacco/alcohol use monitoring surveys; and law enforcement data. To estimate the volume of cannabis consumption for this paper, health, addiction, and drug/tobacco/alcohol use monitoring surveys data are used (e.g., OPBO 2016; ESPAD 2015; Abramsky and Drew 2014; Kilmer et al. 2013, 2011). To do so, population estimates are combined with an estimate of the proportion of cannabis consumers by age group, an estimate of the frequency of use and an estimate of consumption by frequency. The age groups used are 15 to 17 years, 18 to 24 years, 25 to 44 years and 45 to 64 years. Combining these estimates and aggregating across groups allows a volume estimate of cannabis consumption to be tabulated.

The results show that the total consumption of cannabis has tended to increase for a long time. In the early to mid-1960s, before the rapid spread of cannabis consumption among 15- to 17-year-olds and 18- to 24-year-olds, it is estimated that 24 to 29 tonnes of cannabis were consumed annually in Canada. By 1972, this had increased to 223 tonnes. The increase slowed over the rest of the 1970s and the early 1980s, but consumption reached 361 tonnes in 1984. The volume of consumption fell as the adjusted and benchmarked estimate for consumption prevalence and the number of adjusted consumers declined through the latter half of the 1980s and the early 1990s, reaching a low of 203 tonnes in 1992. Volumes quickly recovered over the next decade and reached 483 tonnes by 2001. The volume of consumption stabilized around an average of 475 tonnes from 2002 to 2010. A period of rapid increase then occurred from 2010 to 2015, culminating in an estimated 697 tonnes of cannabis being consumed in Canada in 2015.

The granularity of the estimates permits an examination of the age groups responsible for growth in cannabis consumption across periods. The growth in the cannabis market in the late 1960s and early 1970s comes from younger age groups (15- to 17-year-olds and 18- to 24-year-olds). However, after the early 1970s, growth comes from older age cohorts, as the volume of consumption by younger groups does not exhibit an upward tendency.

The remainder of this paper is structured as follows. Section 2 discusses the data sources, and Section 3 outlines the methodology. Section 4 describes how the necessary parameters are estimated, while Section 5 reports the results. Section 6 then examines the sensitivity of the estimates, and Section 7 concludes the paper.

2   Data sources

This study uses data from a range of sources. These include the report by the Office of the Parliamentary Budget Officer (PBO) (OPBO 2016), whose methodology this report expands upon; estimates of cannabis consumption prevalence and frequency from numerous surveys; and Statistic Canada's population estimates.

Data drawn from the PBO report are noted in the discussion of parameter estimates and are used here because they facilitate comparisons between this work and that of the PBO. They are also used because they are professionally sourced and examined, and because there are no reasonable grounds to challenge these estimates, given the paucity of information regarding some cannabis consumption questions.

Survey estimates are drawn predominantly from national surveys, with the exception of earlier periods when less data are available.

The national surveys include the 1970 surveys for the Commission of Inquiry into the Non-Medical Use of Drugs, commonly referred to as the Le Dain Commission (Le Dain 1972); the Health Promotion Survey (HPS) (Statistics Canada n.d.*a*, n.d.*b*); the National Alcohol and Drug Survey (NADS) (Statistics Canada n.d.*c*); the General Social Survey (GSS) (Statistics Canada n.d.*d*); Canada's Alcohol and Other Drugs Survey (CADS) (Statistics Canada n.d.*e*); the Canadian Community Health Survey (CCHS) (Statistics Canada n.d.*f*, n.d.*g*); the Canadian Addiction Survey (CAS) (Adlaf, Begin and Sawka 2005); the Canadian Alcohol and Drug Use Monitoring Survey (CADUMS) (Health Canada n.d.); the Canadian Tobacco Use Monitoring Survey (CTUMS) (Statistics Canada n.d.*h*); and the Canadian Tobacco, Alcohol and Drugs Survey (CTADS) (Statistics Canada n.d.*i*, n.d.*j*).

Early-period estimates are taken from surveys conducted by the Centre for Addiction and Mental Health (CAMH) and by independent researchers.

The CAMH data are used because they report on Ontario, which is the most populous province, and because of their extended time series. Both the Ontario Student Drug Use and Health Survey (OSDUHS) of high school students (Boak et al. 2015) and the CAMH Monitor (Ialomiteanu et al. 2016), which surveys people aged 18 and older, began in 1977. The former is conducted every two years, while the latter was conducted in particular years up to 2006, after which it has been conducted annually.

Published results from independent researchers are taken from Lanphier and Phillips[2] (1971); Smart and Fejer (1971); Smart, Fejer and White (1972); Rootman (1972); and Currie, Perlman and Walker (1977). Most of these studies focus on high-school-aged people, so this age group has the majority of the data points for this period.

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2. Lanphier and Phillips published results based on work done for the Commission of Inquiry into the Non-Medical Use of Drugs.

The surveys from which the data are drawn typically target the Canadian population aged 15 and older, but a number of people are excluded. People younger than 15 are assumed to consume sufficiently small quantities of cannabis that their exclusion will not have an impact on the results. Common survey exclusions are people living in institutions, people living on reserves, people serving in the Canadian Forces, people living in the territories and people without a landline telephone (see Rotermann and Macdonald 2018). To produce an estimate of the cannabis-consuming population, the estimate of the Canadian population aged 15 and older is used instead of the population estimate from the individual surveys. This imposes the assumption that the excluded population has the same characteristics as the surveyed population.[3]

Population estimates by age for the years 1960 to 1970 are taken from CANSIM Table 051-0026 (Statistics Canada n.d.*k*), while estimates for the years 1971 to 2016 are taken from CANSIM Table 051-0001 (Statistics Canada n.d.*l*). These population estimates are aggregated into five age categories. The first four correspond to the age categories used to estimate prevalence: 15 to 17 years, 18 to 24 years, 25 to 44 years and 45 to 64 years.

The fifth category is for people aged 65 years and older. People in this category are included in order to match the target population from the national surveys that are employed as data sources. This age group is assumed not to engage in noteworthy levels of cannabis consumption, and are included only for the purpose of examining the rate of cannabis use for the Canadian population aged 15 and older.

3   Methodology

There are three steps for combining the information on cannabis consumption to produce an estimate of the volume of cannabis consumed.

First, the number of cannabis consumers is estimated. This is accomplished by multiplying a benchmarked prevalence estimate by the population estimate. The prevalence estimate is constructed from survey responses where participants indicated whether or not they had consumed cannabis in the previous year. For some early studies, the prevalence question refers to the previous six months.

To estimate prevalence, four age groups are used: 15 to 17 years, 18 to 24 years, 25 to 44 years and 45 to 64 years. Each age group is treated separately, allowing for the examination not only of the total quantity of cannabis consumed, but of the evolution of the age composition of cannabis consumption over long periods of time.

For each age group, the number of consumers in each year is estimated as follows:

$$Consumers_{i,t} = \underset{\text{Population}}{p_{i,t}} \times \underset{\text{Prevalence}}{\% \mathrm{p}_{i,t}}$$

$$i = 15 \text{ to } 17, \ 18 \text{ to } 24, \ 25 \text{ to } 44, \ 45 \text{ to } 64 \qquad\qquad (1)$$

$$t = 1950 \text{ to } 2015$$

where $p_{i,t}$ is the population of each age group and $\% \mathrm{p}_{i,t}$ is the benchmarked prevalence of people in each age group who reported consuming cannabis in the previous year.

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3. This follows the approach taken by the PBO.

Second, the frequency distribution of cannabis consumers for each age group and the frequency-specific underreporting factor are used to allocate the number of consumers into the frequency categories and adjust for underreporting. These estimates are assumed to be fixed through time. The number of adjusted consumers in each age group in each year by frequency of consumption is expressed as follows:

$$
\begin{aligned}
&\hat{C}onsumers_{k,i,t} = \left(Consumers_{i,t} \times \% F_k\right) \times F_k \\
&k = once, 0 \geq 1/\text{month}, 1 \text{ to } 3/\text{month}, \min\{1\}/\text{week}, daily \\
&i = 15 \text{ to } 17, 18 \text{ to } 24, 25 \text{ to } 44, 45 \text{ to } 64 \\
&t = 1950 \text{ to } 2015
\end{aligned}
\tag{2}
$$

where $Consumers_{i,t}$ is the number of consumers in each age group as estimated in step 1, F is the frequency-specific adjustment factor for underreporting, $\% F$ is the proportion of consumers from each age group reporting different frequencies of consumption and $\hat{C}onsumers$ is the adjusted number of consumers.

Third, the volume of consumption for each age group in each year by frequency type is calculated as follows:

$$
\begin{aligned}
&volume_{k,i,t} = \hat{C}onsumers_{k,i,t} \times \text{Average consuming days}_k \times \text{Grams/Day}_k \\
&k = once, 0 \geq 1/\text{month}, 1 \text{ to } 3/\text{month}, \min\{1\}/\text{week}, daily \\
&i = 15 \text{ to } 17, 18 \text{ to } 24, 25 \text{ to } 44, 45 \text{ to } 64 \\
&t = 1950 \text{ to } 2015
\end{aligned}
\tag{3}
$$

where $\hat{C}onsumers_{k,i,t}$ is the adjusted number of consumers from Equation (2), $\text{Average consuming days}_k$ is an estimate of the average number of days on which consumption occurs for each frequency category and Grams/Day_k is the quantity of cannabis consumed each day for each frequency group.

4   Parameter estimates

4.1   Prevalence of consumption

To estimate the benchmarked prevalence of cannabis consumption, a meta-analysis and instrumental variable approach is used. In this approach, estimates for growth rates and levels are combined, allowing data sources to be used based on their relative strengths. This effectively decomposes the problem into two distinct elements: estimating as accurately as possible the level of the prevalence of cannabis consumption and estimating as accurately as possible the growth rates or path through time of the prevalence of cannabis consumption.

The survey data sources are divided between those to use as benchmarks and those to use as projectors (Table 1). The choice of benchmark series stems from the likelihood that these data sources have more accurate results (Rotermann and Macdonald 2018) or from an inability to use them as projectors because of their intermittent nature. The projector series candidates are grouped according to collection methodology and collector, reflecting quality or bias differences stemming from these differences (Rotermann and Macdonald 2018).

Table 1

Surveys including data on cannabis consumption, by use

	Benchmark series	Projectors
Included	Canadian Community Health Survey – Mental Health	**Group 1**
	Canadian Community Health Survey – Mental Health and Well-being	Canadian Tobacco, Alcohol and Drugs Survey
		Canadian Tobacco Use Monitoring Survey
		Group 2
		Centre for Addiction and Mental Health
		Group 3
		Early academic studies
		Le Dain Commission
Excluded	Health Promotion Survey	**Group 4**
	Canada's Alcohol and Other Drugs Survey	Canadian Addiction Survey
	National Alcohol and Drug Survey	Canadian Alcohol and Drug Use Monitoring Survey
	General Social Survey	

Source: Statistics Canada, authors' compilation.

4.1.1 Benchmark estimates

The 2002 Canadian Community Health Survey – Mental Health and Well-being (CCHS-MHW) and the 2012 Canadian Community Health Survey – Mental Health (CCHS-MH) are assumed to have the least error because of their data collection method, their relatively larger sample sizes and the context within which their questions were posed (Rotermann and Macdonald 2018). The HPS, CADS, NADS and GSS present data that are interspersed enough that using them amounts to an additional benchmarking exercise. They were considered as a group for inclusion as benchmarks for the 1980s and 1990s. However, series created using them as benchmarks generate results significantly at odds with other data sources, ultimately leading to their omission from the time series construction exercise. The prevalence estimates from the CCHS-MHW and the CCHS-MH form the benchmark levels to which movements through time are affixed.

4.1.2 Projector estimates

To construct time series projectors, the survey data are grouped by collection methodology and collection source to limit the extent to which bias from different methodologies can influence trend estimates for cannabis consumption prevalence. Here, four groups are used:

- Group 1: data collected by Statistics Canada (CTUMS and CTADS)
- Group 2: the CAMH estimates (OSDUHS and Monitor)
- Group 3: early estimates (Le Dain Commission and academic studies)
- Group 4: CAS and CADUMS.

For the CAMH estimates, the age groups do not align exactly with the age groups available from later surveys. The same is true of independent studies from earlier periods. This feature of the data is difficult to control for. Here, the CAMH data and the data from earlier periods are used as instrumental variables rather than as direct observations. For the CAMH data, combinations of different age groups, weighted by population, are used. Based on examinations with other data points, they exhibit a strong correlation, supporting their use as instruments. For earlier-period surveys, the results are assumed to be acceptable, as it is not possible to compare overlapping periods.

Analysis of the time series properties of data from these groups shows clearly that the trends in data from Group 1 and Group 2 are consistent, but that data from Group 4 can be at odds with other sources. It is unclear how data from Group 3 compare with other sources, as there is no overlapping data from which comparisons can be made.

Therefore, time series projectors are created as follows. The same approach is used for all age groupings back to 1977. First, data from CTUMS and CTADS are used to interpolate for 2014. Based on the growth rate between the benchmarks from 2002 to 2012, the implied projector data point is projected for 2002, and then the missing value is interpolated for 2013. The CAMH data are used to chain the series back to 1977 (or the earliest year available for older age groupings).

For earlier periods, more judgment is applied to promote time series consistency because fewer data points are available. For 15- to 17-year-olds, the projector continues to backcast by linking data from CAMH to that from Smart, Fejer and White (1972). Beginning in 1970, the Le Dain Commission data are incorporated. The direct question on cannabis consumption prevalence is used as is for this age group, and the information from the graphical question is used to back-chain the series to the earliest year possible. This produces a projector that, after benchmarking, fits well with observed information. For 18- to 24-year-olds, the growth rate between the study by Smart and Fejer (1971) and the 1977 data point based on the CAMH data is used to create the historical projection. From this projected point, the Le Dain Commission survey data are used to back-chain the prevalence estimate. This produces a benchmarked estimate that is higher than the published estimates but maintains the relative position of the early data points compared with those of later periods. For 15- to 17-year-olds and 18- to 24-year-olds, the time series are assumed to be constant from the earliest data point back to 1960. This creates a low level of early total consumption that helps in applying time series filters. For 25- to 44-year-olds, there are more limited data available. Prevalence estimates for this age group are projected back to 1971 based on the growth rate between CAMH and Smart and Fejer (1971). The level from Lanphier and Phillips (1971) is then used as is for 1970. For 45- to 64-year-olds, the prevalence series are assumed to begin in 1977 and are based on back-chaining to the earliest data point from the CAMH.

4.1.3   Benchmarked estimates

Charts 1 through 4 show the results of the benchmarking exercise, along with the source data estimates and the results of including the extended group of HPS, CADS, NADS and GSS benchmarks. The results present three salient points.

First, there is sufficient information on cannabis consumption in Canada to construct long-run estimates of the benchmarked prevalence of consumption. These estimates can be constructed for different age groups, and, as the benchmarking exercise shows, not all data sources should be used in constructing the time series. It is beneficial to omit certain data to improve the projection and benchmarking results. It is also important to note that the data are not of consistent quality, and data from further in the past should be viewed as less exact than modern estimates. Moreover, the benchmarked estimates do not correspond to the values derived directly from surveys (except for the benchmark CCHS-MH and CCHS-MHW data points), and this discrepancy can be larger for historical periods.

Second, using the extended set of benchmarks leads to benchmarked series that are too low in historical periods. They are too low compared with existing survey estimates and compared with results from the United States for the two younger age groups (Appendix A).

Chart 1
Estimated prevalence of cannabis consumption in Canada, persons aged 15 to 17

percent

Note: The potential benchmark values form the HPS, NADS and GSS are reported in a single sequence.
Sources: Statistics Canada, 2012 Canadian Community Health Survey - Mental Health (CCHS-MH), 2002 Canadian Community Health Survey - Mental Health and Well-being (CCHS-MHW), 1985 Health Promotion Survey (HPS), 1994 National Alcohol and Drug Survey (NADS), 1993 General Social Survey - Personal Risk (GSS) (Cycle 8), 2004 to 2012 Canadian Tobacco Use Monitoring Survey (CTUMS), February to December 2013 and 2015 Canadian Tobacco, Alcohol and Drugs Survey (CTADS); G. Le Dain (chairman), 1972, *Cannabis: A Report on the Commission of Inquiry into the Non-Medical Use of Drugs* (Le Dain Commission); A. Boak et al., 2015, Centre for Addition and Mental Health (CAMH) Research Document Series, no. 41; A.R. Ialomiteanu et al., 2016, CAMH Research Document Series, no. 45; E.M. Adlaf et al., 2005, *Canadian Addiction Survey (CAS): A National survey of Canadians' use of alcohol and other drugs: Prevalence of use and related harms: detailed report*; Health Canada, 2008-to-2012 reports, Canadian Alcohol and Drug Use Monitoring Survey (CADUMS). For other individual studies, please see the References.

Chart 2
**Estimated prevalence of cannabis consumption in Canada,
persons aged 18 to 24**

percent

- – – · CCHS-MH and CCHS-MHW
- ● HPS, NADS and GSS
- ■— CTUMS and CTADS
- ●— CAMH, ages 18 to 29
- ◆ Le Dain Commission (simple response)
- – – – Le Dain Commission (graphic question)
- ■ Lanphier and Phillips (1971), college and university
- ■ Smart and Fejer (1971), Toronto, ages 18 to 25
- ▬ ▬ CAS and CADUMS
- —— Benchmarked series (CCHS-MH and CCHS-MHW only)
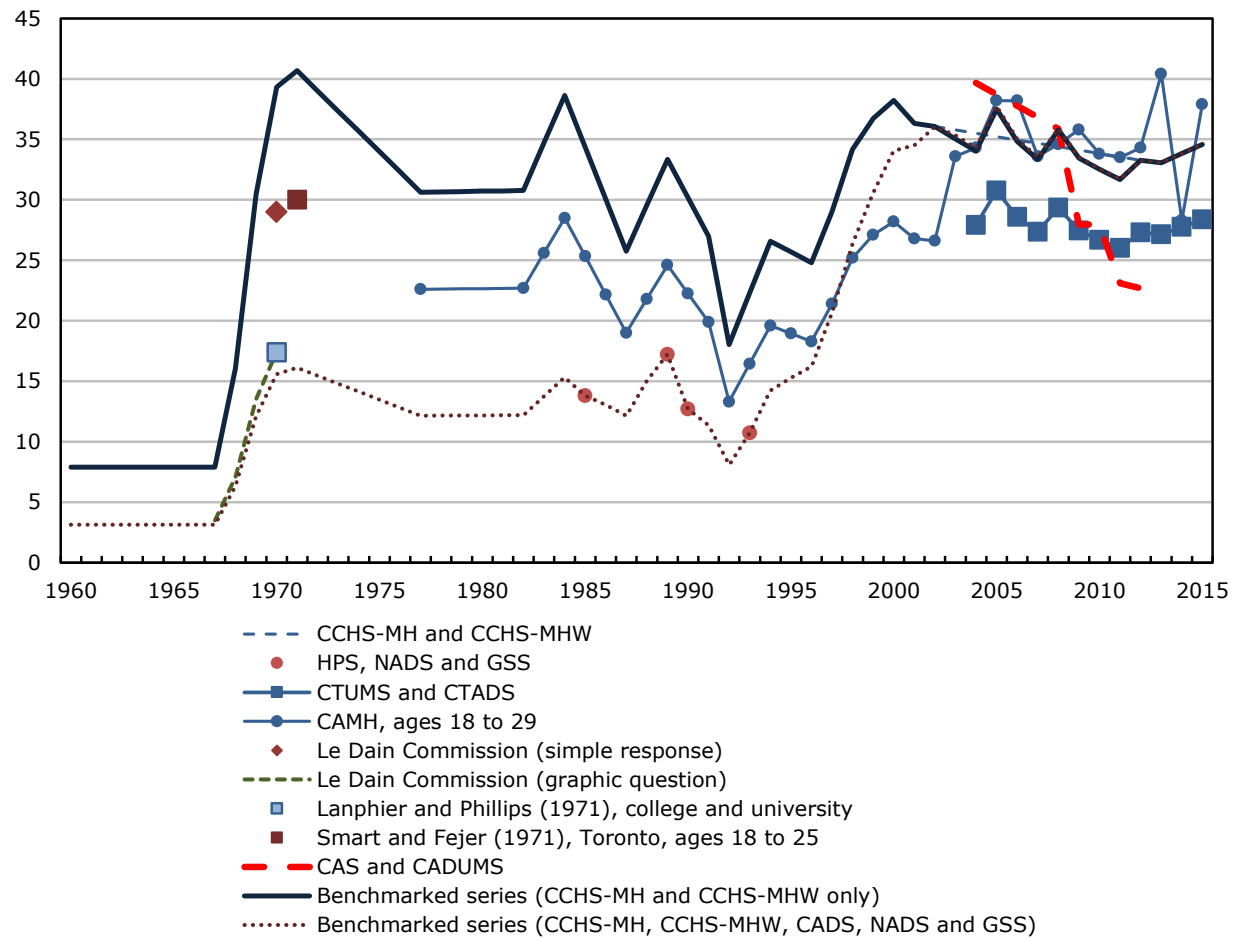- ········ Benchmarked series (CCHS-MH, CCHS-MHW, CADS, NADS and GSS)

Note: The potential benchmark values form the HPS, NADS and GSS are reported in a single sequence.
Sources: Statistics Canada, 2012 Canadian Community Health Survey - Mental Health (CCHS-MH), 2002
Canadian Community Health Survey - Mental Health and Well-being (CCHS-MHW), 1985 Health Promotion
Survey (HPS), 1994 National Alcohol and Drug Survey (NADS), 1993 General Social Survey - Personal Risk
(GSS) (Cycle 8), 2004 to 2012 Canadian Tobacco Use Monitoring Survey (CTUMS), February to December 2013
and 2015 Canadian Tobacco, Alcohol and Drugs Survey (CTADS); G. Le Dain (chairman), 1972, *Cannabis: A
Report on the Commission of Inquiry into the Non-Medical Use of Drugs* (Le Dain Commission); A. Boak et al.,
2015, Centre for Addition and Mental Health (CAMH) Research Document Series, no. 41; A.R. Ialomiteanu et al.,
2016, CAMH Research Document Series, no. 45; E.M. Adlaf et al., 2005, *Canadian Addiction Survey (CAS): A
National survey of Canadians' use of alcohol and other drugs: Prevalence of use and related harms: detailed
report*; Health Canada, 2008-to-2012 reports, Canadian Alcohol and Drug Use Monitoring Survey (CADUMS). For
other individual studies, please see the References.

Chart 3
**Estimated prevalence of cannabis consumption in Canada,
persons aged 25 to 44**

percent

- - - CCHS-MH and CCHS-MHW
 ● HPS, NADS and GSS
───■─── CTUMS and CTADS
───●─── CAMH, ages 30 to 49
 ▪ Lanphier and Phillips (1971), adults
 ● Smart and Fejer (1971), Toronto, ages 26 to 35
 ■ Smart and Fejer (1971), Toronto, ages 36 and older
━ ━ ━ CAS and CADUMS
───── Benchmarked series (CCHS-MH and CCHS-MHW only)
·········· Benchmarked series (CCHS-MH, CCHS-MHW, HPS, NADS and GSS)
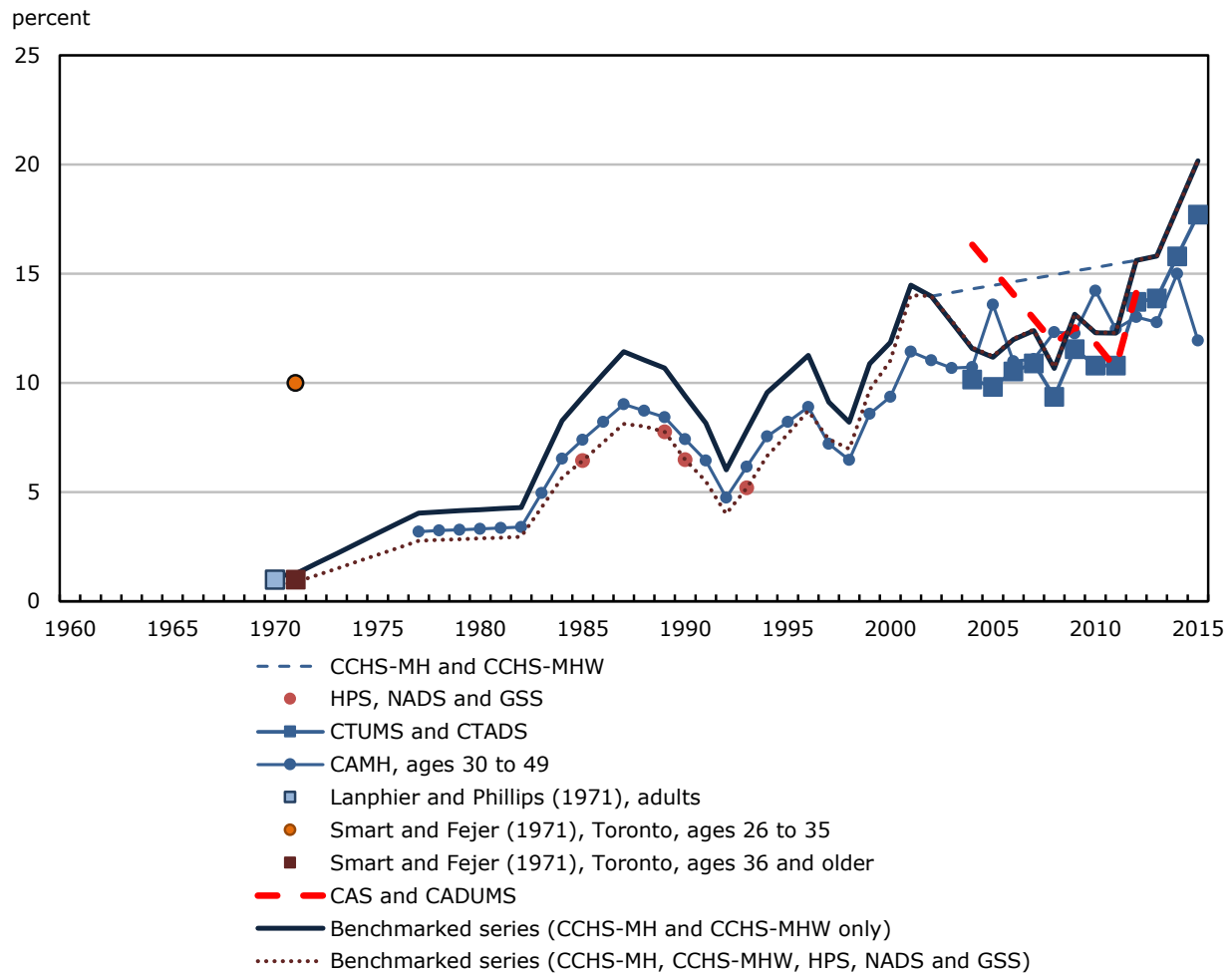
Note: The potential benchmark values form the HPS, NADS and GSS are reported in a single sequence.
Sources: Statistics Canada, 2012 Canadian Community Health Survey - Mental Health (CCHS-MH), 2002
Canadian Community Health Survey - Mental Health and Well-being (CCHS-MHW), 1985 Health Promotion
Survey (HPS), 1994 National Alcohol and Drug Survey (NADS), 1993 General Social Survey - Personal Risk
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Report on the Commission of Inquiry into the Non-Medical Use of Drugs* (Le Dain Commission); A. Boak et al.,
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2016, CAMH Research Document Series, no. 45; E.M. Adlaf et al., 2005, *Canadian Addiction Survey (CAS): A
National survey of Canadians' use of alcohol and other drugs: Prevalence of use and related harms: detailed
report*; Health Canada, 2008-to-2012 reports, Canadian Alcohol and Drug Use Monitoring Survey (CADUMS). For
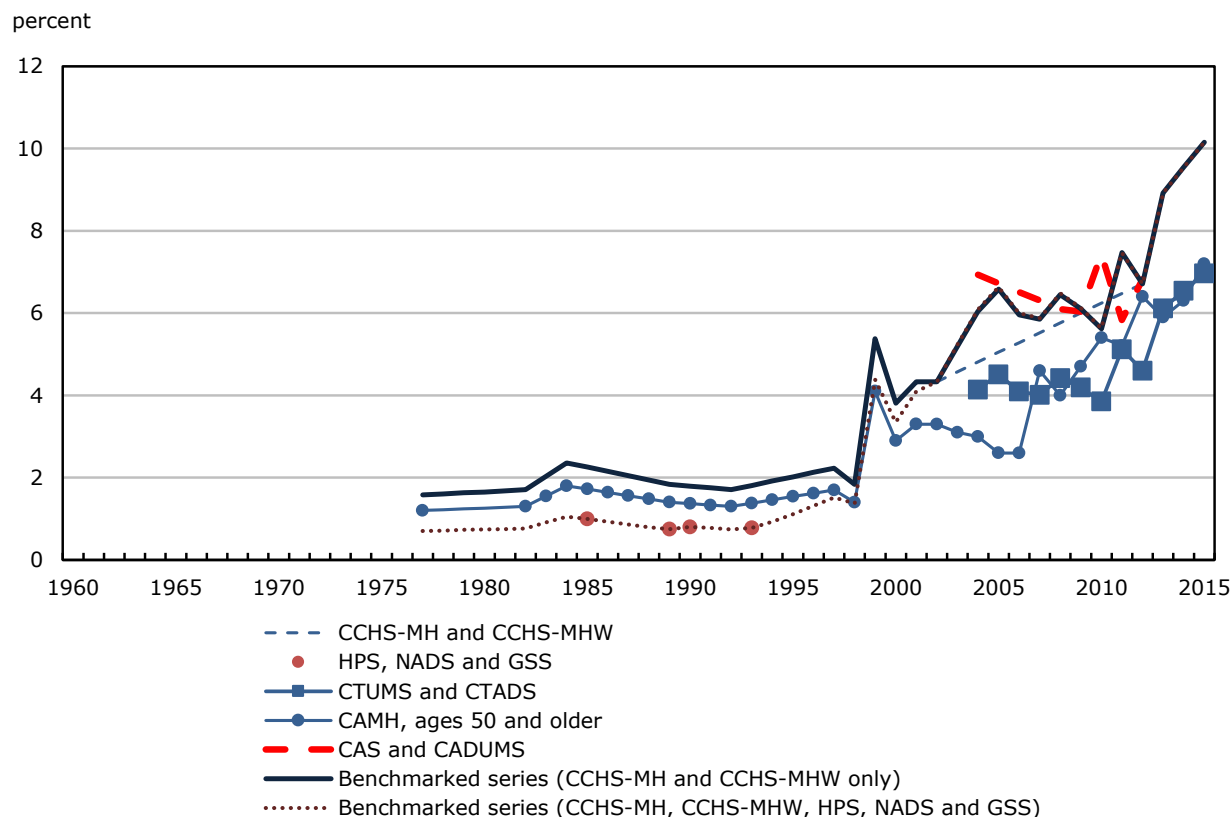other individual studies, please see the References.

Chart 4
**Estimated prevalence of cannabis consumption in Canada,
persons aged 45 to 64**

percent

CCHS-MH and CCHS-MHW
● HPS, NADS and GSS
■ CTUMS and CTADS
● CAMH, ages 50 and older
▬ ▬ CAS and CADUMS
Benchmarked series (CCHS-MH and CCHS-MHW only)
········· Benchmarked series (CCHS-MH, CCHS-MHW, HPS, NADS and GSS)
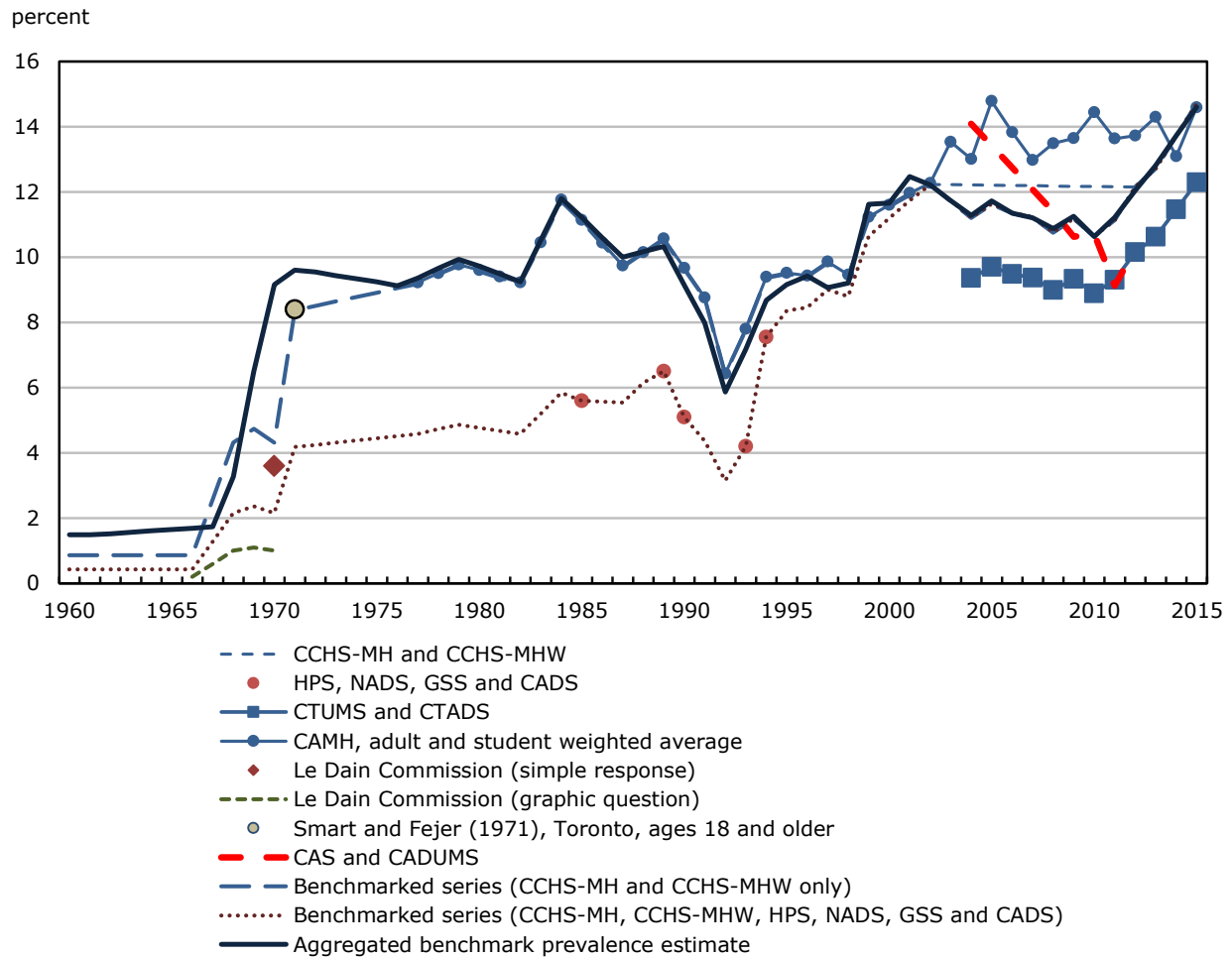
Note: The potential benchmark values form the HPS, NADS and GSS are reported in a single sequence.
Sources: Statistics Canada, 2012 Canadian Community Health Survey - Mental Health (CCHS-MH), 2002 Canadian Community Health Survey - Mental Health and Well-being (CCHS-MHW), 1985 Health Promotion Survey (HPS), 1994 National Alcohol and Drug Survey (NADS), 1993 General Social Survey - Personal Risk (GSS) (Cycle 8), 2004 to 2012 Canadian Tobacco Use Monitoring Survey (CTUMS), February to December 2013 and 2015 Canadian Tobacco, Alcohol and Drugs Survey (CTADS); A. Boak et al., 2015, Centre for Addition and Mental Health (CAMH) Research Document Series, no. 41; A.R. Ialomiteanu et al., 2016, CAMH Research Document Series, no. 45; E.M. Adlaf et al., 2005, *Canadian Addiction Survey (CAS): A National survey of Canadians' use of alcohol and other drugs: Prevalence of use and related harms: detailed report*; Health Canada, 2008-to-2012 reports, Canadian Alcohol and Drug Use Monitoring Survey (CADUMS). For other individual studies, please see the References.

Third, prevalence estimates from CAS and CADUMS present a noticeably different time path from other data sources. For 15- to 24-year-olds, the difference is less pronounced and manifests itself as a stronger decline in prevalence than is shown in other data sources. For older age groups, the CAS and CADUMS data show a declining prevalence rather than a rising prevalence. Given their differences from other survey data (see Rotermann and Macdonald 2018) and their contradictory information, CAS and CADUMS are viewed as aberrant observations[4] and are not used to assess changes in prevalence through time.

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4. "Aberrant observation" is the statistical term for data points that are noticeably different from the majority of data. They can occur for a variety of reasons, such as the use of different populations or different methodologies and concepts, measurement error, data entry errors, or changes in economic or societal conditions. Aberrant observations are not necessarily "bad data." For example, models that seek to estimate general responses from consumers to price changes must adjust for periods of recession, when data on household behaviour are different from the majority of observations. These data are thus termed aberrant. For the purpose of constructing an extended timeline of cannabis consumption prevalence by age group, the CAS and CADUMS data present results that can be significantly at odds with other data sources and are consequently not used for constructing time trends.

Chart 5
Estimated prevalence of cannabis consumption in Canada, persons aged 15 to 64

percent

- - - CCHS-MH and CCHS-MHW
● HPS, NADS, GSS and CADS
■ CTUMS and CTADS
● CAMH, adult and student weighted average
◆ Le Dain Commission (simple response)
- - - Le Dain Commission (graphic question)
● Smart and Fejer (1971), Toronto, ages 18 and older
▬ ▬ CAS and CADUMS
— — Benchmarked series (CCHS-MH and CCHS-MHW only)
······· Benchmarked series (CCHS-MH, CCHS-MHW, HPS, NADS, GSS and CADS)
——— Aggregated benchmark prevalence estimate

Note: The potential benchmark values form the HPS, NADS, GSS and CADS are reported in a single sequence.
Sources: Statistics Canada, 2012 Canadian Community Health Survey - Mental Health (CCHS-MH), 2002 Canadian Community Health Survey - Mental Health and Well-being (CCHS-MHW), 1985 Health Promotion Survey (HPS), 1994 National Alcohol and Drug Survey (NADS), 1993 General Social Survey - Personal Risk (GSS) (Cycle 8), 1994 Canada's Alcohol and Other Drugs Survey (CADS), 2004 to 2012 Canadian Tobacco Use Monitoring Survey (CTUMS), February to December 2013 and 2015 Canadian Tobacco, Alcohol and Drugs Survey (CTADS); G. Le Dain (chairman), 1972, *Cannabis: A Report on the Commission of Inquiry into the Non-Medical Use of Drugs* (Le Dain Commission); A. Boak et al., 2015, Centre for Addition and Mental Health (CAMH) Research Document Series, no. 41; A.R. Ialomiteanu et al., 2016, CAMH Research Document Series, no. 45; E.M. Adlaf et al., 2005, *Canadian Addiction Survey (CAS): A National survey of Canadians' use of alcohol and other drugs: Prevalence of use and related harms: detailed report*; Health Canada, 2008-to-2012 reports, Canadian Alcohol and Drug Use Monitoring Survey (CADUMS). For other individual studies, please see the References.

Given the available data sources, there are two approaches that can be used to estimate cannabis consumption prevalence for people aged 15 and over. The first is to use the estimates of prevalence for people aged 15 and over from survey data to create a benchmarked estimate following the same approach used above for the four age groups. The other is to aggregate the benchmarked values from the four age groups to estimate prevalence for people aged 15 and over. The results of both approaches are presented in Chart 5 where the line for the CCHS only benchmark (the result using the same approach chosen above from the four age groups) and the line for the aggregated benchmark values are shown. The difference between the aggregated benchmark values and the CCHS only values is minimal after 1975. Prior to 1975, however, there is a difference that results from more information being available to estimate prevalence for people aged 15 to 17 and people aged 18 to 24. This occurs because more data were collected on the consumption patterns of young people than on those of the whole population. Given the greater information present for the younger age groups, the estimate for prevalence among persons aged 15 and over is based on the aggregated benchmark value.[5]

4.2   Frequency of consumption

Estimates of the frequency of consumption are derived from the 2012 CCHS-MH. The frequency of consumption is categorized as consuming cannabis once in the past year, less than once a month, one to three times a month, at least once a week (excluding daily) or daily. The CCHS-MH has a sufficiently large sample that frequencies can be calculated by age for all age groups considered here.

Rotermann and Langlois (2015) previously examined the frequency of consumption by age group, and the PBO (OPBO 2016) looked at it for the total population. In these assessments, the frequency is reported relative to the population in each age group. Here, the frequency distribution of each age group is used (Table 2). This allows the population of cannabis consumers from each age group to be allocated into the frequency categories.

Table 2
Cannabis consumption frequency by age and underreporting factor

Frequency	15 to 17 years	18 to 24 years	25 to 44 years	45 to 64 years	Underreporting factor
	percent				scalar
Once in the past year	0.15	0.08	0.03	0.03	1.125
Less than once a month	0.31	0.33	0.38	0.39	1.125
One to three times a month	0.22	0.20	0.17	0.14	1.125
At least once a week (excludes daily)	0.22	0.24	0.28	0.26	1.125
Daily	0.10	0.15	0.14	0.18	1.063

Source: Statistics Canada, authors' calculations based on data from M. Rotermann and K. Langlois, 2015, "Prevalence correlates of Marijuana use in Canada, 2012" and the Office of Parliamentary Budget Officer, 2016, *Legalized Cannabis: Fiscal Considerations.*

An underreporting factor, taken from the PBO (OPBO 2016), is also applied. The underreporting factor represents an attempt to adjust for the tendency of survey respondents to underreport their actual consumption patterns for questions that may involve social stigma or criminal charges. The underreporting factor is assumed to be fixed for all years.

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5. Using the bottom-up approach creates a prevalence estimate for people aged 15 and older that differs from that reported in the CCHS-MH and CCHS-MHW. This occurs because the population used to establish the number of cannabis consumers differs from the in-scope population of the CCHS-MH and CCHS-MHW. For each age group, the prevalence estimates match the benchmark, but a difference can arise when aggregation occurs and from the exclusion of people 65 and over from the cannabis consumption estimates.

4.3 Average consumption days and grams per day

The estimate for the average consumption days per year by frequency of use is taken from the PBO (OPBO 2016).[6] Given the lack of information about average consumption days, and the PBO's care in constructing such an estimate for Canada, the PBO's figures are assumed to be representative of the average consumption days of the Canadian population over time (Table 3).

Table 3
Average consumption days per year and grams consumed per day by frequency of consumption

Frequency	Average cannabis consumption	
	days per year	grams per day
Once in the past year	1.0	0.30
Less than once a month	6.5	0.30
One to three times a month	24.0	0.67
At least once a week (excludes daily)	208.0	1.01
Daily	365.0	1.60

Source: Office of Parliamentary Budget Officer, 2016, *Legalized Cannabis: Fiscal Considerations.*

The estimate of the number of grams per day is taken from the PBO (OPBO 2016). It is calculated based on the PBO's interpretation of the work of Light et al. (2014). The PBO provides upper and lower bounds to represent uncertainty around the estimate. Here, the midpoint is used. As there is limited information on the amount consumed, values from the 2016 study are assumed to be constant across time and age groups.

5 Time series estimates

The process of constructing the time series model parameters produces three pieces of information that provide insight into the size, composition and evolution of cannabis consumption in Canada. The first is the number of adjusted consumers. This is the number of estimated consumers in each age group including the frequency-specific underreporting adjustment, and it will be higher than results compiled directly from the underlying surveys. It informs about the age composition of cannabis consumers.

The second is the benchmarked and adjusted prevalence of cannabis consumption. The benchmarked and adjusted prevalence for cannabis consumption is calculated as the ratio of the number of adjusted cannabis consumers to the population for each age group and for the population 15 and over. The levels of the benchmarked and adjusted prevalence of cannabis consumption are higher than those found in survey data. The time trends from the underlying data, however, are reflected in the benchmarked and adjusted estimates. The benchmarked and adjusted prevalence estimates illustrate the estimated frequency of consumption used in the model after all adjustments and inform about how that frequency adjusts over time.

The third is the volume of consumption measured in tonnes of cannabis consumed.

5.1 Adjusted consumers and the benchmarked and adjusted consumption prevalence

The results show a long-run positive trend in the number of adjusted consumers in Canada and the benchmarked and adjusted prevalence of consumption (Chart 6).

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6. See Appendix A.

In the early part of the period, estimates suggest a benchmarked and adjusted prevalence rate around 1.7%. This comes from the consumption of cannabis among 15- to 17-year-olds and 18- to 24-year-olds, which accords with observations made by the Le Dain Commission (Le Dain 1972). After a rapid increase through the late 1960s and early 1970s, benchmarked and adjusted prevalence rates reached 10.7% in 1971. The year 1970 marks the point at which 25- to 44-year-olds began consuming cannabis in this study. Through the 1970s and mid-1980s, the trend in consumption is moderately positive. There is some variance that resulted in a local peak in the benchmarked and adjusted consumption prevalence of 13.2% in 1984. The benchmarked and adjusted prevalence of cannabis consumption in Canada then declined to 6.6% in 1992 before returning to pre-decline levels through the 1990s. There was a local peak in 2001 at 13.9% before several years of decline, leading to a return to a rapid increase in the benchmarked and adjusted prevalence of cannabis consumption around 2010. In 2015, the benchmarked and adjusted prevalence estimate was 16.3%, which is the highest in the time series.

The positive trend in the adjusted number of cannabis consumers in Canada over the 1960-to-2015 period is stronger than the trend in benchmarked and adjusted prevalence. In several periods, the number of adjusted consumers increased more rapidly or more slowly than its trend. A rapid increase occurred around the late 1960s and early 1970s as reported cannabis consumption became more widespread. Through the 1970s and mid-1980s, the number of adjusted consumers continued to rise, but at a slower rate. The increase was interrupted by a short-term decline in the number of adjusted consumers that occurred from the mid-1980s to the early 1990s. Through the 1990s, the number of adjusted consumers once again increased, and this increase was more rapid than that experienced from the early 1970s to the mid-1980s. The 2000s were a stable period before the number of adjusted consumers increased from 2010 to 2015.

Chart 6
Benchmarked and adjusted prevalence of cannabis consumption and number of adjusted cannabis consumers aged 15 and over, 1960 to 2015

consumers (000s)   prevalence (percent)

Adjusted consumers (persons)   ----- Benchmarked and adjusted prevalence (percent)
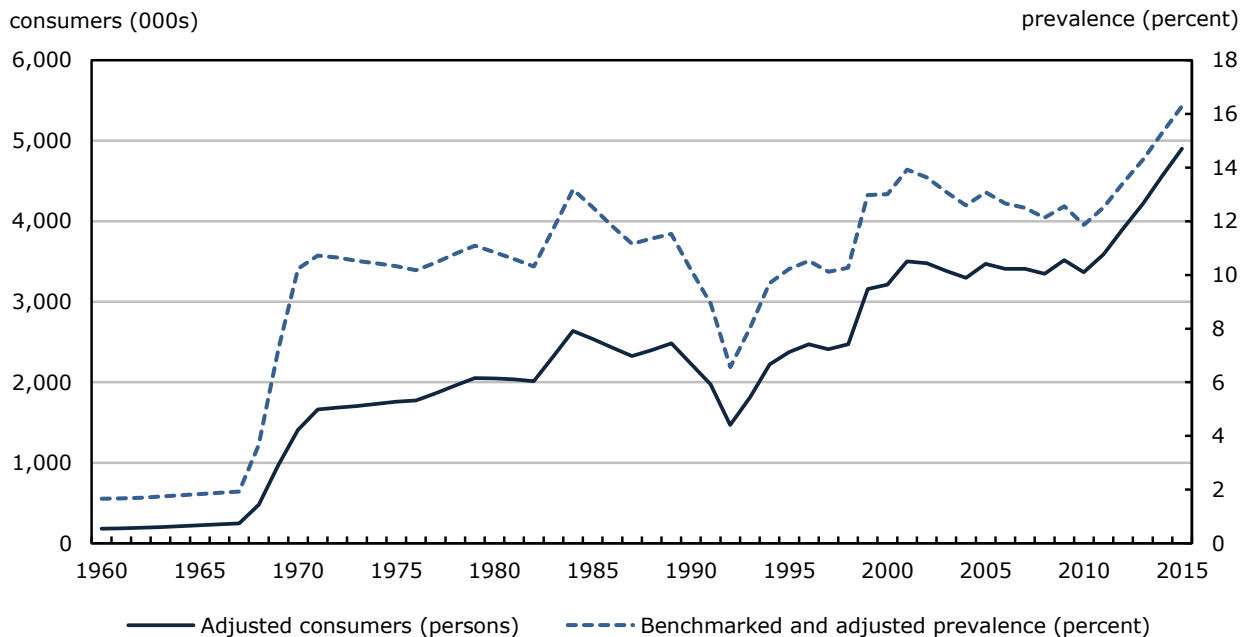
Source: Statistics Canada, authors' calculations.

Chart 7
Benchmarked and adjusted prevalence of cannabis consumption by age group, 1960 to 2015

percent
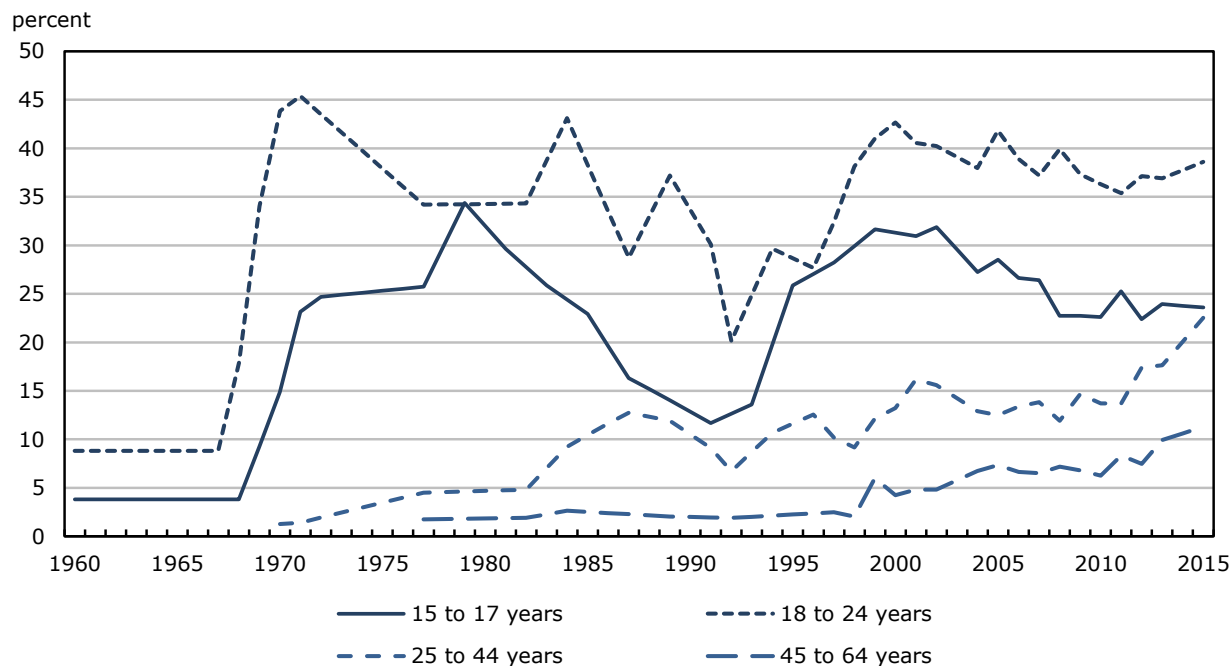
Source: Statistics Canada, authors' calculations.

The movement around the trend growth in the adjusted cannabis-consuming population does not stem from the same age groups through time (Chart 7).

The early increases of the late 1960s and early 1970s are centred on the change in benchmarked and adjusted prevalence for 15- to 17-year-olds and 18- to 24-year-olds. Through the 1970s and early 1980s, the benchmarked and adjusted prevalence of cannabis consumption in these age groups was stable or may have declined. The degree of variance in the time series makes it difficult to assess the stability of these age groups in this period. However, 25- to 44-year-olds experienced an unambiguous increase in their consumption prevalence.

The decline in the estimated number of adjusted cannabis consumers in Canada from the mid-1980s to the early 1990s is the result of declines in the benchmarked and adjusted consumption prevalence among 15- to 17-year-olds, 18- to 24-year-olds and 25- to 44-year-olds. The largest decline came from the first two of these age groups. The benchmarked and adjusted prevalence among these two age groups also rebounded the most through the 1990s and is a primary source of the increase in the benchmarked and adjusted prevalence and adjusted number of cannabis consumers through the 1990s.

Chart 8
Composition of the adjusted cannabis-consuming population by age group, 1960 to 2015

percent

■ 15 to 17 years　　■ 18 to 24 years　　■ 25 to 44 years　　■ 45 to 64 years
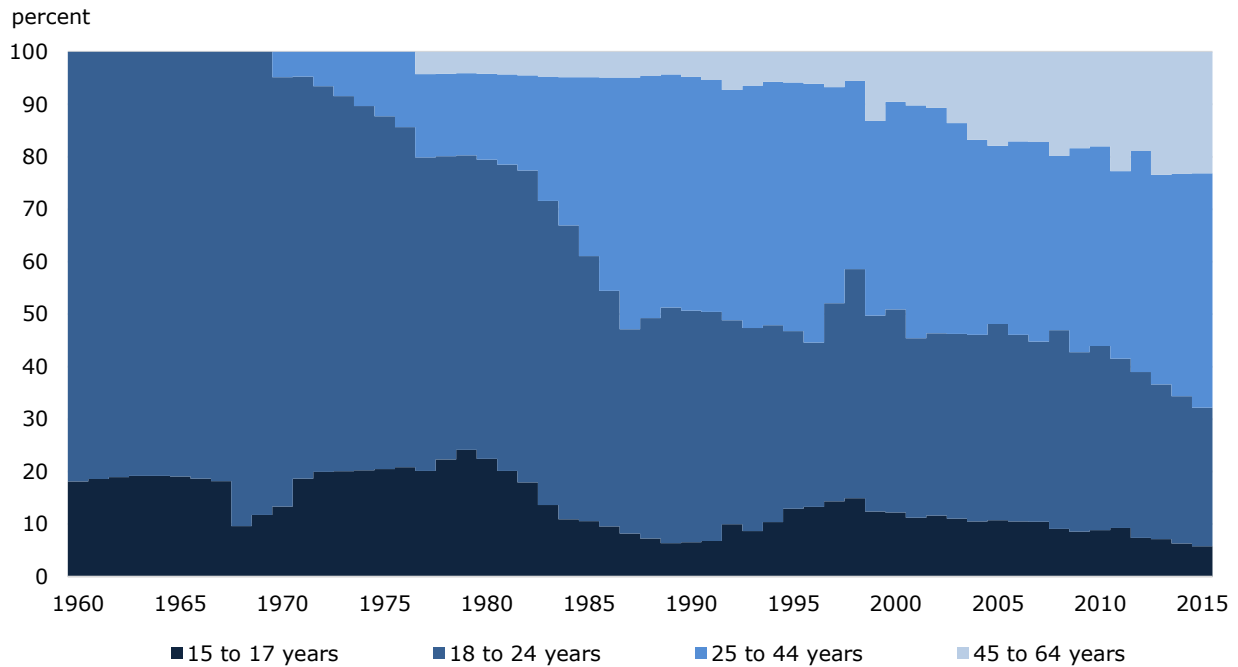
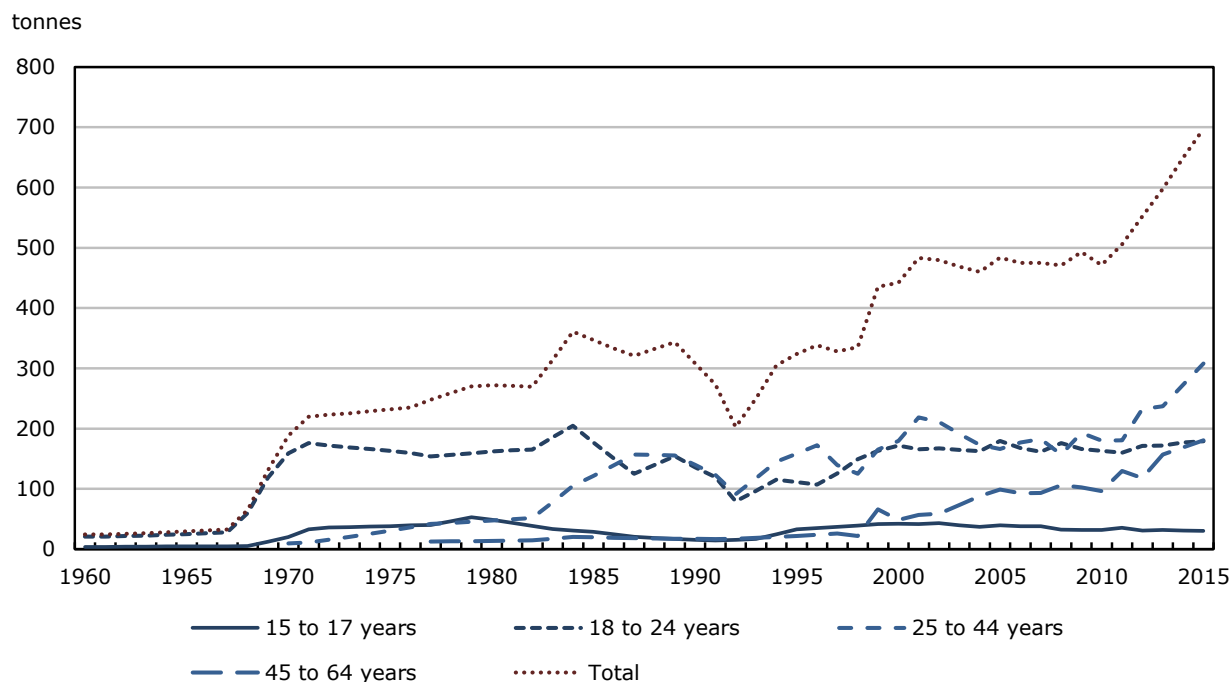**Source:** Statistics Canada, authors' calculations.

During the 2000s, the adjusted number of cannabis consumers was stable, as declines in benchmarked and adjusted prevalence among younger age groups were offset by rising benchmarked and adjusted prevalence among older age groups. The tendency of declining benchmarked and adjusted prevalence among younger age groups continued until the end of the period. However, after 2010, it was outweighed by an increasing tendency to consume among older age groups.

As a result of the changing benchmarked and adjusted prevalence rates across age groups and the aging of the baby boomer cohort, the composition of the cannabis-consuming population changes in a noteworthy fashion over time. In the years when boomers were in high school and university, youth dominated the cannabis market (Chart 8). However, after 1970, there was a steady movement towards older age cohorts that continued until the end of the period. The movement towards older cohorts occurred as the boomers transitioned across age groups. The share of the population of cannabis consumers aged 15 to 17 and aged 18 to 24 fell below 50% for the first time in 1987 and 1988. While it rose above the 50% threshold a number of times in subsequent years, the trend in the declining share of consumers in these two age groups continued until 2015. In 2015, the two youngest age groups accounted for 32.2% of cannabis consumers in Canada.

5.2   Volume of cannabis consumed

The estimated volume of cannabis consumed in Canada rises over time as the number of adjusted cannabis consumers rises and as the composition of the market moves towards older age groups that have a higher proportion of more consistent consumers (Chart 9). In the early to mid-1960s, before the rapid spread of cannabis consumption among 15- to 17-year-olds and 18- to 24-year-olds, it is estimated that 24 to 29 tonnes of cannabis were consumed annually in Canada. By 1972, this had increased to 223 tonnes. The increase slowed over the rest of the 1970s and the early 1980s, but consumption still reached 361 tonnes in 1984. As consumption prevalence and the number of consumers declined through the latter half of the 1980s and the early 1990s, the volume of consumption fell, reaching a low of 203 tonnes in 1992. The level of consumption recovered over the 1990s and reached 483 tonnes by 2001. The volume of consumption stabilized around an average of 475 tonnes from 2002 to 2010. A period of rapid increase then occurred from 2010 to 2015, culminating in an estimated 697 tonnes of cannabis being consumed in Canada in 2015.

Chart 9
Estimated cannabis consumption by age group, 1960 to 2015

Source: Statistics Canada, authors' calculations.

The volume of cannabis consumption varies significantly across age groups.

For the two youngest age groups—15 to 17 years and 18 to 24 years—the volume of consumption rose rapidly in the late 1960s and early 1970s, but then levelled off (Chart 9). Consumption for the former group tended to be around 33 tonnes from 1970 to 2015, while the latter group averaged 170 tonnes over the same period. With the exception of the short-term decline from the mid-1980s to the early 1990s, these levels are fairly stable.

The growth in the cannabis market after the early 1970s comes from older age groups. The volume of consumption increased along a linear trend from 1970 to 2015 for 25- to 44-year-olds and from 1977 to 2015 for 45- to 64-year-olds. People aged 25 to 44 increased their consumption from 10 tonnes in 1970 to 308 tonnes in 2015, while 45- to 64-year-olds went from 13 tonnes in 1977 to 180 tonnes in 2015.

6   Sensitivity tests

Estimates of the number of cannabis consumers and the volume of cannabis consumed depend on the accuracy with which parameters can be estimated. Moreover, given the benchmarking approach employed here, the data may be sensitive to assumptions pertaining to the level of consumption and to the path through time.

6.1   Level of consumption

The parameters used to estimate the volume of consumption are associated with plausible ranges or confidence intervals. For all parameters except the prevalence of consumption, the parameter is fixed through time, and the effects of its uncertainty act as a scalar on the consumption estimate, raising it or lowering it by a particular percentage in all years.

For the prevalence of consumption, only the benchmark years have confidence intervals. To assess the sensitivity of the consumption estimate, the 2012 CCHS-MH benchmark year is used. It is sufficiently similar to the 2002 benchmark year in terms of the magnitude of its confidence interval that conclusions about accuracy would not be different if the benchmark year were changed. Moreover, the frequency distribution from the 2012 benchmark year is used to determine consumption patterns, so basing calculations on the year 2012 maintains greater consistency. The year 2012 is also closer to the time period of the data sources used by the PBO (OPBO 2016) to derive the remaining parameter estimates, so it is more consistent in terms of societal norms with other data sources.

Parameter estimates and their 95% confidence intervals from the 2012 CCHS-MH are reported in Table 4, while those from the PBO (OPBO 2016) and their plausible ranges are reported in Table 5. Each table also includes an indication of how much the parameter estimate would change in percentage terms were the minimum or maximum confidence interval value used instead of the midpoint estimate. The confidence intervals and plausible ranges are not always symmetrical, and this can cause a larger adjustment in one direction than the other.

Prevalence estimates can rise by as much as 17.0% and decline by as much as 15.0% over the range of the confidence interval. The largest confidence intervals are for 15- to 17-year-olds and 45- to 64-year-olds. The confidence intervals are larger for those frequency of use categories associated with smaller underlying sample sizes, in particular when the data are further disaggregated by age group. In general, there is greater uncertainty and greater adjustment for 15- to 17-year-olds and 45- to 64-year-olds. There also tends to be greater uncertainty (in terms of the percentage change of the estimate) for respondents who consumed cannabis once in the past year.

Table 4

95% confidence intervals for parameter estimates from the 2012 Canadian Community Health Survey – Mental Health

	95% confidence interval				
	From	To	Estimate	Plus percent[1]	Minus percent[1]
	percent				
Past year prevalence					
Aged 15 to 64 years	11.5	12.8	12.2	4.9	-5.7
Aged 15 to 17 years	17.0	23.4	20.0	17.0	-15.0
Aged 18 to 24 years	30.6	36.0	33.3	8.1	-8.1
Aged 25 to 44 years	14.4	16.9	15.6	8.3	-7.7
Aged 45 to 64 years	5.9	7.6	6.7	13.4	-11.9
Reported use frequency					
Aged 15 to 17 years					
Once in the past year	1.9	4.6	2.9	58.6	-34.5
Less than once a month	4.3	8.9	6.2	43.5	-30.6
One to three times a month	3.2	6.1	4.4	38.6	-27.3
At least once a week (excludes daily)	3.0	6.1	4.3	41.9	-30.2
Daily	1.0	3.9	2.0	95.0	-50.0
Aged 18 to 24 years					
Once in the past year	1.6	4.0	2.5	60.0	-36.0
Less than once a month	9.4	12.8	11.0	16.4	-14.5
One to three times a month	5.3	8.2	6.6	24.2	-19.7
At least once a week (excludes daily)	6.7	9.8	8.1	21.0	-17.3
Daily	4.0	6.0	4.9	22.4	-18.4
Aged 25 to 44 years					
Once in the past year	0.3	0.8	0.5	60.0	-40.0
Less than once a month	5.1	6.7	5.9	13.6	-13.6
One to three times a month	2.2	3.3	2.7	22.2	-18.5
At least once a week (excludes daily)	3.6	5.3	4.4	20.5	-18.2
Daily	1.7	2.7	2.2	22.7	-22.7
Aged 45 to 64 years					
Once in the past year	0.1	0.4	0.2	100.0	-50.0
Less than once a month	2.1	3.3	2.6	26.9	-19.2
One to three times a month	0.7	1.2	0.9	33.3	-22.2
At least once a week (excludes daily)	1.4	2.1	1.7	23.5	-17.6
Daily	1.0	1.5	1.2	25.0	-16.7

1. Confidence interval as a percentage of midpoint estimate.
Source: Statistics Canada, authors' calculations.

For parameter estimates drawn from the PBO (OPBO 2016), the survey misreporting factor ranges from no change (a scalar factor of 1) to a 25% increase (a scalar factor of 1.250) (Table 5). The PBO used the midpoint, which is also used in this paper. The lower-end estimates represent an 11.1% decline from the midpoint estimate, while the upper-end estimates represent an 11.1% increase.

For estimates of cannabis consumption days, the frequency categories are transformed into the number of days a person consumed cannabis. For people who consumed cannabis once in the past year and daily, the range is fixed at 1 and 365, respectively. For intermediate consumption frequencies, the range can be consequential, raising or lowering the number of consumption days by up to 75%. Similarly, the parameter estimates for daily consumption quantities can vary from as much as a 100% increase to a 35.8% decrease.

Table 5
**Ranges for parameter estimates, 2016**

| | Plausible range | | | | |
	From	To	Estimate	Plus percent[1]	Minus percent[1]
		scalar		percent	
Survey misreporting in percentage					
Once in the past year	1	1.250	1.125	11.1	-11.1
Less than once a month	1	1.250	1.125	11.1	-11.1
One to three times a month	1	1.250	1.125	11.1	-11.1
At least once a week (excludes daily)	1	1.250	1.125	11.1	-11.1
Daily	1	1.125	1.063	5.8	-5.9
		days		percent	
Cannabis consumption days					
Once in the past year	1	1	1	0.0	0.0
Less than once a month	2	11	7	69.2	-69.2
One to three times a month	12	36	24	50.0	-50.0
At least once a week (excludes daily)	52	364	208	75.0	-75.0
Daily	365	365	365	0.0	0.0
		grams		percent	
Grams per day					
Once in the past year	0.20	0.60	0.30	100	-33.3
Less than once a month	0.20	0.60	0.30	100	-33.3
One to three times a month	0.43	0.95	0.67	41.8	-35.8
At least once a week (excludes daily)	0.75	1.30	1.01	28.7	-25.7
Daily	1.30	1.90	1.60	18.8	-18.8

1. Plausible range as a percentage of midpoint estimate.
Source: Office of Parliamentary Budget Officer, 2016, *Legalized Cannabis: Fiscal Considerations.*

For consumption estimates, uncertainty comes from the cumulative effect of all parameters rather than directly from any single parameter. Therefore, it is informative to add the uncertainty from the estimates sequentially to illustrate which parameter estimates contribute the most to the overall uncertainty for the estimated number of tonnes consumed.

Chart 10
Cumulative confidence region for the estimated volume of cannabis consumption, by uncertainty source
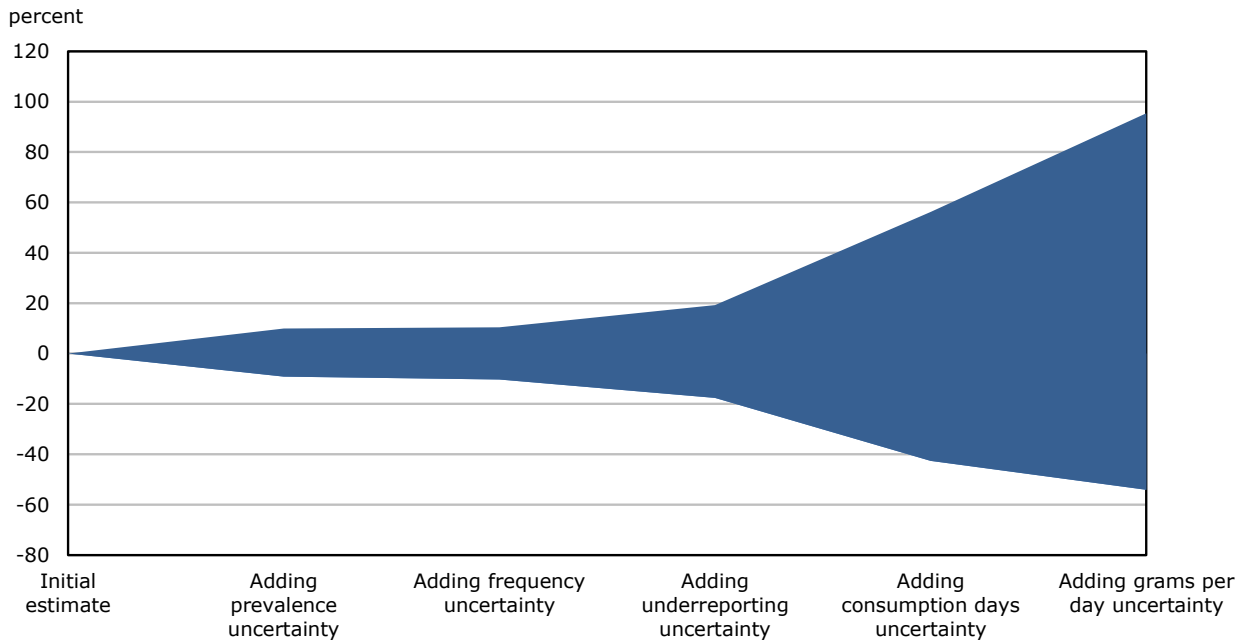
percent

Source: Statistics Canada, authors' calculations.

Table 6
Confidence region for tonnes of cannabis consumed, 2012

	Possible range		Cumulative percentage change from initial estimates	
	Lower bound	Upper bound	Lower bound	Upper bound
	tonnes		percent	
Initial estimate	552	552	0.0	0.0
Adding prevalence uncertainty	501	607	-9.2	9.9
Adding frequency uncertainty	495	610	-10.3	10.4
Adding underreporting uncertainty	455	658	-17.6	19.2
Adding uncertainty about the number of consumption days	317	862	-42.6	56.2
Adding uncertainty about the number of grams per day	253	1,079	-54.1	95.4

Source: Statistics Canada, authors' calculations.

This is done in Chart 10, where the range of potential values is indicated as a percentage of the initial starting point, and in Table 6, where the plausible range of values is presented in tonnes. The starting point is the initial estimate for 2012: 552 tonnes. The effect of adding uncertainty stemming from estimating prevalence produces a widening of the confidence interval to between 501 and 607 tonnes. The effect of including uncertainty about frequency and about underreporting increases the confidence range. The influence of uncertainty about frequency on the estimates is more muted than that from other sources, as it is used to spread population estimates between frequency categories, and the relative values of the categories are more stable than uncertainty about the level estimate implies. Adding uncertainty about the number of consumption days produces a large symmetric effect, which raises the confidence region to between 317 and 862 tonnes. Finally, adding the effect of uncertainty about the number of grams per day increases the confidence region asymmetrically to between 253 and 1,079 tonnes. In percentage terms, the range goes from 54.1% of the time series estimate to 95.4% more than the time series estimate.

6.2   Time path for consumption

It is difficult to numerically assess the uncertainty surrounding the time path for consumption. The data sources present gaps, and differences in survey methodologies can create issues for comparability. Moreover, because the projectors are based on chaining estimates through time, using the upper and lower values for confidence intervals (where they are available) does not lead to notable changes. Therefore, the time series is assessed in light of historical events and associated data.

The time series estimates first show a low level of consumption that is consistent with early reports. They also show a rapid increase in the late 1960s and early 1970s that is centred on younger age cohorts and that is consistent with historical accounts (Le Dain 1972; Canada. Library of Parliament 2002) and with law enforcement records (Le Dain 1972). The progression through time, particularly in the 1980s, 1990s and 2000s for high school students and, to a lesser degree, people in their early 20s, is consistent with changes in the United States (UNODC 2007; Appendix A) and with changes in law enforcement effort during those years. The progression towards increased cannabis consumption in older age groups is also found in the United States (NIDA 2015) and Australia (Kostadinov and Roche 2017).

In general, the time series estimates appear to capture the major events that could be expected in the cannabis market. However, there remains uncertainty about earlier periods. It is clear, based on records of criminal charges, that people older than 24 participated in the cannabis market before 1971. Based on the data assembled here and on the available historical record, it is necessary to assume that these individuals did not consume noteworthy quantities of cannabis.

Conclusion

This report assesses the capacity of the various existing surveys spanning many decades about cannabis consumption in Canada to provide information that can be compiled into an extended narrative. It shows that this is possible, but the methodology used to create the time series requires some assumptions whose validity can influence the results. It is preferable to decompose the challenge of estimating the time series into two parts: estimating as accurately as possible the level of consumption and estimating as accurately as possible the time path for consumption. To do so, it is useful to group data sources based on context, methodology and collector.
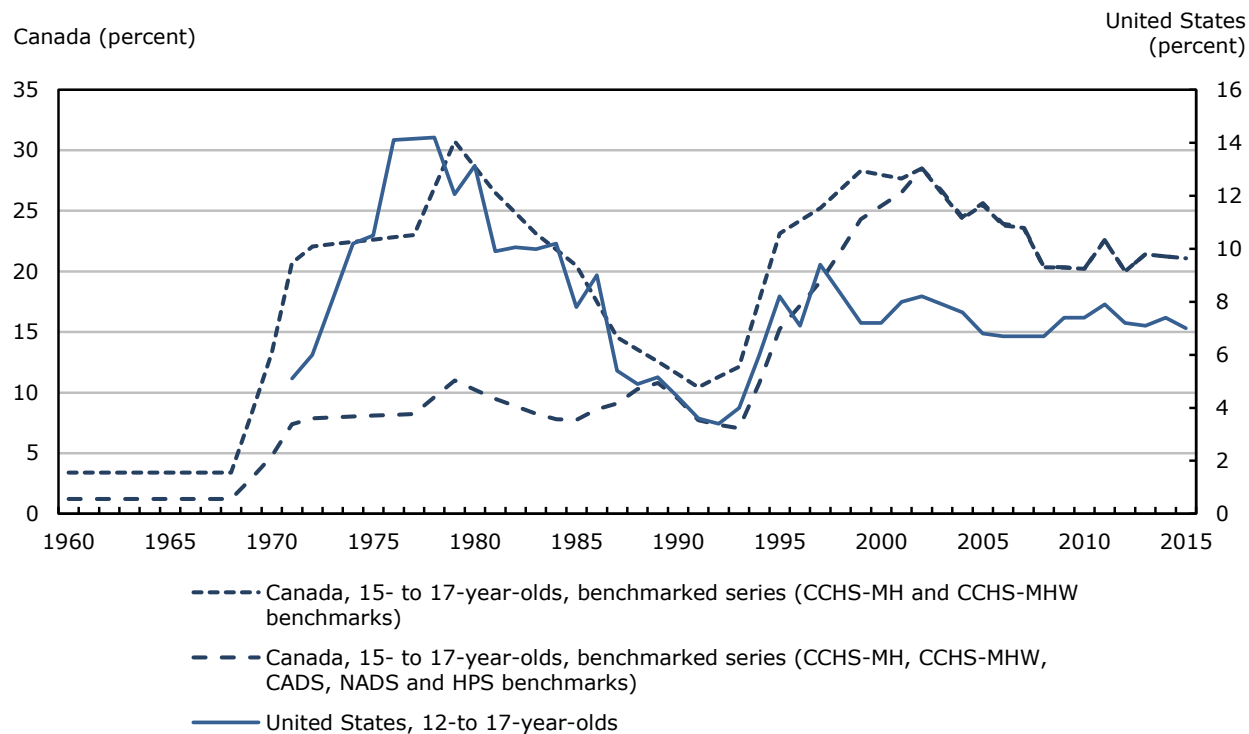
Comparing data sources in this manner shows that the Canadian Community Health Survey – Mental Health and Well-being and the Canadian Community Health Survey – Mental Health are the most appropriate sources for estimates of the level of prevalence. To create a time series projector, the following surveys can be combined: the Canadian Tobacco, Alcohol and Drugs Survey; the Canadian Tobacco Use Monitoring Survey; Centre for Addiction and Mental Health surveys; and early surveys.

The resulting estimate for the cannabis market in Canada from 1960 to 2015 illustrates that this market increased in Canada over the last 50 years. From low levels of consumption in the early years, cannabis consumption rapidly became more prevalent among 15- to 17-year-olds and 18- to 24-year-olds in the 1960s and 1970s, then spread among older age groups after the 1970s.

These results are subject to qualifications. A number of survey biases cannot be explicitly controlled for, such as changes in response rates. There are also uncertainties about the parameter estimates used for the level estimates, and accounting for these uncertainties shows that the level estimates can decrease by 54.1% or increase by 95.4% in any given year. Nevertheless, the estimates use the best available data, and the resulting time path is viewed as representative.

Appendix: Estimates of the prevalence of cannabis consumption in Canada and the United States
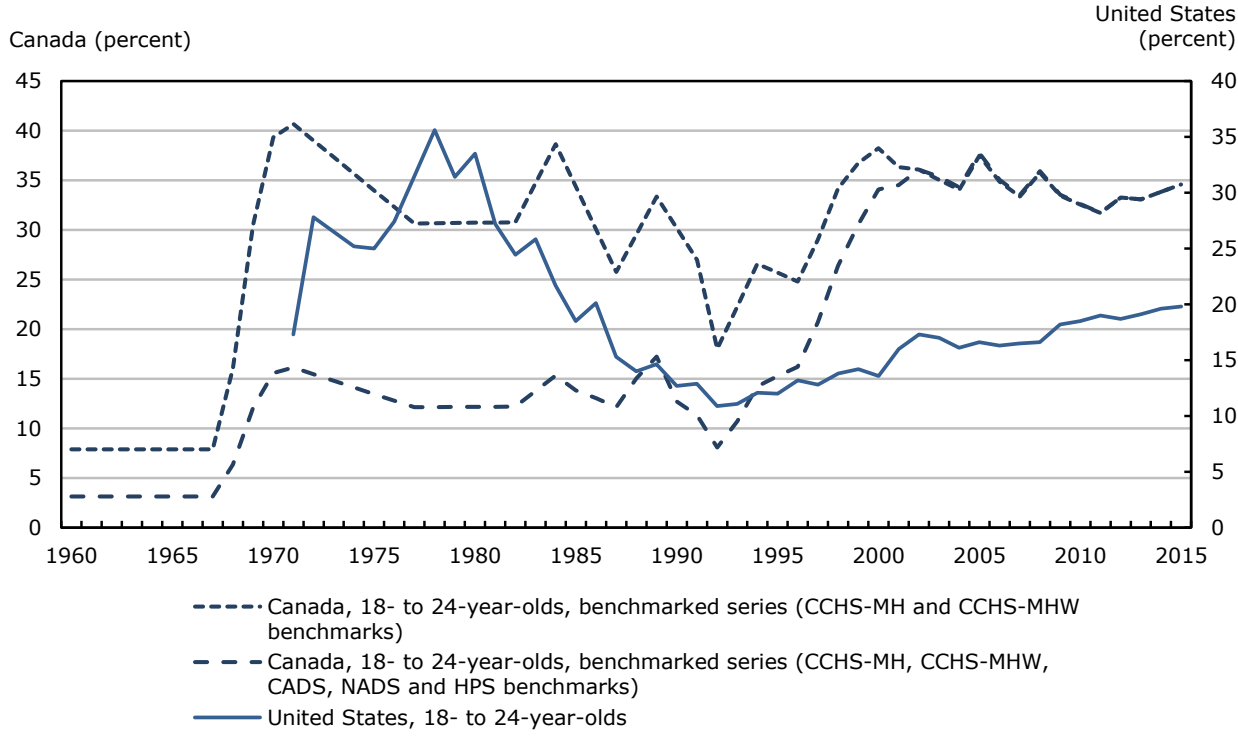
Appendix Chart 1
Cannabis consumption prevalence through time, high-school-aged persons, Canada and the United States

Canada (percent)

United States (percent)

- - - - Canada, 15- to 17-year-olds, benchmarked series (CCHS-MH and CCHS-MHW benchmarks)

– – – Canada, 15- to 17-year-olds, benchmarked series (CCHS-MH, CCHS-MHW, CADS, NADS and HPS benchmarks)

—— United States, 12-to 17-year-olds

Notes: CCHS-MH: Canadian Community Health Survey - Mental Health; CCHS-MHW: Canadian Community Health Survey - Mental Health and Well-being; CADS: Canada's Alcohol and Other Drugs Survey; NADS: National Alcohol and Drug Survey; HPS: Health Promotion Survey.
Sources: Statistics Canada, authors' calculations based on data from the benchmarked series; Center for Behavioral Health Statistics and Quality, 2016, *2015 National Survey on Drug Use and Health: Detailed Tables*, Table 7.50B, Marijuana Use in Past Month, by Age Group: Percentages, 1971-2015.

Appendix Chart 2
Cannabis consumption prevalence through time, university-aged persons, Canada and the United States

Canada (percent)

United States (percent)

- - - - Canada, 18- to 24-year-olds, benchmarked series (CCHS-MH and CCHS-MHW benchmarks)
- - - Canada, 18- to 24-year-olds, benchmarked series (CCHS-MH, CCHS-MHW, CADS, NADS and HPS benchmarks)
——— United States, 18- to 24-year-olds

Notes: CCHS-MH: Canadian Community Health Survey - Mental Health; CCHS-MHW: Canadian Community Health Survey - Mental Health and Well-being; CADS: Canada's Alcohol and Other Drugs Survey; NADS: National Alcohol and Drug Survey; HPS: Health Promotion Survey.
Sources: Statistics Canada, authors' calculations based on data from the benchmarked series; Center for Behavioral Health Statistics and Quality, 2016, *2015 National Survey on Drug Use and Health: Detailed Tables*, Table 7.50B, Marijuana Use in Past Month, by Age Group: Percentages, 1971-2015.

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