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Cannabis and driving: A repeat cross-sectional analysis of driving after cannabis use pre- vs. post-legalization of recreational cannabis in Canada

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ABSTRACT

Objective: The potential impact of cannabis legalization on driving after cannabis use is an important public health consideration. The current paper examined the prevalence of driving after cannabis use and being a passenger of a driver who recently consumed cannabis pre- and five years post- legalization of recreational cannabis.

Method: National population-based surveys were conducted annually between 2018 and 2023 as part of the International Cannabis Policy Study (ICPS). A total of 93,933 participants aged 16–65 years from Canada were included in the analysis. Logistic regression models assessed trends in driving after cannabis use by age, sex-at-birth, income adequacy, ethnicity, and educational attainment.

Results: In 2018, 5.7 % of all respondents and 19.9 % of past 12-month consumers reported driving within 2 h of cannabis consumption in the past year. Driving after consumption increased moderately in the five years post legalization among all participants, with a significantly higher prevalence reported in 2022 (8.8 % vs. 5.7 %, OR = 1.43, 95 % CI = 1.22, 1.66, $p < 0.001$) and 2023 (7.6 % vs. 5.7 %, OR = 1.20, 95 % CI = 1.03, 1.40, $p = 0.018$) than in 2018. However, driving after consumption remained stable among past 12-month consumers, with a moderately lower prevalence in 2023 than in 2018 (18.3 % vs. 19.9 %, OR = 0.81, 95 % CI = 0.68, 0.97, $p = 0.024$).

Conclusions: The increase in the overall rate of driving after use likely reflects the increase in consumption among all Canadians following recreational cannabis legalization. There was no evidence to support changes in the overall prevalence of passenger behaviour following legalization. Differences across sociodemographic variables are discussed.

1. Introduction

In 2018, 5 years after Uruguay, Canada became the second country to 'legalize' recreational cannabis at the national level. The impact of legalization will depend on indicators of problematic use, such as driving after cannabis consumption, rather than overall prevalence estimates. Ample research suggests cannabis intoxication can impair driving abilities and increase the risk of injury. (Hall et al., 2023; Brubacher et al., 2022; Asbridge et al., 2012; Ramaekers et al., 2009; Ramaekers et al., 2006; Bondallaz et al., 2016) A case-crossover study utilizing emergency department collision cases found that participants who tested positive for acute cannabis use (THC level >0.2 ng/mL) were 4 times more likely to experience a collision than those who did not. (Asbridge et al., 2014) This is consistent with a systematic review that found the pooled risk of motor-vehicle collisions while driving under the influence of cannabis was twice the risk of driving unimpaired. (Asbridge et al., 2012) Given this associated risk of injury, it is necessary to investigate the prevalence of driving under the influence of cannabis after recreational cannabis legalization in Canada.

Numerous cross-sectional studies have estimated the prevalence of driving after cannabis use and being a passenger of a driver who recently consumed cannabis prior to legalization in Canada. A biennial school-based survey among grade 11 and 12 students in Canada found that nearly 10 % of participants reported driving after cannabis use in their lifetime, and 20 % reported being a passenger of a high driver in their lifetime. (Carpino et al., 2020) Similarly, a cross-sectional study in Ontario found that 15.4 % of adult past-year cannabis users reported driving after consuming cannabis. (McDonald et al., 2021) These estimates are smaller than those from Canada's 2017 national monitoring survey, which found that 39 % of past-year cannabis users reported ever

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driving within two hours of using cannabis and 39 % of all respondents reported being the passenger of a driver who had recently consumed cannabis. (Canadian Cannabis Survey, 2017) These discrepancies are likely due to different samples and inconsistent measures.

It is possible that these estimates have fluctuated since legalization in Canada, as there could be an increase in frequent cannabis use through more accessible cannabis and decreased risk perceptions. (Blevins et al., 2018; Carliner et al., 2017; Erin Goodman et al., 2020; Keyes et al., 2016; McDonald et al., 2021; Myran et al., 2022; Salas-Wright et al., 2021; Wadsworth et al., 2022; Wadsworth & Hammond, 2018; Health Canada, 2018) Legalization could also prompt the development of policies and prevention campaigns to reduce driving after cannabis use. To date, a large portion of the research analysing cannabis legalization and impaired driving is from the United States (US) and utilizes traffic-related injuries to estimate driving after cannabis use. (González-Sala et al., 2023) In an interrupted time-series study conducted in US states with legalized recreational cannabis, there was a significant increase in the prevalence of traffic fatalities after legalization. (Lane and Hall, 2019) However, this effect was also observed in neighbouring states without legalized recreational cannabis, and the authors did not differentiate between fatal traffic accidents in which cannabis was involved and those in which it was not. (González-Sala et al., 2023; Lane and Hall, 2019) An ecological study conducted in Washington State and Colorado between 2005 and 2017 demonstrated a significant increase in cannabis-related traffic fatalities in Colorado following recreational legalization, but not in Washington State. (Santaella-Tenorio et al., 2020) This is consistent with interrupted time-series evidence from Washington State that found no increase in fatal collisions after recreational legalization, but rather a decline in fatal, serious and minor injury-traffic collisions. (Voy, 2023)

Taken together, existing research does not provide clear evidence for an association between recreational cannabis legalization and driving after cannabis consumption. However, there are clear risks associated with driving after cannabis consumption, given the psychomotor impairment associated with cannabis intoxication. To date, little research has examined trends in driving after cannabis use following recreational cannabis legalization in Canada. Therefore, this study aims to discern patterns of driving after cannabis use and being a passenger of a driver who recently consumed cannabis in Canada from 2018–2023.

2. Method

This study was reviewed by and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE#31330). Data are from the International Cannabis Policy Study (ICPS), a national population-based study conducted in six countries. (ICPS Methods, 2024) This study will only examine Canadian data collected annually between October and September from 2018–2023. Pre-legalization data was collected prior to October 17, 2018, before the legalization of recreational cannabis. ICPS respondents are aged 16–65 and recruited through Nielsen Global Panels, which utilize probability and non-probability sampling methods. A detailed summary of Nielsen's recruitment method is available in the ICPS Technical Report. (ICPS Methods, 2024)

2.1. Measures

2.1.1. Sociodemographic variables

Respondents reported demographic information, including state of residence, sex-at-birth, age group, ethnicity, and highest education level and income adequacy—see Table 1.

2.1.2. Driving after cannabis use

To assess driving after cannabis consumption in the past 12 months, all participants were asked "have you ever driven a vehicle within 2 h of using marijuana?" (Yes, in the past 30 days/Yes, in the past 12months/Yes, more than 12 months ago/No, never). The 2-hour timeframe was selected based on experimental evidence that suggests the onset of psychomotor impairment occurs in the first 2 h of consuming cannabis and declines within 3–6 h. (Zhao et al., 2024) Responses were categorized into two levels: "Yes, in the past 12 months" or "No, never or not in the past 12 months". Participants who reported "Don't know" (n = 1926) or refused to answer (n = 520) were removed from models with driving after cannabis use as the outcome.

Table 1
Sample characteristics among all participants.

	Unweighted. % (n)	Weighted. % (n)
	N = 93 933	N = 93 933
Sample		
Wave 1-2018	10.7 % (10057)	10.7 % (10057)
Wave 2-2019	16.2 % (15356)	16.2 % (15356)
Wave 3-2020	16.8 % (15780)	16.8 % (15780)
Wave 4-2021	18.0 % (16952)	18.0 % (16952)
Wave 5-2022	17.0 % (15924)	17.0 % (15924)
Wave 6-2023	21.3 % (19964)	21.3 % (19964)
Sex at Birth		
Female	61.2 % (57442)	49.7 % (46672)
Male	38.8 % (36491)	50.3 % (47261)
Age, year		
16–18	5.2 % (4857)	9.1 % (8563)
19–24	7.1 % (6639)	8.0 % (7539)
25–30	9.7 % (9134)	10.7 % (10066)
31–50	39.9 % (37457)	40.9 % (38429)
51–65	38.2 % (35846)	31.2 % (29336)
Education		
Less than high school	14.7 % (13812)	8.0 % (7542)
High school diploma or equivalent	26.3 % (24673)	15.0 % (14102)
Some college or university	31.7 % (29780)	40.0 % (37531)
Bachelor's Degree or higher	26.1 % (24527)	36.0 % (33787)
Not Reported	1.2 % (1141)	1.0 % (971)
Ethnicity		
Black Only	3.4 % (3189)	4.1 % (3832)
East/South East Asian	8.6 % (8108)	8.7 % (8126)
Indigenous Only	2.5 % (2336)	2.5 % (2345)
Latino Only	1.6 % (1476)	1.9 % (1749)
Middle Eastern Only	1.6 % (1476)	1.8 % (1677)
South Asian Only	3.9 % (3665)	4.2 % (3981)
White Only	72.0 % (67657)	69.7 % (65509)
Mixed/Other/Not Reported	6.4 % (6026)	7.1 % (6026)
Income Adequacy		
Very difficult	9.7 % (9070)	9.2 % (8625)
Difficult	20.9 % (19625)	20.9 % (19606)
Neither easy nor difficult	35.0 % (32845)	35.0 % (32910)
Easy	20.4 % (19123)	20.9 % (19638)
Very Easy	10.4 % (9744)	10.9 % (10224)
Not Stated	3.8 % (3526)	3.1 % (2930)
Frequency of Cannabis Consumption[a]		
Monthly or less	51.8 % (15969)	49.0 % (15851)
Weekly	18.6 % (5732)	19.3 % (6249)
Daily/Almost Daily	29.6 % (9113)	31.7 % (10272)

[a] Among those who report consuming cannabis in the last 12-months.

2.2. Passenger of a driver who consumed cannabis (Passenger Behaviour)

To assess the prevalence of being a passenger of a driver who recently consumed cannabis, all participants were asked "have you ever been a passenger in a vehicle driven by someone who used marijuana in the last 2 h?" (Yes, in the past 30 days/Yes, in the past 12 months/Yes, more than 12 months ago/No, never). First, responses were categorized into two levels to create a binary passenger variable: "Yes, in the past 12

months" or "No, never or not in the past 12 months". Participants who reported "Don't know" (n = 8101) or refused to answer (n = 571) were removed from logistic regression models with passenger behaviour as its outcome.

2.3. Statistical analysis

Overall, 93,933 participants completed the Canada ICPS survey from 2018 to 2023 and were included in analyses; 10,057 respondents were from 2018; 15,356 respondents were from 2019; 15,780 respondents were from 2020; 16,952 respondents were from 2021; 15,924 respondents were from 2022; and 19,964 respondents were from 2023. Missing responses were excluded using case-wise deletion. In total, 2456 responses were excluded in models utilizing driving after cannabis use as the outcome variable due to missing values (n = 91,477) while 8762 responses were excluded in models utilizing passenger behaviour as the outcome variable for the same reason (n = 85,261). Post stratification weights were constructed based on age, sex, education, ethnicity and region, using a raking algorithm, as reported in the ICPS technical reports. (ICPS Methods, 2024).

Descriptive statistics were used to characterize the sample and overall prevalence of driving within 2 h of cannabis use and being a passenger of a driver who recently consumed cannabis over time. Unadjusted and adjusted main effects models were fitted. In Model 1, a logistic regression was conducted among all participants (n = 93,933) to examine trends in driving within 2 h of cannabis use. Survey year served as the primary independent variable, with 2018 (pre-legalization) as the primary reference category. Pairwise comparisons were also made between years post-legalization. Adjusted models included the following covariates: sex at birth, age group, ethnicity, and highest education level and income adequacy. Model 2 was identical to Model 1, except it was restricted to a subsample of past 12-month consumers only (n = 30,814) and included frequency of cannabis use as a covariate. Finally, Model 3 included a logistic regression model fitted to examine trends in being a passenger of a driver who consumed cannabis within 2 h of driving among all participants (n = 93,933). Identical to Model 1, survey year was the primary independent variable, and the same covariates were included. Next, 2-way interaction effects for survey year and each sociodemographic variable were included in separate models. The Variance Inflation Factor (VIF) was used to assess potential multicollinearity between the covariates in Model 1 and Model 2, and the results demonstrated low multicollinearity. (Thompson et al., 2017) As a sensitivity test, the main effects models were also run among participants who reported having a driver's license in the last 12 months (n = 68,355). In total, there were 12,517 drivers in Wave 2; 12,824 in Wave 3; 13,903 in Wave 4; 12,823 in Wave 5; and 16,288 in Wave 6. Wave 1 participants were not asked if they had a driver's license and were therefore excluded from this analysis. The driver only model yielded the same results as the all-participant models. Therefore, all participants were included in this analysis, regardless of their drivers-license status.

3. Results

3.1. Sample characteristics

Table 1 shows the unweighted and weighted sample characteristics of all participants included in the current analysis.

3.2. Prevalence of driving after cannabis use

Fig. 1 shows the prevalence of self-reported driving within 2 h of consuming cannabis between 2018 and 2023. In 2018, 5.7 % of all respondents and 19.9 % of past 12-month consumers reported driving within 2 h of consuming cannabis in the past 12 months. In the adjusted logistic regression model among all participants, there was a significant effect of survey year and an increasing trend (see Supplementary Table S1). In the first three years following legalization, the prevalence of driving within 2 h of use did not differ significantly compared to pre-legalization, despite a slight increase in prevalence. Driving after use was more prevalent in 2022 (8.8 % vs. 5.7 %, OR = 1.43, 95 % CI = 1.22, 1.66), and in 2023 (7.6 % vs. 5.7 %, OR = 1.20, 95 % CI = 1.03, 1.40) than in 2018. However, from 2022 to 2023, driving after cannabis use significantly decreased among all participants (8.8 % vs. 7.6 %, OR = 0.84, 95 % CI = 0.76, 0.93, p = 0.001). These results are consistent with the unadjusted model among all participants, except for 2021 (Wave 4)—see Table 2.

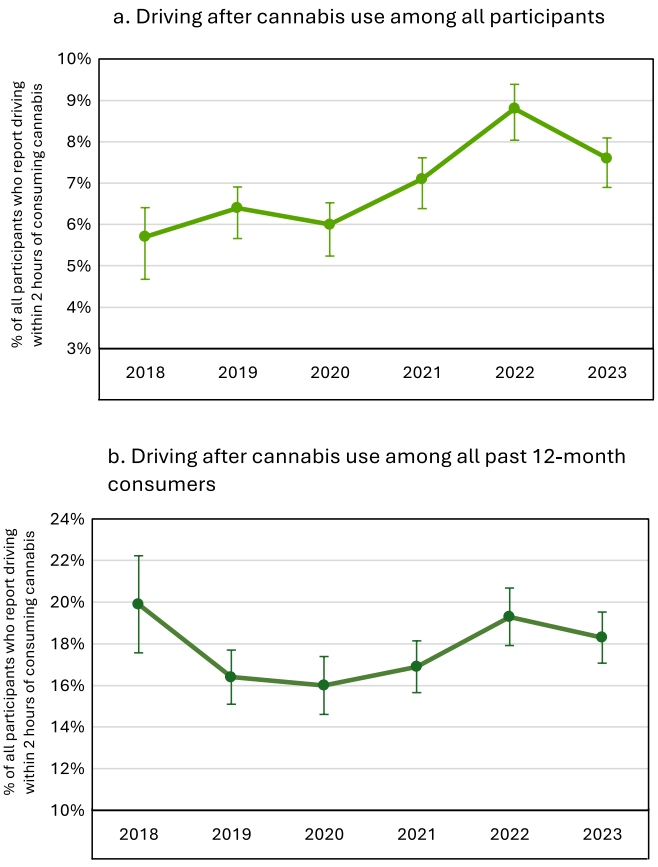

Fig. 1. Prevalence of driving within 2 h of consuming cannabis since legalization among (a) all participants and (b) all past 12-month consumers.

A different pattern of findings was observed in the model that only included respondents who used cannabis in the past 12 months (see Supplementary Table S2). As Fig. 1b shows, prevalence of driving after cannabis use decreased among past 12-month consumers in the year following legalization (2018 = 19.9 % vs. 2019 = 16.4 %, OR = 0.76, 95 % CI = 0.64, 0.92, p = 0.004) and increased between 2021 and 2022 (16.9 % vs. 19.3 %, OR = 1.26 95 % CI = 1.11, 1.44, p < 0.001). In 2023, however, the prevalence of consumers who reported driving after cannabis use in the past 12 months was significantly lower than prevalence at the time of legalization in 2018 (2023 = 18.6 % vs. 2018 = 19.9 %, OR = 0.81, 95 % CI = 0.68, 0.97, p = 0.024). These results were consistent with the unadjusted model—see Table 2. Additionally, driving within 2 h of cannabis use increased with frequency of use: those who reported consuming cannabis weekly (18.6 %) were 2 times more likely to report driving after use than those who consumed monthly or less (9.9 %, OR = 2.01, 95 % CI = 1.79, 2.25), while daily and almost daily consumers were four times more likely than those who reported consuming monthly or less (29.4 % vs. 9.9 %, OR = 4.21 95 % CI = 3.81, 4.65).

Among all participants, driving after cannabis use was lowest among ages 51 to 65 years (3.3 %) and highest in ages 25 to 30 years (12.2 %,

Table 2
Unadjusted and adjusted ORs, counts and prevalence estimates for driving after cannabis use and being a passenger of a driver who recently consumed cannabis.

All participants (n = 91,477)			
	% Driver (n)	Unadjusted OR (95 %CI) P-Level	Adjusted OR (95 % CI) P-Level
Sample			
Wave 1-2018	5.7 % (561)	Ref	Ref
Wave 2-2019	6.4 % (944)	1.13 (0.97, 1.32), p = 0.132	1.05 (0.89, 1.23), p = 0.571
Wave 3-2020	6.0 % (915)	1.05 (0.90, 1.24), p = 0.541	1.02 (0.87, 1.20), p = 0.812
Wave 4-2021	7.1 % (1156)	1.26 (1.08, 1.47), p = 0.003	1.12 (0.96, 1.30), p = 0.169
Wave 5-2022	8.8 % (1352)	1.60 (1.37, 1.86), p < 0.001	1.43 (1.22, 1.66), p < 0.001
Wave 6-2023	7.6 % (1459)	1.36 (1.17, 1.58), p < 0.001	1.20 (1.03, 1.40), p = 0.018
	% Passenger	**Unadjusted OR (95 %CI) P-level**	**Adjusted OR (95 % CI) P-Level**
Wave 1-2018	13.3 % (1186)	Ref	Ref
Wave 2-2019	14.5 % (2019)	1.10 (0.99, 1.23), p = 0.075	1.03 (0.92, 1.15), p = 0.597
Wave 3-2020	13.4 % (1912)	1.01 (0.90, 1.13), p = 0.884	0.99 (0.88, 1.11), p = 0.862
Wave 4-2021	12.5 % (2230)	1.10 (0.99, 1.22), p = 0.079	0.98 (0.88, 1.10), p = 0.775
Wave 5-2022	16.2 % (2125)	1.26 (1.14, 1.40), p < 0.001	1.14 (1.02, 1.27), p = 0.020
Wave 6-2023	15.9 % (2859)	1.23 (1.11, 1.37), p < 0.001	1.10 (0.99, 1.23), p = 0.073
All consumers (n = 28,864)			
	% Driver (n)	**Unadjusted OR (95 %CI) P-Level**	**Adjusted OR (95 % CI) P-Level**
Wave 1-2018	19.9 % (503)	Ref	Ref
Wave 2-2019	16.4 % (792)	0.79 (0.67, 0.94), p = 0.009	0.76 (0.64, 0.92), p = 0.004
Wave 3-2020	16.0 % (770)	0.77 (0.64, 0.92), p = 0.003	0.71 (0.60, 0.86), p < 0.001
Wave 4-2021	16.9 % (922)	0.82 (0.69, 0.97), p = 0.021	0.72 (0.59, 0.85), p < 0.001
Wave 5-2022	19.3 % (968)	0.96 (0.81, 1.14), p = 0.676	0.89 (0.75, 1.07), p = 0.227
Wave 6-2023	18.3 % (1139)	0.90 (0.76, 1.07), p = 0.234	0.81 (0.68, 0.97), p = 0.024

see Supplementary Table S1). Compared to those aged 16 to 18 years, participants aged 19 to 24 years (3.4 % vs. 9.1 %, OR = 3.47, 95 % CI = 2.77, 4.35, p < 0.001), 25 to 30 years (3.4 % vs. 12.2 %, OR = 5.13, 95 % CI = 4.10, 6.42, p < 0.001) and 31 to 50 years (3.4 % vs. 9.0 %, OR = 3.62, 95 % CI = 2.92, 4.48, p < 0.001) had higher odds of driving after cannabis consumption. Male participants had about twice the odds of driving after cannabis use than female participants (9.1 % vs. 4.9 %, OR = 2.01, 95 % CI = 1.87, 2.15, p < 0.001), and those who reported having an education less than high school had higher odds of driving after cannabis consumption than all other educational groups (p < 0.05 for all contrasts as reported in Supplementary Table S1).

Compared to participants who reported their ethnicity as White, participants who identified as Black (6.3 % vs. 14.7 %, OR = 1.92, 95 % CI = 1.66, 2.21, p < 0.001), Indigenous (6.3 % vs. 12.4 %, OR = 1.57, 95 % CI = 1.31, 1.89, p < 0.001), and Mixed/Other/Not Reported (6.3 % vs. 8.6 %, OR = 1.31, 95 % CI = 1.15, 1.50, p < 0.001) had higher odds of driving after cannabis use, while East/South East Asian participants had lower odds of driving after cannabis consumption than White participants (6.3 % vs. 5.2 %, OR = 0.72, 95 % CI = 0.62, 0.83, p < 0.001). The odds of driving after cannabis use was greater among participants who reported their income adequacy as being 'very difficult' to make ends meet than all other income adequacy groups (p < 0.05 for all contrasts, as reported in Supplementary Table S1), except compared to those who reported their income adequacy as being 'very easy' (9.2 % vs. 8.8 %, OR = 1.12, 95 % CI = 0.97, 1.29).

Among all participants, interaction effects between survey year and several sociodemographic variables were observed—see Fig. 2. A two-way interaction between survey year and income adequacy (F = 2.84, p < 0.001) demonstrated that driving within 2 h of use has gradually increased over time among most income adequacy groups, except among those who reported their income adequacy as being 'neither easy nor difficult'.

A two-way interaction between survey year and ethnicity (F = 1.58, p = 0.016) found that driving within 2h of use increased slightly over time among all ethnic groups, except among those who self-identified as Latino—See Fig. 2b.

A two-way interaction between survey year and age (F = 2.57, p < 0.001) revealed a moderate increase in driving within 2 h of cannabis use among 16 to 18-year-olds, 25 to 30-year-olds and 31 to 50-year-olds in the five years following legalization. In 2019, driving after cannabis consumption increased among 25 to 30-year-olds and 16 to 18-year-olds, but decreased among 19 to 24-year-olds—see Fig. 2c.

A significant two-way interaction between survey year and sex at birth (F = 2.48, p = 0.030) revealed that driving after cannabis consumption increased more among male participants than female participants—see Fig. 2d.

A two-way interaction between survey year and education (F = 29.85, p < 0.001) demonstrated that driving after cannabis consumption in the past 12 months remained relatively stable over time among those who reported having a 'high school diploma or equivalent' and among those who reported having 'some college or technical/vocational training', but increased among those who reported having an educational attainment 'less than high school'; 'bachelor's degree or higher', and those who did not report their educational attainment.

3.3. Prevalence of being a passenger of a driver who recently consumed cannabis

Fig. 3 shows the prevalence of being a passenger of a driver who recently consumed cannabis before and after legalization. In 2018, 13.3 % of all participants reported being the passenger in the last 12-months of a driver who recently consumed cannabis. In the model adjusted for sociodemographic characteristics, there was no evidence of changes over time, except for a significant increase among all participants between 2021 and 2022 (12.5 % vs. 16.2 % OR = 1.16, 95 % CI = 1.06, 1.25, p < 0.001) that slightly surpassed the prevalence at the time of legalization (2022 = 16.2 % vs. 2018 = 13.3 %, OR = 1.14, 95 % CI = 1.02, 1.27). These results are consistent with the unadjusted model, except for Wave 6—see Table 2.

About a quarter of all participants aged 19 to 24 and 25 to 30 years reported being a passenger in the last 12months of a driver who recently consumed cannabis (25.5 % and 25.1 %, respectively). Compared to 16 to 18-year-olds, participants aged 19 to 24 years-old (12.5 % vs. 25.5 %, OR = 2.84 95 % CI = 2.47, 3.26), 25 to 30 years-old (12.5 % vs. 25.1 %, OR = 2.87, 95 % CI = 2.50, 3.30) and 31 to 50 years-old (12.5 % vs. 16.5 %, OR = 1.78, 95 % CI = 1.57, 2.02) had higher odds of engaging in passenger behaviour, while participants aged 51 to 65 years old had lower odds (12.5 % vs. 7.30 %, OR = 0.69, 95 % CI = 0.61, 0.76). Passenger behaviour was more prevalent among male participants than female participants (15.8 % vs. 13.8 %, OR = 1.21, 95 % CI = 1.15, 1.27), and those who reported having an education less than high school than all other educational groups (all contrasts p < 0.001, as reported in Supplementary Table S3). Participants who identified as Black (27.6 % vs. 13.5 %, OR = 1.85, 95 % CI = 1.64, 2.06), Indigenous (28.5 % vs. 13.5 %, OR = 1.83, 95 % CI = 1.60, 2.10) and Latino (21.0 % vs. 13.5 %, OR = 1.32, 95 % CI = 1.10, 1.58) who recently consumed cannabis

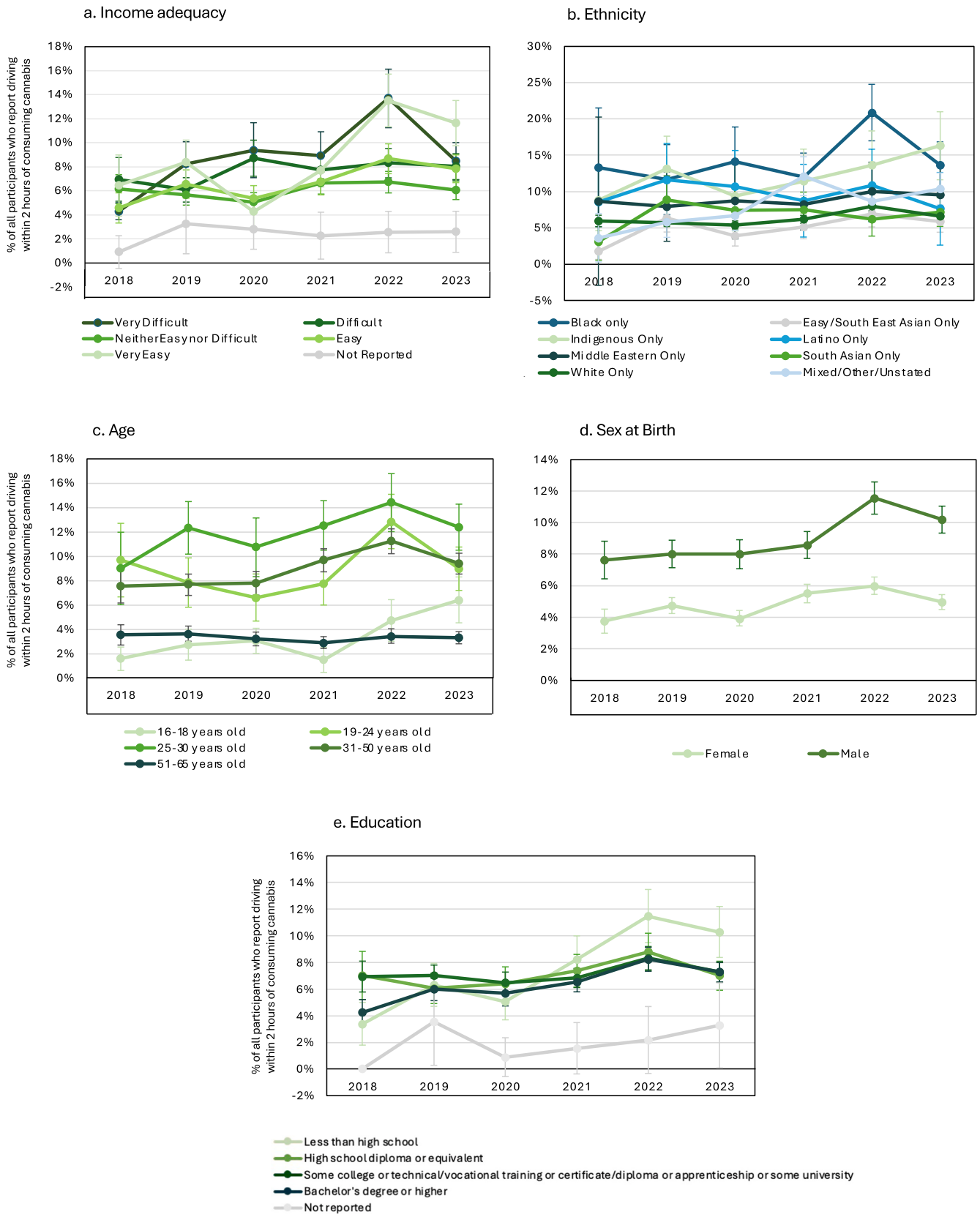

Fig. 2. Interaction effects between survey year and sociodemographic variables on driving within 2 h of using cannabis.

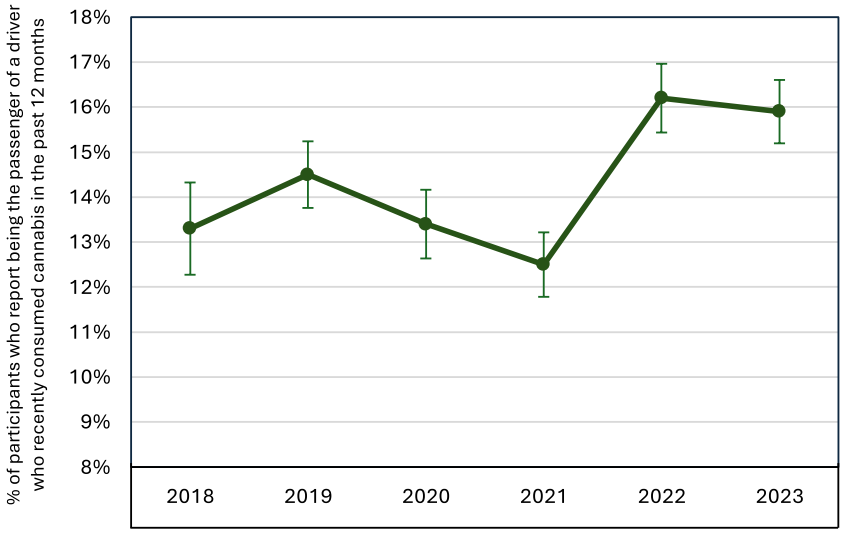

Fig. 3. Prevalence of all participants who reported being a passenger of a driver who consumed cannabis within 2 h of driving pre- (2018) vs. post-legalization (2019–2023) of recreational legalization of cannabis.

compared had higher odds of reporting passenger behaviour than White participants, while those who identified as East/Southeast Asian (10.1 % vs. 13.5 %, OR = 0.67, 95 % CI = 0.60, 0.74) and South Asian (13.9 % vs. 13.5 %, OR = 0.83, 95 % CI = 0.73, 0.94) had lower odds than White participants. Participants who reported their income adequacy as being 'very difficult' to make ends meet ends meet had higher odds of being a passenger of a driver who recently consumed cannabis than all other income adequacy groups (All $p < 0.001$, as reported in Supplementary Table S3).

There was a significant two-way interaction between income adequacy and survey year among all participants ($F = 1.96$, $p = 0.003$)—see Fig. 4a. In 2019, passenger behaviour increased among all income adequacy groups, except among those who reported it 'neither easy nor difficult' to make ends meet. Across the five years following legalization, passenger behaviour increased slightly among those who reported it being 'very difficult' and 'very easy' to make ends meet, and among those who did not report their income adequacy.

A two-way interaction was also observed between survey year and age ($F = 2.78$, $p < 0.001$)—see Fig. 4c. Across the five years following legalization, passenger behaviour increased slightly among participants 30 years and younger but remained stable for participants 30 to 65 years old. From 2020 to 2021, passenger behaviour increased among participants 31 to 50 years, decreased among 16- to 18-year-olds and remained stable for all other ages.

A two-way interaction between survey year and education ($F = 1.61$, $p = 0.041$) demonstrated that prevalence of passenger behaviour remained relatively stable across all educational groups, with slight variations. From 2020 to 2021, passenger behaviour increased among all educational attainment groups, but individuals who did not report their educational attainment demonstrated the greatest magnitude of increase—See Fig. 4e.

4. Discussion

This study is among the first to examine patterns of driving after cannabis use before and after legalization of recreational cannabis in Canada. Following legalization, driving after cannabis use decreased among past 12-month consumers, but increased overall, likely due to the total increase in the number of cannabis consumers post-legalization. (Canadian Community Health Survey, 2024) These findings are consistent with studies utilizing data from both self-report measures and cannabis-related traffic fatalities in the United States. (Lensch et al., 2020; Aydelotte et al., 2019) Cross-sectional evidence comparing prevalence of driving after cannabis use between states with different cannabis laws found that driving after use was more prevalent in states with legal recreational cannabis compared to illegal and legal medical states, which is likely the result of a higher prevalence of cannabis consumers in recreational states. (Lensch et al., 2020) However, past 12-month cannabis consumers from legal recreational states had significantly lower rates of driving after consumption than those from states without legal recreational cannabis, and were more likely to believe driving 'high' increased the risk of an accident. (Lensch et al., 2020) It is possible that the decrease in driving after cannabis use among consumers in the current study is due to greater perceived risks, possibly because of the Canadian government's drug-impaired driving efforts post-legalization. (Blevins et al., 2018; Boicu et al., 2024; Government of Canada, 2017; Canada Policing Services, 2017).

The patterns of driving after cannabis use in the present paper also coincide with the COVID-19 global pandemic restrictions and regional lockdowns. There was an increase in driving after use in 2019, followed by a reduction in 2020, consistent with other cross-sectional evidence that found a decline in the prevalence of drug-impaired driving during the COVID-19 pandemic. (Lyon et al., 2024) In 2021, there was an increase in driving after use, possibly because COVID-19 restrictions were lifted and cannabis consumption increased during the pandemic. (Wadsworth et al., 2023).

Driving after cannabis use and passenger behaviour were more prevalent among male than female participants and there was a greater magnitude of increase in driving after use over time among males than females. This is consistent with toxicological evidence from Canada that found a significant increase in the prevalence of THC positive (>0 ng/mL, >2 ng/mL, >5 ng/mL) injured drivers following legalization, with the greatest magnitude of increase among male individuals. (Brubacher et al., 2022) This likely reflects differences in consumption patterns, as males historically report more overall cannabis consumption. (ICPS, 2023) Future research should assess potential correlates of driving after cannabis use among individuals assigned male at birth, such as perceptions of risk, to better inform impaired driving prevention efforts.

In this study, no significant differences in driving after cannabis consumption were observed among older adults aged 51 to 65 years old, which contrasts previous literature that shows an increased likelihood of driving after use in this age group following legalization. (Brubacher et al., 2022; Imtiaz et al., 2024) This discrepancy could be due to methodological differences, as most literature only assesses driving estimates one year following legalization when the impact of legalization will be seen in the long term. (Imtiaz et al., 2024).

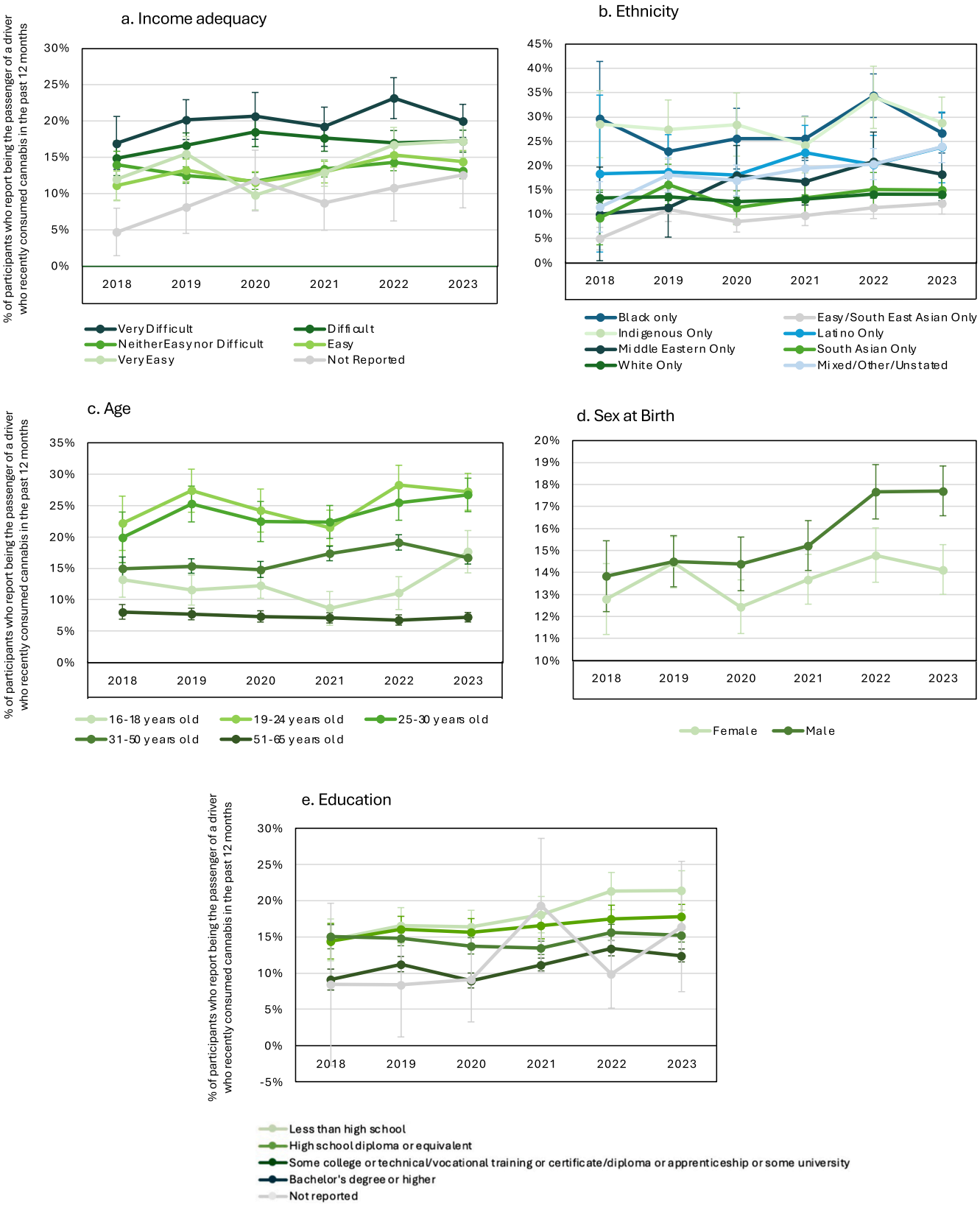

Fig. 4. Interaction effects between survey year and sociodemographic variables on being a passenger of a driver who consumed cannabis within 2 h of driving.

Driving after cannabis use and being a passenger of a driver who recently consumed cannabis increased significantly among 16 to 18-year-olds following legalization. This has potentially important implications, as one of the main objectives of recreational legalization was to protect youth by restricting access to legal cannabis. (Government of Canada, 2018) Future research should analyse the effectiveness of cannabis and driving efforts among youth and explore changes in perceived risk towards driving after cannabis consumption following

legalization in Canada.

Finally, racialized individuals and those of lower income adequacy and educational attainment were more likely to report driving after use and being a passenger of a driver who consumed cannabis. This is consistent with pre-existing research that shows lower socioeconomic groups are more likely to experience cannabis-related harms despite similar levels of overall consumption to higher socioeconomic groups. (Fischer et al., 2021) Future research should assess the impact of cannabis legalization among these groups to inform public education efforts and other policy measures that may need to be adapted for specific socioeconomic groups.

5. Strenths and limitations

This study used repeat cross-sectional data from the ICPS project, a large national survey, to examine trends in driving within 2 h of consuming cannabis and being a passenger of a driver who recently consumed cannabis from 2018 (pre-legalization) to 2023 (4 years post-legalization). The ICPS has several strengths, including large sample sizes pre-and post-legalization, and the use of post-stratification weights to ensure the analyses are representative of the Canadian population for each wave of data.

This study also has several limitations. Self-report data was used, and social desirability bias is a potential limitation. As a result, driving after cannabis consumption and passenger behaviour may be underestimated. However, responses were anonymized and self-administered online, and respondents were asked whether they were able to answer questions honestly. Participants who reported 'no' were excluded from the sample. Another potential limitation is the use of nonprobability-based sampling; however, data were weighted to match the age, sex, region, and education profile of the population.

The current study assessed self-reported driving after cannabis use and not the extent of impairment. In assessing the potential implications for traffic safety, it is important to distinguish between cannabis use and impairment or intoxication. Participants were only asked about driving within 2 h of using cannabis, however, impairment can persist beyond 2 h, which this study does not capture. Additionally, not all individuals who consume cannabis before driving will be impaired, particular among some medical consumers who either consumer lower THC products, or frequent consumers who have built up considerable tolerance. (Colizzi and Bhattacharyya, 2018) Therefore, the increased 'risk' from driving after cannabis consumption is likely to differ between individuals and should not be equated with the overall prevalence of use.

6. Conclusions

Driving after cannabis use and being a passenger of a driver who recently consumed cannabis is relatively common, especially among past 12-month cannabis consumers. Increases in cannabis and driving are likely due to overall changes in cannabis consumption following legalization. The results suggest that driving and cannabis use could be an important indicator of problematic cannabis use that warrants greater attention. Future research should examine the effectiveness of public health efforts to target perceived risks associated with impaired driving, particularly among individuals aged 16 to 18 years, racialized individuals, and those of lower socioeconomic position.

7. Contributors

DH designed and conducted research; AK analysed data; AK and DH wrote the paper; DH is the guarantor of the study. All authors reviewed and edited the manuscript. All authors read and approved the final manuscript.

CRediT authorship contribution statement

Ava Kucera: Writing – review & editing, Writing – original draft, Conceptualization. **David Hammond:** Writing – review & editing, Supervision, Project administration, Methodology, Funding acquisition, Data curation, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: [David Hammond (PI) reports financial support was provided by Canadian Institutes for Health Research - Research grant. David Hammond reports financial support was provided by Canadian Centre on Substance Use and Addiction - Research grant. David Hammond reports financial support was provided by Funding from state health & regulatory agencies. David Hammond reports a relationship with Expert witness on behalf of public health authorities that includes: paid expert testimony. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper].

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.addbeh.2025.108419.

Data availability

Data will be made available on request.

References

Hall, W., Stjepanović, D., Dawson, D., & Leung, J. (2023). The implementation and public health impacts of cannabis legalization in Canada: A systematic review. *Addiction, 118*(11), 2062–2072.

Brubacher, J. R., Chan, H., Erdelyi, S., Staples, J. A., Asbridge, M., & Mann, R. E. (2022). Cannabis legalization and detection of tetrahydrocannabinol in injured drivers. *The New England Journal of Medicine, 386*(2), 148–156.

Asbridge, M., Hayden, J. A., & Cartwright, J. L. (2012). Acute cannabis consumption and motor vehicle collision risk: Systematic review of observational studies and meta-analysis. *BMJ, 344*(2), e536.

Ramaekers, J. G., Kauert, G., Theunissen, E. L., Toennes, S. W., & Moeller, M. R. (2009). Neurocognitive performance during acute THC intoxication in heavy and occasional cannabis users. *Journal of psychopharmacology (Oxford, England), 23*(3), 266–277.

Ramaekers, J. G., Kauert, G., van Ruitenbeek, P., Theunissen, E. L., Schneider, E., & Moeller, M. R. (2006). High-potency marijuana impairs executive function and inhibitory motor control. *Neuropsychopharmacology: Official Publication of the American College of Neuropsychopharmacology, 31*(10), 2296–2303.

Bondallaz, P., Favrat, B., Chtioui, H., Fornari, E., Maeder, P., & Giroud, C. (2016). Cannabis and its effects on driving skills. *Forensic Science International, 268*, 92–102.

Asbridge, M., Mann, R., Cusimano, M. D., Trayling, C., Roerecke, M., Tallon, J. M., et al. (2014). Cannabis and traffic collision risk: Findings from a case-crossover study of injured drivers presenting to emergency departments. *International Journal of Public Health, 59*(2), 395–404.

Carpino, M., Langille, D., Ilie, G., & Asbridge, M. (2020). Cannabis-related driving and passenger behaviours among high school students: A cross-sectional study using survey data. *CMAJ Open, 8*(4), E754–E761.

McDonald, A. J., Hamilton, H. A., Wickens, C. M., Watson, T. M., Elton-Marshall, T., Wardell, J. D., et al. (2021). Driving under the influence of cannabis risk perceptions and behaviour: A population-based study in Ontario. *Canada Preventive Medicine, 153*, Article 106793.

Blevins, C. E., Marsh, E., Banes, K. E., Stephens, R. S., Walker, D. D., & Roffman, R. A. (2018). The implications of cannabis policy changes in Washington on adolescent perception of risk, norms, attitudes, and substance use. *Substance Abuse: Research Treatment, 12*, Article 1178221818815491.

Keyes, K. M., Wall, M., Cerdá, M., Schulenberg, J., O'Malley, P. M., Galea, S., et al. (2016). How does state marijuana policy affect U.S. youth? Medical marijuana laws, marijuana use and perceived harmfulness: 1991–2014. *Addict Abingdon Engl, 111* (12), 2187–2195.

Wadsworth, E., & Hammond, D. (2018). Differences in patterns of cannabis use among youth: Prevalence, perceptions of harm and driving under the influence in the USA where non-medical cannabis markets have been established, proposed and prohibited. *Drug and Alcohol Review, 37*(7), 903–911.

Carliner, H., Brown, Q. L., Sarvet, A. L., & Hasin, D. S. (2017). Cannabis use, attitudes, and legal status in the U.S.: A review. *Preventive Medicine, 104*, 13–23.

Wadsworth, E., Driezen, P., Pacula, R. L., & Hammond, D. (2022). Cannabis flower prices and transitions to legal sources after legalization in Canada, 2019-2020. *Drug and Alcohol Dependence, 231*, Article 109262.

Canadian Cannabis Survey 2017 - Summary [Internet]. 2017 [cited 2024 Jun 4]; Available from: https://www.canada.ca/en/health-canada/services/publications/drugs-health-products/canadian-cannabis-survey-2017-summary.html.

Myran, D. T., Staykov, E., Cantor, N., Taljaard, M., Quach, B. I., Hawken, S., et al. (2022). How has access to legal cannabis changed over time? an analysis of the cannabis retail market in Canada 2 years following the legalisation of recreational cannabis. *Drug and Alcohol Review, 41*(2), 377–385.

Erin Goodman, S., Leos-Toro, C., & Hammond, D. (2020). Risk perceptions of cannabis- vs. alcohol-impaired driving among Canadian young people. *Drugs: Education, Prevention Policy, 27*(3), 205–212.

Salas-Wright, C. P., Cano, M., Hai, A. H., Oh, S., & Vaughn, M. G. (2021). Prevalence and Correlates of Driving under the Influence of Cannabis in the U.S. *American Journal of Preventive Medicine, 60*(6), e251–e260.

González-Sala, F., Tortosa-Pérez, M., Peñaranda-Ortega, M., & Tortosa, F. (2023). Effects of cannabis legalization on road safety: A literature review. *International Journal of Environmental Research and Public Health, 20*(5), 4655.

Lane, T. J., & Hall, W. (2019). Traffic fatalities within US states that have legalized recreational cannabis sales and their neighbours. *Addiction, 114*(5), 847–856.

Santaella-Tenorio, J., Wheeler-Martin, K., DiMaggio, C. J., Castillo-Carniglia, A., Keyes, K. M., Hasin, D., et al. (2020). Association of recreational cannabis laws in colorado and washington state with changes in traffic fatalities, 2005-2017. *JAMA Internal Medicine, 180*(8), 1061–1068.

Voy, A. (2023). Collisions and cannabis: Measuring the effect of recreational marijuana legalization on traffic crashes in Washington State. *Traffic Injury Prevention, 24*(7), 527–535.

Zhao, S., Brands, B., Kaduri, P., Wickens, C. M., Hasan, O. S. M., Chen, S., et al. (2024). The effect of cannabis edibles on driving and blood THC. *Journal of Cannabis Research, 6*(1), 26.

Thompson, C. G., Kim, R. S., Aloe, A. M., & Becker, B. J. (2017). Extracting the variance inflation factor and other multicollinearity diagnostics from typical regression results. *Basic and Applied Social Psychology, 39*(2), 81–90.

Health Canada. Authorized cannabis retailers in the provinces and territories [Internet]. 2018 [cited 2024 Feb 14];Available from: https://www.canada.ca/en/health-canada/services/drugs-medication/cannabis/laws-regulations/provinces-territories.html.

ICPS Methods [Internet]. Cannabis Proj.2024 [cited 2024 Oct 4];Available from: https://cannabisproject.ca/methods/.

Lensch, T., Sloan, K., Ausmus, J., Pearson, J. L., Clements-Nolle, K., Goodman, S., et al. (2020). Cannabis use and driving under the influence: Behaviors and attitudes by state-level legal sale of recreational cannabis. *Preventive Medicine, 141*, Article 106320.

Aydelotte, J. D., Mardock, A. L., Mancheski, C. A., Quamar, S. M., Teixeira, P. G., Brown, C. V. R., et al. (2019). Fatal crashes in the 5 years after recreational marijuana legalization in Colorado and Washington. *Accident; Analysis and Prevention, 132*, Article 105284.

Boicu, B., Al-Hakim, D., Yuan, Y., & Brubacher, J. (2024). Attitudes toward driving after cannabis use: A systematic review. *Journal of Cannabis Research, 6*(1), 37.

Canadian Community Health Survey (CCHS) - 2024 [Internet]. [cited 2024 Oct 4]; Available from: https://www23.statcan.gc.ca/imdb/p3Instr.pl?Function=assembleInstr&lang=en&Item_Id=1532313#qb1532641.

Government of Canada. Don't Drive High Campaign [Internet]. 2017 [cited 2025 Jan 11];Available from: https://www.canada.ca/en/campaign/don-t-drive-high.html.

Lyon, C., Vanlaar, W., & Robertson, R. D. (2024). The impact of COVID-19 on transportation-related and risky driving behaviors in Canada. *Transportation Research Part F: Traffic Psychology and Behaviour, 100*, 13–21.

Wadsworth, E., Goodman, S., & Hammond, D. (2023). Self-reported Impact of the COVID-19 Pandemic on Cannabis Use in Canada and the United States. *Journal of Psychoactive Drugs, 55*(4), 483–492.

Canada Policing Services. Drug-impaired driving [Internet]. 2017 [cited 2025 Jan 11]; Available from: https://www.canada.ca/en/services/policing/police/community-safety-policing/impaired-driving/drug-impaired-driving.html.

ICPS. International Cannabis Policy Study: National Report Canada. 2023.

Imtiaz, S., Nigatu, Y. T., Ali, F., Branka, A., Elton-Marshall, T., Jiang, H., et al. (2024). Cannabis legalization and driving under the influence of cannabis and driving under the influence of alcohol among adult and adolescent drivers in Ontario. *Canada, 255*, 11060.

Government of Canada D of J. Cannabis Legalization and Regulation [Internet]. 2018 [cited 2024 Dec 10];Available from: https://www.justice.gc.ca/eng/cj-jp/cannabis/.

Fischer, B., Lee, A., Robinson, T., & Hall, W. (2021). An overview of select cannabis use and supply indicators pre- and post-legalization in Canada. *Substance Abuse Treatment, Prevention, and Policy, 16*(1), 77.

Colizzi, M., & Bhattacharyya, S. (2018). Cannabis use and the development of tolerance: A systematic review of human evidence. *Neuroscience and Biobehavioral Reviews, 93*, 1–25.