



Harm perceptions of smoking versus vaping cannabis and correlates: national surveys of youth and young adults in England, Canada, and the United States

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ABSTRACT

Purpose: Cannabis products and routes of administration (e.g., smoking, vaping) vary. Harm perceptions are associated with use, yet little research examines these across routes of administration. We compared harm perceptions of cannabis smoking versus cannabis vaping and correlates among young people across England, Canada, and the US.

Methods: Youth (ages 16–19; $n = 37,761$) and young adults (20–29; $n = 8,762$) completed the ITC Youth & Young Adult Tobacco and Vaping Survey (2022–2024). Relative perceived harms of daily cannabis smoking versus daily cannabis vaping were assessed; adjusted regressions examined differences by country, mental health, nicotine smoking/vaping, and cannabis use.

Results: Overall, 10.4% of youth and 11.8% of young adults perceived smoking cannabis as more harmful than vaping cannabis. Odds of perceiving smoking cannabis as more harmful than vaping cannabis were higher in England versus the US (youth: OR = 1.89, 95%CI:1.69–2.13, $p < 0.001$; young adults OR = 1.47, CI:1.14–1.92, $p = 0.004$) and versus Canada among youth (OR = 1.47, CI:1.35–1.61, $p < 0.001$), among youth with moderate-to-high mental health symptoms (vs. no/low symptoms, OR = 1.23, CI:1.13–1.35, $p < 0.001$) and youth who smoked and/or vaped nicotine or formerly used cannabis (vs. never used, all $p < 0.05$). Among young adults, perceptions did not vary by mental health or nicotine/cannabis use.

Discussion: Few youth and young adults perceive cannabis smoking as more harmful than cannabis vaping. Differences by country, mental health, and cannabis/nicotine use indicate that cannabis harm perceptions vary by geographic context and individual factors, supporting tailored health communication efforts about the potential and uncertain risks of different routes of cannabis administration.

Cannabis is widely used globally, with an estimated 228 million people using it in 2022 (United Nations Office on Drugs and Crime. *World Drug Report*, 2024). It can be administered via a range of routes; some involve combustion (e.g., smoking in joints or waterpipes), while others involve inhalation of cannabis products which are heated but not burned (e.g., vapes and dry-herb vapourisers) or oral ingestion (e.g., oils and edibles) (MacCallum et al., 2023). Non-combustible use is increasingly popular in jurisdictions where cannabis is legal, such as Canada and certain states in the United States (US), although smoking remains common (Lim et al., 2022; Hammond et al., 2017). In England,

where recreational cannabis is illegal and medical cannabis is tightly restricted, smoking is the predominant route (Hammond et al., 2017). Further, in some regions, including most of Europe, cannabis is commonly smoked in combination with tobacco, a practice known as ‘co-administration’ (Hammond et al., 2017; Hindocha and McClure, 2020).

Smoking cannabis is associated with respiratory symptoms and other health risks including cardiovascular harms (Khoj et al., 2024; National Academies of Sciences E, and Medicine. *The Health Effects of Cannabis and Cannabinoids: The Current State of Evidence and Recommendations*

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for Research. The National Academies Press, 2017; Muheriwa-Matumba et al., 2024). Albeit less severe than the serious harms associated with tobacco smoking (National Center for Chronic Disease Prevention and Health Promotion (US) Office on Smoking and Health. The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General., 2014); these warrant attention. Switching to non-combustible modes of cannabis use can reduce exposure to harmful combustion by-products (MacCallum et al., 2023; Loflin and Earleywine, 2015), as well as preventing the co-administration of cannabis with tobacco (Hammond et al., 2017; Hindocha and McClure, 2020). Reflecting these risks, public health authorities in some jurisdictions recommend prioritising non-combustible routes as a harm reduction approach, such as in Canada's Lower-Risk Cannabis Use Guidelines (Centre for Addiction and Mental Health. Lower-Risk Cannabis Use Guidelines: Evidence summary., 2017). Similarly, medical cannabis programmes typically prioritise oral ingestion, with dry-herb vapourisers sometimes recommended, and smoking typically discouraged (Institute, 2019).

Avoiding smoked cannabis may offer harm-reduction potential, however, non-smoked routes also carry risks. Liquid-based cannabis vaping products ('vapes') in particular pose unique risks due to potentially harmful carrier ingredients (MacCallum et al., 2023). For instance, the 2019 outbreak of E-cigarette or Vaping-Associated Lung Injury (EVALI) in the US was largely linked to unregulated tetrahydrocannabinol (THC) vapes containing vitamin E acetate (Centers for Disease Control and Prevention. Outbreak of lung injury associated with the use of e-cigarette, or vaping, products. U.S. Department of Health and Human Services., 2025). Further, vapes typically have high THC concentrations and regulating their content is complex, making them riskier overall than oral ingestion products or dry-herb vapourisers (MacCallum et al., 2023).

Evidence from the nicotine field provides relevant context in understanding how administration routes are perceived, and how perceptions relate to behaviour. In recent years, perceptions that nicotine vaping is equally or more harmful than smoking have increased, despite substantial evidence to the contrary (Bandi et al., 2022; Buss et al., May 2025; Academies, 2018; College, 2024; McNeill et al., 2022; East et al., 2022). This shift coincided with media coverage of events like the 2019 EVALI outbreak, especially in the US (Bandi et al., 2022; Buss et al., May 2025; East et al., 2022; Jackson et al., 2024). While nicotine and cannabis products are not directly comparable, this demonstrates how cultural and policy factors can shape harm perceptions. Further, perceptions matter for nicotine behaviours: individuals who perceive nicotine vaping as less harmful than smoking are more likely to switch from smoking to vaping (East et al., 2025), and UK young adults who perceived vaping as less harmful than smoking were more likely to transition from smoking to vaping over time (East et al., 2025). Similar patterns may apply to cannabis: greater perceived harm is associated with lower likelihood of use (Nguyen et al., 2023; Kleine et al., 2025), and perceptions may influence preferences across routes. One study of US young adults who vaped cannabis and/or nicotine revealed that those who believed vaping cannabis could cause lung injuries were less likely to increase use, while those who viewed it as safer than smoking were more likely to do so (Nguyen et al., 2021).

As cannabis markets diversify, understanding how people perceive different routes of administration becomes increasingly important. Available evidence suggests that, among Canadian young adults, smoking and vaping cannabis are viewed as similarly harmful, with both perceived as riskier than consuming edibles (McMahon et al., 2023), while US adults associated more health benefits with vaping cannabis and more health risks with smoking cannabis (Fisher et al., 2025). Further evidence is needed to better understand cannabis smoking and vaping harm perceptions as well as associated factors, such as national context, nicotine use status, and mental health status.

This study examines harm perceptions of cannabis smoking compared to cannabis vaping among youth and young adults in Canada,

England, and the US, three countries with differing cannabis usage patterns and policies (summarised in Appendix 1). We focus on youth and young adulthood, transitional developmental stages often characterised by experimentation with substances which risks establishing long-term use patterns (Cadigan et al., 2019; Degenhardt et al., 2016). We consider mental health because individuals with mental health conditions are more likely to use cannabis and nicotine than those without and they may favour certain routes of administration (Rup et al., 2021; Lev-Ran et al., 2013; Hackworth et al., 2025); cannabis vaping in particular has been understudied among young adults with mental health conditions (Chung et al., 2025). We address three questions:

- 1) What are the perceived harms of smoking cannabis relative to vaping cannabis, and do these differ by country? We hypothesised that participants in England would be more likely to perceive smoking as more harmful than vaping, compared with Canada and the US, consistent with nicotine harm perceptions.
- 2) Do these relative harm perceptions vary by mental health symptoms? This question was exploratory.
- 3) Do these relative harm perceptions vary by cannabis and nicotine use status? We hypothesised that individuals' perceptions will align with their own use patterns, i.e., those who vape cannabis or nicotine are more likely to perceive vaping as less harmful than smoking cannabis.

1. Methods

This study was pre-registered on the Open Science Framework (OSF; osf.io/enq6b) (Nottage et al.). The [Redacted] Research Ethics Committee (ORE#21847/31017) and the [Redacted] Ethics Subcommittee provided ethics clearance.

1.1. Data source

The International Tobacco Control (ITC) Youth and Young Adult Tobacco and Vaping Survey is an annual cross-sectional online survey (Youth, 2025). This study included youth (ages 16–19) and young adult (ages 20–29) samples, collected in August–September of 2022, 2023, and 2024 in England, Canada, and the US. Participants, recruited through Nielsen's Consumer Insights Global Panel and partners, were screened for eligibility, and, upon participant (and parental) consent, completed a 15- to 20-minute survey including questions on sociodemographics, mental health, tobacco and nicotine products, and health behaviours including cannabis. Compensation followed each panel's standard incentive structure. Full sampling procedures are described elsewhere (Youth, 2025). After ITC standard exclusions (e.g., failed attention checks) and 222 cases removed due to responding 'Refused' on harm perception questions, final datasets included 37,761 youths and 8,762 young adults across countries and waves.

1.2. Measures

Variables used in this study are summarised below; detailed survey items are provided in Supplementary Materials (Table S1) and on OSF (Nottage et al.).

1.2.1. Outcome: Harm perceptions

Primary outcome. Perceptions of daily cannabis smoking vs vaping, i.e., rating daily cannabis smoking as more harmful than daily cannabis vaping, derived from two items: "How harmful is it to SMOKE marijuana/cannabis every day?" and "How harmful is it to VAPE marijuana/cannabis every day?". Each had response options: "Not at all harmful," "Slightly harmful," "Somewhat harmful," "Very harmful," "Extremely harmful," "Don't know," and "Refused". "Refused" responses were deleted listwise; others were dichotomised as "Yes" (smoking harm

score > vaping harm score) or “Other” (smoking harm score < vaping harm score, smoking harm score = vaping harm score, or “Don’t know” on either item).

Outcomes for sensitivity analyses. (1) Primary outcome with “Don’t know” responses separated from the “Other” category; (2) Relative harm perceptions of less-than-daily cannabis use, using questions about use “some days but not every day” (variable Smoking-HigherRiskOCC in Table S1); (3) Primary outcome with perceptions of daily vaping as more harmful than daily smoking (reverse coded response options).

1.2.2. Mental health symptoms

Mental health symptoms were measured using two items from the Screening Tool for Psychological Distress (STOP-D) on depression and anxiety, and a single-item perceived life stress question. The STOP-D items asked participants how bothered they were by feeling sad/down or anxious/nervous in the last month; responses ranging from “0 – Not at all” to “9 – Severely” were dichotomised based on cutoffs (≥ 4 for depression, ≥ 5 for anxiety) into “Moderate/High symptoms” or “No/Low symptoms” (Young et al., 2015). Responses to the perceived life stress question (“Thinking about the amount of stress in your life, would you say that most days are...?”) ranging from “1 – Not at all stressful” to “5 – Extremely stressful” were dichotomised into “No/Low stress” (≤ 3) and “Moderate/High stress” (≥ 4) (Association of Public Health Epidemiologists in Ontario. Self-Perceived Life Stress. Accessed 13 May, 2025). All three items included “Don’t know” and “Refused” response options. Based on prior ITC analyses demonstrating strong associations between STOP-D items (Hackworth et al., 2025), a combined mental health variable grouped participants into: 1) “Moderate/High mental health symptoms” if they scored in the moderate/high range on any of the three items; 2) “No/Low mental health symptoms” if they scored low/no on all three; 3) “Don’t know/Refused” if they answered “Don’t know” or “Refused” on any item and did not score “Moderate/High” on any.

1.2.3. Nicotine and cannabis

Nicotine smoking/vaping was categorised into five mutually exclusive groups: 1. Never vaped nor smoked, 2. Former smoking or vaping (lifetime smoking and/or vaping but not in the past 30 days), 3. Exclusive vaping (past 30-day vaping but no past 30-day smoking), 4. Exclusive smoking (past 30-day smoking but no past 30-day vaping), 5. Dual vaping and smoking (past 30-day vaping and cigarette smoking). These were derived from questions about lifetime and last use of each product separately (Table S1). “Never use” categories are inclusive of “Don’t know” or “Refused” responses.

Cannabis use was categorised into six mutually exclusive groups: 1. Never use, 2. Former use (lifetime cannabis use but not in the past 30 days), 3. Exclusive vaping (past 30-day use via vaping only), 4. Exclusive smoking (past 30-day use via smoking only), 5. Dual smoking and vaping (used cannabis in the past 30 days via both smoking and vaping), 6. Other routes of administration (past 30-day use exclusively via non-smoking/vaping methods, e.g., edibles or extracts). “Never use” categories are inclusive of “Don’t know” or “Refused” responses.

1.2.4. Socio-demographic measures

Country of residence, sex at birth (Male; Female), race/ethnicity (White; Racialised minorities; Don’t know/Refused), perceived household income adequacy (Not/just meeting basic expenses; Meeting needs with a little left over; Living comfortably), student/employment status (Current student, not employed; Currently employed, not a student; Current student and employed; Neither student nor employed; Other, including “Don’t know/Refused”).

1.3. Statistical analyses

Weighting procedures are described elsewhere (Hammond et al.,

2024). Briefly, post-stratification weights were constructed for youth and young adults separately, based on population estimates for socio-demographic variables and calibration to smoking trends from national surveys. All analyses were weighted and conducted in R Studio separately for youth and young adults. Multicollinearity was checked using generalised variance inflation factor (GVIF) raised to the power of $1/(2 \times \text{Df})$; all covariates in both samples had values below 1.1, indicating no concerns.

To evaluate between-country differences in relative harm perceptions for daily use, pairwise comparisons and binomial logistic regression models were employed, both adjusted. Associations between relative harm perceptions and mental health symptoms, smoking/vaping nicotine, and cannabis use were examined using adjusted binomial logistic regression. Adjustments included survey wave, mental health, cannabis use status, nicotine use status, and socio-demographics (see 2.2.4), excluding the outcome variable in each analysis. For all research questions, a set of sensitivity analyses was performed: (1) running the analyses unadjusted, (2) recalculating the relative harm perception variable after excluding “Don’t know” responses ($n = 1,069$ young adults, $n = 5,591$ youth); (3) using a measure of relative harm perception for less-than-daily use; (4) using a reversed relative harm perception variable for perceiving cannabis vaping as more harmful than cannabis smoking; (5) using separate (rather than combined) mental health variables for analyses involving mental health.

1.4. Deviations from the pre-registration

While the OSF pre-registration (Nottage et al.) mentioned data from waves 6–7 (2022–2023) only, newly available wave 8 (2024) data was also included. The management of “Refused” and “Don’t know” answers to certain survey items was revised to ensure consistency across derived variables and to avoid data loss. Although listwise deletion was originally specified, the ITC-provided nicotine use variables had already recoded these responses into non-use categories (Table S1). Cannabis use variables were coded similarly to maintain consistency across substance use measures. For mental health variables, “Don’t know” and “Refused” responses remained identifiable in the raw data and were retained as a separate category, as they do not provide interpretable information on symptom severity. Additionally, in response to newly published research showing high correlation between depression and anxiety in this dataset (Hackworth et al., 2025) and to facilitate interpretation, anxiety, depression, and stress were combined into a single variable, and sensitivity analyses were conducted with separate mental health items as initially registered. Finally, due to small subgroup sizes, cannabis ‘exclusive vaping’ and cannabis ‘other routes’ (Table 1) were combined in regression analyses: a sensitivity analysis without this combination is presented in Table S6.

2. Results

Participant characteristics are shown in Table 1 and harm perceptions in Table 2. Overall, more than half of youth perceived daily cannabis smoking and daily cannabis vaping as very to extremely harmful (55.1% smoking, 57.1% vaping), with slightly lower figures among young adults (45.9% smoking, 49.0% vaping). Daily cannabis smoking was perceived as more harmful than daily cannabis vaping by 10.4% of youth ($n = 37,761$) and 11.8% of young adults ($n = 8,762$); by country, this represented 13.7% of youth and 10.4% of young adults in England, 9.7% and 13.7% in Canada, and 7.6% and 12.1% in the US, respectively. In total, 14.7% of youth ($n = 5,591$) and 11.1% of young adults ($n = 1,069$) responded “Don’t know” to at least one of the two harm perception items, while 59.6% of youth ($n = 22,135$) and 58.6% of young adults ($n = 4,947$) perceived cannabis smoking and vaping as equally harmful.

Table 1
Sample characteristics by age group and country (2022–2024).

Characteristics	Youth, 16–19 years old n (%) ^a			Young adults, 20–29 years old n (%) ^a		
	England	Canada	US	England	Canada	US
N	12,723	12,722	12,316	2,754	3,338	2,670
Sex at birth						
Female	7,920 (48.6)	7,856 (48.8)	8,116 (48.8)	1,895 (49.9)	2,185 (48.1)	1,843 (48.9)
Race/Ethnicity						
White	8,802 (69.9)	7,322 (54.3)	6,854 (72.2)	1,929 (68.2)	1,565 (48.2)	1,274 (72.6)
Racialised minorities	3780 (29.1)	5,144 (43.9)	5,360 (27.3)	793 (30.4)	1,700 (49.5)	1,377 (27.0)
Don't know/refused	141 (0.97)	256 (1.9)	102 (0.4)	32 (1.39)	73 (2.31)	19 (0.37)
Perceived household income adequacy						
Not/just meeting basic expenses	4,294 (31.5)	3,806 (28.1)	4,686 (34.5)	1,152 (38.1)	1,445 (39.3)	1,360 (48.6)
Meeting needs with a little left over	4,243 (33.9)	4,563 (34.9)	3,706 (31.4)	908 (34.3)	1,049 (32.7)	693 (26.9)
Living comfortably	3,560 (29.9)	3,818 (32.9)	3,287 (29.7)	604 (23.8)	732 (24.0)	528 (21.2)
Don't know/refused	626 (4.7)	535 (4.09)	637 (4.4)	90 (3.8)	112 (4.0)	89 (3.3)
Student/Employment status						
Student (not employed)	6,635 (57.3)	5,202 (44.2)	5,650 (50.2)	250 (10.8)	425 (13.2)	260 (10.1)
Employed (not student)	1,161 (5.0)	743 (4.10)	1,033 (4.6)	1,683 (60.5)	1,595 (46.8)	1,234 (47.9)
Student and employed	3,997 (33.6)	6,128 (48.0)	4,490 (40.3)	494 (17.1)	904 (28.0)	588 (20.1)
Neither student/employed	690 (2.8)	484 (2.6)	948 (4.0)	283 (9.44)	344 (9.9)	540 (20.4)
Other/Don't know/Refused	240 (1.3)	165 (1.2)	195 (0.8)	44 (2.13)	70 (2.02)	48 (1.52)
Mental health symptoms						
No/Low	3,800 (35.1)	4,145 (36.5)	4,138 (39.0)	498 (21.2)	609 (22.9)	533 (23.8)
Moderate/High	8,674 (63.1)	8,403 (62.1)	7,978 (59.8)	2,211 (76.9)	2,687 (75.4)	2,097 (74.9)
Don't know/refused	249 (1.76)	174 (1.37)	200 (1.25)	45 (1.85)	42 (1.73)	40 (1.3)
Nicotine vaping/smoking						
Never vaped nor smoked	5,219 (44.9)	6,665 (57.3)	6,287 (58.4)	444 (24.7)	1,057 (38.9)	732 (35.0)
Former vaping and/or smoking	2,966 (23.4)	3,226 (25.2)	3,064 (25.9)	776 (40.3)	996 (39.3)	684 (33.4)
Exclusive smoking	771 (6.6)	531 (2.9)	440 (1.0)	443 (5.4)	465 (4.6)	396 (5.8)
Exclusive vaping	2,009 (13.7)	1,521 (10.7)	1,705 (13.0)	426 (22.2)	345 (12.9)	320 (18.0)
Dual vaping & smoking	1,758 (11.5)	779 (3.9)	820 (1.7)	665 (7.5)	475 (4.3)	538 (7.8)
Cannabis use						
Never cannabis use	9,587 (78.6)	8,628 (71.3)	7,814 (69.7)	1,452 (59.6)	1,342 (47.0)	963 (40.9)
Former cannabis use	1,678 (11.4)	1,870 (13.4)	1,867 (14.1)	794 (27.1)	826 (25.1)	624 (24.2)
Exclusive smoking	835 (5.8)	861 (5.85)	891 (5.1)	264 (6.23)	495 (11.4)	457 (14.1)
Exclusive vaping	36 (0.2)	113 (0.8)	93 (0.6)	22 (0.6)	53 (1.76)	27 (1.37)
Dual smoking and vaping	452 (3.1)	1,039 (7.2)	1,432 (8.8)	170 (4.7)	481 (11.2)	511 (16.2)
Other routes of administration	135 (0.9)	211 (1.5)	219 (1.8)	52 (1.7)	141 (3.6)	88 (3.0)

Note. ^a Counts are presented unweighted, and percentages weighted.

2.1. Differences in perceptions of smoking versus vaping cannabis by country, mental health symptoms, smoking/vaping nicotine and cannabis use

The main analysis (Table 3) and pairwise regression models (Table S2) found that among youth, the odds of perceiving cannabis smoking as more harmful than cannabis vaping were higher in England than Canada (OR = 1.47, 95% CI: 1.34–1.61, $p < 0.001$), and lower in the US than England (OR = 0.52, 95% CI: 0.47–0.58, $p < 0.001$) and Canada (OR = 0.79, 95% CI: 0.71–0.89, $p < 0.001$). Among young adults, odds were lower in the US than England (OR = 0.67, 95% CI: 0.51–0.88, $p = 0.003$).

Youth who reported moderate/high mental health symptoms (compared to no/low) were more likely to perceive cannabis smoking as more harmful than cannabis vaping (OR = 1.23, 95% CI: 1.13–1.35, $p < 0.001$; Table 3). Among young adults, mental health symptoms were not associated with relative harm perceptions (Table 3).

Youth who currently or formerly smoked/vaped nicotine had higher odds of perceiving cannabis smoking as more harmful than vaping compared to those who never smoked/vaped (OR range 1.22–1.28;

Table 3). Odds were higher among youth who formerly used cannabis compared to those who never used it (OR = 1.15, 95% CI: 1.01–1.30, $p = 0.031$; Table 3). Among young adults, neither nicotine smoking/vaping nor cannabis use status were associated with relative harm perceptions (Table 3).

2.2. Sensitivity analyses

Sensitivity analyses broadly supported the main findings regarding country and mental health differences, while associations with nicotine and cannabis use status were less consistent across alternative models.

Unadjusted models. Results aligned with the main analysis, with one exception: young adults' odds of perceiving daily cannabis smoking as more harmful than daily cannabis vaping were lower in the US than Canada as well as lower in the US than England (Table S2).

Models excluding 'Don't know' responses. Results aligned with the main analysis, except that former cannabis use was not associated with higher odds of perceiving daily cannabis smoking as more harmful than vaping among youth (Table S3).

Harm perceptions of less-than-daily use. Odds of perceiving less-

Table 2

Relative and absolute harm perceptions of vaping and smoking cannabis, by age group and country (2022–2024).

	Youth, 16–19 years old <i>n</i> (%) ^a				Young adults, 20–29 years old <i>n</i> (%) ^a			
	England	Canada	US	Total	England	Canada	US	Total
<i>Relative harm perceptions</i>								
Cannabis smoking more harmful than cannabis vaping (daily)								
Yes	1,730 (13.7)	1,302 (9.7)	972 (7.6)	4004 (10.4)	399 (13.7)	385 (12.1)	246 (9.48)	1030 (11.8)
Other ^b	10,993 (86.3)	11,420 (90.3)	11,344 (92.4)	33,757 (89.6)	2,355 (86.3)	2,953 (87.9)	2,424 (90.5)	7732 (88.2)
<i>Of which: 'don't know'</i>	2,136 (16.8)	1,444 (11.5)	2,011 (15.7)	5591 (14.7)	385 (13.4)	328 (9.01)	356 (11.3)	1069 (11.1)
Cannabis smoking more harmful than cannabis vaping (less-than-daily)								
Yes	1,343 (10.3)	1,222 (8.6)	764 (5.9)	3329 (8.3)	344 (12.6)	350 (10.5)	268 (9.7)	962 (10.9)
Other ^b	11,380 (89.7)	11,500 (91.4)	11,552 (94.1)	34,432 (91.7)	2,410 (87.4)	2,988 (89.5)	2,402 (90.3)	7800 (89.1)
<i>Of which: 'don't know'</i>	2114 (16.7)	1435 (11.5)	1994 (15.5)	5543 (14.5)	384 (13.1)	317 (8.7)	341 (10.6)	1042 (10.7)
Cannabis vaping more harmful than cannabis smoking (daily)								
Yes	1742 (13.1)	1925 (15.1)	2364 (17.9)	6031 (15.3)	450 (14.5)	673 (19.6)	593 (21.2)	1716 (18.5)
Other ^b	10,981 (86.3)	10,797 (84.9)	9952 (82.1)	31,730 (84.7)	2304 (85.5)	2665 (80.4)	2077 (78.8)	7046 (81.5)
<i>Of which: 'don't know'</i>	2136 (16.8)	1444 (11.5)	2011 (15.7)	5591 (14.7)	385 (13.4)	328 (9.0)	356 (11.3)	1069 (11.1)
<i>Absolute harm perceptions</i>								
Cannabis smoking (daily)								
Not at all harmful	396 (2.7)	410 (3.0)	1433 (9.2)	2239 (4.9)	143 (4.7)	199 (5.2)	557 (18.4)	899 (9.0)
Slightly harmful	1342 (10.2)	1325 (10.2)	1841 (14.3)	4508 (11.5)	398 (12.5)	596 (16.6)	490 (17.8)	1484 (15.7)
Somewhat harmful	2064 (15.8)	2413 (18.7)	2250 (19.0)	6727 (17.8)	568 (20.7)	798 (23.8)	551 (20.5)	1917 (21.8)
Very harmful	2854 (22.9)	3149 (24.7)	2070 (17.3)	8073 (21.7)	530 (18.8)	688 (20.9)	357 (15.0)	1575 (18.4)
Extremely harmful	4644 (37.3)	4348 (34.9)	3155 (27.9)	12,147 (33.4)	886 (35.3)	816 (27.0)	465 (20.1)	2167 (27.5)
Don't know	1423 (11.1)	1077 (8.5)	1567 (12.3)	4067 (10.6)	229 (8.1)	241 (6.5)	250 (8.2)	720 (7.5)
Cannabis vaping (daily)								
Not at all harmful	289 (2.0)	302 (2.2)	1007 (6.8)	1598 (3.6)	100 (3.7)	148 (3.4)	428 (14.2)	676 (6.8)
Slightly harmful	1016 (7.7)	1049 (8.1)	1467 (11.2)	3532 (8.9)	320 (10.6)	448 (12.0)	420 (16.5)	1188 (12.9)
Somewhat harmful	2211 (16.8)	2256 (16.9)	2174 (17.2)	6641 (17.0)	557 (19.3)	797 (23.8)	540 (20.1)	1894 (21.2)
Very harmful	2955 (23.7)	3451 (26.9)	2306 (19.7)	8712 (23.5)	604 (21.4)	789 (25.2)	416 (14.8)	1809 (20.8)
Extremely harmful	4275 (34.1)	4377 (35.6)	3542 (30.8)	12,194 (33.6)	820 (33.1)	864 (27.4)	546 (24.0)	2230 (28.2)
Don't know	1977 (15.6)	1287 (10.3)	1820 (14.2)	5084 (13.4)	353 (12.0)	292 (8.2)	320 (10.4)	965 (10.1)
Cannabis smoking (less-than-daily)								
Not at all harmful	743 (5.4)	756 (5.7)	2006 (13.9)	3505 (8.2)	222 (7.3)	342 (8.6)	661 (23.2)	1225 (12.7)
Slightly harmful	1718 (13.3)	1995 (15.1)	2079 (16.9)	5792 (15.1)	450 (15.2)	715 (20.3)	515 (20.2)	1680 (18.7)
Somewhat harmful	2740 (21.0)	3137 (24.0)	2394 (19.2)	8271 (21.4)	657 (22.9)	910 (27.5)	531 (19.0)	2098 (23.5)
Very harmful	3034 (24.3)	3145 (24.9)	2038 (17.9)	8217 (22.4)	602 (22.8)	641 (20.5)	377 (15.2)	1620 (19.6)
Extremely harmful	3064 (24.9)	2575 (21.4)	2226 (19.8)	7865 (22.1)	583 (23.6)	504 (17.1)	332 (14.4)	1419 (18.3)
Don't know	1424 (11.2)	1114 (8.9)	1573 (12.3)	4111 (10.8)	240 (8.1)	226 (6.0)	254 (8.0)	720 (7.3)
Cannabis vaping (less-than-daily)								
Not at all harmful	464 (3.4)	537 (3.8)	1275 (8.9)	2276 (5.3)	155 (5.7)	257 (6.3)	492 (17.5)	904 (9.5)

(continued on next page)

Table 2 (continued)

	Youth, 16–19 years old n (%) ^a				Young adults, 20–29 years old n (%) ^a			
	England	Canada	US	Total	England	Canada	US	Total
Slightly harmful	1497 (11.3)	1807 (13.4)	1866 (14.8)	5170 (13.2)	421 (15.3)	635 (18.3)	515 (20.1)	1571 (17.9)
Somewhat harmful	2825 (21.8)	3156 (24.1)	2557 (20.5)	8538 (22.1)	615 (20.9)	883 (27.0)	569 (21.4)	2067 (23.4)
Very harmful	2970 (23.7)	3257 (25.9)	2350 (20.0)	8577 (23.3)	603 (21.1)	735 (22.1)	400 (15.8)	1738 (19.9)
Extremely harmful	2972 (24.1)	2643 (22.1)	2433 (21.5)	8048 (22.6)	599 (24.6)	540 (18.0)	381 (15.6)	1520 (19.3)
Don't know	1995 (15.7)	1322 (10.6)	1835 (14.2)	5152 (13.5)	361 (12.4)	288 (8.2)	313 (9.7)	962 (10.0)

Note. ^a Counts are presented unweighted, and percentages weighted. ^b The 'Other' category includes participants who perceived cannabis vaping as more harmful than cannabis smoking, perceived equal harm, or responded 'don't know'.

than-daily cannabis smoking as more harmful than less-than-daily cannabis vaping were partially consistent with main analyses, except that: 1) among young adults, odds were higher in England than Canada in addition to being higher in England than the US, and marginally higher among those with moderate/high mental health symptoms (Tables S4 and S4); 2) youth who exclusively smoked cannabis were less likely to perceive smoking as more harmful than vaping (contrasting with former use in the main analysis; Table S3), and; 3) young adults who vaped or both vaped and smoked were more likely to perceive smoking as more harmful than vaping (none were significant in the main analysis; Table S5).

Reversed outcome: perceptions of daily cannabis vaping as more harmful than daily cannabis smoking. Results for the country variable mirrored the main findings, except that no difference was observed between England and Canada among youth (Table S2). For youth nicotine use, no differences were observed between nicotine use groups whereas all were significant in the main analysis (Table S5). For cannabis use, all use groups were more likely than the never-use group to perceive vaping as more harmful than smoking among both youth and young adults, in contrast to the main analysis where only youth former cannabis use was significant (Table S3).

Separating mental health items. Findings using separate mental health outcomes were consistent with the combined measure, except that moderate/high stress was not independently associated with youth's odds of perceiving smoking as more harmful than vaping (Table S4).

Sensitivity cannabis use variable. Results held when cannabis 'exclusive vaping' and cannabis 'other routes' were analysed separately (Table S6), except that exclusive cannabis vaping was associated with higher odds of perceiving cannabis smoking as more harmful than cannabis vaping among young adults; this should be interpreted with caution due to wide confidence intervals and small group size.

3. Discussion

This study examined perceptions of the relative harms of cannabis smoking versus cannabis vaping among youth and young adults in England, Canada, and the US from 2022 to 2024. Around half of participants perceived both daily cannabis smoking and vaping as very to extremely harmful. About one in ten perceived cannabis smoking as more harmful than vaping (rather than perceiving vaping as more harmful than smoking, both equal, or 'don't know'), and these perceptions varied by country, mental health status, and cannabis and nicotine use history.

In line with our hypothesis and previous work on nicotine vaping and smoking harm perceptions (East et al., 2022), participants in England were more likely than those in Canada and the US to perceive cannabis smoking as more harmful than vaping. Among youth, and among young adults in some sensitivity analyses, a gradient was observed: highest in England, intermediate in Canada, and lowest in the US. These

differences may reflect national variation in cannabis regulation, product availability, and cultural narratives around cannabis and nicotine smoking and vaping (Hammond et al., 2017). They raise the possibility that perceptions of harm by route of administration may generalise across both cannabis and nicotine, potentially bidirectionally. However, perceptions may reflect not only the route of administration but also the types of products commonly associated with each route in different countries (e.g., smoking may be more often associated with tobacco in England, or vaping with high-potency cannabis concentrates in Canada), even though the same routes can be used with different products.

Among youth, but not young adults, mental health symptoms were associated with greater odds of perceiving cannabis smoking as more harmful than vaping. Because people with anxiety and/or depression symptoms are more likely to use cannabis and nicotine (National Academies of Sciences E, and Medicine. *The Health Effects of Cannabis and Cannabinoids: The Current State of Evidence and Recommendations for Research*. The National Academies Press, 2017; Hackworth et al., 2025; Beletsky et al., 2024), it is possible that experience with these products leads to greater exposure to health information, and therefore, increased awareness of absolute and relative health risks. Another possible explanation is that youth with symptoms are more likely to vape, as they are more likely to use nicotine (Hackworth et al., 2025), and nicotine vaping was more common than nicotine smoking in our sample; they may therefore perceive vaping as more normalised than smoking. However, this is not supported by findings on cannabis use and nicotine vaping/smoking status: contrary to our hypotheses, these did not reveal an alignment between current route of administration and harm perceptions. Further, analyses among young adults did not reveal differences in harm perceptions by mental health symptoms, which may relate to the high prevalence of mental health symptoms in that group (76%, vs. 61.7% in youth) that could have reduced the measure's discriminatory power despite validated cutoffs (Young et al., 2015; Association of Public Health Epidemiologists in Ontario. *Self-Perceived Life Stress*. Accessed 13 May, 2025), particularly as this was a smaller sample than youth.

These findings suggest that the relationship between cannabis and nicotine smoking/vaping patterns and harm perceptions may be more complex than initially hypothesised. In main analyses, current or former nicotine smoking/vaping and former cannabis use were associated with perceiving cannabis smoking as more harmful, yet these associations were limited to youth and did not differ by current route of administration. Further, while sensitivity analyses supported the main findings regarding differences by country and mental health, they yielded inconsistent findings for differences by nicotine and cannabis use status. Reversed models (vaping perceived as more harmful) were null for nicotine smoking/vaping, while the main model showed associations across all use groups, suggesting nicotine experience may increase awareness of the harms of smoking rather than shifting perceptions of vaping. Overall, these findings underscore the need for further research to disentangle the complex relationships between personal use, product

Table 3

Relative harm perceptions of cannabis smoking as more harmful than cannabis vaping by country, nicotine use, cannabis use, and mental health status (weighted, adjusted).

	Youth, 16–19 years old (N = 37,761)			Young adults, 20–29 years old (N = 8,762)		
	OR	95% CI	p-value	OR	95% CI	p-value
Country						
England	REF	—	—	—	—	—
Canada	0.68	0.62–0.74	<0.001	0.81	0.65–1.02	0.068
US	0.53	0.47–0.59	<0.001	0.68	0.52–0.88	0.004
Mental health symptoms						
No/Low symptoms	REF	—	—	—	—	—
Moderate/High symptoms	1.23	1.13–1.35	<0.001	1.21	0.94–1.57	0.142
Don't know/Refused	0.59	0.39–0.90	0.015	0.94	0.36–2.48	0.899
Nicotine vaping/smoking						
Never vaped nor smoked	REF	—	—	—	—	—
Former vaping and/or smoking	1.28	1.15–1.42	<0.001	0.93	0.72–1.21	0.581
Past 30-day smoking	1.24	1.02–1.51	0.031	0.87	0.62–1.21	0.402
Past 30-day vaping	1.23	1.08–1.41	0.003	1.13	0.82–1.57	0.448
Past 30-day dual smoking and vaping	1.22	1.05–1.43	0.010	1.12	0.81–1.55	0.490
Cannabis use						
Never cannabis use	REF	—	—	—	—	—
Former cannabis use	1.15	1.01–1.30	0.031	1.21	0.94–1.55	0.133
Past 30-day smoking	0.97	0.81–1.16	0.734	1.03	0.71–1.48	0.893
Past 30-day vaping or other routes	1.16	0.88–1.55	0.295	1.06	0.66–1.70	0.805
Past 30-day dual smoking and vaping	1.07	0.90–1.28	0.416	1.04	0.74–1.47	0.808

Note. This binomial logistic regression model used weighted data and was adjusted for the variables in this table as well as survey wave, perceived household income adequacy, sex at birth, race/ethnicity, and student/employment status. The outcome describes perceptions of cannabis smoking as more harmful than cannabis vaping, as opposed to perceptions of cannabis vaping as more harmful than cannabis smoking, equal harm, or 'don't know'.

type, and harm perceptions. This will become increasingly important as more robust evidence emerges on the actual relative health harms of smoking versus vaping cannabis, which currently remains unclear.

4. Limitations

The survey question on “vaping cannabis” may have been interpreted variably, most likely as liquid-based THC vapes which are increasingly common (Hammond et al., 2017), but also potentially as dry herb vapourisers or other products which differ in design, content, and health risks (MacCallum et al., 2023). Future research should clearly define routes of administration, possibly using product images, and assess perceptions of other non-combustible products like edibles. Due

to the coding of cannabis and nicotine variables, “exclusive” groups for one route may have included individuals with former (>30 days) use of other routes. Validated mental health measures were used, but high symptomatology among young adults raises concerns about ceiling effects and variability. Similarly, moderately high levels of absolute harm perception may have limited variability in the relative harm outcome. Finally, samples were not probability based and survey weights differed between countries (Youth, 2025), yet the large country differences observed are unlikely to be due to weighting alone. Nonetheless, this study is among the first to examine perceptions of cannabis harm by route of administration and associated factors across multiple countries; findings from these large, weighted samples provide new insights of international relevance.

5. Conclusion

Around one in ten youth and young adults in England, Canada, and the US perceived that cannabis smoking is more harmful than cannabis vaping. Country-level differences suggest the influence of regulatory and cultural contexts. Individual-level factors also play a role, with youth with mental health symptoms more likely to perceive cannabis smoking as more harmful than cannabis vaping. Findings highlight the need for nuanced research on cannabis routes of administration, particularly in relation to harm perceptions, use behaviours, and product safety, to inform tailored public health messaging that supports harm-reducing practices.

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CRediT authorship contribution statement

Matilda K. Nottage: Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Leonie Brose:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Deborah Robson:** Writing – review & editing, Supervision, Conceptualization. **Emily Hackworth:** Writing – review & editing, Methodology. **Jessica L. Reid:** Writing – review & editing, Resources, Methodology. **David Hammond:** Writing – review & editing, Resources, Methodology. **Katherine East:** Writing – review & editing, Supervision, Methodology, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: One author (DH) reports serving as a paid expert witness on behalf of public health authorities in litigation involving the cannabis, tobacco, and vaping industries; no other authors have conflicts of interest to declare.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.addbeh.2026.108785>.

Data availability

Data may be made available upon request to the International Tobacco Control Policy Evaluation Project team.

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