

Original Paper

A Digital Health Tool to Understand and Prevent Cannabis-Impaired Driving Among Youth: A Cross-sectional Study of Responses to a Brief Intervention for Cannabis Use

Georgina Moreno^{1,2*}, BA, MA, PhD; Trevor van Mierlo^{3*}, BA(Hons), MScCH, MBA, GEMBA, MScBMR, DBA

¹Department of Economics, California State University, Long Beach, Long Beach, CA, United States

²South Bay Economics LLC, Hermosa Beach, CA, United States

³Evolution Health Systems, Toronto, ON, Canada

* all authors contributed equally

Corresponding Author:

Georgina Moreno, BA, MA, PhD

Department of Economics

California State University, Long Beach

1250 Bellflower Blvd MS-4607

Long Beach, CA, 90840-4607

United States

Phone: 1 310 600 1767

Email: gigi.moreno@csulb.edu

Abstract

Background: Cannabis legalization has raised concern about an increased risk of cannabis-impaired driving, particularly among youth. Youth advocates and policy makers require cost-effective tools to target educational resources to promote responsible cannabis use.

Objective: The objective of this paper is threefold. First, it describes how a youth advocacy organization disseminated a low-cost digital brief intervention to educate and inform young people about responsible cannabis use. Second, it illustrates how digital tools can help promote understanding about attitudes and behaviors toward cannabis while simultaneously offering tailored education. Finally, this paper contributes to examining behavioral factors associated with youth cannabis-impaired driving by quantifying relationships between cannabis users' willingness to drive impaired and self-reported demographic and behavioral factors.

Methods: This paper analyzed data from 1110 completed Check Your Cannabis (CYC) brief interventions between March 2019 and October 2020. The CYC asks respondents a brief set of questions about their cannabis use and their personal beliefs and behaviors. Respondents receive comprehensive feedback about their cannabis use and how it compares with others. They also receive a summary of reported behaviors with brief advice. An ordered probit model was used to test relationships between cannabis use, demographics, and driving behaviors to gain further insights.

Results: The vast majority (817/1110, 73.6%) of respondents reported using cannabis. However, a much smaller share of respondents reported problems associated with their cannabis use (257/1110, 23.2%) or driving after cannabis use (342/1110, 30.8%). We found statistically significant relationships between driving after cannabis use and age; Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST) risk score; and polysubstance use. However, we did not find gender to be a significant determinant of driving after cannabis use. We estimated that every 10-point increase in the ASSIST score increased the probability of sometimes driving after cannabis use by 7.3% ($P < .001$). Relative to respondents who reported never drinking alcohol or using other substances with cannabis, those who sometimes drink or use other substances with cannabis were 13% ($P < .001$) more likely to sometimes or always drive after using cannabis.

Conclusions: The digital health tool cost the youth advocacy organization approximately Can \$0.90 (US \$0.71) per use. Due to the tool's unlimited use structure, the per-use cost would further decrease with increased use by the organization's target population. Based on our results, public health campaigns and other interventions may consider tailoring resources to frequent cannabis users, youth with high ASSIST scores, and those with polysubstance abuse. The cost-effectiveness of delivering digital brief interventions with unlimited use is attractive, as increased use decreases the per-user cost. Further research examining the efficacy of digital health interventions targeting problematic cannabis use is required.

KEYWORDS

cannabis use; driving after cannabis use; internet; intervention; online intervention; digital health; cannabis; drug; online tool; youth; adolescent; Canada

Introduction

Background

The legalization of cannabis in Canada and several US states has raised concerns over cannabis-impaired driving. For example, a 2019 Gallup poll found that the top concern among opponents of legalization in the United States was the belief that legalization would increase vehicle accidents [1]. A 2019 survey found that 71% of Canadians were concerned about the impacts of cannabis legalization on road safety [2]. At the same time, many younger drivers do not perceive driving after cannabis use to be a safety risk, and some believe that cannabis use improves driving performance [3-5]. Although cannabis use impairs driving [6-11], practical and feasible means for testing for cannabis impairment are limited [8,11].

Hall [11] acknowledged that a major problem in addressing cannabis-impaired driving is the lack of a practical test for impairment and called for changing attitudes toward cannabis-impaired driving. Wadsworth and Hammond [12] compared patterns of cannabis use among youth in Canada, England, and the United States [12]. They found higher rates of driving after cannabis use among US youth relative to youth in Canada and England and attributed this finding to greater accessibility of cannabis and lower perceived harm among US youth [12]. Wadsworth and Hammond's [12] findings suggest that understanding cannabis risk perceptions may help development of cannabis harm reduction programs.

Using an online survey of US cannabis users, Borodovsky et al [5] examined the relationship between perceived intoxication levels and driving after cannabis use and found evidence that the perception of a safe level of cannabis intoxication, not the typical level of intoxication, is associated with driving after using cannabis use. These findings support the need for identifying perceptions of harm from cannabis use and suggest that tools that can identify these perceptions may inform preventative messaging and screening for harmful cannabis use. One approach for identifying and mitigating risks associated with cannabis use is implementing a digital health screener, such as the Check Your Cannabis (CYC) brief intervention, an anonymous digital health brief intervention designed for personal computers, tablets, and smartphones [13].

The CYC, developed by Evolution Health Systems and independent academic researchers, asks respondents questions about their cannabis use and provides respondents with personalized feedback about how the severity of their cannabis use compares with others of the same age and gender. The CYC screener provides a nonjudgmental approach for educating and positively influencing respondents' awareness of harm from cannabis consumption.

The primary theoretical behavior change constructs used in the CYC design are normative feedback, harm reduction, and

motivational interviewing. The CYC's design, workflow, and technical infrastructure are based on a similar brief intervention for addressing alcohol use, Check Your Drinking (CYD). Evolution Health Systems and independent academic researchers also developed this tool [14]. Like the CYC, the CYD provides respondents with a brief tailored feedback report summarizing personal substance use and comparing it with others of the same age, sex, and country of residence [14]. The CYD has been subject to 7 randomized controlled trials demonstrating support of its efficacy in reducing alcohol consumption [14-20].

The CYC is publicly available at no cost at a number of URLs [21,22]. The intervention consists of a 13-item questionnaire (Multimedia Appendix 1) and an output report tailored to the user (Multimedia Appendix 2). The first 3 questions of the CYC collect demographic data used to tailor the report to the individual (first name or anonymous nickname, gender, age). Questions 4 and 5 address personal use of cannabis in the past 3 months. Questions 6 to 9 address personal negative consequences of cannabis use. Question 10 addresses driving behavior following cannabis use, and question 11 addresses polysubstance abuse. Questions 12 and 13 request information about the user's cannabis expenditure patterns. Before the user submits their responses, they must actively endorse a checkbox that acknowledges that their nonpersonal information will be used for improving the tool, and they receive a link to the intervention's privacy policy.

Upon completing the questionnaire, the user receives a tailored personal report divided into either 3 or 4 sections, depending on user inputs and output algorithms. The first section contains normative feedback based on the user's age, gender, country of residence (United States or Canada), and cannabis use patterns, presented in text and graphical format. The second section reports the user's estimated annual expenditure on cannabis and compares this expenditure to purchases of movie passes and pizza slices. The third section reports the user's Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST) score through text and graphical representation, which can be used to evaluate whether a person's cannabis use is problematic. If users indicate that they drive after cannabis use or use other substances with cannabis, their report includes a fourth section with information about the risks of cannabis-impaired driving, polysubstance use, or both.

In 2019, Parent Action on Drugs (PAD), an Ontario-based community youth advocacy group, licensed a white-label version of CYC from Evolution Health Systems at the standard nonprofit annual rate of Can \$1000 (US \$787.01), including hosting and reporting fees. Use of the tool is unlimited, meaning that there is no restriction on the number of respondents or reports generated. PAD also entered into a research partnership with Evolution Health Systems in which Evolution Health Systems assisted with the intervention dissemination strategy, data analysis, and technical guidance. PAD's white-label version of

the digital intervention is available for public use on PAD's website [23].

The primary purpose of PAD licensing a white-label version of the CYC was to offer high school students in the Greater Toronto Area information and advice about cannabis use, which Canada had recently legalized. A secondary purpose was to collect data on cannabis consumption patterns, polysubstance abuse, and driving.

Objective

This paper analyzes the data collected from PAD's licensed version of the CYC and focuses on the behavioral factors associated with cannabis-impaired driving from the cannabis user's perspective. The objective of this paper is threefold. First, it illustrates how low-cost brief interventions can be broadly implemented to educate young people about responsible cannabis use. Second, data from these tools can help promote understanding about attitudes and behaviors toward cannabis while anonymously offering tailored education. Finally, this paper contributes to examining behavioral factors associated with cannabis-impaired driving by quantifying relationships between cannabis users' willingness to drive impaired and self-reported demographic and behavioral factors.

Methods

This paper's analysis relies on data obtained between March 2019 and October 2020 from the CYC brief intervention.

Table 1. Age and gender distribution for included respondents.

Gender	Minimum age (years)	Median age (years)	Maximum age (years)	Observations, n
Female	12	17	25	447
Male	12	17	25	593
Transgender or nonbinary	14	16	25	50
Not reported	14	16	18	20
Overall	12	17	25	1110

Data were extracted from the intervention platform's pre-coded custom structure query language database. All responses were anonymous, and data collection procedures adhered to American and Canadian privacy guidelines [25-27]. Respondents actively endorsed a checkbox consenting to the use of their nonpersonal responses to analyze and improve the intervention and received a link to the intervention's privacy policy. As the study relies on unidentifiable archival data, the study was exempt from further review.

After reporting gender and age, respondents answered 8 questions related to their use of cannabis. The questionnaire allowed respondents to report their gender as female, male, transgender, nonbinary, or not reported. Respondents also reported age as an open-ended question. The brief intervention asks respondents about their expenditures on cannabis and measures expenditures in 2 ways: the average monthly

Identical versions of the CYC intervention are available from the Evolution Health website or PAD's websites [21-23]. PAD promoted their version of the CYC on their website and at speaking engagements at several high schools in the Greater Toronto Area. Participants were ad libitum and anonymous, and there were no incentives for completing the intervention. All study participants consented to the use of their anonymous data for research purposes. This study relied on convenience nonprobabilistic sampling, in which respondents self-selected to respond to the digital brief intervention questionnaire [24]. [Multimedia Appendices 1](#) and [2](#) include images of the CYC interface.

Between March 28, 2019, and October 23, 2020, we collected 1553 completed CYC questionnaires. With the goal of informing responsible cannabis use among young adults in Canada, we limited the sample to participants aged 25 years and younger from Canada, thus reducing the sample to 1175. We eliminated from the analysis 34 responses that appeared to be duplicates. We further reduced the sample by dropping from the analysis 6 responses with extreme outlier values for the reported expenditures on cannabis and 25 responses with inconsistencies (eg, reported not using cannabis but reported positive expenditures on cannabis). The final study data set included 1110 responses. [Table 1](#) summarizes the age and gender distribution for the included responses.

expenditure on cannabis over the past year and the largest single-day expenditure over the past year. Average monthly expenditures capture typical use. Expenditures are reported in Canadian dollars.

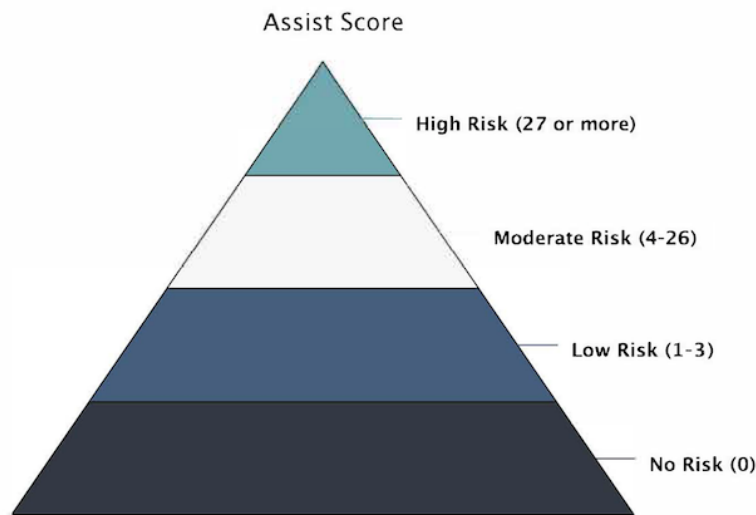
A key component of the intervention is a calculated score from the 6-item ASSIST developed by the World Health Organization (WHO) [28]. The ASSIST evaluates an individual's use of cannabis and classifies individuals into risk categories, with high risk indicating the experience of problems resulting from cannabis consumption. [Figure 1](#) is an illustration explaining the ASSIST score after completion of the CYC questionnaire. The WHO ASSIST score is the sum of weights assigned to the 6 questions listed in [Table 2](#) [28]. The questionnaire asks respondents to answer the 6 ASSIST questions. We computed the ASSIST score based on the response weights, also shown in [Table 2](#).

Figure 1. Check Your Cannabis ASSIST score. ASSIST: Alcohol, Smoking, and Substance Involvement Screening Test.

Your ASSIST Score?

The ASSIST score was developed by the World Health Organization to evaluate a person’s use of cannabis. The ASSIST score shows whether a person’s cannabis use should be considered a problem. Higher scores usually mean serious problems. The chart is in the shape of a pyramid to show that there are more people with low ASSIST scores than high ones.

Your ASSIST score is **19**. The white area of the chart shows where your score falls.



Score	Definition	Probable Life Consequences
0	No risk	No cannabis use in the last 3 months.
1-3	Low risk	You are at low risk of health and other problems from your current pattern of cannabis use.
4-26	Moderate risk	You are at risk of health and other problems from your current cannabis use.
27 or more	High risk	You are at high risk of experiencing severe problems (health, social, financial, legal, relationship) as a result of your current pattern of use and are likely to be dependent on cannabis.

You noted that you **usually** drive after using cannabis, or ride with a driver who has. Research has shown that driving high causes you to weave in and out of lanes, slow down and then speed up, miss signs, misjudge time and distance, exhibit slow reaction time, and it can double your risk for a serious crash. Treat cannabis like alcohol and do not drive, or arrange a ride from a sober driver.

You noted that you **usually** drink alcohol or use other substances when using cannabis. Here are some common risks:

Table 2. ASSIST score questions, possible responses, and WHO weights [28]. ASSIST: Alcohol, Smoking, and Substance Involvement Screening Test; WHO: World Health Organization.

Question	Response (WHO weight)
1. During the past 3 months, how often have you used cannabis?	Never (0); once or twice (4); monthly (5); weekly (6); daily or almost daily (7)
2. During the past 3 months, how often have you had a strong desire or urge to use cannabis?	Never (0); once or twice (4); monthly (5); weekly (6); daily or almost daily (7)
3. During the past 3 months, how often has your use of cannabis led to health, social, legal, or financial problems?	Never (0); once or twice (4); monthly (5); weekly (6); daily or almost daily (7)
4. During the past 3 months, how often have you failed to do what was normally expected of you because of your use of cannabis?	Never (0); once or twice (4); monthly (5); weekly (6); daily or almost daily (7)
5. Has a friend or relative or anyone else ever expressed concern about your use of cannabis?	No, never (0); yes, but not in the past 3 months (3); yes, in the past 3 months (6)
6. Have you ever tried and failed to control, cut down, or stop using cannabis?	No, never (0); yes, but not in the past 3 months (3); yes, in the past 3 months (6)

Respondents also answered questions about driving after using cannabis and polysubstance use. These questions were “How often do you drive after using cannabis, or ride with someone who has?” and “When you use cannabis, how often do you drink alcohol or use other substances?” The possible responses for these questions were “Never,” “Sometimes,” “Usually,” or “Always.”

To better understand the factors associated with driving after cannabis use, we modeled driving after cannabis use as a function of age, gender, ASSIST score, whether the respondent drinks or uses other substances with cannabis (ie, polysubstance use), and cannabis expenditures. Given the qualitative and ordered nature of the responses to the question about driving after cannabis use, we estimated the probability of driving after using cannabis using an ordered probit regression [29]. We combined the “usually drives” and “always drives” categories for the ordered probit model. Therefore, the dependent variable in the model included 3 categories: (1) never drives after using cannabis, (2) sometimes drives after using cannabis, and (3) usually or always drives after using cannabis. For this analysis, we limited the data to respondents of driving age (n=913). All analysis was conducted using Stata 16 (StataCorp) [30].

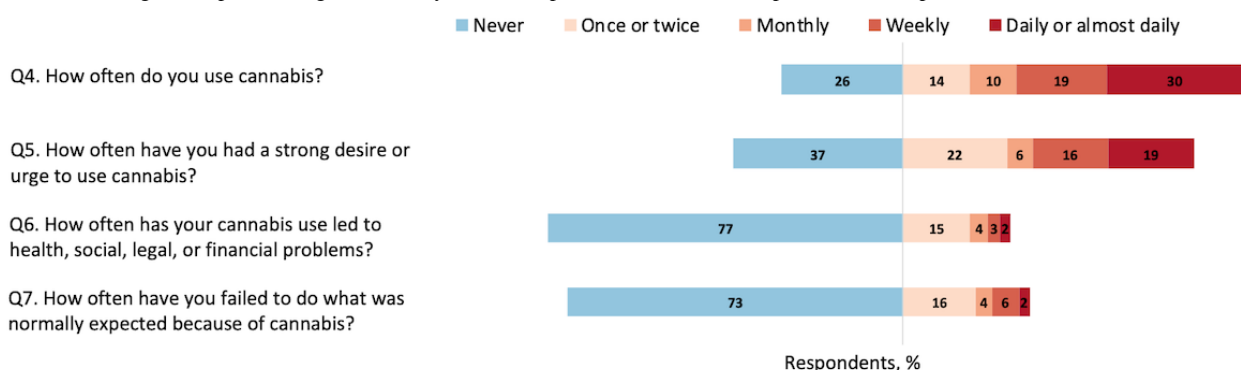
We hypothesized that age has an increasing and diminishing effect on driving after using cannabis and included age as a quadratic in the ordered probit model. Because the vast majority of participants in the analytical data reported their gender as female (447/1110, 40.3%) or male (593/1110, 53.4%), we

defined the gender variable in the model as female, male, or other. Based on past studies, we expected differences by gender in cannabis use and attitudes [31]. We also hypothesized that respondents with higher ASSIST scores are more likely to drive after using cannabis, since a higher ASSIST score indicates a higher risk of harmful cannabis use. We hypothesized that polysubstance use is positively correlated with driving after cannabis use, as it reflects risky behaviors. To the extent that higher expenditures reflect greater use, we hypothesized that higher expenditures are associated with heavier cannabis use and therefore a higher probability of driving after using cannabis.

Results

Figures 2-4 report the distribution of responses for the 3 categories of questions included in the brief intervention: (1) cannabis use behaviors in the past 3 months, (2) concerns about cannabis use, and (3) driving after cannabis use and polysubstance use. While 73.6% (817/1110) of respondents reported using cannabis and 63.1% (700/1110) reported having a desire or urge to use cannabis, over 76.8% (853/1110) reported never having problems with cannabis use (Figure 2, question 6) and 72.7% (807/1110) reported never failing to meet expectations because of their cannabis use (Figure 2, question 7). However, among the heaviest cannabis users or those using daily or almost daily (n=330), 48.8% (161/330) reported having incidents of health, social, legal, or financial problems associated with cannabis use.

Figure 2. Percentage of respondents aged 12 to 25 years who reported cannabis use and problems in the past 3 months (N=1110).



As seen in Figure 3, 22.0% (244/1110) of respondents reported having problems controlling their cannabis use (question 9). Although only 12.6% (140/1110) reported having such problems in the past 3 months, 79.3% (111/140) of the respondents in this category were aged between 12 and 18 years, below the legal age for cannabis consumption in Canada. When asked

about others' concerns over their cannabis use (question 8), a smaller proportion, 62.4% (693/1110), reported "never." Figure 4 shows that the vast majority of driving-age respondents, 66.5% (607/913), reported never driving after using cannabis (question 10), and 61.0% (557/913) reported using alcohol and other substances with cannabis (question 11).

Figure 3. Percentage of respondents aged 12 to 25 years who reported concerns about their cannabis use (N=1110).

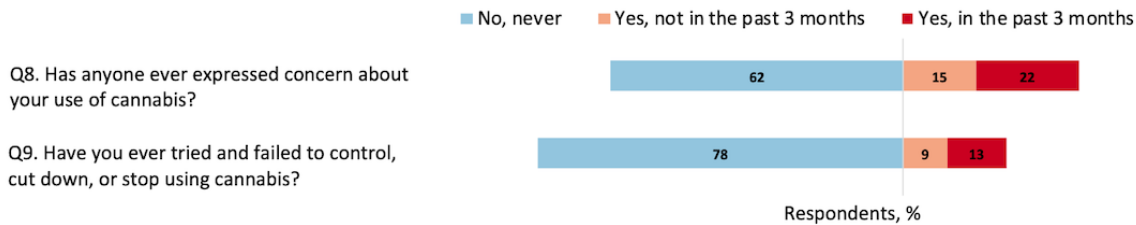
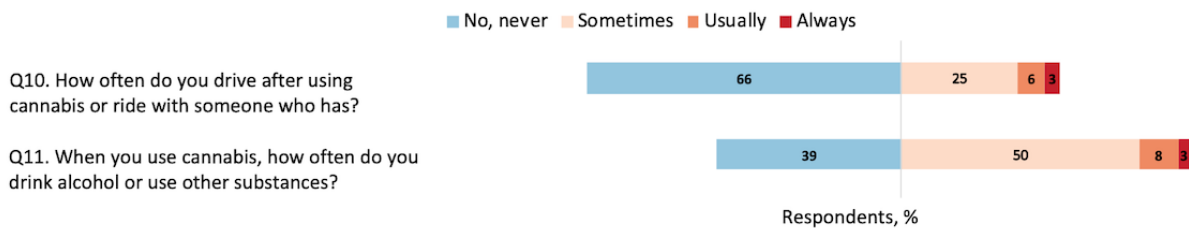


Figure 4. Percentage of driving-age respondents aged 16 to 25 years who reported risky behaviors (n=913).



In our sample, the ASSIST score varied from 0 to 40, with 66.3% (736/1110) of respondents falling in the moderate risk category. The average ASSIST score was 12 among teenaged respondents (aged 12-18 years) and 18 for young adult respondents (aged 19-25 years). ASSIST scores for teenagers were statistically significantly smaller than ASSIST scores for young adults ($P<.001$).

Table 3 reports the ordered probit coefficient estimates. Male gender ($P=.28$), other gender ($P=.36$), and monthly expenditures ($P=.07$) were not statistically significant at the .05 level. Age ($P<.001$), polysubstance use sometimes ($P<.001$) and usually or always ($P<.001$), ASSIST score ($P<.001$), and maximum expenditure ($P=.02$) were statistically significant.

Table 3. Ordered probit estimates for the question "How often do you drive after using cannabis or ride with someone who has?" (n=913).

Covariate	Coefficient estimate ^a	P value
Age ^b	0.6586	.04
Age ²	-0.0162	.051
Gender (base=female)		
Male	0.1105	.23
Other gender	-0.2876	.20
ASSIST ^c score	0.0450	<.001
Polysubstance use (base=never)		
Sometimes	0.4221	<.001
Usually or always	0.5942	<.001
Average monthly expenditure	0.0006	.11
Maximum single expenditure	0.0004	.11

^aThe log-likelihood for this model was -640.1 and the pseudo-R² was 0.1569.

^bAge and Age² are jointly significant with a P value of .10.

^cASSIST: Alcohol, Smoking, and Substance Involvement Screening Test.

Table 4 reports the average marginal effects for each of the outcomes of the driving after cannabis use variable. In Table 4,

ASSIST scores and polysubstance use have the largest association with driving after using cannabis. The model predicts

that every 10-point increase in the ASSIST score increases the probability of sometimes driving after cannabis use by 7.3% ($P<.001$) and increases the probability of usually or always driving after using cannabis by 5.8% ($P<.001$).

Relative to respondents who reported never using other substances with cannabis, respondents who reported sometimes

using other substances with cannabis were 13% ($P<.001$) more likely to report driving after using cannabis. Those who reported usually or always using other substances were 18% ($P<.001$) more likely to report driving after using cannabis. This suggests that using alcohol and other substances with cannabis increases the probability of driving after cannabis use, consistent with other studies in the literature [8].

Table 4. Average marginal effects for ordered probit outcomes (n=913).

Covariate	"How often do you drive after using cannabis or ride with someone who has?"					
	Never		Sometimes		Usually or always	
	Effect	P value	Effect	P value	Effect	P value
Age ^a	-0.0253	.03	0.0152	.03	0.0101	.03
Gender (base=female)						
Male	-0.0327	.23	0.0182	.23	0.0144	.22
Other gender	0.0781	.17	-0.0482	.20	-0.0299	.14
ASSIST ^b score	-0.0132	<.001	0.0073	<.001	0.0058	<.001
Polysubstance use (base=never)						
Sometimes	-0.1245	<.001	0.0767	<.001	0.0478	<.001
Usually or always	-0.1811	<.001	0.1062	<.001	0.0750	.001
Average monthly cannabis expenditure	-0.0002	.11	0.0001	.11	0.0001	.11
Maximum single cannabis expenditure	-0.0001	.11	0.0001	.11	0.0001	.11

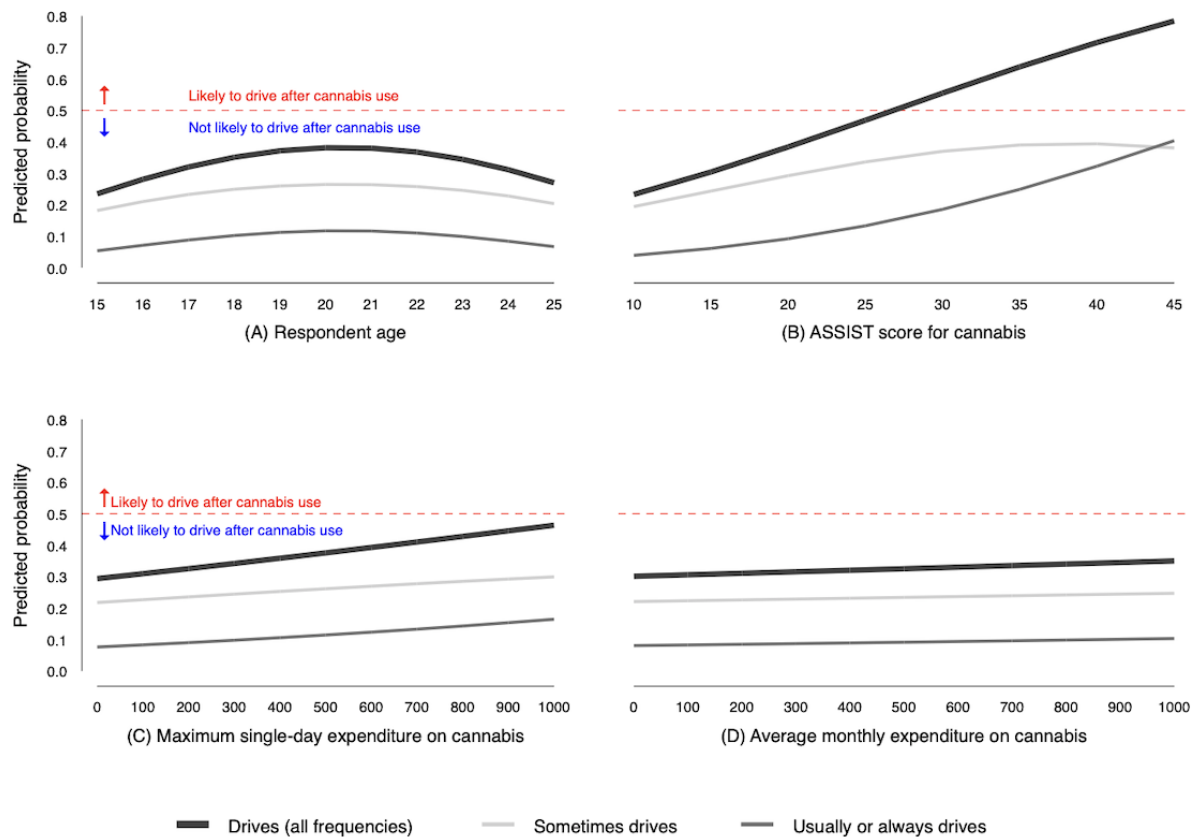
^aThe marginal effect on age includes the full quadratic effect of age on the probability of driving after cannabis use.

^bASSIST: Alcohol, Smoking, and Substance Involvement Screening Test.

Figure 5 plots the predicted probability of driving after using cannabis at varying levels of age, ASSIST scores, maximum expenditures, and average expenditures. This figure plots the predicted probability by respondents who sometimes drive and those who usually or always drive after cannabis use and the overall predicted probability of driving after cannabis use (ie, the probability of sometimes driving plus the probability of

usually or always driving). In Figure 5, we explored how the predicted probability of driving after cannabis use changes with respondent characteristics. If the predicted probability exceeds 0.5, the model predicts that respondents are more likely than not to drive after cannabis use, indicated with a red dashed line in the figure.

Figure 5. Probability of driving after cannabis use is low over a range of respondent characteristics (n=913). ASSIST: Alcohol, Smoking, and Substance Involvement Screening Test.

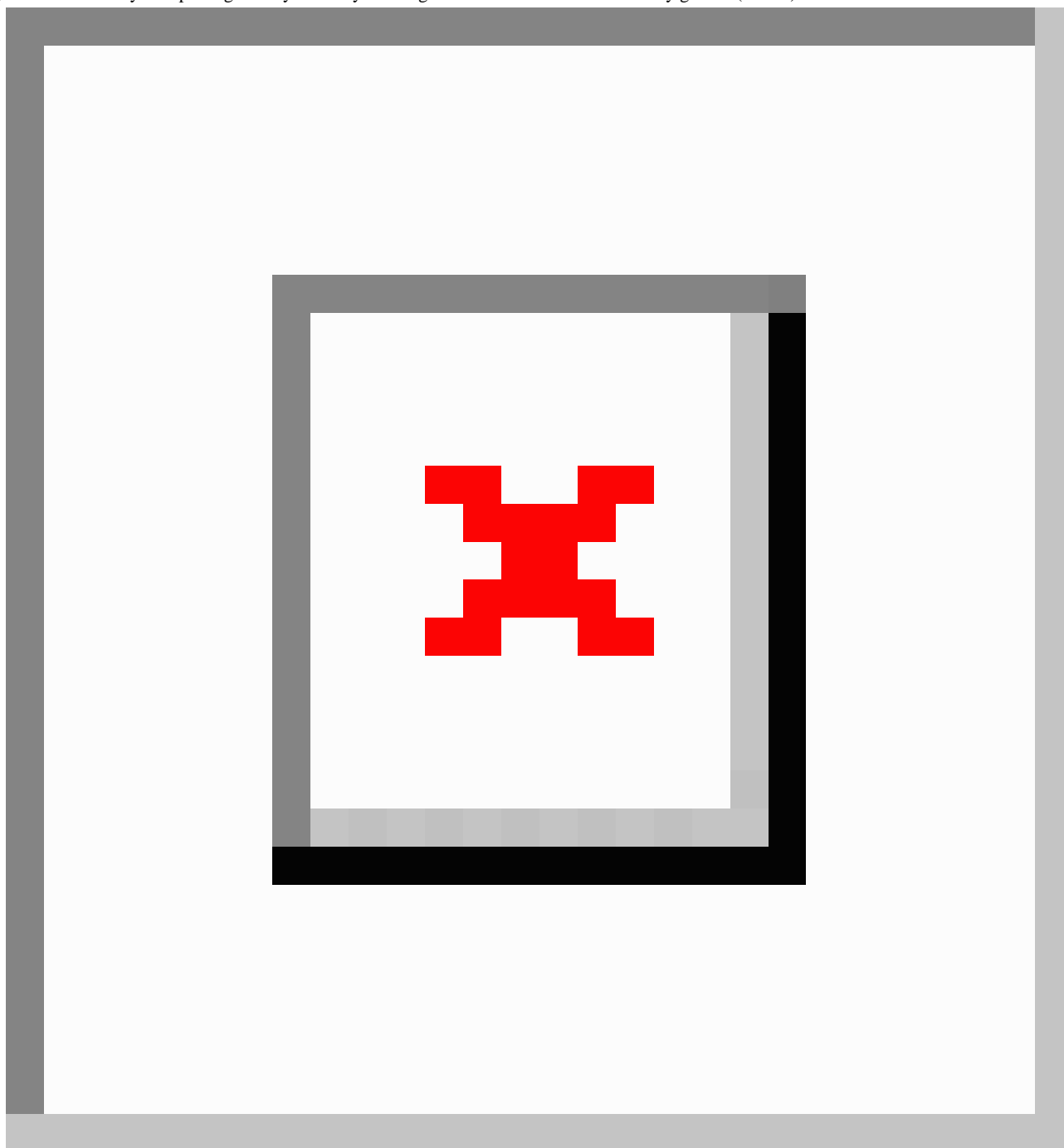


Panel A of Figure 5 shows that holding constant gender, ASSIST score, and cannabis expenditures, the overall probability of driving after cannabis use was 0.28 for the youngest respondents in the sample, peaked at 0.35 for 20-year-olds, and dropped to approximately 0.20 for the oldest respondents. Panel B shows that the overall predicted probability of driving after using cannabis, all else constant, increased with ASSIST score, suggesting that respondents with ASSIST scores greater than 25 are more likely than not to drive after using cannabis. As seen in panel C, the predicted probability of driving after cannabis use increased with maximum single-day expenditures. However, the model predicted that even the respondents with the highest expenditures, those most likely to be the heaviest users, are unlikely to drive after cannabis use (ie, the predicted probability of driving after cannabis use is less than 0.5). Similarly, panel D shows that the predicted probability of driving after cannabis use increased with average monthly

expenditures, holding all other factors constant. Only at extreme monthly expenditures (over Can \$800 [US \$630.09]) did the model predict that respondents are more likely than not to drive after cannabis use.

Figure 6 plots the probability of responding “usually” or “always” drives after cannabis use by gender. We found that gender was not a statistically significant factor in determining the probability of driving after using cannabis after controlling for age, ASSIST score, polysubstance use, and expenditures on cannabis. The figure plots the 95% CI for the probability of usually or always driving after cannabis use for male respondents and shows that the probability of usually or always driving after cannabis use for female respondents is within the 95% CI for men at all ages. Respondents younger than 24 years who reported being of another gender have a slightly lower predicted probability of usually or always driving after cannabis use than male respondents.

Figure 6. Probability of reporting usually or always driving after cannabis does not differ by gender (n=913).



Our results show that except for individuals with high ASSIST scores, after controlling for age, gender, and polysubstance use, respondents in our sample were unlikely to drive after using cannabis. Contrary to the literature [31,32], we found that gender is not a statistically significant factor in determining the probability of driving after using cannabis. We also found that polysubstance use and ASSIST scores were strongly correlated with driving after using cannabis. While the level of cannabis expenditures was statistically significant, the effects on driving after cannabis use were small.

Discussion

Principal Findings

The brief intervention questionnaire sheds light on self-reported harmful cannabis use behaviors. We observed that the vast majority of respondents reported cannabis use; however, they also reported not experiencing problems with cannabis use. However, daily cannabis users did report experiencing issues resulting from their use of cannabis. More respondents reported having family or others express concerns about their cannabis use than reported their own concerns about cannabis use. This may suggest that while respondents may not acknowledge problems with their cannabis use, they report an awareness of others' concerns about their use of cannabis.

At an implementation cost of Can \$1000 (US \$787.62), the digital health tool cost PAD approximately Can \$0.90 (US \$0.71) per use. Due to the unlimited use structure, the per-use cost would further decrease with PAD's target population's increased use. The digital brief intervention is an example of a low-cost tool that public health campaigns can leverage to tailor resources toward the most at-risk populations. While we focused on cannabis-impaired driving concerns, the tool is flexible and customizable to explore specific cannabis use concerns.

Strengths and Limitations

This study provides insights into how young cannabis users perceive their cannabis use and examines the relationship between cannabis use and driving behaviors from their perspectives. A particular strength is that the CYC intervention has limited use barriers, is anonymous, and was disseminated by a well-known youth advocacy group (PAD). However, as is common with self-reported digital health interventions, there is no way to guarantee that user responses are accurate or honest. Nevertheless, we have shown that a simple, low-cost digital health tool such as the CYC can provide insights to guide cannabis education programs and assist policy makers and youth health advocates targeting efforts for preventing cannabis abuse specific to a community.

The population analyzed in this study can be described as self-seeking and may be problematic cannabis users who actively sought help or more information on their behavior. As a result, they may not be considered representative of the general population. However, if this is the case, it may add strength to our principal finding that the largest amount spent on any given day, higher ASSIST scores, and polysubstance use were positively and significantly associated with driving under the influence of cannabis. As a result, these preliminary results should be interpreted with caution, and there is a need for replication studies that may or may not confirm our results.

Future Research Directions

The CYC has recently been enhanced to include questions addressing the source of cannabis acquisition (primarily

dispensaries or licensed services versus informal connections) as well as employment status and the user's geographic location. These additional questions are designed to generate further insight into cannabis use patterns and behavior. Geospatial analysis will allow us to gather further insights and compare use patterns across specific jurisdictions. The CYC has also been modified to include users' first 3 characters in their zip or postal code, and ongoing research is focusing on geospatial analysis to help assess regional patterns.

Based on the ability of digital health interventions to collect self-reported demographic and behavioral data and compare and contrast these data for specific geographic areas, there is the potential for these tools to examine associations between cannabis use and driving at a regional level. This may give further insight on potential predictors of increased risk, which could support or validate findings from other, nondigital studies.

Conclusion

To our knowledge, this is the first study to examine associations between self-reported cannabis use and driving behaviors through the use of a digital brief intervention, which has the dual purpose of educating cannabis users and collecting data to help inform and shape responsible cannabis use programs. Our analysis indicates that the largest amount spent on any given day, higher ASSIST scores, age, and polysubstance use were positively and significantly associated with driving under the influence of cannabis. Gender was not a significant factor.

We have shown how a low-cost digital health tool can inform programs and policies for educating young people about responsible cannabis use. Based on these results, public health campaigns or other interventions may have a more significant impact if they focus resources on problematic cannabis users rather than the general population. The largest amount spent variable may give insight into those who purchase their cannabis from nonretail sources. Further research is required.

Conflicts of Interest

TvM is the CEO and founder of Evolution Health Systems. Evolution Health owns and manages digital health interventions, including the application analyzed in this study. No financial compensation was provided for his participation in this study. GM has no conflicts of interest to declare.

Multimedia Appendix 1

CYC Interface.

[\[PDF File \(Adobe PDF File\), 90 KB-Multimedia Appendix 1\]](#)

Multimedia Appendix 2

CYC Sample Report.

[\[PDF File \(Adobe PDF File\), 1048 KB-Multimedia Appendix 2\]](#)

References

1. Jones JM. In U.S., Medical Aid Top Reason Why Legal Marijuana Favored. Gallup News. 2019 Jun 12. URL: <https://news.gallup.com/poll/258149/medical-aid-top-reason-why-legal-marijuana-favored.aspx> [accessed 2021-02-09]

2. Abbott. Canadians Indicate Growing Concern About Road Safety at One-year Anniversary of Recreational Cannabis Legalization, New Survey Finds. Cision Canada. 2019. URL: <https://tinyurl.com/26jzxdds> [accessed 2021-02-20]
3. Arterberry BJ, Treloar HR, Smith AE, Martens MP, Pedersen SL, McCarthy DM. Marijuana use, driving, and related cognitions. *Psychol Addict Behav* 2013 Sep;27(3):854-860 [FREE Full text] [doi: [10.1037/a0030877](https://doi.org/10.1037/a0030877)] [Medline: [23276319](https://pubmed.ncbi.nlm.nih.gov/23276319/)]
4. Robertson RD, Woods-Fry H, Morris K. Traffic Injury Research Foundation. Ottawa, Ontario: Traffic Injury Research Foundation; 2016. URL: https://tirf.ca/wp-content/uploads/2016/12/TIRF_DruggedDriving_Policy-Challenges_13_published.pdf [accessed 2020-12-27]
5. Borodovsky JT, Marsch LA, Scherer EA, Grucza RA, Hasin DS, Budney AJ. Perceived safety of cannabis intoxication predicts frequency of driving while intoxicated. *Prev Med* 2020 Feb;131:105956 [FREE Full text] [doi: [10.1016/j.ypmed.2019.105956](https://doi.org/10.1016/j.ypmed.2019.105956)] [Medline: [31863787](https://pubmed.ncbi.nlm.nih.gov/31863787/)]
6. Brands B, Mann RE, Wickens CM, Sproule B, Stoduto G, Sayer GS, et al. Acute and residual effects of smoked cannabis: Impact on driving speed and lateral control, heart rate, and self-reported drug effects. *Drug Alcohol Depend* 2019 Dec 01;205:107641. [doi: [10.1016/j.drugalcdep.2019.107641](https://doi.org/10.1016/j.drugalcdep.2019.107641)] [Medline: [31678833](https://pubmed.ncbi.nlm.nih.gov/31678833/)]
7. Hartman R, Huestis M. Cannabis effects on driving skills. *Clin Chem* 2013 Mar;59(3):478-492 [FREE Full text] [doi: [10.1373/clinchem.2012.194381](https://doi.org/10.1373/clinchem.2012.194381)] [Medline: [23220273](https://pubmed.ncbi.nlm.nih.gov/23220273/)]
8. Kleiman M, Jones T, Miller C, Halperin R. Driving While Stoned: Issues and Policy Options. *J Drug Policy Anal* 2018;11(2) [FREE Full text] [doi: [10.1515/jdpa-2018-0004](https://doi.org/10.1515/jdpa-2018-0004)]
9. Mann RE, Stoduto G, Ialomiteanu A, Asbridge M, Smart RG, Wickens CM. Self-reported collision risk associated with cannabis use and driving after cannabis use among Ontario adults. *Traffic Inj Prev* 2010 Apr;11(2):115-122. [doi: [10.1080/15389580903536704](https://doi.org/10.1080/15389580903536704)] [Medline: [20373229](https://pubmed.ncbi.nlm.nih.gov/20373229/)]
10. Cook S, Shank D, Bruno T, Turner NE, Mann RE. Self-reported driving under the influence of alcohol and cannabis among Ontario students: Associations with graduated licensing, risk taking, and substance abuse. *Traffic Inj Prev* 2017 Jul 04;18(5):449-455. [doi: [10.1080/15389588.2016.1149169](https://doi.org/10.1080/15389588.2016.1149169)] [Medline: [28095034](https://pubmed.ncbi.nlm.nih.gov/28095034/)]
11. Hall W. How should we respond to cannabis-impaired driving? *Drug Alcohol Rev* 2018 Jan;37(1):3-5. [doi: [10.1111/dar.12651](https://doi.org/10.1111/dar.12651)] [Medline: [29345082](https://pubmed.ncbi.nlm.nih.gov/29345082/)]
12. Wadsworth E, Hammond D. *Addict Behav* 2019 Mar;90:171-175 [FREE Full text] [doi: [10.1016/j.addbeh.2018.10.050](https://doi.org/10.1016/j.addbeh.2018.10.050)] [Medline: [30412908](https://pubmed.ncbi.nlm.nih.gov/30412908/)]
13. Cunningham JA, van Mierlo T. The check your cannabis screener: a new online personalized feedback tool. *Open Med Inform J* 2009 May 07;3(1):27-31 [FREE Full text] [doi: [10.2174/1874431100903010027](https://doi.org/10.2174/1874431100903010027)] [Medline: [19587808](https://pubmed.ncbi.nlm.nih.gov/19587808/)]
14. Cunningham J, Wild T, Cordingley J, van Mierlo T, Humphreys K. A randomized controlled trial of an internet-based intervention for alcohol abusers. *Addiction* 2009 Dec;104(12):2023-2032 [FREE Full text] [doi: [10.1111/j.1360-0443.2009.02726.x](https://doi.org/10.1111/j.1360-0443.2009.02726.x)] [Medline: [19922569](https://pubmed.ncbi.nlm.nih.gov/19922569/)]
15. Cunningham JA, Koski-Jännes A, Wild TC, Cordingley J. Treating alcohol problems with self-help materials: a population study. *J Stud Alcohol* 2002 Nov;63(6):649-654. [doi: [10.15288/jsa.2002.63.649](https://doi.org/10.15288/jsa.2002.63.649)] [Medline: [12529064](https://pubmed.ncbi.nlm.nih.gov/12529064/)]
16. Cunningham JA, Godinho A, Kushnir V. Can Amazon's Mechanical Turk be used to recruit participants for internet intervention trials? A pilot study involving a randomized controlled trial of a brief online intervention for hazardous alcohol use. *Internet Interv* 2017 Dec;10:12-16 [FREE Full text] [doi: [10.1016/j.invent.2017.08.005](https://doi.org/10.1016/j.invent.2017.08.005)] [Medline: [30135748](https://pubmed.ncbi.nlm.nih.gov/30135748/)]
17. Cunningham JA, Murphy M, Hendershot CS. Treatment dismantling pilot study to identify the active ingredients in personalized feedback interventions for hazardous alcohol use: randomized controlled trial. *Addict Sci Clin Pract* 2014 Dec 10;10(1):1 [FREE Full text] [doi: [10.1186/s13722-014-0022-1](https://doi.org/10.1186/s13722-014-0022-1)] [Medline: [25539597](https://pubmed.ncbi.nlm.nih.gov/25539597/)]
18. Dumas DM, Hannah E. Preventing high-risk drinking in youth in the workplace: a web-based normative feedback program. *J Subst Abuse Treat* 2008 Apr;34(3):263-271. [doi: [10.1016/j.jsat.2007.04.006](https://doi.org/10.1016/j.jsat.2007.04.006)] [Medline: [17600650](https://pubmed.ncbi.nlm.nih.gov/17600650/)]
19. Dumas DM, McKinley LL, Book P. Evaluation of two Web-based alcohol interventions for mandated college students. *J Subst Abuse Treat* 2009 Jan;36(1):65-74. [doi: [10.1016/j.jsat.2008.05.009](https://doi.org/10.1016/j.jsat.2008.05.009)] [Medline: [18657941](https://pubmed.ncbi.nlm.nih.gov/18657941/)]
20. Dumas DM, Haustveit T, Coll KM. Reducing Heavy Drinking Among First Year Intercollegiate Athletes: A Randomized Controlled Trial of Web-Based Normative Feedback. *J Appl Sport Psychol* 2010 Jul 23;22(3):247-261. [doi: [10.1080/10413201003666454](https://doi.org/10.1080/10413201003666454)]
21. Check Your Cannabis Screener. Evolution Health. URL: <http://www.CheckYourCannabis.net> [accessed 2021-02-21]
22. Evolution Health Check Your Screener Questionnaire. Evolution Health. URL: <https://evolutionhealth.care/cyc> [accessed 2021-02-21]
23. What's With Weed Questionnaire. Evolution Health Care. URL: <https://whatswithweed.evolutionhealth.care> [accessed 2021-02-21]
24. Shorten A, Moorley C. Selecting the sample. *Evid Based Nurs* 2014 Apr;17(2):32-33. [doi: [10.1136/eb-2014-101747](https://doi.org/10.1136/eb-2014-101747)] [Medline: [24561511](https://pubmed.ncbi.nlm.nih.gov/24561511/)]
25. Personal Information Protection and Electronic Documents Act. Office of the Privacy Commissioner of Canada. 2000. URL: <https://www.priv.gc.ca/en/privacy-topics/privacy-laws-in-canada/the-personal-information-protection-and-electronic-documents-act-pipeda/> [accessed 2021-02-08]
26. Summary of the HIPAA Privacy Rule. US Department of Health & Human Services. 2003. URL: <https://www.hhs.gov/hipaa/for-professionals/privacy/laws-regulations/index.html> [accessed 2021-02-09]

27. Directive 2002/58/E.C. of the European Parliament and of the Council of 12 July 2002 Concerning the Processing of Personal Data and the Protection of in the Electronic Communications Sector (Directive on Privacy and Electronic Communications). European Parliament and the Council of the European Union. 2002. URL: <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32002L0058> [accessed 2021-02-09]
28. Humeniuk R, Henry-Edwards S, Ali R, Poznyak V, Monteiro MG. The Alcohol, Smoking and Substance involvement Screening Test (ASSIST) : manual for use in primary care. World Health Organization. 2010. URL: <https://apps.who.int/iris/handle/10665/44320> [accessed 2021-02-09]
29. Greene WH, Hensher DA. Modeling ordered choices: A primer. Cambridge, England: Cambridge University Press; 2010.
30. Stata Statistical Software: Release 16. In: StataCorp. College Station, TX: StataCorp; 2019.
31. Carliner H, Mauro PM, Brown QL, Shmulewitz D, Rahim-Juwel R, Sarvet AL, et al. The widening gender gap in marijuana use prevalence in the U.S. during a period of economic change, 2002-2014. Drug Alcohol Depend 2017 Jan 01;170:51-58 [FREE Full text] [doi: [10.1016/j.drugalcdep.2016.10.042](https://doi.org/10.1016/j.drugalcdep.2016.10.042)] [Medline: [27875801](https://pubmed.ncbi.nlm.nih.gov/27875801/)]
32. Brubacher J, Chan H, Staples J. Cannabis-impaired driving and Canadian youth. Paediatr Child Health 2020 Jun;25(Suppl 1):S21-S25. [doi: [10.1093/pch/pxaa017](https://doi.org/10.1093/pch/pxaa017)] [Medline: [32581627](https://pubmed.ncbi.nlm.nih.gov/32581627/)]

Abbreviations

ASSIST: Alcohol, Smoking, and Substance Involvement Screening Test
CYC: Control Your Cannabis
CYD: Control Your Drinking
PAD: Parent Action on Drugs
WHO: World Health Organization

Edited by G Eysenbach; submitted 07.11.20; peer-reviewed by S Moore; comments to author 27.11.20; revised version received 07.01.21; accepted 29.01.21; published 02.03.21

Please cite as:

Moreno G, van Mierlo T

A Digital Health Tool to Understand and Prevent Cannabis-Impaired Driving Among Youth: A Cross-sectional Study of Responses to a Brief Intervention for Cannabis Use

JMIR Form Res 2021;5(3):e25583

URL: <https://formative.jmir.org/2021/3/e25583>

doi: [10.2196/25583](https://doi.org/10.2196/25583)

PMID: [33650982](https://pubmed.ncbi.nlm.nih.gov/33650982/)

©Georgina Moreno, Trevor van Mierlo. Originally published in JMIR Formative Research (<http://formative.jmir.org>), 02.03.2021. This is an open-access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in JMIR Formative Research, is properly cited. The complete bibliographic information, a link to the original publication on <http://formative.jmir.org>, as well as this copyright and license information must be included.