Perceptions of cannabis health information labels among people who use cannabis in the U.S. and Canada

TITLE PAGE

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ABSTRACT

Background: The emergence of legal cannabis industries poses a new public health challenge. Health information labels are part of the public health strategy for tobacco and alcohol, but there is limited research on cannabis-related messaging. This study explored perceptions of cannabis health information labels among people who used cannabis in the last 12 months residing in the U.S. and Canada.

Methods: The Global Drug Survey (GDS) is a large anonymous cross-sectional web-survey. In GDS2019, respondents were presented with six labels with cannabis-related health information (dependence; driving stoned; harms of smoking; harms to developing brain; lack of motivation; effects on memory), and asked if information was new, believed, would it change behavior, and about acceptability of having health labels on legal products. This paper includes 1,275 respondents from Canada and 2,224 from U.S. states where cannabis was legal at the time of the survey, and 5,230 from other U.S. states.

Results: Few respondents said that the information was new (6.6-24.6%). Most said the information was believable (63.5-72.0%) other than for the dependence message (28.1% new, 56.8% believed), which was perceived to be the least likely to change behavior (10.2%). Driving stoned was the message perceived to be the most likely to change behavior (58.5%). Respondents living in Canada were less likely to say information was new and rated most messages more believable than those in the U.S. Respondents from legal U.S. states were less likely to say information was new compared to other states. Respondents who used cannabis daily rated acceptability of labels lower (27.8%) than those using 1-48 days (40.6%).

Conclusions: Novel, believable information may be more effective at changing behavior. Regular consumers may be less susceptible to messages. Information focusing on safer use strategies and benefits of reducing use may be more acceptable and should be assessed in future research.

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INTRODUCTION

Rapid changes in legal approaches to cannabis production, supply, and possession throughout the US, Canada, and internationally, have led to the evolution of a highly commercialized legal cannabis industry. Historical experience with the tobacco and alcohol industries suggests implementation of public health strategies in this new framework need to be protected from the influence of lobby groups (Spithoff, Emerson, & Spithoff, 2015). This is important in order to reduce potential harms of a drug that is associated with dependence in at least 9% of people who use it (Anthony, Warner, & Kessler, 1994; Hamilton & Tracy, 2020). Although this conditional dependence is lower than for other drugs, including alcohol, cannabis dependence in the general community is at least twice as prevalent as dependence on any other illicit drug (cocaine, 1.8 percent; heroin, 0.7 percent) due to the higher prevalence of cannabis use. (Anthony et al., 1994; Budney, Roffman, Stephens, & Walker, 2007; Craft et al., 2019; Hasin et al., 2015). Research evidence exploring rates of cannabis dependence vary by culture and can be impacted by the changing definitions of dependence used historically and in recent diagnostic manuals (Compton, Han, Jones, & Blanco, 2019; Hamilton & Tracy, 2020). Furthermore, with the increase in availability in higher potency preparations (and especially concentrates) it is likely that previously cited rates of dependence may need upward adjustment for consumers of these products (e.g. Freeman & Winstock, 2015).

Emerging cannabis companies seek to demarcate their territory by adopting strategies like those used by the tobacco and alcohol industries. There is clear evidence that the tobacco industry ran a coordinated campaign to resist effective public policy on health (Saloojee & Dagli, 2000) including regulation on its products, lobbying, and buying scientific and other expertise. Consequently, there have been calls to ensure public health policies for regulated cannabis

markets are resistant to such strategies (Pacula, Kilmer, Wagenaar, Chaloupka, & Caulkins, 2014). Alongside possible dependence, other potential harms from cannabis use include cognitive impairment, increased risk of car accidents, impacts on the respiratory system from cannabis smoke, as well as impacts on the developing brain when used in adolescence (Hall, 2015). Objective product information and health advice is needed to balance the positive messages promulgated by advertising and lobbying efforts.

Although restrictions on outlets, legal minimum age of purchase and taxation will form the cornerstones of any regulatory approach, raising public health awareness of varying tetrahydrocannabinol (THC) levels (Hammond, 2019) and potential health risks associated with cannabis use through mandatory health labels has been considered. The evidence that labelling works as part of a wider public health strategy to reduce harmful tobacco smoking and raise awareness of alcohol-related health risks is persuasive (Hammond, 2011). While tobacco health information labels on cigarette packaging are now commonplace, mandatory specific health information on alcohol products is less widespread. The alcohol lobby, like the tobacco industry before them, resist calls for such labels, instead engaging, often with explicit government support, a model of self-regulation (Petticrew et al., 2016). This leaves the alcohol industry free to engage in promoting seemingly pro-health messages such as "enjoy responsibly', without having to disclose evidence of health harms. This approach, termed 'strategic ambiguity' (Smith, Atkin, & Roznowski, 2006), is unhelpful to those interested in crafting optimal public health strategies. Health information labels can form part of a comprehensive public health strategy to reduce health harms associated with the consumption of regulated psychoactive and other substances. Within a legal market they ensure that private companies cannot mislead the public by either failing to disclose harmful consequences or by minimizing them.

To date few countries have introduced a legal recreational cannabis market that requires mandatory health information on cannabis products. Text warnings are used in some U.S. states where recreational cannabis is regulated, for example. They include information about not using

products when pregnant or breastfeeding, and that edible products may take up to two hours to have an effect (Barry & Glantz, 2018). However, the content of the messages varies between states and some are focused on regulatory status rather than health effects (Shi, Cao, Shang, & Pacula, 2019). The Canadian regulation model included the provision of mandatory health warnings for cannabis products, including specific health messages about dependence and the risks of driving when under the influence of cannabis (Government of Canada, 2016). Drawing on what is known about the tobacco industry, and taking lessons from those countries where mandated health information is required on alcoholic beverages, informative labels should be large, offering rotating messages and can be helpfully enhanced by the use of pictures (Orenstein & Glantz, 2018).

Recent studies on perceptions of cannabis labels have suggested that including information on packaging could have an impact on behavior. For example, Mutti-Packer et al., (2018) found that people rated branded packages without any information on them much more appealing than those that had a health information label. However, another study found mixed results – with information labels to prevent driving under the influence of cannabis increasing product preference in some respondents who used cannabis (Shi et al., 2019). As previously demonstrated with tobacco and alcohol products, the majority of participants (87.7%) in Leos-Toro et al.'s (2019) study supported the inclusion of health information on cannabis product labels.

Research on the impact of cannabis health information labels is still in relative infancy compared with alcohol and tobacco. However, in common with those substances, it seems likely that there will be different impacts based on how messages on the labels are framed. For example, people may prefer positive, gain framed messages (using less cannabis reduces your risks), rather than negatively framed messages (using cannabis increases your risks) and therefore be more motivated to consider changing their behaviour (Gallagher & Updegraff, 2011; Mays et al., 2015; Pettigrew et al., 2014). It is also important to consider that some

messages may lead to reactance - a combination of anger and negative emotions - that lead the recipient to disregard a health message (Reynolds-Tylus, 2019; Richards & Banas, 2015).

Given that the open cannabis market is in its infancy we sought to undertake the first large scale international survey of perceptions of cannabis health information labels. Identifying levels of awareness among people who recently used cannabis and the likelihood of positive behavior change through messaging may increase the understanding of labeling impact and may vary based on the legal status.

Thus, the current study explored the perception of cannabis information labels in people in Canada and the U.S. who reported cannabis use in the last year. Recreational cannabis has been legalized in Canada since 2018. In the U.S., state laws vary, so it is worthwhile comparing perceptions of people in states with vs. without legal markets. At the time of the study, recreational cannabis was legal in Alaska (since 2014), California (2016), Colorado (2012), DC (2014), Maine (2016), Massachusetts (2016), Michigan (2019), Nevada (2017), Oregon (2014), Vermont (2018) and Washington (2012). The study aimed to explore whether people in the U.S. and Canada who used cannabis in the last year already knew and believed information about cannabis and whether they perceived that it would be able to change their behavior. Information labels were based on those already used in Canada and on information that Global Drug Survey participants gave in response to a question about what would encourage them to reduce their intake in a previous survey (Winstock, Barratt, Maier, & Ferris, 2018). We explored whether responses to the presented labels varied by demographic characteristics and frequency of use. We also aimed to explore whether these factors are associated with acceptability of having such message on legally available products.

METHOD

The Global Drug Survey (GDS) is an independent research organization that collects data on drug use patterns and trends worldwide. GDS recruits people opportunistically and as such the

data are not representative of the general population. However, compared to general household surveys, analyses have shown that GDS recruits people similar in demographic characteristics to people who reported cannabis use from representative surveys in the U.S., Australia, and Switzerland (Barratt et al., 2017). The survey is advertised to potential participants via media partners and collaborating institutions worldwide. The full survey asks respondents about the use of a range of legal and illegal drugs. Those who have used any of the drugs within the last 12 months go on to view further sections pertaining to that specific drug. Participants are able to skip questions that they do not wish to answer. There are no incentives provided for participation. Further more detailed information about the recruitment strategies are available elsewhere (Barratt et al., 2017). Ethical approval was obtained from the Joint South London and Maudsley and Institute of Psychiatry NHS (No: 141/02), the University of Queensland (No: 2017001452) and The University of New South Wales (HREC HC17769) Research Ethics Committees. GDS2019 launched on October 24, 2018 and ran until January 10, 2019. It was translated into 19 languages (English, Albanian, Azerbaijani, Brazil, Czech, Danish, Dutch, Finnish, French, German, Hungarian, Italian, Lithuanian, Portuguese, Romanian, Serbian, Slovak, Spanish, and Turkish).

Measures

Socio-demographic information including age, sex, and place of residence were collected. Due to low numbers of respondents who identified as non-binary or a different gender identity, the subsequent analyses of gender differences are limited to those who identified as male or female. Respondents were asked to indicate their country and state/province of residence. For the present study, respondents were categorized into: 1) those who lived in Canada, 2) those who lived in a U.S. state where recreational cannabis was legal at the time of survey completion and 3) those living in a U.S. state where recreational cannabis was not legally available.

Cannabis consumption: Respondents were first asked 'on how many days in the last year have you used cannabis with THC? They were able to enter the number of days from 0-365. Only those who responded that they used cannabis at least once in the last year were included in this study. We split the sample into quartiles to allow comparisons between people who use less and more frequently, particularly as a quarter of the sample reported daily or almost daily use (on 360+ days) meaning that the frequency variable was highly skewed. Respondents were then asked if they would like to use less cannabis in the next 12 months (yes/no).

Cannabis labels: Six health messages with information about the effects of cannabis use were presented as text labels for legally available cannabis products (Figure 1). Four were based on the existing suite of current Canadian health warnings (Government of Canada, 2017): risks associated with adolescent cannabis use on brain development, driving while under the influence of THC, smoking harms, and dependence. The other two messages were undesirable 'side effects' based upon data from GDS2018 which identified major motivations for quitting or cutting down on cannabis use, including decreased motivation and negative impacts on work and studying (memory) (Winstock et al., 2018). The six messages were presented individually and in the same order.

Following each message, respondents were asked to respond to three measures. These measures were based on previous work undertaken by the group on alcohol labelling (Winstock, Holmes, Ferris, & Davies, 2020), which drew on research from the alcohol labelling literature (Maynard et al., 2018; Pettigrew et al., 2014).

Newness: Respondents were asked if the information was new to them. Response options were no and yes.

Believability Respondents were asked if they believed the information. Response options were no, unsure and yes.

Potential behaviour change: For the messages about brain development, dependence, memory and motivation respondents were asked "Does it make you think about using less cannabis?". For the message about cannabis smoke they were asked "Does it make you think about not smoking" and for the driving message they were asked "Does it make you think about not driving stoned?" Response options were no, unsure and yes.

Acceptability: After viewing the messages, respondents were asked" *Would you overall be happy to see such health messages on your legally purchased THC-containing cannabis products?"* Response options were yes, no and don't know/don't care.

[Insert Figure 1]

Study population

GDS2019 respondents who reported the use of THC-containing cannabis at least once in the last 12 months and lived in the U.S. or Canada when taking the survey.

Analysis

Descriptive statistics and χ^2 *tests* were used to explore responses relating to newness, believability, and possible behavior change for each cannabis health information label and overall acceptability of labels by sociodemographic characteristics, jurisdiction, frequency of use, and desire to reduce use during the next 12 months. Bonferroni corrections were applied where multiple comparisons were made. Binary logistic regression was used to explore all variables as predictors of possible behavior change. Yes was compared to no and unsure combined. This decision was taken based on the stages of change model (Prochaska & Diclemente, 1983) to compare people who are likely to be contemplating changing their behaviour (answering 'yes') with those who are at the pre-contemplation stage (saying no or unsure).

RESULTS

Sample characteristics (Table 1)

The final sample included 8,729 people; 1,275 resided in Canada, 2,224 in a U.S. state where recreational cannabis was legal at the time of the survey (see measures section), and 5,230 in a U.S. state where no or only medical cannabis was legal at that time. Two thirds of the sample were men and the average age was 30 years (*SD*=12.61). A quarter of the sample were aged 16-20 years (Table 1). Respondents reported having used cannabis on a median of 200 days (*IQR*=312) in the last year. A quarter of the sample reported daily cannabis use in the last year (on more than 360 days); a quarter said they would like to use less cannabis in the next 12 months, but only 17.1% of those people wanted help to use less.

[Insert Table 1]

Newness, believability and potential for behavior change of the six health information messages (Tables 2-4).

Bivariate relationships and χ^2 tests for each message and response option are displayed in Table 2.

[Insert Tables 2-4]

Newness (Table 2): Most of the health information presented on the six labels was already known. Approximately one quarter of respondents reported that information about cannabis dependence and harmful chemicals in cannabis was new to them. Overall, respondents who resided in Canada were less likely to rate the presented cannabis facts as new information when compared to respondents in the U.S. Female respondents were more likely to report that the health information related to dependence, smoking harms and the impaired adolescent brain,

were new. People who aimed to reduce their cannabis use in the next 12 months were more likely to say that possible dependence and the risks of driving stoned were new information.

Believability (Table 3): The fact that cannabis use may negatively impact the adolescent brain was the most believable message, while the dependence message was believed the least. Respondents from Canada were more likely to believe the information when compared to people in the U.S; although this difference was not significant for impaired motivation, driving and consequences of adolescent use. Male respondents were more likely to believe all of the messages other than the message about driving stoned. The older the respondents, the lower the believability of the messages. The higher the number of days of cannabis use in the past year the lower the proportion of people who believed that the information. Respondents who reported that they would like to reduce their cannabis use in the next 12 months were more likely to believe the messages except for driving stoned.

Behavior change (Table 4): The only message that would make more than half of respondents reflect on changing their behavior was the message about impaired driving while under the influence of cannabis. Respondents from Canada were more likely to think about changing their behavior compared to respondents in the U.S. Female respondents were more likely to report potential adjustments to their behavior related to the messages about impaired driving and impaired motivation, while male respondents were reactive to the other messages. For most messages, older people were less likely to change behavior. However, they were most likely to be influenced by messages related to the consequences of driving under the influence and the harms associated with cannabis smoke. Once more, people who reported daily cannabis use were the least likely to consider changing their behavior.

Acceptability of health information labels (Table 5)

While one third of the sample reported they found cannabis labels with health information acceptable, four in 10 respondents either was undecided or did not care (Table 5). One quarter

of the respondents were against the implementation. Female respondents were more likely to rate the labels as not acceptable than males. The idea of providing health information on cannabis packaging was most accepted by respondents aged under 25 years, those who resided in Canada, those who used cannabis less frequently, and those who intended to reduce cannabis use in the next 12 months. Uncertainty about labelling was highest among older people and in U.S. regions where recreational cannabis was still illegal.

[Insert Table 5]

Information label perceptions, cannabis use characteristics, and sociodemographic associations with potential for behavior change (Table 6)

The likelihood that cannabis health information would make people reflect about behavior change was significantly higher for all messages if the information was considered new and/or if the respondents indicated that they believed the information (Table 6). If the information about dependence was perceived as believable, respondents were three times as likely to think about reducing their own cannabis use. Male respondents were more likely to think about it when the effects on memory and the adolescent brain were mentioned and less likely when the focus was on driving. Most messages were most convincing for the youngest age group and only the information about potential harm from smoking cannabis made older respondents reflect more about behavior change (Table 6). By jurisdiction, the association was weaker: When compared to people living in U.S. jurisdictions where recreational cannabis was illegal, people in legal areas only reflected more about reducing their cannabis use when being confronted with considering impaired driving. So were people in Canada and they were also more likely to pick-up on the harms related to smoking as well as impaired motivation and memory. Increased frequency of use was associated with decreased likelihood to consider behavior change. Finally, people who were intending to reduce cannabis use in the next 12 months were seven times more likely to report considering change when being reminded of the possibility of dependence

and more than four times more likely to consider change when reflecting on the impact on the adolescent brain and motivation overall.

[Insert Table 6]

DISCUSSION

This study represents the largest evaluation of the potential impact of cannabis health information labels on legal products on raising awareness and potential behavior change among people who recently consumed cannabis. Overall, awareness of the cannabis information presented was high, with the information about 1 in 10 people becoming dependent the least well known. Two thirds of respondents believed information, although levels of belief were slightly lower for the dependence label. However, for most of the labels, there were low proportions (<30%) of respondents who said it would make them consider changing their behavior. For the dependence label it was only 10%. The notable exception was for the driving label, for which nearly 60% said that this would make them consider reducing their cannabis use.

There were differences observed between respondents from Canada compared to the U.S. Canadian respondents were less likely to say the information was new; they were more likely to believe two out of six of the pieces of information, and they were more likely to say that the labels would make them consider changing their behavior than respondents from the U.S. When comparing U.S. respondents, those from states where recreational cannabis was legal exhibited higher levels of awareness, believability and were more likely to report that the labels would make them consider changing their behavior than respondents from states where recreational cannabis was not legal.

While Canada has implemented a range of messages that are mandated by law, Colorado, Washington, and Alaska have opted for messages that use vague health risk statements and

risks to particular groups such as pregnant women and those driving or operating heavy machinery (Barry & Glantz, 2018). As such, these resemble those adopted by the alcohol industry in many countries, which are not effective in preventing problematic alcohol use (Greenfield, Graves, & Kaskutas, 1999; MacKinnon, Nohre, Pentz, & Stacy, 2000). Unlike Canada, no current U.S. state requires rotating health message content.

Our findings are consistent with other studies that show health messages impact people with different patterns of cannabis use differently (Leos-Toro et al., 2019). Higher frequency of use was associated with lower believability of health messages and lower likelihood for behavior change. As such, cannabis health information labels may exert their greatest influence among younger, people who use cannabis only occasionally, while people who use more regularly are more resistant to the messages and their potential to change behavior. People who use cannabis more regularly may be less receptive to some messages because they may actually experience lower levels of impairment in some perceptual and attentional domains than those who use cannabis less regularly (Desrosiers, Ramaekers, Chauchard, Gorelick, & Huestis, 2015; Ramaekers, Kauert, Theunissen, Toennes, & Moeller, 2009).

For the most part, one third of respondents considered reducing their cannabis use when being confronted with health information on cannabis product labels. Driving while under the influence of cannabis made even two thirds of respondents critically reflect on their use. Roadside testing alone will not be sufficient to address this issue as some people who use cannabis on a regular basis will always perceive themselves as able to conduct a vehicle. Furthermore, roadside tests are currently not able to accurately detect impairment versus prior usage (Owusu-Bempah, 2014). As self-driving cars are being developed, the dialogue will soon be offered a new dimension.

A surprising finding that was inconsistent with previous research was that there were relatively low levels of support for health information labels on legal cannabis products. In our study, only

a third of people who recently used cannabis expressed support for this policy, which contrasts with the 87.7% of Canadian respondents who took part in a different online study (Leos-Toro et al., 2019). Finally, about 4 in 10 respondents said they were undecided or that they did not care about having cannabis health information available which may reflect that people in the U.S. and Canada simply don't care or that they already know most of the information based on their own experience.

Implications

The cannabis health information messages that we presented were considered believable. They were to varying extents associated with some positive perceptions that they might change behavior. Our research indicates that health messages appear to be most appealing for people who use cannabis on an occasional basis. As such, the adoption of cannabis health information labels can only represent part of an overall public health strategy to optimize the potential benefits and minimize the possible harms of legalization. The results of our study also suggest that most people who use cannabis are aware of associated health risks, though women and those residing in North America reported more frequently that the health information presented was new to them. It is also worth noting that information on labels may impact people who have not initiated cannabis use, but are considering it, and in this case may have an educational role to play. Future research to explore perceptions of labels among young people in particular, who have never used cannabis is warranted.

Cannabis companies may be resistant to the use of cannabis health information labels on product packaging even if the evidence shows that they may only have a small impact on behavior. However, both the industry and policy makers can learn from the experience of tobacco and alcohol control and incorporate best practice in terms of communicating accurate risk information to consumers as the markets change internationally. In this case, companies may be viewed more favorably as treating their customers with honesty and respect. People

who use cannabis want to be informed about the content of the products they use. Alcohol labels have demonstrated very small, or negligible impact on behavior (Hassan & Shiu, 2018; Stockwell, 2006) and this is likely true for cannabis health information labels as well. However, every person who learns something new and/or adapts their use behavior as a consequence of such messaging means it is worth placing it there. Importantly, mandating cannabis health information labels should be accompanied by additional public health strategies including providing access to accurate evidence based health information, and support services for those who need them.

Limitations

It is important to acknowledge that the measures used in this study were unable to elicit information about actual behavior change in our respondents, and only their perceptions of whether the message may have some kind of impact. GDS recruits a large sample, but is limited by the opportunistic nature of recruitment, and generally attracts a younger and better educated group when compared to the general population. This may mean that there are higher levels of health literacy in this sample than in the general population, which could impact on the perception of health labels. The large sample size means that some of the significant differences between groups may only be small and thus should be interpreted with caution. Self-report is an important limitation that is, however, less relevant when assessing personal attitudes and beliefs as they are usually measured via self-report. The health messages presented in this study were text based only, and literature from the tobacco and alcohol field has previously highlighted the benefits of using imagery (Noar et al., 2016). Although it has been demonstrated that textual labels are rated as similarly informative to pictorial labels (Popova, Owusu, Jenson, & Neilands, 2018), future research using messages from this study could incorporate images. Similar to research on the impact of alcohol product labelling, there is currently a lack of theory driven research, which could illuminate factors that moderate message effectiveness. It is also important to consider that people who use cannabis regularly may be benefitting from their

usage, for example it may alleviate physical pain or enable people to cope with mental health issues.

Conclusions

The results of this large study of people from the U.S. and Canada who recently used cannabis showed that most respondents are generally familiar with the cannabis health information presented. However, only few people considered behavior change following exposure to the health messages, indicating on the one hand that their cannabis use was mostly non-problematic, and on the other hand that messaging alone is likely not sufficient. However, even the potential to change a small number of people's behavior is preferable to there being no information on labels at all. Universal messaging raises awareness of health risks among consumers. For issues such as driving while under the influence of THC-containing cannabis, increasing awareness should be regarded as supporting public health policy. For other messages, such as those tapping into impacts on memory and motivation, the aim is to resonate with people who frequently use cannabis and experience negative consequences, and build on existing motivations to reduce their use. Respondents from jurisdictions where recreational cannabis was legal at the time of the study had a greater awareness of the health impacts of their behavior, suggesting that regulated markets may help to increase knowledge and awareness through product labeling. Cannabis health information labels offer the opportunity to intervene at the point of legal product purchase and potentially consumption. Thus, non-judgmental, objective labeling should be incorporated as part of a broader public health strategy to reduce health harms among people who are less educated about the effects and side effects of cannabis use.

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TABLES AND FIGURES

TABLES

Table 1: *Sociodemographic characteristics of GDS2019 respondents residing in the U.S. (states where cannabis was legal in 2018 vs. others) and Canada who used THC-containing cannabis in the year prior to taking the survey*

	Canada	U.S. legal	U.S. illegal	Total
	1,275 (14.6)	2,224 (25.5)	5,230 (59.9)	8,729
Gender (n, %)				
Male	832 (65.3)	1,435 (64.5)	3,505 (67.0)	5,772 (66.1)
Female	416 (32.6)	730 (32.8)	1,614 (30.9)	2,760 (31.6)
Age (Mean, SD)				
Mean age	28.33 (11.2)	31.14 (13.5)	29.25 (12.5)	29.59 (12.61)
Age 16-20	344 (27.0)	515 (23.2)	1,478 (28.3)	2,337 (26.8)
21-25	306 (24.0)	495 (22.3)	1,212 (23.2)	2,013 (23.1)
26-35	372 (29.2)	586 (26.3)	1,300 (24.9)	2,258(25.9)
36+	253 (19.8)	628 (28.2)	1,240 (23.7)	2,121 (24.3)
Frequency of cannabis use in the last year				
Median number of days (*IQR*)	150 (335)	250 (313)	200 (308)	200 (312)
1-48 days	407 (32.1)	523 (23.7)	1,232 (23.6)	2,162 (25.1)
49-200 days	297 (23.4)	543 (24.6)	1,380 (26.8)	2,220 (25.8)
201-360 days	269 (21.2)	549 (24.9)	1,290 (25.0)	2,108 (24.5)
361 days+	295 (23.1)	588 (26.7)	1,248 (24.2)	2,131 (24.7)
Would like to use less in next 12 months (N, %)				
Yes	362 (28.4)	587 (26.5)	1,255 (24.0)	2,204 (25.3)

Notes: * due to small numbers, non-binary/different identity participants were not included in the analysis of data by gender presented in the other tables

Table 2: *Bivariate relationships between **newness** of the message content by sociodemographic characteristics, legal jurisdiction, frequency of use, and intention to reduce use*

N (%)	**Dependence**	**Drive**	**Smoke**	**21+**	**Motivation**	**Forgetfulness**
All	2,455 (28.1)	1,241 (14.2)	2,151 (24.6)	1,066 (12.2)	574 (6.6)	628 (7.2)
Jurisdiction						
U.S. illegal, *N*=5,230	1,536 (29.4)	810 (15.5)	1,385 (26.5)	690 (13.2)	338 (6.5)	374 (7.2)
U.S. legal, *N*=2,224	635 (28.6)	312 (14)	508 (22.8)	270 (12.1)	152 (6.8)	166 (7.5)
Canada, *N*=1,275	284 (22.3)	119 (9.3)	258 (20.2)	106 (8.3)	84 (6.6)	88 (6.9)
χ^2, *p, V*	25.80, *p*<.001, V =.054	31.92, *p*<.001, V=.060	26.75, *p*<.001, V=.055	22.78, *p*<.001, V =.051	.35, *p*=.839	.42, *p*=.811
Gender						
Male	1,428 (25.7)	796 (13.8)	1,117 (20.3)	596 (10.3)	385 (6.7)	388 (6.7)
Female	914 (33.1)	412 (14.9)	936 (33.9)	450 (16.3)	175 (6.3)	218 (7.9)
χ^2, *p, V*	51.18, *p*<.001, V=.077	1.99, *p*=.159	186.40, *p*<.001, V=.148	62.05, *p*<.001, V=.085	.33, *p*=.565	3.92, *p*=.048
Age						
16-20	612 (26.2)	302 (12.9)	631 (27.0)	280 (12.0)	168 (7.2)	165 (7.1)
21-25	588(29.2)	320(15.9)	539 (26.8)	283 (14.1)	133 (6.6)	137 (6.8)
26-35	688(30.5)	326(14.4)	549 (24.3)	275 (12.2)	133 (5.9)	161 (7.1)
36+	567(26.7)	293(13.8)	432 (20.4)	228 (10.7)	140 (6.6)	165 (7.8)
χ^2, *p, V*	13.69, *p*=.003, V=.040	8.24, *p*=.041,	32.93, *p*<.001, V=.061	10.75, *p*=.013,	3.16, *p*=.037	1.62, *p*=.655
Frequency of use						
1-48 days, *N*=2,162	765 (35.0)	278 (12.9)	614 (28.4)	330 (15.3)	145 (6.7)	187 (8.6)
49-200 days, *N*=2,220	673 (30.3)	314 (14.1)	576 (25.9)	288 (13.0)	128 (5.8)	157 (7.1)
201-360 days, *N*=2,108	545 (25.9)	337 (16.0)	463 (22.0)	216 (10.2)	136 (6.5)	153 (7.3)
361 days+, *N*=2,131	453 (21.3)	301 (14.1)	475 (22.3)	219 (10.3)	154 (7.2)	124 (5.8)
χ^2, *p, V*	110.37, *p*<.001, V=.113	8.67, *p*=.034	32.92, *p*<.001. V=.062	35.01, *p*<.001, V=.064	3.95, *p*=.267	12.94, *p*=.005, V=.039
Would like to use less in next 12 months						
No *N*=6,511	1,761 (21.0)	848 (13.0)	1,585 (24.3)	818 (12.6)	417 (6.4)	469 (7.2)_
Yes, *N*=2,204	688 (31.2)	389 (17.6)	558 (25.3)	246 (11.2)	156 (7.1)	157 (7.1)
χ^2, *p, V*	14.17, *p*<.001, V=.040	28.93, *p*<.001, V=.058	.84, *p*=.359	3.02, *p*=.082	1.22, *p*=.270	.02, *p*=.900

Note: Due to multiple comparisons between six labels the alpha level was adjusted to .008. Effect size Cramer's V included for results where p<.008.

Table 3: *Bivariate relationships between **believability** of the message content by sociodemographic characteristics, legal jurisdiction, frequency of use, and intention to reduce use*

N (%)	Dependence	Drive	Smoke	21+	Motivation	Forgetfulness
All	4,962 (56.8)	5,546 (63.5)	5,667 (64.9)	6,287 (72.0)	5,932 (68.0)	5,845 (67.0)
Jurisdiction						
U.S. illegal, *N*=5,230	2,883 (55.1)	3,262 (62.4)	3,304 (63.2)	3,719 (71.1)	3,539 (67.7)	3,354 (66.0)
U.S. legal, *N*=2,224	1,284 (57.7)	1,425 (64.1)	1,453 (65.3)	1,622 (72.9)	1,509 (67.9)	1,492 (67.1)
Canada, *N*=1,275	795 (62.4)	859 (67.4)	910 (71.4)	946 (74.2)	884 (69.3)	899 (70.5)
χ^2, *p*, *V*	24.50, *p*<.001, V=.037	11.78, *p*=.019, V=.026	35.42, *p*<.001, V=.045	6.60, *p*=159	7.17, *p*=.127	10.63, *p*=.031
Gender						
Male	3,400 (58.9)	3,578 (62.0)	3,960 (68.6)	4,250 (73.6)	3,943 (68.3)	3,906 (67.7)
Female	1,442 (52.2)	1,839 (66.6)	1,576 (57.1)	1,894 (68.6)	1,858 (67.3)	1,804 (65.4)
χ^2, *p*, *V*	34.63, *p*<.001, V=.064	24.36. *p*<.001, V=.053	120.72, *p*<.001, V=.119	25.81, *p*<.001, V=.055	6.09, *p*=.048	12.28, *p*=.002, V=.038
Age						
16-20	1,574 (67.4)	1,654 (70.8)	1,608 (68.8)	1,635 (70.0)	1,728 (73.9)	1,765 (75.5)
21-25	1,275 (63.3)	1,267 (62.9)	1,299 (64.5)	1,527 (75.9)	1,440 (71.5)	1,418 (70.4)
26-35	1,150(50.9)	1,352 (59.9)	1,444 (64.0)	1,647 (72.9)	1,459 (64.6)	1,410 (62.4)
36+	963 (45.5)	1,273 (60.0)	1,316 (62.0)	1,478 (69.7)	1,305 (61.5)	1,252 (59.0)
χ^2, *p*, *V*	325.48, *p*<.001, V=.137	98.47, *p*<.001, V =.075	27.31, *p*<.001, V=.040	40.91, *p*<.001, V=.048	114.84, *p*<.001, V=.081	203.98, *p*<.001, V=.108
Frequency of use						
1-48 days, *N*=2,162	1,242 (57.4)	1,731 (80.1)	1,494 (69.1)	1,657 (76.6)	1,670 (77.2)	1,602 (74.1)
49-200 days, *N*=2,220	1,288 (58.0)	1,564 (70.5)	1,509 (68.0)	1,616 (72.8)	1,601 (72.1)	1,577 (71.0)
201-360 days, *N*=2,108	1,299 (61.6)	1,209 (57.4)	1,392 (66.0)	1,557 (73.9)	1,429 (67.8)	1,420 (67.4)
361 days+, *N*=2,131	1,072 (50.3)	977 (45.8)	1,208 (56.7)	1,377 (64.6)	1,173 (55.0)	1,183 (55.5)
χ^2, *p*, *V*	158.24, *p*<.001, V=.209	751.15, *p*<.001, V=.101	174.96, *p*<.001, V=.087	129.73, *p*<.001, V=.142	345.50, *p*<.001, V=.120	250.02, *p*<.001, V=.206
Would like to use less in next 12 months						
No *N*=6,511	3,331 (51.3)	4,137 (63.5)	4,118 (63.2)	4,533 (69.6)	4,199 (64.5)	4,134 (63.5)
Yes *N*=2,204	1,624 (73.7)	1,401 (63.6)	1,541 (69.9)	1,744 (79.1)	1,721 (78.1)	1,700 (77.1)
χ^2, *p*, *V*	369.60, *p*<.001, V=.206	4.32, *p*=.115	43.10, *p*<.001, V=.070	90.10, *p*<.001, V=.102	148.83, *p*<.001, V=.131	156.41, *p*<.001, V=.134

Note: Due to multiple comparisons between six labels the alpha level was adjusted to .008. Effect size Cramer's V included for results where p<.008.

Table 4: *Bivariate relationships between whether the message would make people think about* ***changing behavior*** *by sociodemographic characteristics, legal jurisdiction, frequency of use, and intention to reduce use*

N (%)	**Dependence**	**Drive**	**Smoke**	**21+**	**Motivation**	**Forgetfulness**
All	886 (10.2)	5,110 (58.5)	2,410 (27.6)	1,360 (15.6)	2,485 (28.5)	2,137 (24.5)
Jurisdiction						
U.S. illegal, *N*=5,230	496 (9.5)	2,947 (56.3)	1,361 (26.0)	799 (15.3)	1,438 (27.5)	1,215 (23.2)
U.S. legal, *N*=2,224	235 (10.6)	1,350 (60.7)	630 (28.3)	323 (14.5)	632 (28.4)	561 (25.2)
Canada, *N*=1,275	155 (12.2)	813 (63.8)	419 (32.9)	238 (18.7)	415 (32.5)	361 (28.3)
χ^2, *p*	15.74, *p*=.003, V=.030	32.05, *p*<.001, V=.043	32.95, *p*<.001, V=.043	11.79, *p*=.019	14.52, *p*=.006, V=.029	15.46, *p*=.004, V=.030
Gender						
Male	617 (10.7)	3,182 (55.1)	1,617 (28.0)	976 (16.9)	1,702 (29.5)	1,487 (25.8)
Female	249 (9.0)	1,792 (64.9)	732 (26.5)	359 (13.0)	726 (36.3)	595 (21.6)
χ^2, *p*	6.42, *p*=.040	79.28, *p*<.001	11.29, *p*=.004	22.60, *p*<.001	9.30, *p*=.010	18.25, *p*<.001
Age						
16-20	355 (15.2)	1,490 (63.8)	613 (26.2)	731 (31.3)	834 (35.7)	798 (34.1)
21-25	256 (12.7)	1,128 (56.0)	549 (27.3)	325 (16.1)	705 (35.0)	569 (28.3)
26-35	182 (8.1)	1,228 (54.4)	607 (26.9)	210 (9.3)	588 (26.0)	474 (21.0)
36+	93 (4.4)	1,264 (59.6)	641 (30.2)	94 (4.4)	358 (16.9)	296 (14.0)
χ^2, *p*	301.46, *p*<.001, V=.131	73.89, *p*<.001, V=.065	25.38. *p*<.001, V=.038	920.99, *p*<.001, V=.320	289.00, *p*<.001, V=.129	337.56, *p*<.001, V=.139
Frequency of use						
1-48 days, *N*=2,162	189 (8.7)	1,659 (76.7)	747 (34.6)	431 (19.9)	587 (27.2)	514 (23.8)
49-200 days, *N*=2,220	258 (11.6)	1,472 (66.3)	702 (31.6)	387 (17.4)	675 (30.4)	611 (27.5)
201-360 days, *N*=2,108	271 (12.9)	1,114 (52.8)	568 (26.9)	361 (17.1)	753 (35.7)	628 (29.8)
361 days+, *N*=2,131	160 (7.5)	814 (38.2)	375 (17.6)	168 (7.9)	447 (21.0)	361 (16.9)
χ^2, *p*	103.44, *p*<.001, V=.077	784.63, *p*<.001, V=.213	253.54, *p*<.001, V=.121	191.50, *p*<.001, V=.105	126.90, *p*<.001, V=.086	145.13, *p*<.001, V=.092
Would like to use less in next 12 months						
No *N*=6,511	264 (4.1)	3,824 (58.7)	1,602 (24.6)	586 (9.0)	1,253 (19.2)	1,039 (16.0)
Yes *N*=2,204	619 (28.1)	1,278 (58.0)	803 (36.4)	770 (34.9)	1,226 (55.6)	1,094 (49.6)
χ^2, *p*	1427.60, *p*<.001, V=.405	19.01, *p*<.001, V=.047	167.33, *p*<.001, V=.139	939.06, *p*<.001, V=.328	1104.88, *p*<.001, V=.356	1069.16, *p*<.001, V=.350

Note: Due to multiple comparisons between six labels the alpha level was adjusted to .008. Effect size Cramer's V included for results where p<.008.

Table 5: ***Overall acceptability*** *of messages with health information on cannabis products by sociodemographic characteristics, legal jurisdiction, frequency of use, and intention to reduce use:*

N %	**No**	**Yes**	**Don't know / don't care**
All= 8662 [a]	2,019 (23.3)	3,048 (35.2)	3,595 (41.5)
Jurisdiction			
U.S. illegal, *N*=5,184	1,153 (22.2)	1,801 (34.7)	2,230 (43.0)
US Legal *N*=2,213	577 (26.1)	763 (34.5)	873 (39.4)
Canada, *N*=1,265	289 (22.8)	484 (38.3)	492 (38.9)
χ^2, p, V			21.10, *p*<.001, V=.035
Gender [b]			
Male, *N*=5,733	1,291 (22.5)	2,132 (37.2)	2,310 (40.3)
Female, *N*=2,732	683 (25.0)	839 (30.7)	1,210 (44.3)
χ^2, p			34.12, *p*<.001, V=.063
Age			
16-20 *N*=2,320	487 (21.0)	893 (38.5)	940 (40.5)
21-25 *N*=2,002	464 (23.2)	764 (38.2)	774 (38.7)
26-35 *N*=2,239	582 (26.0)	717 (32.0)	940 (42.0)
36+ *N*= 2,101	486 (23.1)	674 (32.1)	941 (44.8)
χ^2, p			46.71, *p*<.001, V=.052
Frequency of use			
1-48 days, *N*=2,147	373 (17.4)	871 (40.6)	903 (42.1)
49-200 days, *N*=2,205	485 (22.0)	836 (37.9)	884 (40.1)
201-360 days, *N*=2,094	518 (24.7)	708 (33.8)	868 (41.5)
361 days+, *N*=2,108	620 (29.4)	587 (27.8)	901 (42.7)
χ^2, p			127.38, *p*<.001, V=.086
Would like to use less in next 12 months			
No *N*=6,461	1,577 (24.4)	2,084 (32.3)	2,800 (43.3)
Yes *N*=2,187	435 (19.9)	959 (43.9)	793 (36.3)
χ^2, p			96.46, *p*<.001, V=.106

Notes: a = There were 8,662 responses to the acceptability question in total, b = non-binary and different identify not included in this analysis due to small numbers for comparisons.

Table 6: Adjusted OR and 95% CI for logistic regression models predicting whether placing each label on cannabis packages would make people reflect about behavior change.

	Dependence	Drive	Smoke	21+	Motivation	Forgetfulness
AOR (95% CI) p						
Message perception						
New = yes	2.00 (1.69-2.36)**	1.35 (1.22-1.51)**	1.35 (1.21-1.51)**	1.43 (1.24-1.66)**	1.31 (1.16-1.47)**	1.55 (1.37-1.75)**
Believe = yes	3.36 (2.75-4.12)**	1.54 (1.40-1.70)**	1.90 (1.71-2.21)**	2.23 (1.91-2.60)**	1.99 (1.77-2.22)**	2.23 (1.98-2.52)**
Gender						
Male	1.04 (0.87-1.23)ns	0.65 (0.59-0.72)**	1.07 (0.96-1.19)ns	1.19 (1.02-1.37)*	1.07 (0.96-1.20)ns	1.16 (1.03-1.31)*
Age						
Age 21-25	0.90 (0.74-1.10)ns	0.72(0.63-0.82)**	1.18 (1.02-1.36)*	0.43 (0.37-0.51)**	1.09 (0.95-1.26)ns	0.83 (0.72-0.96)*
Age 26-35	0.70 (0.56-0.86)*	0.73(0.64-0.84)**	1.31(1.14-1.51)**	0.27 (0.23-0.33)**	0.84 (0.73-0.97)*	0.67 (0.58-0.78)**
Age 36+	0.47 (0.36-0.60)**	1.12(0.98-1.28)ns	1.86 (1.62-2.15)**	0.15 (0.12-0.19)**	0.57 (0.49-0.67)**	0.49 (0.42-0.58)**
Jurisdiction						
U.S. legal	1.09 (0.91-1.32)ns	1.21 (1.08-1.35)*	1.08 (0.96-1.22)ns	0.97 (0.82-1.13)ns	1.01 (0.89-1.14)ns	1.11 (0.97-1.26)ns
Canada	1.24 (1.00-1.53)ns	1.31 (1.14-1.50)**	1.33 (1.16-1.53)**	1.15 (0.96-1.38)ns	1.18 (1.02-1.37)*	1.23 (1.05-1.43)*
Frequency of use						
49-200 days	1.03 (0.83-1.29)ns	0.60 (0.52-0.69)**	0.86 (0.75-0.98)*	0.60 (0.50-0.71)**	1.02(0.88-1.18)ns	1.03 (0.88-1.19)ns
201-360 days	0.92 (0.74-1.15)ns	0.34 (0.34-0.39)**	0.61(0.53-0.70)**	0.51 (0.42-0.61)**	1.09(0.94-1.26)ns	0.96 (0.83-1.12)ns
361 days+	0.81 (0.64-1.04)ns	0.19 (0.17-0.22)**	0.38(0.33-0.44)**	0.32 (0.26-0.40)**	0.71(0.61-0.83)**	0.65(0.55-0.76)**
Use less in next 12 months						
Yes	7.23 (6.13-8.54)**	0.98 (0.88-1.10)ns	1.75(1.56-1.97)**	4.63 (4.03-5.33)**	4.25(3.80-4.75)**	4.11(3.66-4.61)**

Note: Reference category for new = no, believe = no and unsure, male=female (due to small N, non-binary and other gender identity excluded from this analysis) age = 16-20, Jurisdiction = U.S. Illegal, Frequency of use = 1-48 days, use less = no
** p<.001, *p<.05, ns not significant

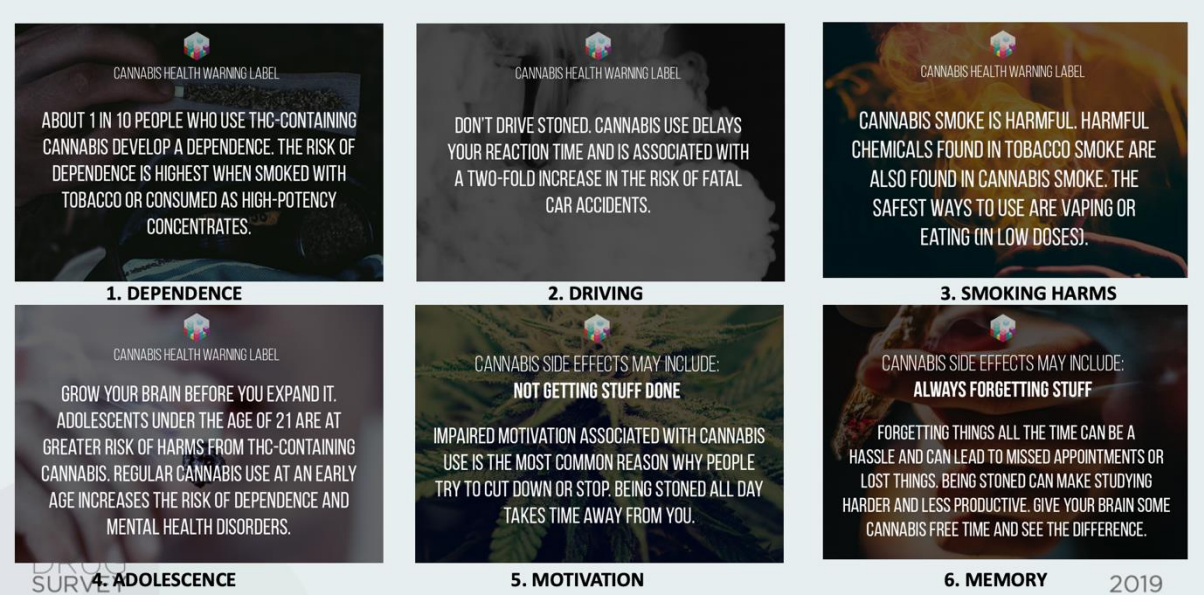

Figure 1: **Health information labels presented to GDS2019 respondents**