

Research Paper

Perceptions of effectiveness and believability of pictorial and text-only health warning labels for cannabis products among Canadian youth

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ABSTRACT

Background: Health warnings have been shown to increase knowledge and awareness of health risks, influence social norms, and reduce consumption of tobacco products. With the legalization of non-medical cannabis in Canada and other subnational jurisdictions, there is a need for empirical studies to examine the impact of cannabis health warnings on consumer perceptions and behaviour relevant to cannabis.

Methods: In October 2017, a between-group experiment was conducted as part of an online survey of Canadians aged 16 to 30 years (N = 870) recruited from a national consumer panel. Participants rated the perceived effectiveness and believability of either text-only or pictorial cannabis health warnings and then completed a message recall task. Participants also reported their level of support for cannabis warnings, and support for including cessation information and a quitline on the warnings.

Results: Pictorial health warnings for cannabis products were perceived as more effective and believable than text-only warnings ($p < 0.001$), and the superiority of pictorial warnings was found across different warnings: dose ($p = 0.039$), co-morbid drug use ($p = 0.006$), and pregnancy ($p < 0.001$). Pictorial warnings were also rated as more believable ($p = 0.048$). Overall, 87.7% respondents supported having health warnings on cannabis products, and 84.0% supported the inclusion of a quitline number on cannabis health warnings.

Conclusion: The current study provides the first empirical test of cannabis health warnings, consistent with the considerable body of evidence on the effectiveness of pictorial warnings on tobacco products. There was strong support for the inclusion of picture warnings and the inclusion of resources and quitlines on cannabis packaging.

Background

In October 2018, non-medical cannabis was legalized in Canada (An Act respecting cannabis, 2018; Department of Justice, 2018). One of the primary objectives of the *Cannabis Act* is to protect the health of young persons and enhance public awareness of associated health risks (An Act respecting cannabis, 2018). Cannabis is the most prevalent substance used among Canadian youth after alcohol; approximately 17% of students in grades 7 to 12 reported used cannabis in the past year according to the nationally representative 2016/17 Canadian Student Tobacco, Alcohol and Drugs Survey (Health Canada, 2018a; Popova, Rhem, Patra, Baliunas, & Taylor, 2007). The most recent general population survey on cannabis, the 2018 National Cannabis Survey, found that 33% of young Canadians aged 18 to 24 reported past 3-month cannabis use – significantly higher than in other age groups in which prevalence ranged from 5 to 21% (Statistics Canada, 2019).

Like most other substances, the risks of cannabis depend upon the context of use, dose, form, mode of administration, and co-morbid substance use (Degenhardt & Hall, 2012; Fischer, Imtiaz, Rudzinski, & Rehm, 2016; Hall & Degenhardt, 2009; National Academies of Sciences, Engineering, & Medicine, 2017; Popova et al., 2007). Overall, two-thirds (62.4%) of Canadian current and past 3-month cannabis users have been found to be at a moderate risk of developing health or other problems due to their use (Leos-Toro, Rynard, & Hammond, 2017). Early and frequent use of cannabis is among the best predictors of subsequent problematic use, lower academic performance, heightened risk for cannabis dependence, and problematic use of other drugs (Coffey & Patton, 2016; Degenhardt & Hall, 2012; Government of Canada, 2017; Hall & Degenhardt, 2009; Meier et al., 2012; Morin et al., 2018). Frequent and heavy cannabis use is also associated with an increased risk of psychosis and other mental health disturbances (Grinspoon, Bakalar, & Russ, 2005; Hall & Degenhardt, 2009; Hirvonen

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et al., 2012; Swift, Hall, Didcott, & Reilly, 1998; Swift, Hall, & Copeland, 2000). Cannabis use during pregnancy may increase the risks of stillbirth, preterm birth, fetal development issues, as well as having an adverse effect on child neurodevelopment (Conner et al., 2016; Hall & Degenhardt, 2009; Metz & Stickrath, 2016). Acute impairment from cannabis increases the risk of motor vehicle accidents and evidence indicates that chronic exposure to cannabis smoke may increase risk of respiratory disease; high potency THC products may also increase adverse health risks (Hall & Degenhardt, 2009; Paglia-Boak, Adlaf, & Mann, 2011; Stogner & Miller, 2015). Finally, concurrent use of cannabis with other drugs may also give rise to negative health and social outcomes (Moss, Chen, & Yi, 2014; Tomczyk, Isensee, & Hanewinkel, 2016).

Research has identified youth in Canada as having low cannabis literacy. Focus groups conducted in 2013 found that many Canadian youth did not recognize the word *marijuana* in study pre-screening forms (Porath-Waller, Brown, Frigon, & Clark, 2013). A more recent focus group study conducted in 2017 found that, while young people perceive that they have accurate understanding of the potential adverse health effects of cannabis, they just “don’t care” about the health effects and would use cannabis regardless (McKiernan & Fleming, 2017). Young Canadians report that cannabis is generally benign and is a substance used by “everybody” referring to it as “natural” and “not really a drug at all” (George & Vaccarino, 2015; McKiernan & Fleming, 2017; Spackman et al., 2007). Young users report taking comfort in the opinion that cannabis “affects everyone differently” to selectively determine the degree of harm that use might produce (George & Vaccarino, 2015). As with most other health behaviours, perceptions of risk are inversely related to behaviour: youth who perceive cannabis as more harmful are less likely to use it (Boak, Hamilton, Adlaf, & Mann, 2015; Johnston, O’Malley, Bachman, & Schulenberg, 2005; Volkow, Baler, Compton, & Weiss, 2014). Most youth and general population surveys do not provide information regarding perceptions of risk attributed to different modes of delivery (e.g., smoking, vaping, edibles, etc.) but are consistent in finding that young Canadians are unclear as to how cannabis use may affect their physical and psychological well-being (Wallingford, Konefal, Young, & Student Drug Use Surveys Working Group, 2019).

Health warning labels (HWLs) are a prominent policy measure to communicate the health effects of consumer products. Research in the domain of tobacco control demonstrates that HWLs have high reach and frequency of exposure with more consumers reporting noticing information from product warnings than any other source (Noar, Francis et al., 2016). Comprehensive HWLs have been shown to influence social norms, increase health knowledge, and reduce consumption (Hammond, 2011; Levy, Chaloupka, & Gitchell, 2004; Noar, Hall et al., 2016; WHO, 2013).

The effectiveness of HWLs depends upon their design. Key elements of effective health warnings include size, position, borders, and the general appearance of the warning (e.g., colour, graphics and graphic content, and message content) (Hammond, 2009). Vivid colour affects overall noticeability and maximizes legibility of text which may lead to increased cognitive processing of content (O’Hegarty, Pederson, Yenokyan, Nelson, & Wortley, 2007; WHO FCTC, 2018). Relative to text-only HWLs, pictorial HWLs are more likely to promote cognitive elaboration of risks, increased ability to attract and hold attention, and improve recall as they are more likely to remain salient over time and promote encoding to memory (Cho et al., 2018; Evans et al., 2016; Noar, Hall et al., 2016). Among youth, HWLs that highlight negative aesthetic effects or those that portray messages that suggest an inability to participate in a valued activity are rated as having a greater impact (Corporate Research Associates, 2005; Devlin, Anderson, Hastings, & MacFadyen, 2005; Magnan & Cameron, 2015, 2017). Integrating information on resources such as telephone quitlines (telephone services providing behavioural change resources, e.g., treatment for dependence, reduction of use, etc.) also increases the impact of health

warnings on behaviour change (Baskerville et al., 2015, 2016).

Canada’s *Cannabis Act* requires that products feature rotating health warnings, including general warnings about potential hazards from use, precautions of use during pregnancy or while breastfeeding, driving or operating heavy machinery while intoxicated, addiction, mental health implications, and impact from use in adolescence (*Cannabis Regulations: SOR/2018-144, 2018; Government of Canada, 2018*). Currently, however, there is a lack of evidence on the impact of health warnings for cannabis products. Despite increased calls and recommendations for health warnings on cannabis, there are no empirical studies examining the design or content of messages on consumption perceptions or behavior (Hamilton, 2016; Large, 2016; Malouff & Rooke, 2013; Malouff, Johnson, & Rooke, 2016).

The current study took place in the year immediately preceding legalization, in October 2017, when use outside the auspices of the Access to Cannabis for Medical Purposes Regulations was a criminal offense (*Government of Canada, 2019*). The current study examined the effectiveness of health warnings for cannabis products. The study had three primary objectives: 1) to test differences in perceived effectiveness and believability of text and pictorial cannabis product health warning labels; 2) examine whether certain label themes were more likely to be recalled than others; and 3) to examine levels of support from Canadian youth, including general support for health warnings, support for pictorial warnings, and whether a call to action such as a quitline should be present.

Methods

Design

Between-group experimental tasks were conducted as part of a 30-minute online survey examining a range of areas related to cannabis use behaviours, beliefs, and attitudes (Leos-Toro & Hammond, 2019). Approximately 15 min into the survey, respondents were randomized to view either text-only or pictorial health warnings. Respondents rated the perceived effectiveness and believability of the warnings and completed a message recall task approximately 10 min after viewing the warnings. Participants also reported their level of support for cannabis warnings, pictorial vs. text warnings, and the inclusion of cessation information and a quitlines as part of the warnings. A description of the tasks and measures is presented below.

Respondents

Respondents were individuals aged 16 to 30 (N = 870) years of age with a Canadian IP address, and included cannabis users and non-users. Recruitment for participation in an online survey occurred by e-mail through Léger’s consumer panel for web surveys consisting of approximately 400,000 active members, with half of respondents sampled using probability-based methods using the Canadian Census, along with other non-probability based methods, including commercial surveys (Leger Web, 2019). Respondents aged 16 to 30 were recruited across Canada directly with the exception of youth in Quebec where youth aged 16 and 17 who were recruited through their parents; parental consent was obtained prior to Quebec youth accessing the survey. Respondents received remuneration from Léger in accordance with their usual incentive structure. All of the data provided by respondents were anonymous and information was kept strictly confidential. The study was reviewed by and received ethics clearance from the Office of Research Ethics at the University of Waterloo (ORE# 22392). Data collection was conducted from October 10th to October 24th, 2017.

Development of health warnings

The health warning messages tested in the study were created in a multi-step process. First, a literature review was conducted to identify

known health effects associated with cannabis use and was used to create an initial set of warnings. Second, this initial set of warnings was incorporated into an anonymous online survey, hosted by SurveyGizmo (Widgix, LLC, Colorado, USA), and was sent to 51 experts on August 26, 2016. These experts included members of the Expert Advisory Committee on Information for Physicians on Marijuana for Medical Purposes, the Canadian Centre on Substance Abuse Scientific Advisory Council, and other prominent cannabis researchers (SurveyGizmo Enterprise, 2018). Of the 51 experts, 25 completed the survey, and the warning messages were refined based on their responses. Third, four focus groups were conducted in February 11–12, 2017 among 35 Canadian cannabis users (those who had used cannabis in the past 12 months) and non-users (those who had either never used or had abstained in the past 12 months), aged 16–24 years. Focus group participants were asked about their perceptions of cannabis, and for their opinions of the refined warnings; the focus group results led to a final set of warnings, which were then constructed to be consistent with the graphic design of Canadian tobacco health warnings.

Protocol and measures

Randomization for the between-group health warning experiment occurred in two steps. First, participants were randomized to receive 4 of any of the 8 prepared health warning messages: 1) driving while intoxicated, 2) use during pregnancy, 3) use and mental health, 4) co-morbid use, 5) youth use, 6) addictive potential, 7) dose, and 8) second-hand smoke (see Fig. 1).

Second, participants were randomized to view either a text-only or text and pictorial warnings (henceforth simply ‘pictorial’) for each of the 4 messages they viewed. Participants rated each health warning of perceived effectiveness and believability using a 10-point scale from 1 = ‘Not at all effective/believable’ to 10 = ‘Extremely effective/believable’. Ratings were made while the message appeared on the screen.

Following the experimental tasks, three measures of support were assessed. Respondents could respond yes/no/don’t know to the



Fig. 2. Health warning label with call to action.

following questions: 1) “In your opinion, if it were legal to sell marijuana, should health warnings be required on products?”; 2) “Should health warnings include pictures?”; 3) “Do you think this information (in the red rectangle) should be included on marijuana packages?”. The information referenced in the last question is reproduced in Fig. 2.

At the end of the survey, approximately 10 min after viewing the warnings, participants were asked to recall as many of the four health warnings they viewed as possible. ‘Unprompted recall’ was assessed using open-ended fields. Responses were coded by two coders, both of whom were blind to the experimental condition and one who was unaware of the study hypotheses. A correct recall was operationally defined as one that contained references and phrases contained in the health warning that had been presented. For example, mentions of “mixing”, “combining”, or “using both weed and alcohol” were coded as having recalled the warning about co-morbid drug use; mentioning “car accident”, “crashing”, or “too high to drive” were coded as having recalled the warning about driving while intoxicated. The percentage of agreement by the two coders of correct vs. incorrect (73/75) recall was very high: 97.3%.

Sociodemographic characteristics included sex (male or female),



Fig. 1. Health Warning Labels presented to survey respondents.

age, ethnicity (white, non-white), and cannabis use status. Cannabis use status measures ('never', 'recent – in the past 12-months', and 'current use – in the past 30 days') were drawn from a modified Canadian Student Tobacco, Alcohol and Drugs Survey, "Have you ever tried marijuana?" and a new item, "When was the last time you used marijuana" with options "More than 12 months ago", "More than 3 months to 12 months ago", "Within the last month" (Government of Canada, 2019; University of Waterloo, 2018).

Analysis

All analyses were conducted using SPSS 25.0 (Armonk, NY: IBM Corp.). All analyses were conducted using SPSS 25.0 (Armonk, NY: IBM Corp.). OLS linear regression models were fitted to examine perceived effectiveness and perceived believability, while accounting for correlated responses across the 8 warnings. The models were adjusted for age, sex, ethnicity, cannabis use status, and indicator variables were included for experimental condition (0 = text-only, 1 = pictorial warning), the order by which warnings were shown, and warning label theme (1 = Driving, 2 = Pregnancy, 3 = Mental Health, 4 = Co-morbid Drug Use, 5 = Early use, 6 = Addiction, 7 = Overdose, 8 = Toxic smoke). Logistic regression models were fitted to examine correlates of support for requiring cannabis product health warning labels, inclusion of pictures on labels, and the inclusion of a call to action (0 = Not supportive/ Don't Know, 1 = Supportive). Adjusted odds ratios (AOR) and 95% Confidence Intervals (Cis) are reported throughout the paper, unless otherwise noted.

Results

Table 1 displays the sample characteristics. A total of 1045 respondents completed the survey; however, the final analytic sample was 870 as the rest were excluded from analysis due to completing survey from a mobile device instead of a desktop computer (28), missing data on key measures including cannabis use status (8) and/or failed data integrity questions; 62 records deleted due to incorrectly identifying the current month and 77 respondents reported being unable to provide honest answers to all of the survey questions.

Perceptions of health warning effectiveness and believability

Overall, pictorial warnings were rated as significantly more effective than text-only warnings (AOR = 1.59, 95%CI 1.33–1.89, $p < 0.001$). Fig. 3 displays the mean ratings of perceived effectiveness of text-only and pictorial health warnings among participants by message theme. Pictorial warnings were rated as more effective than text-only warnings overall. However, of the eight health message themes, only three differed statistically by execution (pictorial vs. text-only warning): dose, co-morbid drug use, and pregnancy (AOR = 1.79,

Table 1
Unweighted sample characteristics (n = 870).

		% (N) N = 870
Sex	Female	52.1 (453)
	Male	47.9 (417)
Age (yrs.)	16–18	25.2 (219)
	19–24	30.7 (267)
	25–30	44.1 (384)
Ethnicity	White	64.5 (561)
	Non-white	35.5 (309)
Cannabis use status	Never use	41.5 (361)
	Former use, not in past 30 days	36.0 (313)
	Current use, within past 30 days	22.5 (196)

95%CI 1.03–2.79, $p = 0.039$; AOR = 1.91, 95%CI 1.20–3.04, $p = 0.006$; and AOR = 3.20 95%CI 2.06–4.97, $p < 0.001$ respectively).

Table 2 displays the results of linear regression models for perceived effectiveness and believability across the eight themes. Pregnancy-related warnings were consistently more likely to receive greater mean scores of effectiveness than any of the other health warning themes. For example, the pregnancy health warning labels were approximately twice as likely to receive greater mean scores of perceived effectiveness than the drugged driving warnings (AOR = 2.09 95%CI 1.45–3.02, $p < 0.001$).

Fig. 4 displays the mean ratings of believability of the text-only and pictorial health warnings by message theme. Pictorial warnings were rated as slightly more believable than text-only warnings, although the effect size was small (AOR = 1.19 95%CI 1.002–1.41, $p = 0.048$), and for none of the 8 individual themes did pictorial and text-only warnings differ significantly. Table 2 displays the results of the linear regression model examining believability across the eight themes. The pattern of differences across themes for believability were quite similar to the pattern of differences found for ratings of effectiveness.

Support for health warnings and health warning elements

Table 3 displays respondents' support of health warning labels on cannabis products, pictorial labels, and calls to action displayed on labels such as quitlines. A very high percentage of respondents supported putting health warnings on cannabis products (88%). Logistic regression analyses revealed that respondents who had used cannabis in the past 30 days (current users) were less likely to be supportive of health warnings than those who had never used cannabis (75.5% vs. 93.6%; AOR = 0.23 95%CI 0.13–0.40, $p < 0.001$). In contrast, those who reported that they had ever used cannabis, but not in the past 30 days (former users), were associated with greater odds of support for health warnings on cannabis products than current users (88.5% vs. 75.5%; AOR = 2.51 95%CI 1.55–4.06, $p < 0.001$).

Nearly 7 in 10 respondents (69%) supported having pictorial warnings on cannabis products. White respondents had lower odds of supporting pictures on health warning labels than non-White respondents (72.9% vs. 81.8%; AOR = 0.57 95%CI = 0.39–0.84, $p = 0.004$). Significant differences were reported by cannabis use characteristics; 86.1% of never users, 77.4% of former users and 53% of current users reported support for pictorial warnings. Former and current cannabis users were less likely to support pictorial warnings than respondents who had never used cannabis (AOR = 0.61, 95%CI = 0.39–0.94, $p = 0.025$ and AOR = 0.20, 95%CI = 0.13–0.31, $p < 0.001$ respectively). However, former users had a greater likelihood of supporting pictorial warning labels than current users (AOR = 3.09 95%CI = 2.03–4.70, $p < 0.001$).

The inclusion of calls to action such as quitlines were also well-supported (84.0%). Males were less likely than females to support the inclusion of these resources (79.1% vs. 88.5%, AOR = 0.49 95%CI = 0.33–0.73, $p < 0.001$). Similar to questions of support for warnings and pictures, former users were more likely to support resources such as quitlines than current users (86.9% vs. 69.4%, AOR = 2.89 95%CI = 1.83–4.55, $p < 0.002$), and current users had significantly lower odds of supporting the same than never users (69.4% vs. 89.5%, AOR = 0.28 95%CI = 0.17–0.44, $p < 0.001$ respectively).

Health warning recall

Table 4 displays the number of times each message theme was accurately recalled as well as the number of respondents that were shown each warning (n). For the majority of health warning themes, pictorial warnings were recalled with the same or greater frequency as text warnings, with the exception of the driving and pregnancy themes which were recalled most frequently.

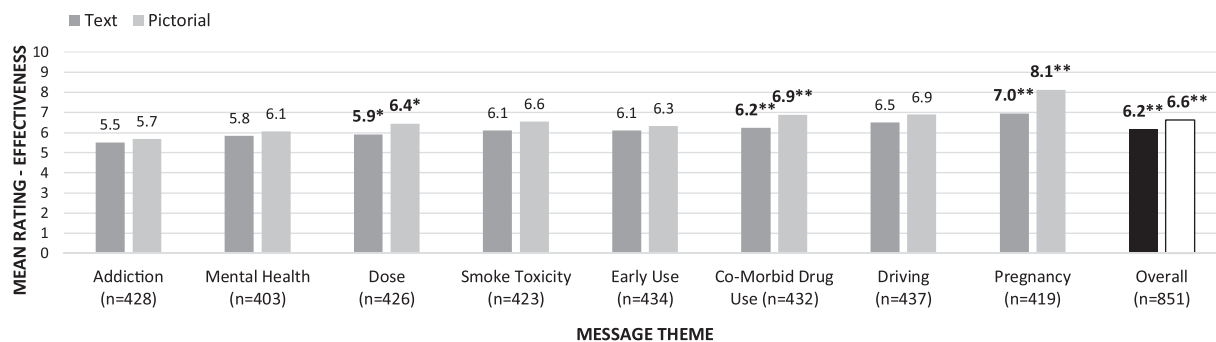


Fig. 3. Mean ratings of effectiveness of text-only and pictorial health warning label among Canadian youth and young adults (out of 10). (n = 851). Values adjusted for age, sex, ethnicity, and cannabis use status. *p < .05, **p < 0.001
 “Overall” columns adjusted for age, sex, ethnicity, cannabis use status, order by which warning was shown, and warning message theme.

Table 2

Linear regression analyses examining ratings of effectiveness and believability between cannabis health warning labels (N = 851).

Health Warning Label Theme	Ref.	Model 1 Effectiveness			Model 2 Believability		
		p	OR	95%CI	p	OR	95%CI
Pregnancy	Driving	< 0.001	2.09	1.45-3.02	< 0.001	1.96	1.35-2.82
Mental Health		< 0.001	0.44	0.29-0.67	0.004	0.54	0.36-0.82
Co-morbid drug use		0.441	0.84	0.54-1.31	0.189	1.35	0.86-2.10
Early Use		0.109	0.68	0.42-1.09	0.494	0.85	0.53-1.36
Addiction		< 0.001	0.40	0.24-0.67	< 0.001	0.35	0.21-0.58
Overdose		0.144	0.66	0.38-1.15	0.037	0.56	0.32-0.97
Smoke toxicity		0.119	0.62	0.34-1.13	0.010	0.46	0.25-0.83
Mental Health	Pregnancy	< 0.001	0.21	0.15-0.31	< 0.001	0.28	0.19-0.40
Co-morbid drug use		< 0.001	0.40	0.27-0.59	0.055	0.69	0.47-1.01
Early Use		< 0.001	0.32	0.22-0.49	< 0.001	0.43	0.29-0.65
Addiction		< 0.001	0.19	0.12-0.30	< 0.001	0.18	0.11-0.47
Overdose		< 0.001	0.32	0.19-0.52	< 0.001	0.29	0.18-0.47
Smoke toxicity		< 0.001	0.30	0.17-0.52	< 0.001	0.23	0.13-0.40
Co-morbid drug use	Mental Health	< 0.001	1.89	1.33-2.70	< 0.001	2.48	1.75-3.54
Early Use		0.027	1.53	1.05-2.22	0.020	1.56	1.07-2.27
Addiction		0.610	0.90	0.59-1.36	0.036	0.64	0.43-0.97
Overdose		0.085	1.50	0.95-2.37	0.897	1.03	0.65-1.63
Smoke toxicity		0.208	1.40	0.83-2.36	0.505	0.84	0.50-1.41
Early Use	Co-morbid drug use	0.223	0.81	0.57-1.14	0.008	0.63	0.45-0.89
Addiction		< 0.001	0.47	0.33-0.69	< 0.001	0.26	0.18-0.38
Overdose		0.271	0.79	0.52-1.20	< 0.001	0.42	0.27-0.63
Smoke toxicity		0.221	0.74	0.45-1.20	< 0.001	0.34	0.21-0.55
Addiction	Early Use	0.003	0.59	0.41-0.84	< 0.001	0.41	0.29-0.59
Overdose		0.919	0.98	0.66-1.45	0.036	0.66	0.45-0.97
Smoke toxicity		0.704	0.92	0.58-1.45	0.008	0.54	0.34-0.85
Overdose	Addiction	0.005	1.67	1.17-2.38	0.009	1.61	1.13-2.29
Smoke toxicity		0.035	1.56	1.03-2.35	0.205	1.31	0.86-1.97
Smoke toxicity	Overdose	0.714	0.93	0.65-1.35	0.268	0.81	0.56-1.17

Values adjusted for age, sex, ethnicity, cannabis use status, order by which warning was shown, and warning message theme.

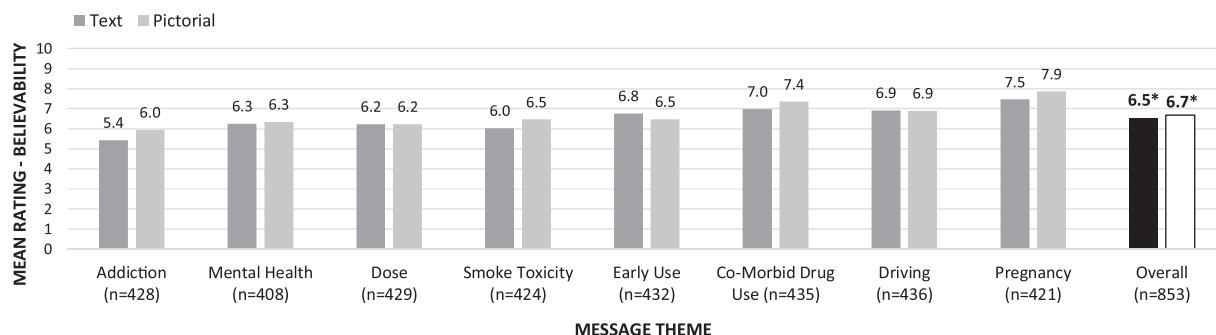


Fig. 4. Mean ratings of believability of text-only and pictorial health warning label among Canadian youth and young adults (out of 10). (n = 853). Values adjusted for age, sex, ethnicity, and cannabis use status, *p < 0.05
 “Overall” columns adjusted for age, sex, ethnicity, cannabis use status, order by which warning was shown, and warning message theme.

Table 3
Support for health warnings and health warning elements (N = 870).

Support for	% (N)
Health warning labels on cannabis products	87.7 (763)
Pictures on health warning labels ^a	69.8 (607)
Calls to action/quitlines on cannabis products	84.0 (731)

^a Only those that answered in support for health warning labels on cannabis products were asked about support for pictures on said products.

Table 4
Health warning recall.

Health Warning Theme	Experimental Condition	Recalled warning % (n)
Pregnancy (n = 430)	Pictorial (n = 221)	49.5 (213)
	Text-Only (n = 209)	45.2 (102)
Mental Health (n = 414)	Pictorial (n = 216)	53.1 (111)
	Text-Only (n = 198)	43.2 (179)
Smoke Toxicity (n = 435)	Pictorial (n = 204)	43.5 (94)
	Text-Only (n = 231)	42.9 (85)
Youth/Early Use (n = 440)	Pictorial (n = 217)	33.1(144)
	Text-Only (n = 223)	36.8 (75)
Addiction (n = 436)	Pictorial (n = 209)	29.9 (69)
	Text-Only (n = 227)	31.1 (65)
Overdose (n = 440)	Pictorial (n = 221)	28.6 (65)
	Text-Only (n = 219)	18.4 (80)
Co-Morbid Drug Use (n = 441)	Pictorial (n = 223)	19.0 (42)
	Text-Only (n = 218)	17.8 (38)
	Pictorial (n = 223)	17.2 (76)
	Text-Only (n = 218)	17.5 (39)
		17.0 (37)

Note: *Driving* theme recall not reported as Fig. 2, a driving warning, was shown to all respondents.

Discussion

The current study found that pictorial health warnings for cannabis products were perceived as more effective and believable than text-only warnings. These findings are consistent with the extensive tobacco control literature and recommendations from the WHO Framework Convention on Tobacco Control that specify that pictorial health warnings on tobacco product are more effective and believable than text-only warnings (Brewer et al., 2016; Maynard, Gove, Skinner, & Munafò, 2018; Noar, Hall et al., 2016; WHO FCTC, 2018). Notably, however, the greater effectiveness of pictorial warnings was not as strong for cannabis as for cigarettes in this study.

The current study was also able to identify thematic areas for further public health information campaigns, such as cannabis dependence which was consistently rated as relatively less effective or believable than the other cannabis health warning themes, and which has been a challenging area in cannabis health communications identified by previous researchers (George & Vaccarino, 2015). Recent work from tobacco control research suggests that the use of graphic imagery, enhanced by testimonial content may be perceived as more effective and should be considered in the further development of cannabis product health warnings (Hammond et al., 2018). These principles may be useful in resonating more abstract health effects such as those related to mental health and cannabis use.

No significant differences were observed between text and pictorial warnings in the recall task. The current findings contrast with other studies showing greater recall for pictorial warnings (Mutti, Hammond, Reid, & Thrasher, 2013). Typically, warnings that display and highlight stark or graphic images of physical health effects have been observed to enhance effects on memory; inducing an emotional reaction has been

observed to increase memory for associated information (Kensinger, 2009; Mather, 2007; Wang, Lowen, Romer, Giorno, & Langleben, 2015). In the current study, there was a general trend towards greater recall of pictorial health warnings across most health effects, with the notable exception of the pregnancy warning. This was particularly surprising given that previous studies have identified pictorial health warnings of babies as among the most salient images tested (Hammond et al., 2012, 2018). Other than the pregnancy warning, many of the images were abstract in nature, which may have contributed to lower levels of recall compared to more concrete images with more direct or congruent links to the specific health effect (Lochbuehler et al., 2017). Indeed, most of the images were symbolic which are consistent rated as least effective among themes for pictorial health warnings (Maynard et al., 2018).

There was near universal support for health warning labels on cannabis products and the inclusion of calls to action such as quitlines. Most youth and young adults also supported the use of pictorial health warning labels. The health warnings that are required by Health Canada under the *Cannabis Act* incorporate some the elements tested in the current study, including contrasting colour and a set of rotating health warnings that depict different health effects (Health Canada, 2018b). Although the ‘main’ health warnings are text-only, packages are required to display a ‘universal symbol’ to indicate that the product contains cannabis. In the regulation and consultation reports, Health Canada contrasted the regulations for cannabis warnings against the pictorial warnings required on cigarette packages in Canada; the decision to opt for text-only cannabis warnings may be an effort to communicate the lesser health effects from cannabis use versus smoking (Lochbuehler et al., 2017). Future research should examine the impact of the cannabis health warnings on consumer knowledge and perceptions of risk.

Strengths and limitations

This study has a number of important strengths and limitations. While a commercial sample was used that employed probability and non-probability-based recruitment methods, we were able to include a broad and diverse sample with similar patterns of cannabis use and sociodemographic characteristics as the 2017 Canadian Cannabis Survey (Morin et al., 2018). The study surveyed Canadian young people aged 16–30, who use cannabis at the highest rates and are a priority population in Canada’s legalization efforts (An Act respecting cannabis, 2018). However, findings may not necessarily be generalizable among older age groups. Furthermore, it could be argued that the health warning labels presented in this study were ill-designed, however, an attempt to control for this involved a careful multistage process which included expert opinions and focus groups among youth and young adults. The between-group experimental design was a considerable strength as was the use of tools previously used to develop and evaluate health warnings and messages for tobacco products (Hammond, 2018).

Conclusion

The current study provides the first empirical test of cannabis health warnings. As with warning messages on tobacco products, pictorial warnings were perceived as more effective and believable than text-only warnings. This study also provides evidence of strong support for the inclusion of picture warnings on cannabis products and the inclusion of resources and quitlines on cannabis packaging to strengthen Canadian cannabis product packaging regulations and inform the Government’s continued responsibility to protect population health.

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Declaration of Competing Interest

None to declare.

References

- An Act respecting cannabis (2018). *An Act respecting cannabis and to amend the Controlled Drugs and Substances Act, the Criminal Code and other Acts, Cannabis Act (S.C. 2018, c.16)*. June 21, 2018. Accessed on 18 August 2018 from: <http://laws-lois.justice.gc.ca/eng/acts/C-24.5/page-1.html>.
- Baskerville, N. B., Hayward, L., Brown, K. S., Hammond, D., Kennedy, R. D., & Campbell, H. S. (2015). Impact of Canadian tobacco packaging policy on quitline reach and reach equity. *Preventive Medicine, 81*, 243–250.
- Baskerville, N. B., Brown, K. S., Nguyen, N. C., Hayward, L., Kennedy, R. D., Hammond, D., et al. (2016). Impact of Canadian tobacco packaging policy on use of a toll-free quit-smoking line: An interrupted time-series analysis. *CMAJ Open, 4*(1), E59–65.
- Boak, A., Hamilton, H. A., Adlaf, E. M., & Mann, R. E. (2015). *Drug use among Ontario students, 1977–2015: Detailed OSDUHS findings. CAMH research document series, No. 41*. Toronto: Centre for Addiction and Mental Health.
- Brewer, N. T., Hall, M. G., Noar, S. M., Parada, H., Stein-Seroussi, A., Bach, L. E., et al. (2016). Effect of pictorial cigarette pack warnings on changes in smoking behavior: A randomized clinical trial. *JAMA, 316*(7), 905–912.
- Cannabis Regulations: SOR/2018-144 (2018). *Canada gazette part II, 152(14)*. Retrieved on August 12, 2018 from the Canada Gazette Website: <http://gazette.gc.ca/pr-tp/p2/2018/2018-07-11/pdf/g2-15214.pdf>.
- Cho, Y. J., Thrasher, J. F., Yong, H. H., Szklo, A. S., O'Connor, R., Bansal-Travers, M., et al. (2018). Path analysis of warning label effects on negative emotions and quit attempts: A longitudinal study of smokers in Australia, Canada, Mexico, and the US. *Social Science & Medicine, 197*, 226–234.
- Coffey, C., & Patton, G. C. (2016). Cannabis use in adolescence and youth adulthood: A review of findings from the Victorian Adolescent Health Cohort Study. *The Canadian Journal of Psychiatry, 61*(6), 318–327.
- Conner, S. N., Bedell, V., Lipsey, K., Macones, G. A., Cahill, A. G., & Tuuli, M. G. (2016). Maternal marijuana use and adverse neonatal outcomes: A systematic review and meta-analysis. *Obstetrics and Gynecology, 128*(4), 713–723.
- Corporate Research Associates (2005). *Creative concept testing for health warning messages*. Accessed on 22 February 2018 from: Prepared for Health Canada <http://www.tobaccolabels.ca/wp-content/uploads/2013/12/Canada-2005-Creative-Concept-Testing-for-Health-Warning-Messages-HC-Govt-Report.pdf>.
- Degenhardt, L., & Hall, W. (2012). Extent of illicit drug use and dependence, and their contribution to the global burden of disease. *Lancet, 379*(9810), 55–70.
- Department of Justice (2018). *Cannabis legalization and regulation*. Accessed on 15 August 2018 from: <http://www.justice.gc.ca/eng/cj-jp/cannabis/>.
- Devlin, E., Anderson, S., Hastings, G., & MacFadyen, L. (2005). Targeting smokers with tobacco warning labels - opportunities and challenges for Pan European health promotion. *Health Promotion International, 20*(1), 41–49.
- Evans, A. T., Peters, E., Shoben, A., Meilleur, L., Klein, E. G., Tompkins, M. K., et al. (2016). Cigarette graphic warning labels are not created equal: They can increase or decrease smokers' quit intentions relative to text-only warnings. *Nicotine & Tobacco Research, 19*, 1155–1162.
- Fischer, B., Imtiaz, S., Rudzinski, K., & Rehm, J. (2016). Crude estimates of cannabis-attributable mortality and morbidity in Canada - Implications for public health focused intervention priorities. *Journal of Public Health, 38*(1), 183–188.
- George, T., & Vaccaro, F. (Eds.). (2015). *Substance abuse in Canada: The effects of cannabis use during adolescence*. Ottawa, ON: Canadian Centre on Substance Abuse. Accessed on 17 August 2018 from: <http://www.ccsa.ca/Resource%20Library/CCSA-Effects-of-Cannabis-Use-during-Adolescence-Report-2015-en.pdf>.
- Government of Canada (2017). *Canadian cannabis survey 2017 - Summary*. December 12, 2017. Accessed on 19 September 2018 from: <https://www.canada.ca/en/health-canada/services/publications/drugs-health-products/canadian-cannabis-survey-2017-summary.html>.
- Government of Canada (2018). *Cannabis health warning messages*. July 11, 2018. Retrieved on August 17 from: <https://www.canada.ca/en/health-canada/services/drugs-medication/cannabis/laws-regulations/regulations-support-cannabis-act/health-warning-messages.html>.
- Government of Canada Cannabis for medical purposes under the Cannabis act: Information and improvements. October 17, 2018. Accessed on June 1, 2019 from: <https://www.canada.ca/en/health-canada/services/drugs-medication/cannabis/medical-use-cannabis.html>.
- Grinspoon, L., Bakalar, J. B., & Russ, E. (2005). Marijuana: Clinical aspects. In J. H. Lowinson, P. Ruiz, R. B. Millman, & J. G. Langrod (Eds.). *Substance abuse: A comprehensive textbook* (pp. 263–276). (4th edition). Philadelphia, PA, USA: Lippincott Williams & Wilkins.
- Hall, W., & Degenhardt, L. (2009). Adverse effects of non-medical cannabis use. *Lancet, 374*(9698), 1383–1391.
- Hamilton, I. (2016). Response to the need for health warnings about cannabis and psychosis. *The Lancet Psychiatry, 3*, 322.
- Hammond, D. (2009). *Tobacco Labelling & Packaging Toolkit - A guide to FCTC article 11*. Accessed on 18 August 2018 from: <http://www.tobaccolabels.ca/wp-content/uploads/2013/12/IUATLD-Toolkit-Complete-Mar-3-2009.pdf>.
- Hammond, D. (2011). Health warning messages on tobacco products: A review. *Tobacco Control, 20*, 327–337.
- Hammond, D. (2018). *Tobacco labelling and packaging toolkit: A guide to FCTC Article 11*. February 2009. Accessed on 22 October 2018 from: <http://www.tobaccolabels.ca/wp-content/uploads/2013/12/IUATLD-Toolkit-Complete-Mar-3-2009.pdf>.
- Hammond, D., Thrasher, J., Reid, J. L., Driezen, P., Boudreau, C., & Santillán, E. A. (2012). Perceived effectiveness of pictorial health warnings among Mexican youth and adults: A population-level intervention with potential to reduce tobacco-related inequities. *Cancer Causes & Control*. <https://doi.org/10.1007/s10552-012-9902-4>.
- Hammond, D., Reid, J. L., Driezen, P., Thrasher, J. F., Gupta, P. C., Nargis, N., et al. (2018). Are the same health warnings effective across different countries? An experimental study in seven countries. *Nicotine & Tobacco Research, 21*(7), 887–895.
- Health Canada (2018a). *Summary of results for the Canadian student tobacco, alcohol and drugs survey 2016-17*. Accessed on 17 August 2018 from: <https://www.canada.ca/en/health-canada/services/canadian-student-tobacco-alcohol-drugs-survey/2016-2017-summary.html>.
- Health Canada (2018b). *Proposed approach to the regulation of cannabis - Summary of comments received during the public consultation*. Accessed on August 18, 2018 from: <https://www.canada.ca/en/health-canada/services/publications/drugs-health-products/summary-comments-public-consultation-regulation-cannabis.html>.
- Hirvonen, J., Goodwin, R. S., Li, C.-T., Terry, G. E., Zoghbi, S. S., Morse, C., et al. (2012). Reversible and regionally selective downregulation of brain cannabinoid CB1 receptors in chronic daily cannabis users. *Molecular Psychiatry, 17*(6), 642–649.
- Johnston, L. D., O'Malley, P. M., Bachman, J. G., & Schulenberg, J. E. (2005). *Monitoring the future national survey results on drug use, 1974-2004: Vol 1. Secondary school students*. Bethesda, MD: NIDA.
- Kensinger, E. A. (2009). Remembering the details: Effects of emotion. *Emotion Review, 1*, 99–113.
- Large, M. (2016). The need for health warnings about cannabis and psychosis. *Lancet, 3*(3), 188–189.
- Leger Web Born from research: Data collection 360. Accessed on 14 August 2017 from: http://leger360.com/admin/legerweb/PanelBook_Canada_EN_2016.pdf.
- Leos-Toro, C., & Hammond, D. The Cannabis purchasing and consumption tool: Survey document. November 2017. Accessed on 18 August 2018 from: <http://davidhammond.ca/wp-content/uploads/2018/07/2017-Cannabis-Purchasing-Consumption-Tool-Survey-Document.pdf>.
- Leos-Toro, C., Rynard, V., & Hammond, D. (2017). Prevalence of problematic cannabis use in Canada: Cross-sectional findings from the 2013 Canadian Tobacco, Alcohol and Drugs Survey. *Canadian Journal of Public Health = Revue Canadienne de Sante Publique, 108*(5-6), e516–e522.
- Levy, D. T., Chaloupka, F., & Gitchell, J. (2004). The effects of tobacco control policies on smoking rates: A tobacco control scorecard. *Journal of Public Health Management and Practice, 10*(4), 338–353.
- Lochbuehler, K., Mercincavage, N., Tang, K. Z., Tomlin, C. D., Cappell, J. N., & Strasser, A. A. (2017). Effect of message congruency on attention and recall in pictorial health warning labels. *BMJ Tob Control*. <https://doi.org/10.1136/tobaccocontrol-2016-053615> [e-pub ahead of print].
- Magnan, R. E., & Cameron, L. D. (2015). Do young adults perceive that cigarette graphic warnings provide new knowledge about the harms of smoking? *Annals of Behavioral Medicine, 49*(4), 594–604.
- Magnan, R. E., & Cameron, L. D. (2017). A cross-sectional investigation of positive and negative smoker stereotypes and evaluations of cigarette warnings. *Health Psychology, 36*(5), 486–492.
- Malouff, J. M., & Rooke, S. E. (2013). Expert-recommended warnings for medical marijuana. *Substance Abuse, 34*(2), 92–93.
- Malouff, J. M., Johnson, C. E., & Rooke, S. (2016). Cannabis users' recommended warnings for packages of legally sold Cannabis: An Australia-centered study. *Cannabis and Cannabinoid Research, 1*(1), 239–243.
- Mather, M. (2007). Emotional arousal and memory binding: An object-based framework. *Perspectives on Psychological Science, 2*, 33–52.
- Maynard, O. M., Gove, H., Skinner, A. L., & Munafò, M. R. (2018). Severity and susceptibility: Measuring the perceived effectiveness and believability of tobacco health warnings. *BMC Public Health, 18*(1), 468.
- McKiernan, A., & Fleming, K. (2017). *Canadian youth perceptions on Cannabis*. Accessed on 20 August 2018 from: Ottawa, Ont: Canadian Centre on Substance Abuse. <http://www.ccsa.ca/Resource%20Library/CCSA-Canadian-Youth-Perceptions-on-Cannabis-Report-2017-en.pdf>.
- Meier, M. H., Caspi, A., Ambler, A., Harrington, H. L., Houts, R., Keefe, R. S. E., et al. (2012). Persistent cannabis users show neuropsychological decline from childhood to midlife. *PNAS, 109*(40), E2657–2664.
- Metz, T. F., & Stickrath, E. H. (2016). Marijuana use in pregnancy and lactation: A review of the evidence. *American Journal of Obstetrics and Gynecology, 213*(6), 761–778.
- Morin, J.-F. G., Afzali, M. H., Bourque, J., Stewart, S. H., Séguin, J. R., O'Leary-Barret, M., et al. (2018). A population-based analysis of the relationship between substance use and adolescent cognitive development. *The American Journal of Psychiatry* [ap-1802020202](https://doi.org/10.1176/appi.ajp.18020202) [e-Pub ahead of print].
- Moss, H., Chen, C., & Yi, H. (2014). Early adolescent patterns of alcohol, cigarettes and marijuana polysubstance use and young adult substance use outcomes in a nationally representative sample. *Drug and Alcohol Dependence, 136*, 51–62.
- Mutti, S., Hammond, D., Reid, J. L., & Thrasher, J. F. (2013). The efficacy of cigarette warning labels on health beliefs in the United States and Mexico. *Health Communication, 1*–14 0.
- National Academies of Sciences, Engineering, and Medicine (2017). *The health effects of*

- cannabis and cannabinoids: The current state of evidence and recommendations for research*. Washington, DC: The National Academies Press <https://doi.org/10.17226/24625>.
- Noar, S. M., Francis, D. B., Bridges, C., Sontag, J. M., Ribisl, K. M., & Brewer, N. T. (2016). The impact of strengthening cigarette pack warnings: Systematic review of longitudinal observational studies. *Social Science & Medicine*, 118–129.
- Noar, S. M., Hall, M. G., Francis, D. B., Ribisl, K. M., Pepper, J. K., & Brewer, N. T. (2016). Pictorial cigarette pack warnings: A meta-analysis of experimental studies. *Tobacco Control*, 25(3), 341–354.
- O'Hegarty, M., Pederson, L. L., Yenokyan, G., Nelson, D., & Wortley, P. (2007). Young adults' perceptions of cigarette warning labels in the United States and Canada. *Preventing Chronic Disease*, 4(2), A27.
- Paglia-Boak, A., Adlaf, E. M., & Mann, R. E. (2011). *Drug use among Ontario students, 1977-2011: OSDUHS highlights*. Toronto, ON: Centre for Addiction and Mental Health.
- Popova, S., Rhem, J., Patra, J., Baliunas, D., & Taylor, B. (2007). Illegal drug-attributable morbidity in Canada 2002. *Drug and Alcohol Review*, (26), 251–263.
- Porath-Waller, A. J., Brown, J. E., Frigon, A. P., & Clark, H. (2013). *What Canadian youth think about cannabis: Technical report* Accessed on 17 August 2018 from: Ottawa: ON Canadian Centre on Substance Abuse. <http://www.ccsa.ca/Resource%20Library/CCSA-What-Canadian-Youth-Think-about-Cannabis-2013-en.pdf>.
- Spackman, E., Haines-Saah, R., Danthurebandara, V. M., Dowsett, L. E., Noseworthy, T., & Clement, F. (2007). Marijuana use and perceptions of risk and harm: A survey among Canadians in 2016. *Health Care Policy*, 13(1), 17–27.
- Statistics Canada (2019). *National Cannabis survey, fourth quarter 2018*. February 7, 2019. Accessed on 1 June 2019 from: <https://www150.statcan.gc.ca/n1/daily-quotidien/190207/dq190207b-eng.htm>.
- Stogner, J. M., & Miller, B. L. (2015). Assessing the dangers of “Dabbing”: Mere marijuana or harmful new trend? *Pediatrics*, 136(1), 1–3. <https://doi.org/10.1542/peds.2015-0454>.
- SurveyGizmo Enterprise (2018). *SurveyGizmo enterprise*. Accessed on 1 October 2018 from: <https://www.surveymzmo.com/>.
- Swift, W., Hall, W., Didcott, P., & Reilly, D. (1998). Patterns and correlates of cannabis dependence among long-term users in an Australian rural area. *Addiction*, 93, 1149–1160.
- Swift, W., Hall, W., & Copeland, J. (2000). One year follow-up on cannabis dependence among long-term cannabis users in Sydney. *Australia. Drug and Alcohol Depend*, 59, 309–318.
- Tomczyk, S., Isensee, B., & Hanewinkel, R. (2016). Latent classes of polysubstance use among adolescents – A systematic review. *Drug and Alcohol Dependence*, 160, 12–29.
- University of Waterloo (2018). *Canadian student tobacco alcohol and drugs survey (CSTADS). Questionnaires*. N.d. Accessed on 4 April 2018 from: <https://uwaterloo.ca/canadian-student-tobacco-alcohol-drugs-survey/questionnaires>.
- Volkow, N. D., Baler, R. D., Compton, W. M., & Weiss, S. R. B. (2014). Adverse effects of marijuana use. *NEJM*, 370, 2219–2227.
- Wallingford, S., Konefal, S., Young, M. M., & Student Drug Use Surveys Working Group (2019). *Cannabis use, harms and perceived risks among Canadian students* Accessed from: Ottawa, Ont: Canadian Centre on Substance Use and Addiction. <https://www.ccsa.ca/sites/default/files/2019-04/CCSA-Canadian-Students-Cannabis-Harms-Risks-Report-2019-en.pdf>.
- Wang, A. L., Lowen, S. B., Romer, D., Giorno, M., & Langleben, D. D. (2015). Emotional reaction facilitates the brain and behavioural impact of graphic cigarette warning labels in smokers. *Tobacco Control*, 24, 225–232.
- WHO (2013). *WHO report on the global tobacco epidemic, 2013: The MPOWER package* Accessed on 17 August from: Geneva, Switzerland: World Health Organization. http://apps.who.int/iris/bitstream/10665/85380/1/9789241505871_eng.pdf?ua=1.
- WHO FCTC (2018). *Guidelines for implementation of Article 11 of WHO Framework Convention on Tobacco Control (Packaging and labelling of tobacco products)*. N.d. Accessed on 19 February 2018 from: http://www.who.int/fctc/guidelines/article_11.pdf.