Preventive Medicine 153 (2021) 106788

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Influence of package colour, branding and health warnings on appeal and perceived harm of cannabis products among respondents in Canada and the US

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ARTICLE INFO

Keywords:
Experiment
Cannabis
Health warnings
Branding

ABSTRACT

'Plain packaging' and health warnings can reduce appeal and increase risk perceptions of tobacco products. This study tested the effect of health warnings and restricted brand imagery on perceptions of cannabis products. Participants in Canada and the US ($n = 45{,}378$) were randomized to view packages of three cannabis brands in 2019. A 3 (health warning) x 4 (brand imagery) between-group factorial experimental design was used. Health warning conditions were: none, Canadian or US warning. The Canadian warning conditions had three messages counterbalanced across brands: pregnancy, adolescent risk, and impaired driving. The US warning mentioned the same broad risk categories. The four branding conditions ranged from packages displaying no brand imagery and uniform colours—'plain packaging'—to full brand imagery. Regression tested differences between conditions on product appeal, perceived harm, and free recall of warning messages. Overall, full branding and plain packaging were rated the most and least appealing, respectively ($p < 0.001$). Products were rated as significantly less harmful when they had a white background with no or limited branding versus a coloured background ($p \leq 0.01$). Products with health warnings were rated significantly less appealing and more harmful than those with no warning ($p < 0.001$). Message recall was significantly higher for Canadian versus US health warnings, and for the US warning versus no warning ($p < 0.001$). Message recall was greater among those who saw plain versus fully branded packages for two of the three warning messages ($p < 0.01$). Prominent health warnings and restrictions on brand imagery may be warranted in jurisdictions considering non-medical cannabis legalization.

1. Introduction

Packaging of consumer goods represents an important form of product promotion. Research from the tobacco literature shows that packaging plays a key role in product promotion, by strengthening brand imagery, creating positive product associations, and increasing appeal (Cummings et al., 2002; Hoek et al., 2012; Moodie and Hastings, 2010; US Surgeon General, 2012; Wakefield et al., 2002). Conversely, standardized or 'plain' packaging regulations, which restrict colours and brand imagery, have been shown to decrease product appeal and positive associations (Hammond et al., 2013; Moodie et al., 2012). Prominently displayed plain packaging also has been shown to increase the recall of health warning messages, which can increase knowledge of the health risks and facilitate smoking cessation behaviour (Al-Hamdani, 2013; Hammond, 2011; Moodie et al., 2012). Overall, packaging is an important medium for communicating with consumers in ways that can promote or discourage consumer use, including the use of substances among young people. Given the broad reach of consumer packaging, policies that restrict the promotional aspects of packaging or mandate comprehensive warnings can influence prevalence of use (Hammond, 2011; US Surgeon General, 2012).

Packaging and labelling regulations for cannabis products are relatively new. In Canada, where non-medical cannabis was legalized in 2018, federal regulations restrict the amount of brand imagery that companies may display on the package. Brand elements, such as logos, must be no larger than the government-mandated 'universal' THC symbol, and only one background colour is permitted (Government of Canada, 2019a). Packages must also display one of a series of eight

Abbreviations: ICPS, International Cannabis Policy Study; THC, tetrahydrocannabinol.

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https://doi.org/10.1016/j.ypmed.2021.106788
Received 5 May 2021; Received in revised form 29 July 2021; Accepted 4 September 2021
Available online 8 September 2021

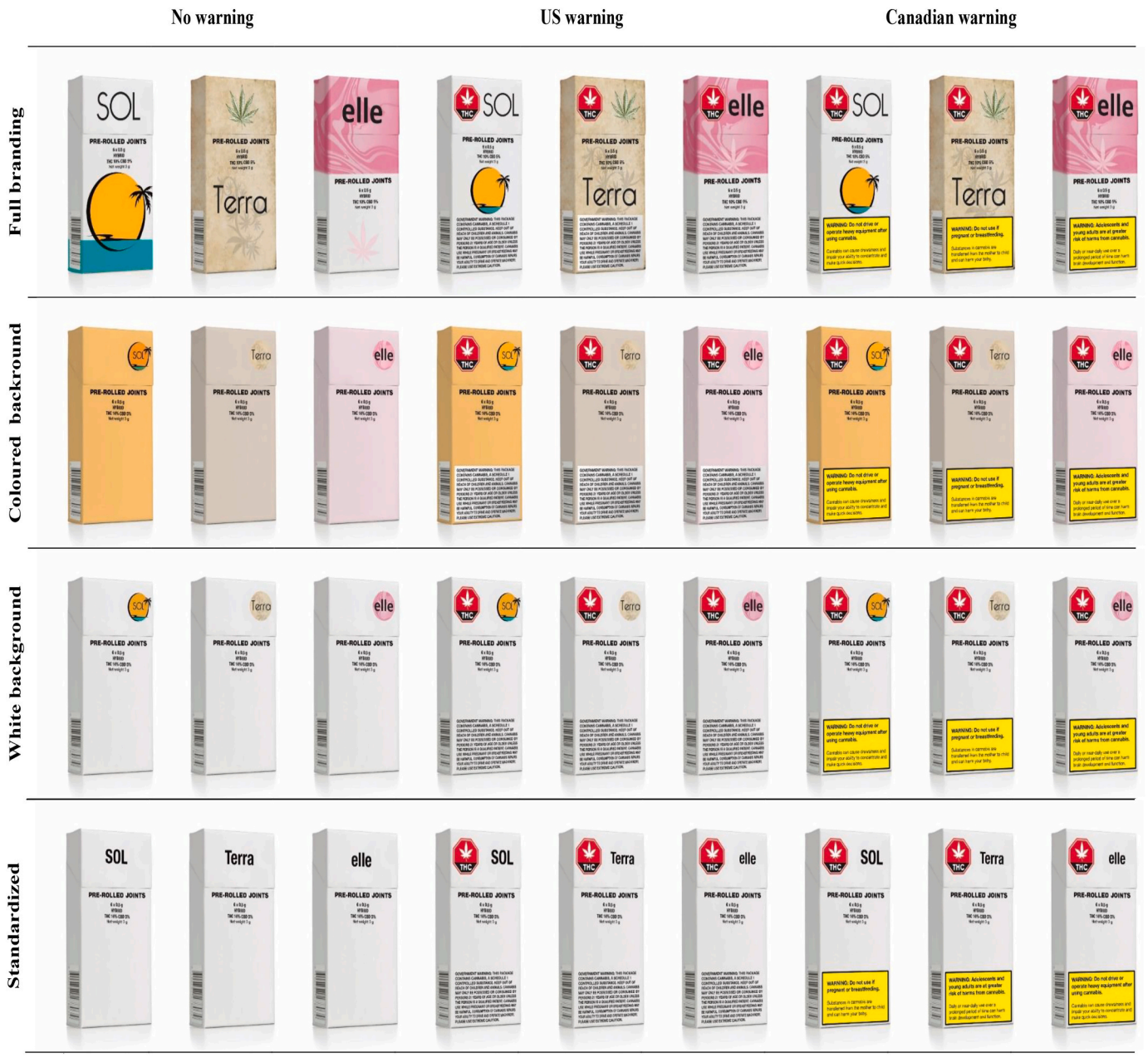

Fig. 1. Experimental conditions*.
*There were 12 main experimental conditions totalling 36 pack images (as shown here). In addition, three Canadian health warnings (related to pregnancy, adolescent risk and driving/operating machinery) were rotated across the Canadian packages (see Fig. 2), for a total of 60 unique pack images. Respondents who completed the survey in French saw packages with French text. Note that images are scaled down for publication but were displayed in a fixed size on the screen.

rotating health warning messages (Government of Canada, 2019b). Warnings must be displayed in black text on a yellow background, with a black border and a font size at least equal to that of the brand name (Government of Canada, 2019a). An increasing number of US states have legalized adult use of non-medical cannabis, and similar to Canada, most have established legal sales require a symbol indicating that the product contains tetrahydrocannabinol (THC) or cannabis. They also require health warnings, which are generally less prominent than the Canadian warnings. US warnings typically feature black text on a white background, and often present multiple health risks together rather than rotating single warnings across products (Alaska Department of Commerce Community and Economic Development, 2019; California Legislative Information, 2018; Colorado Department of Revenue, 2018; Maine Legislature, 2020; Maine Legislature, 2020; Oregon Liquor Control Commission, 2018; State of Illinois, 2019; State of Massachusetts, 2019; State of Michigan, 2020; State of Nevada Department of Taxation, 2017; Washington State Legislature, 2019) (see Appendix A.1). Qualitative research suggests that consumers in Colorado and Washington place varying levels of importance on the various statements present on cannabis warning labels, and some participants specifically suggested "placing the statements inside a box so that the information stands out from other information on package" (Kosa et al., 2017), similar to Canadian regulations.

The few existing studies examining the effects of branding and health warnings on cannabis products suggest that reducing brand imagery and mandating health warnings may reduce product appeal, purchase intentions and positive associations with cannabis products. In one study, 'plain' cannabis packages with health warnings were associated with lower product appeal and purchase intentions than fully branded packages, and warning labels were associated with increased knowledge

Fig. 2. Three brands of pre-rolled cannabis joints used in online experiment*.
*Fully branded packages with Canadian health warning condition shown (see Fig. 1 for all image conditions). The three Canadian health warnings shown here were rotated across brands so that all respondents in the Canadian health warning condition saw all three messages. Respondents who completed the survey in French saw packages with French text.

of health effects (Mutti-Packer et al., 2018). In another study, viewing cannabis packages with health warnings (vs. no warning) increased the perceived harm of smoking cannabis (Pepper et al., 2020). In experimental studies, restricting brand imagery reduced perceived appeal of three cannabis products and perceived youth-orientation (Goodman et al., 2019), whereas celebrity branding increased perceived youth-orientation and lifestyle associations (Leos-Toro et al., 2021) and warning labels reduced cannabis product appeal (Goodman et al., 2019; Leos-Toro et al., 2021). In other research, Canadians rated health warning labels as less novel and more believable than US respondents (Winstock et al., 2020). Finally, increased exposure to health warning labels was reported by regular cannabis consumers and respondents in Canada post-legalization (Goodman and Hammond, 2021a).

To our knowledge, no studies have examined the interactive effects of brand imagery and health warnings, directly compared the effectiveness of Canadian versus US health warnings, or tested the effect of warning style and brand imagery restrictions on message recall. This study sought to test the influence of both brand imagery and health warning format on a) appeal and perceived harm of cannabis products; and b) recall of specific messages related to the health risks of cannabis.

2. Materials and methods

Data were collected via self-completed web-based surveys conducted as part of the International Cannabis Policy Study (ICPS) in Sept-Oct 2019 with Canada and US respondents aged 16–65. Respondents were recruited through the Nielsen Consumer Insights Global Panel and their partners' panels. Email invitations were sent to a random sample of panelists; panelists known to be ineligible due to age or country criteria were not invited. Surveys were conducted in English in the US and English or French in Canada. Median survey time was 25 min. This study received ethics clearance through a University of Waterloo research ethics board (ORE# 31330).

2.1. Experimental task

Using a 4 × 3 between-groups experiment, respondents were randomized to view cannabis packages with different types of branding and health warnings corresponding to their experimental condition. As shown in Fig. 1, cannabis packages were digitally altered to display one of four levels of branding: 1) packages with full brand imagery; 2) packages with limited brand imagery and a single background colour (similar to the current Canadian regulations); 3) packages with limited brand imagery and a white background; and 4) packages with no brand imagery and a white background ('plain' packaging).

The level of branding was 'crossed' with the health warning format, consisting of three levels: 1) no warning; 2) Canadian warning; and 3) US warning. Canadian warnings featured black text on a yellow background and featured differing 'rotating' health warning messages, as per federal regulations (Government of Canada, 2019b). As described below, respondents in the Canadian health warning condition viewed three cannabis packages, each package featuring one of three health warnings: 1) driving/operating machinery after cannabis use, 2) using cannabis while pregnant/breastfeeding, and 3) using cannabis during adolescence. The pairing of health warning and brands was counterbalanced across respondents. The US health warning was based on the mandated warning in California, which mentions the same three broad risk categories as the Canadian warnings: driving, pregnancy, and keep out of reach of young people/adult use only (California Legislative Information, 2018). All conditions that featured a health warning also carried the 'universal' Canadian THC symbol (Fig. 2). Warning size and location was constant across conditions.

Respondents viewed packages in sets of three brands, held constant across conditions. Brands were modelled after cannabis package designs available on the market and paired with a fictional brand name (Fig. 2). Other than the level of branding and health warnings, all labelled product information was held constant. While the product was shown on the screen, respondents were shown Brand 1 and asked to rate its appeal and perceived harm. This was repeated for Brands 2 and 3 on subsequent screens. Brand order was randomized across respondents. Immediately afterward, respondents were asked to recall up to three health warning messages shown on the packages (see Measures).

2.2. Measures

Sociodemographic data collected included sex, age group, ethnicity, highest education level, cannabis use status and perceived income adequacy. Respondent jurisdiction was coded according to legal status of recreational cannabis: Canada (legal), US 'illegal' state or US 'legal' state (11 states plus District of Columbia, based on legality of non-medical cannabis in September 2019). Survey device type was recorded to account for modality effects. Full wording is available in the ICPS 2019

Table 1
Sample characteristics, International Cannabis Policy Study 2019 ($n = 45,378$).

Variable	% (n)	Test of differences between study conditions X^2(df), p-value*
Sex		$X^2(11) = 14.24, 0.22$
Male	30.4% (13,772)	
Female	69.7% (31,606)	
Age group		$X^2(44) = 41.59, 0.58$
16–25	15.9% (7199)	
26–35	21.3% (9685)	
36–45	19.8% (8988)	
46–55	18.7% (8496)	
56–65	24.3% (11,010)	
Ethnicity		$X^2(11) = 11.51, 0.40$
White	77.7% (35,234)	
Other/mixed/unstated	22.4% (10,144)	
Education level		$X^2(44) = 39.68, 0.66$
Less than high school	6.9% (3150)	
High school diploma or equivalent	18.6% (8444)	
Some college/university or technical/vocational training	39.7% (18,028)	
Bachelor's degree or higher	34.2% (15,514)	
Unstated	0.5% (242)	
Perceived income adequacy (difficulty making ends meet)		$X^2(55) = 54.37, 0.50$
Very difficult	10.4% (4697)	
Difficult	23.4% (10,610)	
Neither easy nor difficult	33.5% (15,219)	
Easy	19.7% (8923)	
Very easy	10.4% (4704)	
Unstated	2.7% (1225)	
Cannabis use status		$X^2(33) = 34.15, 0.41$
Never user	34.0% (15,437)	
Used >12 months ago	31.3% (14,201)	
Past 12-month user	22.1% (10,004)	
Daily/almost daily user	12.64% (5736)	
Survey device		$X^2(22) = 35.41, 0.04$
Smartphone	50.4% (22,854)	
Tablet	7.8% (3538)	
Computer	41.8% (18,986)	
Respondent jurisdiction		$X^2(22) = 24.41, 0.33$
Canada (legal)	33.3% (15,116)	
US 'illegal' states	22.5% (10,205)	
US 'legal' states	44.2% (29,057)	

* Distribution of variables across 12 experimental conditions tested using chi-squared test. X^2, chi-squared statistic; df, degrees of freedom. Threshold for significance: $P < 0.01$.

survey (Hammond et al., 2019). See Table 1 for coding of response options.

2.2.1. Outcomes

Respondents were shown 1 of 12 sets of images of packaged pre-rolled cannabis joints and told, "We would like your opinion on three different marijuana products. Click continue to start."

Product appeal: "How appealing is this product?" (11-point Likert scale, where 0 = Not at all appealing, 5 = In the middle, 10 = Very appealing; Don't know/Refuse).

Perceived harm: "How harmful is this product?" (11-point Likert scale, where 0 = Not at all harmful, 5 = In the middle, 10 = Very harmful; Don't know/Refuse).

Recall of health warning messages: "The three packages we showed you had warnings about the health effects of marijuana. Please describe up to three of the health effects mentioned in the warnings" (3 open-ended text boxes; Don't know/remember; Refuse). This question was asked immediately after the previous questions; respondents were not permitted to view the images again. Responses were blind-coded to experimental condition, and considered 'valid' if they related to driving, pregnancy/breastfeeding or risk to adolescents/adult use.

2.3. Data analysis

Respondents were excluded if they selected "No" when asked whether they could provide honest answers about their cannabis use, or failed to select the current month from a list. The final 2019 cross-sectional sample comprised 45,735 respondents. A sub-sample of 45,378 were included in the current analysis after excluding 357 respondents who did not provide valid responses on all three outcomes (appeal, perceived harm, health warning recall). Chi-squared tests were used to test the randomization protocol and distribution of socio-demographic covariates across experimental conditions.

Separate repeated-measures linear regression models were conducted to test the influence of brand imagery and health warning on product appeal and perceived harm (range = 0–10, excluding Don't know/Refuse). Repeated-measures models were used to account for the correlated responses across the three cannabis packages rated by each respondent. Compound symmetric and autoregressive covariance structures were selected for the models on appeal and harm, respectively, based on model convergence and AIC values (Bozdogan, 1987; SAS Institute Inc., 2016). Separate binary logistic regression models were conducted to test the influence of health warning condition on likelihood of recalling each of three health warning themes (Driving, Pregnancy, or Adolescence/Adults only); refusals were excluded. A linear regression model was conducted to examine the influence of health warning condition on number of 'valid' warnings recalled (range = 0–3).

All models were adjusted for respondent sex, age group, ethnicity, education, income adequacy, device type, cannabis use, jurisdiction, and brand order. Two-way interactions between brand imagery and health warning were tested in subsequent models. An unstructured covariance structure was selected for the addition of the interaction term to the appeal model. $P < 0.01$ was used for significance. Analyses were conducted using SAS Studio v.9.4.

3. Results

Table 1 shows sample characteristics. The sample was predominantly female and the majority had at least some college/technical or university education. Distribution of socio-demographic variables across experimental conditions did not significantly differ ($p > 0.01$).

3.1. Product appeal

Fig. 3 shows mean ratings of product appeal by experimental

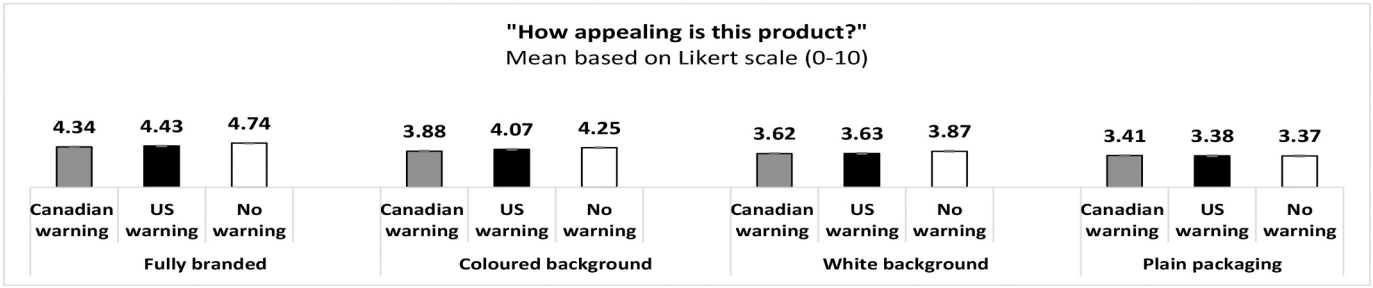

Fig. 3. Interaction of brand imagery and health warning format on appeal of cannabis products (n = 40,618).

Table 2
Influence of health warning format, brand imagery restrictions and cannabis use on appeal and harm of cannabis products, International Cannabis Policy Study 2019*.

Variable	Appeal (n = 40,618)	Perceived harm (n = 35,173)
	Beta coefficient, 99% CI, p-value	
Health warning condition	F(2,41,000) = 30.56, <0.001	F(2,35,000) = 146.16, <0.001
US warning vs. no warning (ref)	−0.18 (−0.27, −0.10), <0.001	0.22 (0.13, 0.31), <0.001
Canada warning vs. no warning (ref)	−0.25 (−0.34, −0.17), <0.001	0.58 (0.49, 0.67), <0.001
Canada warning vs. US warning (ref)	−0.07 (−0.15, 0.02), 0.04	0.35 (0.27, 0.44), <0.001
Brand imagery condition	F(3,41,000) = 304.95, <0.001	F(3,35,000) = 3.62, 0.01
Plain packaging vs. fully branded (ref)	−1.12 (−1.22, −1.02), <0.001	−0.07 (−0.18, 0.03), 0.06
Plain packaging vs. Coloured background (ref)	−0.66 (−0.76, −0.56), <0.001	−0.10 (−0.20, 0.00), 0.01
Plain packaging vs. White background (ref)	−0.35 (−0.45, −0.26), <0.001	0.01 (−0.09, 0.11), 0.85
Coloured background vs. fully branded (ref)	−0.46 (−0.56, −0.36), <0.001	0.02 (−0.08, 0.13), 0.56
White background vs. fully branded (ref)	−0.76 (−0.86, −0.66), <0.001	−0.08 (−0.18, 0.02), 0.04
White background vs. Coloured background (ref)	−0.30 (−0.40, −0.20), <0.001	−0.11 (−0.21, −0.00), <0.01
Frequency of cannabis use	F(3,41,000) = 2501.3, <0.001	F(3,35,000) = 1952.7, <0.001
Daily/almost daily vs. never	3.16 (3.07, 3.25), <0.001	−3.18 (−3.27, −3.09), <0.001
Past 12 months vs. never	2.78 (2.70, 2.85), <0.001	−2.18 (−2.25, −2.10), <0.001
>12 months ago vs. never	1.53 (1.47, 1.60), <0.001	−1.10 (−1.17, −1.03), <0.001

* Repeated-measures regression models were adjusted for respondent sex, age, ethnicity, education level, perceived income adequacy, survey device type, cannabis use status, jurisdiction, and brand order. P-values correspond to type-III F tests of overall effect. 99%CI, 99% confidence interval. Threshold for significance: $P < 0.01$.

condition. Fully branded products were rated most appealing, and those with plain packaging least appealing (Table 2). Products with no health warning were rated most appealing, and those with Canadian warnings least appealing. Daily/almost daily consumers, past 12-month consumers, and those who consumed cannabis more than 12 months ago rated products significantly more appealing than did never cannabis consumers.

A significant interaction between brand imagery and health warning format was observed in a subsequent step (F(6,41,000) = 14.02, $p < 0.001$). Among those who saw plain packaging, there was no significant difference in appeal between warning label formats ($p > 0.01$ for all): respondents who saw products with plain packaging rated them significantly less appealing compared to those who saw all other packaging formats ($p < 0.001$ for all). In contrast, respondents who saw fully branded packages rated them significantly less appealing when they had a Canadian or US warning versus no warning ($p < 0.001$ for both), with no difference between the Canadian and US health warnings ($p = 0.08$). Among those who saw packages with limited branding and a uniform coloured background, those who saw packages with a Canadian or US warning label rated them significantly less appealing than those who saw packages with no warning; in addition, those who saw Canadian warnings rated them less appealing than those who saw the US warning ($p < 0.001$ for all). Finally, among those who saw packages with limited branding and a white background, those who saw the Canadian or US warning labels rated them significantly less appealing than those who saw packages with no warning ($p < 0.001$ for both); with no difference between the Canadian and US warnings ($p = 0.32$).

3.2. Perceived harm

Fig. 4 shows the influence of brand imagery and health warning format on perceived harm of the three cannabis brands. As shown in Table 2, in an adjusted repeated-measures model, products with limited branding on a white background were rated significantly less harmful than products with a coloured background. Products in plain packaging (white background with no branding) were also rated less harmful than those with a coloured background. Products with Canadian warnings were rated significantly more harmful than those with a US warning or

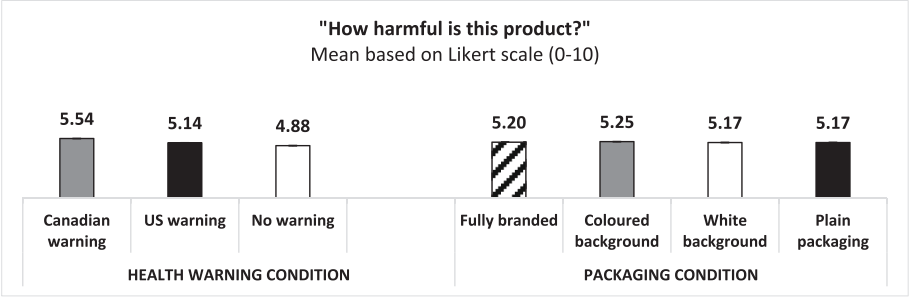

Fig. 4. Influence of health warning and package format on perceived harm of cannabis products (n = 35,173).

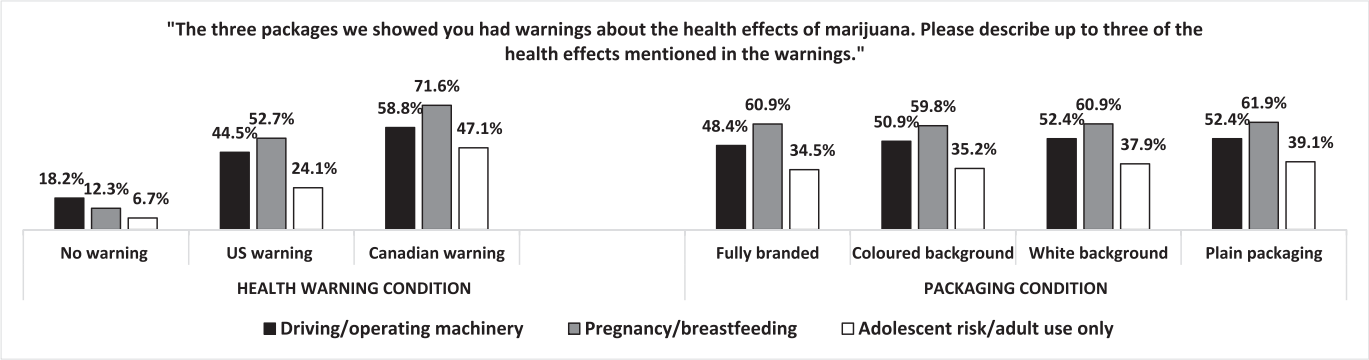

Fig. 5. Influence of health warning and package format on recall of specific health warning messages (n = 13,446)*.
*A total of 38.0% (n = 13,446) of respondents entered a response when asked to recall the health warnings on the experimental packages. Over two thirds (68.4%) responded 'Don't know/I don't remember seeing health warnings' and 2.0% refused to answer.

no warning, as were products with a US warning versus no warning. Daily/almost daily consumers, past 12-month consumers, and those who consumed cannabis more than 12 months ago rated products significantly less harmful than did never cannabis consumers. No significant interaction was observed between brand imagery and health warning format in a subsequent step ($p = 0.54$).

3.3. Recall of health warning messages

Fig. 5 shows differences in recall of warning messages by brand imagery and health warning condition. The total number of warning messages recalled was associated with health warning condition ($F(2) = 1673.41$, $p < 0.001$). Respondents in the Canadian warning condition recalled a greater number of health warning messages (Mean = 1.76, SD = 0.95) than respondents in the US (Mean = 1.03, SD = 0.84; B = 0.72 (0.67, 0.76), $p < 0.001$) and no warning (Mean = 0.36, SD = 0.61; B = 1.33 (1.25, 1.40), $p < 0.001$) conditions. Those in the US warning condition also recalled more warnings versus the no warning condition (B = 0.61 (0.53, 0.69), $p < 0.001$). There was a significant effect of brand imagery ($F(3) = 6.20$, $p < 0.001$), whereby respondents who saw plain packages recalled significantly more of the tested warnings than did those who saw fully branded packages (B = 0.09 (0.03, 0.14) $p < 0.001$) or packages with a coloured background (B = 0.06 (0.01, 0.11), $p < 0.01$). There was no difference in recall among those who saw packages with a coloured background versus plain packages ($p = 0.18$) or white versus coloured packages ($p = 0.26$). There was also a significant effect of cannabis use ($F(3) = 7.13$, $p < 0.001$), whereby daily/almost daily consumers recalled significantly fewer health warnings (Mean = 1.29, SD = 0.99) compared to never consumers (Mean = 1.42, SD = 1.02; B = -0.08 (−0.13, −0.03), $p < 0.01$). No significant interaction was observed between brand imagery and health warning format in a subsequent step ($p = 0.07$).

As shown in Table 3, results of logistic regression models indicated that respondents in the Canadian warning condition were significantly more likely to recall each of the three individual warning messages compared to respondents in the US or no warning conditions. Those in the US warning condition were also significantly more likely to recall each of the three warnings versus the no warning condition. Compared to fully branded packs, use of plain packaging, or modified plain packaging (solid colour or white background) also significantly increased the odds of recalling the driving/machinery and/or adolescent risk/adult only warnings, but did not influence recall of the pregnancy warning, which was higher overall for all brand imagery and warning label formats. Compared to the coloured background, plain packaging also significantly increased the odds of recalling the adolescent risk/adult only warning. There was generally no influence of cannabis use on odds of recalling specific warnings. In subsequent models, there was no significant interaction between brand imagery and health warning format on odds of recalling the driving ($p = 0.33$) or adolescent risk/adult only messages ($p = 0.12$).

4. Discussion

Consistent with previous research, the results of this experiment showed that brand imagery modestly increased cannabis product appeal, whereas both plain packaging and health warnings reduced product appeal (Goodman et al., 2019). However, in contrast to a previous experimental study which found no differences in appeal of branded versus plain cannabis packages when health warning labels were present (Mutti-Packer et al., 2018), respondents in the current study consistently rated products with health warnings as less appealing when they were shown plain rather than fully branded packages. Previous studies have also found that health warnings and restrictions on brand imagery have independent effects on product appeal (Wakefield et al., 2012). Health warnings may reduce product appeal either through the dissuasive effect of highlighting negative health risk or by occupying package space that would otherwise display promotional brand imagery (Hammond, 2011).

The findings highlight the importance of design features in the efficacy of health warnings. A wide range of studies have identified factors such as contrasting background and text colours, minimum font size and message border as important determinants of the legibility, comprehension and recall of health warnings (Hammond, 2011; Wogalter et al., 2002). The findings suggest that the rotating messages used in the Canadian warnings may be more effective than the approach of labelling multiple health effects in the same warning, which requires considerably more text, often at a smaller font size. The current study did not manipulate and test each of these design components individually; rather the net effect of these elements was tested to reflect differences in existing regulatory practices. The magnitude of differences was often considerable: for example, almost twice as many respondents recalled individual health messages, such as the risks to adolescents, when they viewed Canadian versus US-style warnings.

The two variants of the modified 'plain packaging' regulations tested in the current study led to some differences in perceived appeal and harm. Indeed, packages with no imagery other than a brand logo on a solid-coloured background (currently permitted in Canada) were rated as both more appealing *and* more harmful than the same packages with a white background. Previous research shows that consumers consider products in white packages to be milder and have lower health risks (Lempert and Glantz, 2017; Stead et al., 2013), which may have contributed to the higher ratings of appeal. For this reason, the standardized packaging for tobacco products mandated in Canada uses a "drab" brown background (Government of Canada, 2019c).

The current study was well-powered to detect significant differences; therefore, a conservative threshold for significance ($p < 0.01$) was used.

Table 3
Odds of recalling specific cannabis health warnings, International Cannabis Policy Study 2019 (n = 13,446)*.

Variable	Impaired driving/ operating machinery warning	Pregnancy/ breastfeeding warning	Adolescent risk/ adult use only warning
	AOR (99% CI), p-value		
Health warning condition	$X^2(2) = 601.60$, <0.001	$X^2(2) = 1120.99$, <0.001	$X^2(2) = 894.45$, <0.001
US warning vs. no warning	3.37 (2.71, 4.20), <0.001	7.31 (5.68, 9.41) <0.001	4.12 (2.98, 5.71), <0.001
Canada warning vs. no warning	5.96 (4.83, 7.36), <0.001	16.80 (13.13, 21.51), <0.001	11.61 (8.46, 15.94), <0.001
Canada warning vs. US warning	1.77 (1.60, 1.95), <0.001	2.30 (2.07, 2.55), <0.001	2.82 (2.52, 3.15), <0.001
Brand imagery condition	$X^2(3) = 13.24$, <0.01	$X^2(3) = 3.67$, 0.30	$X^2(3) = 18.13$, <0.001
Plain packaging vs. fully branded	1.19 (1.04, 1.35), <0.001	1.05 (0.91, 1.21), 0.40	1.24 (1.08, 1.42), <0.001
Plain packaging vs. Coloured background	1.05 (0.92, 1.19), 0.36	1.08 (0.94, 1.24), 0.17	1.18 (1.03, 1.35), <0.01
Plain packaging vs. White background	1.03 (0.93, 1.14), 0.56	1.11 (0.96, 1.27), 0.07	1.09 (0.95, 1.25), 0.09
Coloured background vs. fully branded	1.13 (1.00, 1.29), 0.01	0.97 (0.85, 1.12), 0.61	1.05 (0.91, 1.20), 0.39
White background vs. fully branded	1.15 (1.01, 1.31), <0.01	0.95 (0.82, 1.09), 0.33	1.13 (0.98, 1.30), 0.02
White background vs. Coloured background	1.02 (0.89, 1.16), 0.77	0.97 (0.85, 1.12), 0.63	1.08 (0.94, 1.24), 0.15
Frequency of cannabis use	$X^2(3) = 3.74$, 0.292	$X^2(3) = 17.95$, <0.001	$X^2(3) = 7.91$, 0.048
Daily/almost daily vs. never	0.92 (0.81, 1.03), 0.154	0.89 (0.78, 1.01), 0.060	0.87 (0.77, 0.99), 0.032
Past 12 months vs. never	1.01 (0.91, 1.11), 0.908	0.99 (0.89, 1.10), 0.811	0.90 (0.81, 1.00), 0.057
>12 months ago vs. never	1.03 (0.94, 1.12), 0.568	1.14 (1.03, 1.25), 0.010	0.99 (0.90, 1.09), 0.901

* Responses were considered 'valid' if they related to: (1) driving (impaired driving/operating machinery, drowsiness, impaired concentration/judgement/ reaction time/reflexes); (2) pregnancy/breastfeeding (use during pregnancy/ breastfeeding, harm to developing fetus/infant) or (3) risk to adolescents/adult use only (harms of using during adolescence/young adulthood/youth/childhood, consumption by adults/qualified patients only, keep out of reach of children, effects on brain development, or harms of prolonged/daily use). Models were coded as 1 = recalled warning on driving, pregnancy, or adolescence/adults only vs. did not recall that warning/Don't know/Don't remember seeing health warnings. Models were adjusted for respondent sex, age, ethnicity, education level, perceived income adequacy, survey device type, cannabis use status, jurisdiction, and brand order. P-value for main effect refers to result of chi-squared test. 99%CI, 99% confidence interval; AOR, adjusted odds ratio; X^2, chi-squared statistic. Threshold for significance: $P < 0.01$.

Nevertheless, the magnitudes of difference for appeal and harm ratings were small. The brand imagery restrictions tested herein seem to have had a modest effect, and may reduce appeal and/or increase harm to a lesser degree than the more comprehensive standardized packaging restrictions implemented for tobacco products described above. Individual-level factors also may influence consumer perceptions; for example, more frequent cannabis consumers rated the joints as more appealing and less harmful overall. Moreover, the content of health warning messages may matter: respondents in a previous study reported "learning more" and "thinking more about the health risks of cannabis" after viewing a cannabis package with a warning on psychosis versus driving. The authors speculated that new and "scary" information may garner more pause from consumers (Pepper et al., 2020). Thus, ratings of harm may have been greater had we tested other existing Canadian warnings, including the warning on psychosis and schizophrenia, which tends to be less well recognized by respondents than the risks of impaired driving, use during pregnancy or adolescent use (Goodman and Hammond, 2021b).

Finally, consistent with a systematic review concluding that plain packaging on cigarettes increased recall of health warnings (Moodie et al., 2012), plain packaging increased recall of the driving and adolescent/adult only warnings on cannabis packages. However, removing brand imagery did not influence recall of the pregnancy warning, highlighting the importance of testing multiple variants to determine the influence of specific attributes. Of the three tested warnings, the pregnancy warning was recalled by the most respondents. It is possible that knowledge of this health risk was pervasive enough that brand imagery format did not influence recall.

4.1. Strengths & limitations

This study was not without limitations. First, experimental studies using online images of packages are likely to underestimate the impact of packaging restrictions compared to 'naturalistic' settings where consumers can closely scrutinize products. Second, the US warning tested in this study was based on the warning requirements for non-medical cannabis in California. Cannabis warnings differ in other US 'legal' states; however, the general format is similar, including the practice of displaying a single warning that conveys multiple health risks in a lengthy paragraph (Leafly, 2015). Third, while specific manipulations used to test brand imagery restrictions, the net effect of the current Canadian health warnings was compared to a generic US warning. The experimental design did not enable testing of the various aspects of the Canadian warning (i.e., font size, bolding, background colour, secondary sentences); however, many of these aspects have been extensively tested in the tobacco literature (Hammond, 2011; Wogalter et al., 2002). Fourth, three fictitious brands of pre-rolled joints were designed for study purposes. The effect of packaging restrictions may interact with specific types of brand imagery or product characteristics, including brand elements not tested herein, or more common product types (e.g., dried flower, edibles). However, this cannot account for the differences that were observed across experimental conditions given that the brands were held constant across conditions. Fifth, prior knowledge of or exposure to cannabis health warning messages were not considered in the current analysis. Sixth, respondents were recruited using non-probability-based sampling. Strengths of this study included a large sample size and experimental design with randomization to experimental conditions and rotation of brand order across respondents. In addition, message recall was assessed using an unprompted 'free recall' task, which provides an objective assessment of message recall that reduces social desirability bias. The consistent pattern of findings across experimental conditions between the message recall task and the perceived harm measure is notable.

5. Conclusions

Prominent health warning messages, such as those used in Canada, may reduce the appeal of cannabis products and/or increase the perceived health risks and recall of specific health effects. In jurisdictions with legal cannabis sales, implementing prominent health warnings and brand imagery restrictions may reduce the appeal of cannabis products, particularly among young people. Given the broad reach of warning labels, reduced product appeal may positively influence age of initiation or reduce risk behaviours such as impaired driving. Future research should examine longer-term implications for prevalence of use and patterns of consumption.

Declaration of Competing Interest

The authors have no conflicts of interest to declare. Funding for this

study was provided by a Canadian Institutes of Health Research (CIHR) Project Bridge Grant (PJT-153342) and a CIHR Project Grant. Additional support was provided by a Public Health Agency of Canada-CIHR Chair in Applied Public Health (DH). The funders had no role in study design, collection, analysis or interpretation of the data, report writing or decision to submit the report for publication.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ypmed.2021.106788.

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