




# Can a health warning label diminish the persuasive effects of health-oriented nutrition advertising on ready-to-drink alcohol product packaging? A randomized experiment

Erin Hobin<sup>1,2</sup>  | Justin Thielman<sup>1</sup> | Samantha M. Forbes<sup>1</sup> | Theresa Poon<sup>1</sup> | Ariane Bélanger-Gravel<sup>3,4,5</sup> | Élisabeth Demers-Potvin<sup>4,6</sup> | Ashleigh Haynes<sup>7,8</sup> | Ye Li<sup>1,2</sup> | Manon Niquette<sup>4,9</sup> | Catherine Paradis<sup>10</sup>  | Véronique Provencher<sup>4,6</sup> | Brendan T. Smith<sup>1,2</sup>  | Samantha Wells<sup>2,11,12,13,14,15</sup> | Amanda Atkinson<sup>16</sup> | Lana Vanderlee<sup>4,6</sup>

## Correspondence

Erin Hobin, Health Promotion, Chronic Disease and Injury Prevention, Public Health Ontario, 661 University Avenue #1700, Toronto, Ontario, M5G 1M1, Canada.  
Email: [erin.hobin@oahpp.ca](mailto:erin.hobin@oahpp.ca)

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## Abstract

**Background and aims:** A health warning label (HWL) cautioning about the link between alcohol and cancer may be able to communicate alcohol risks to consumers and potentially counter health-oriented nutrition advertising on ready-to-drink alcoholic beverages. This study aimed to examine the independent and combined effects of nutrient content claims (e.g. 0 g sugar) and a HWL on perceived product characteristics and intentions to consume, and whether these effects differed by gender and age.

**Design:** A between-subjects randomized experiment. Participants were randomized to view one of six experimental label conditions: nutrient content claims plus nutrition declaration (NCC + ND), ND only, NCC + ND + HWL, ND + HWL, HWL only and no NCC, ND or HWL, all on a ready-to-drink (RTD) vodka-based soda container.

**Setting and participants:** Alcohol consumers ( $n = 5063$ ; 52% women) in Canada aged 18–64 recruited through a national online panel.

**Measurements:** Participants completed ratings of perceived product characteristics, perceived product health risks, and intentions to try, buy, binge and drink the product.

**Findings:** Compared with the reference condition NCC + ND (current policy scenario in Canada), the other five experimental label conditions were associated with lower ratings for perceiving the product as healthy. All experimental conditions with a HWL were associated with lower product appeal, higher risk perceptions and reduced intentions to try, buy and binge. The experimental condition with a HWL only was associated with intentions to consume fewer cans in the next 7 days ( $\beta = -0.72$ , 95% confidence interval [CI] =  $-1.37, -0.08$ ) versus the reference. Few interactions were observed, suggesting that label effects on outcomes were similar by gender and age.

For affiliations refer to page 1249

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**Conclusions:** Health warning labels on alcohol packaging appear to be associated with lower product appeal, higher perceived health risks and reduced consumption intentions, even in the presence of nutrient content claims.

**KEYWORDS**

alcohol, alcohol advertising, alcohol policy, cancer, RCT, health warning label

## INTRODUCTION

Alcohol increases the risk of seven types of cancers, and is a leading risk factor for early-onset cancers [1], new cancer cases, and cancer deaths globally [2]. Evidence shows the potential for interventions to effectively increase awareness of cancer risks from alcohol and reduce per capita alcohol use and alcohol-attributable health consequences [3, 4]. Implementing restrictions on alcohol marketing and mandating a health warning label (HWL) on alcohol containers are two strategies recommended by the World Health Organization and European Commission [5, 6].

Alcohol packaging is a cornerstone of the alcohol industry's marketing strategy to promote positive product characteristics, and to increase drinking intentions and sales [7, 8]. Recently, alcohol companies have identified rising levels of health consciousness among consumers as a primary threat to alcohol sales [9, 10]. Alcohol industry reports show intentions to highlight the health-oriented nutritional attributes of select alcoholic beverages as a marketing strategy to reassure consumers about the safety of alcohol and increase sales [9, 11, 12]. Although lower calorie alcohol, such as 'light' beer, is not new, the global alcohol industry now features health-oriented nutrition information on the principal panel of select alcohol containers and advertising such products as promoting healthier lifestyles [13, 14]. This health-oriented product positioning may be more appealing to certain population subgroups, such as women and young adults, who may have greater alcohol-related body image concerns and weight-control and/or health-oriented motivations [12, 15, 16].

Nutrient content claims (NCC) (e.g. 0 g sugar) are one type of health-oriented nutrition information used by the industry on alcohol packaging, particularly on ready-to-drink (RTD) alcoholic beverages. Data from Canada and Australia indicate 35% to 50% of RTD beverages (e.g. hard seltzers and sodas), beer and cider display these claims on containers [13, 14]. RTD beverages are the fastest growing alcohol category in volume sales in Canada and Australia, although a smaller market share than beer, wine and spirits [17, 18]. The health-oriented nature of NCC on alcohol products is concerning as consumers may extrapolate that one 'healthy' attribute in a claim means the product is healthy (i.e. health halo effect) [19–21]. As a consequence of this halo effect, consumers may continue to drink or drink more alcohol despite health concerns. The perception that alcohol is healthy is erroneous as alcohol is a component cause of 230 negative health conditions [22, 23].

NCC on food packages have been shown to increase product appeal, perceived healthiness and intake; effects that persist even when the nutritional quality of the food is low [24, 25]. Similarly,

health-oriented descriptors on tobacco packs (e.g. organic) have been associated with lower risk beliefs, and stronger appeal and purchase intentions, particularly in women and young adults [26–30]. In the one Australian study conducted on alcoholic beverages, women ages 18 to 35 exposed to low sugar claims on the container perceived the product as healthier, relatively lower in sugar, suitable for a healthy diet and to manage weight and lower in alcohol strength compared to an identical container without claims, but no differences in hypothetical use of the beverage [31]. The authors concluded that low sugar claims may create generalized beliefs about health benefits of alcohol and can mislead women about unrelated product attributes. Despite existing regulations, such as in Canada, which prohibit product labels that are misleading, deceptive or erroneous about its safety [32], NCC on alcohol products are permitted. In Australia, a proposal to prohibit sugar claims on alcoholic beverages is currently under consideration, with a view to protect consumers from being misled about their healthiness [33]. More research is needed to understand if NCC on alcoholic beverages deceive consumers about the suggested health and safety of alcohol and, in turn, influence consumption.

In response to the growing evidence of alcohol health harms, government-mandated HWLs are recommended for communicating health risks to consumers [2, 6, 34, 35]. In 2021, 122 countries required HWLs covering 50% or more of cigarette packs [36]. In contrast, relatively few countries mandate HWLs on alcohol [37], and the HWLs that have been mandated to date are characterized as being poorly designed with weak messages featuring harms that allow most consumers to self-exempt (e.g. cautioning about alcohol use when pregnant) [37, 38]. International evidence indicates well-designed HWLs on alcohol containers can be effective for increasing awareness of alcohol-related health risks and reducing drinking intentions and per capita alcohol sales [4, 39, 40], particularly in women [41–43]. An evaluation of both a HWL and product descriptors on tobacco packs suggests the warning can reduce favourable product perceptions and increase health concerns compared to when no warning is present, yet is not sufficient to overcome the effects of the product descriptors [29]. A United Kingdom experiment testing the provision of a cancer warning and calorie information adjacent to alcohol products in a simulated online supermarket found no evidence that the information impacted the number of alcohol units selected; however, the sample size was determined based on available resources and likely underpowered to detect smaller effects, and displaying the intervention information adjacent to versus on the product may reduce its credibility or appear artificial [44]. Because the primary purpose of HWLs is to communicate risk information, alcohol studies have not

examined the effectiveness of HWLs for countering advertising messages promoting alcohol products as safe, appealing and health enhancing. More research is needed examining how alcohol HWLs might affect product perceptions and interact with other label characteristics, which imply health benefits, such as NCC.

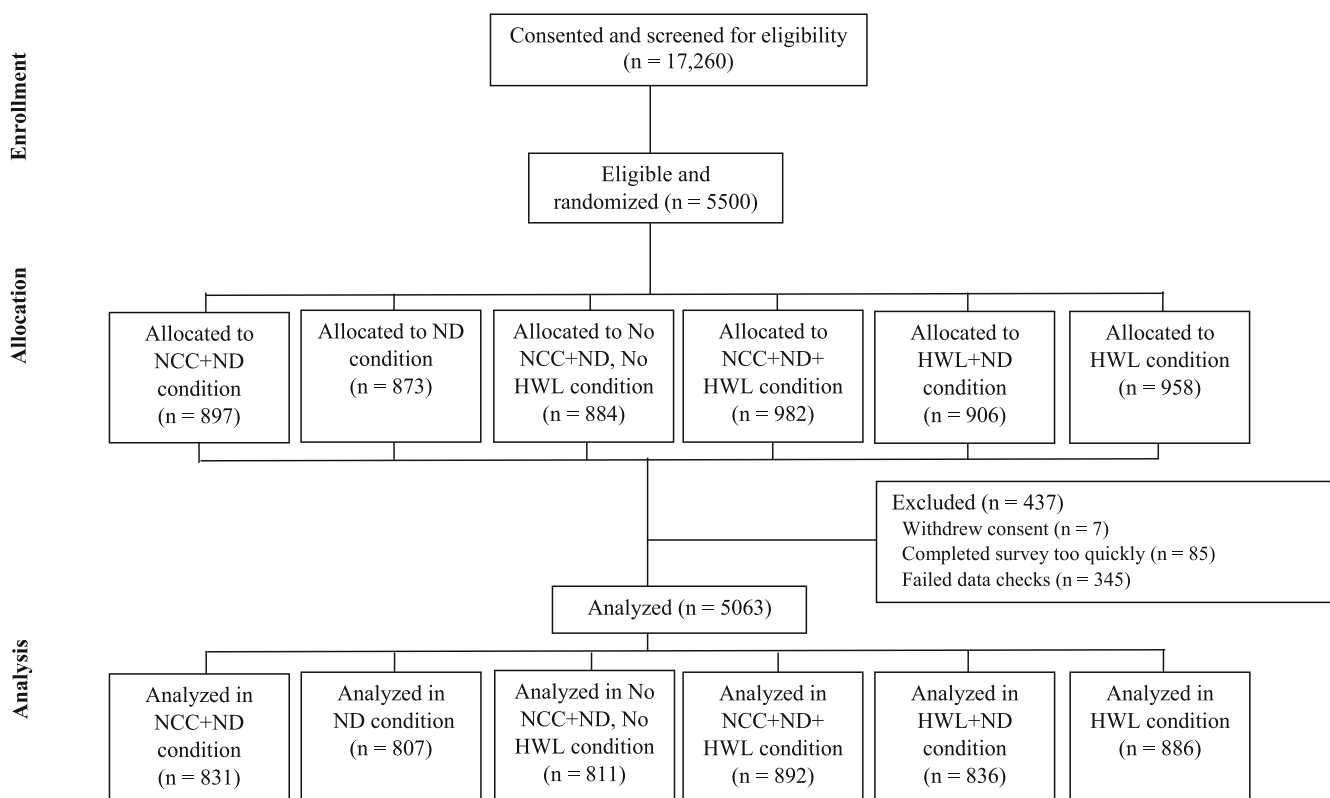
The objectives of this study were to examine independent and combined effects of NCC and a HWL on perceived product characteristics, health risks and intentions to consume and whether these effects differed by gender and age. It was hypothesized that the presence of NCC will have a health halo effect resulting in more favourable perceived product characteristics and stronger consumption intentions, and that the impacts of the NCC will be mitigated by the presence of a HWL. It was also hypothesized these effects will be stronger for women than men and younger versus older adults.

## METHODS

This between-subjects randomized experiment followed the Consolidated Standards of Reporting Trials (CONSORT) reporting guidelines (see Table S1). This study received ethics clearance through Public Health Ontario's Research Ethics Board (REB 2022-030.02), and all participants gave electronic informed consent.

## Participants

Participants were recruited for an online randomized, controlled, between-subjects experiment (single exposure, no follow-up) from March to April 2023 through Leger Opinion, a survey-sampling company that maintains a national online panel of ~400 000 individuals in Canada [45], using quota-based sampling to reflect the population distribution by sex-age-province based on 2021 Census data [46]. Participants had to be living in a Canadian province, between the minimum legal age of purchase in their province (age, 18/19) and age 64, report drinking  $\geq 1$  alcoholic beverage in the past 30 days, not report being pregnant or breastfeeding and have access to the internet (Figure 1). Participants were excluded for completing the survey in <25% of the median time, withdrawing their consent, failing data checks (multiple choice question asking, 'What month is it?'), responding 'No' when asked if they were honest about their alcohol use, or responding 'Prefer not to say' for outcomes analyzed in this study. Participants were provided with remuneration according to Leger's standard structure. Power calculations indicated a sample of 5063 was needed to detect the hypothesized interaction between gender and six conditions with 80% power, based on parameter estimates in the literature examining NCC and HWLs on alcohol, food and tobacco packages [20, 24, 26, 31].



**FIGURE 1** CONSORT participant flow diagram. HWL, health warning label; NCC, nutrient content claim; ND, nutrition declaration.

## Survey procedure

Participants completed an online survey (measures and image information are in Tables S2 and S3) in English or French. In a product rating task, participants viewed two images side-by-side, one of the principal panels and one of the back panels of a RTD vodka-based soda container, with outcome questions, presented one at a time, directly below the images. The survey could be completed on a smartphone, and a zoom function allowed participants to closely view the images. Participants provided alcohol use patterns, such as hazardous alcohol use, dieting behavior and demographic information, including age, gender, race/ethnicity, education, household income, perceived income adequacy, height and weight.

## Experimental label conditions

Participants were allocated randomly (simple randomization) using a computer-generated random sequence to view one of six experimental label conditions (Figure 2). Each label condition varied by the presence/absence of NCC, a HWL and a nutrition declaration (ND). **Condition 1** included a label with both a calorie and a sugars content claim on the principal panel, as these were the most prevalent NCC in audits of RTD beverages in Canada and Australia and are often shown

together [13, 14]. The NCC represented the actual calorie and sugars contents in RTD products. As per regulations in Canada, a ND was displayed on the back panel and designed according to the most recent regulations. **Condition 1** is the reference condition in this study because it represents the current policy scenario in Canada. **Condition 2** featured a ND on the back panel because international recommendations call for standardized nutrient content information on container labels [6, 47]. In **Condition 3**, the container was shown without NCC, a HWL or a ND. **Condition 4** included NCC and HWL on the principal panel and a ND on the back panel. A HWL with a cancer message shown in English and French was tested. Consistent with tobacco label evidence [48], and quantitative and qualitative studies to inform the design, the HWL was relatively large in size, bright yellow with a red border and large black font [40, 49, 50]. Currently in Canada, no HWL is mandated on alcohol containers. **Condition 5** displayed a HWL on the principal panel and a ND on the back panel. In **Condition 6**, the container was shown with a HWL on the principal panel only. It is important to note that, as per regulations in Canada, when NCC are displayed on alcohol, a ND is mandated on the back panel; therefore, a ND was tested on the back panel when NCC were present, and conditions with NCC but no ND were not tested [51]. Container images used a generic branded single-serve RTD vodka-based hard soda beverage container that were digitally altered from existing alcohol products to avoid contamination from pre-existing



**FIGURE 2** Alcohol container by label condition. Images shown in English, identical cans with all information in French were shown to participants completing survey in French.

perceptions of current brands. A RTD hard soda or seltzer beverage contains alcohol, carbonated water and flavoring that is premixed and packaged ready for consumption in a single-serve container. The six label conditions were pretested for credibility with an Advisory Committee of nine women ages 18 to 64 (with 7/9 ages 18–44), as women and adults under age 45 are targets for RTD beverage alcohol marketing [9, 52, 53]. Container images and information, including the ingredients list, were identical except for the systematically altered label information in each condition. All label information was provided in English or French.

## Outcomes

### Perceived product characteristics and health risks

After random assignment to one of the six label conditions, participants viewed the alcohol container with their label condition and were asked to rate it relative to other alcoholic beverages available in stores on: healthiness, calorie content (reverse coded), sugars content (reverse coded), alcohol strength (reverse coded), appeal and perceived health harm. Responses were provided on a visual analogue 7-point scale with anchors (e.g. 1, a lot less healthy; 4, no difference; 7, a lot healthier). Participants were also asked to indicate to what extent they agree or disagree with two measures assessing perceived increases in cancer risk, and health concerns. Responses were again provided on a 7-point scale (1, strongly disagree; 4, neutral; 7, strongly agree).

### Intentions to consume

Participants were asked how likely they would be to try, buy and binge drink (women, 4; men, 5 or more drinks in one occasion) the alcoholic beverage. Responses were provided on a 7-point scale (1, very unlikely; 4, neutral; 7, very likely). Additionally, participants were asked how many cans they would drink over the next 7 days if the alcoholic beverage was available to them. Responses were provided as open text (i.e. enter number: \_\_\_\_ cans).

To assess the robustness of results for product characteristics and intentions to consume, sensitivity analyses were conducted whereby responses assessed on the 7-point scale were dichotomized with ratings from 5 to 7 coded as '1' and ratings from 1 to 4 and 'Don't know' coded as '0', with the opposite for reverse coded outcomes. Survey measures for the 11 outcomes and coding of responses are provided in Table S4.

### Perceived consumer characteristics

Participants were asked to identify the typical consumer of the alcoholic beverage for five characteristics: feminine/masculine, health conscious/not health conscious, healthy weight/overweight,

physically fit/not physically fit and stylish/not stylish. These measures were modified from previous tobacco pack research [54, 55]. For each set of characteristics, respondents could choose either trait or no difference.

## Analysis

Analysis of variance and  $\chi^2$  tests were used to check that random assignment yielded no differences across conditions in participant demographic and alcohol use characteristics. For product characteristics and intentions to consume, separate linear regression models for each outcome were used to compare mean ratings between the reference condition (NCC + ND) and the other five label conditions. Participants who responded 'Don't know' to the outcome being modelled were excluded from that model. Multinomial logistic regression analyses were conducted to model differences in perceived consumer characteristics (reference = no difference) and label condition. Multiplicative interactions between age group and condition and gender and condition were tested by entering both interaction terms into each model. To reduce the risk of type 1 error, *P*-values in all models were adjusted using the Benjamini–Hochberg method. Lastly, pairwise contrasts were assessed between all conditions for four select outcomes, perceived healthiness, product appeal, perceived cancer risk and intentions to buy, adjusted for multiple comparisons using the Tukey–Kramer method. Sensitivity analyses using a binary variable for measures of product perceptions and intentions to consume were conducted. All analyses were conducted using SAS 8.2 (SAS Institute). The significance threshold was set at *P* < 0.05 for all tests. Analyses were not pre-registered because the outcome measures focus on consumer perceptions and do not include health outcomes.

## RESULTS

Table 1 shows sample characteristics. Distribution of sample characteristics across label conditions did not significantly differ (*P* > 0.05).

### Product perceptions and intentions to consume

Table 2 shows the effect of label condition on perceived product characteristics, product health risks and intentions to consume as compared to the NCC + ND reference (mean ratings and standard deviations [SDs] by condition in Table S5). Compared to the reference, the other five label conditions had significantly lower mean ratings for perceiving the product as 'healthy'. Participants in the four conditions without NCC, as compared to the reference, had significantly lower ratings for perceiving the product as low in calories and sugars; the exception was the HWL + ND label condition reaching the null threshold for calories.

**TABLE 1** Sample and alcohol use characteristics by label condition (total  $n = 5063$ ).

	NCC + ND (reference) $n = 831$ % (n)	ND, $n = 807$ % (n)	No NCC, no ND, no HWL, $n = 811$ % (n)	NCC + ND + HWL, $n = 892$ % (n)	HWL + ND, $n = 836$ % (n)	HWL, $n = 886$ % (n)	P-value
Gender							0.80
Men	46.6 (387)	48.7 (393)	50.1 (406)	49.1 (438)	48.3 (404)	47.9 (424)	
Women	53.4 (444)	51.3 (414)	49.9 (405)	50.9 (454)	51.7 (432)	52.1 (462)	
Age group							0.21
18/19–40	52.6 (437)	50.3 (406)	50.6 (410)	48.3 (431)	52.2 (436)	48.5 (430)	
41–64	47.4 (394)	49.7 (401)	49.4 (401)	51.7 (461)	47.8 (400)	51.5 (456)	
Education							0.70
High school or below	15.2 (126)	13.1 (106)	16.7 (135)	14.0 (125)	15.7 (131)	15.2 (135)	
Trades/college/some university	37.5 (312)	37.8 (305)	36.5 (296)	37.1 (331)	39.5 (330)	38.2 (338)	
Bachelor or above	46.9 (390)	48.3 (390)	46.2 (375)	48.4 (432)	44.4 (371)	45.6 (404)	
Don't know	0.4 (3)	0.7 (6)	0.6 (5)	0.5 (4)	0.5 (4)	1.0 (9)	
Annual household Income							0.92
<\$50 K	19.7 (164)	22.2 (179)	21.3 (173)	20.9 (186)	23.6 (197)	21.8 (193)	
\$50 K to <\$100 K	37.3 (310)	34.8 (281)	32.6 (264)	34.8 (310)	33.1 (277)	34.5 (306)	
\$100 K to <\$150 K	21.1 (175)	19.8 (160)	21.8 (177)	21.6 (193)	21.4 (179)	22.2 (197)	
\$150 K or above	13.1 (109)	14.5 (117)	15.2 (123)	15.1 (135)	13.8 (115)	13.9 (123)	
Don't know/PNS	8.8 (73)	8.7 (70)	9.1 (74)	7.6 (68)	8.1 (68)	7.6 (67)	
Perceived income adequacy							0.79
Do not meet basic expenses	6.0 (50)	5.8 (47)	5.7 (46)	5.4 (48)	6.6 (55)	5.4 (48)	
Just meet basic expenses	25.5 (212)	24.7 (199)	23.5 (191)	23.8 (212)	24.5 (205)	26.5 (235)	
Meet needs with little left	35.1 (292)	35.2 (284)	33.7 (273)	38.9 (347)	33.7 (282)	35.3 (313)	
Live comfortably	30.9 (257)	31.7 (256)	34.6 (281)	30.0 (268)	32.4 (271)	31.0 (275)	
Don't know/PNS	2.4 (20)	2.6 (21)	2.5 (20)	1.9 (17)	2.8 (23)	1.7 (15)	
Ethnicity/race							0.86
White	72.6 (603)	72.2 (583)	72.4 (587)	72.2 (644)	75.5 (631)	72.2 (640)	
Other than White	25.0 (208)	24.9 (201)	24.7 (200)	25.4 (227)	22.0 (184)	24.9 (221)	
Don't know	2.4 (20)	2.9 (23)	3.0 (24)	2.4 (21)	2.5 (21)	2.8 (25)	
Hazardous alcohol use (AUDIT-C) <sup>a</sup>							0.69
AUDIT-C score <3/4	46.8 (389)	46.3 (374)	47.3 (384)	48.5 (433)	49.9 (417)	46.2 (409)	
AUDIT-C score ≥3/4	52.0 (432)	52.7 (425)	51.1 (414)	50.6 (551)	49.2 (411)	52.1 (462)	
Reported DK/PNS to ≥1	1.2 (10)	1.0 (8)	1.6 (13)	0.9 (8)	0.9 (8)	1.7 (15)	
Use vodka seltzer beverage, past 12 months (% yes)	72.6 (603)	73.1 (590)	74.1 (601)	71.2 (635)	68.8 (575)	68.5 (607)	0.08
BMI category							0.64
Healthy weight	33.1 (275)	37.4 (302)	35.1 (285)	37.7 (336)	34.4 (288)	33.1 (293)	
Not healthy weight	46.2 (384)	42.8 (345)	44.9 (364)	42.7 (381)	44.9 (375)	45.8 (406)	
Don't know/PNS	20.7 (172)	19.8 (160)	20.0 (162)	19.6 (175)	20.7 (173)	21.1 (187)	
Trying to lose weight							0.21
Yes	44.6 (371)	42.5 (343)	42.5 (345)	46.0 (410)	41.5 (347)	43.2 (383)	
No (gaining weight, not doing anything about weight)	54.8 (455)	57.0 (460)	57.1 (463)	53.6 (478)	58.1 (486)	56.7 (502)	
Don't know/PNS	0.6 (5)	0.5 (4)	0.4 (3)	0.4 (4)	0.4 (3)	0.1 (1)	

(Continues)

TABLE 1 (Continued)

	NCC + ND (reference) n = 831 % (n)	ND, n = 807 % (n)	No NCC, no ND, no HWL, n = 811 % (n)	NCC + ND + HWL, n = 892 % (n)	HWL + ND, n = 836 % (n)	HWL, n = 886 % (n)	P-value
Preferred flavour							0.71
Cranberry-lime (including DK/PNS)	64.0 (532)	61.5 (496)	63.7 (517)	62.3 (556)	64.6 (540)	62.1 (550)	
Lime	36.0 (299)	38.5 (311)	36.3 (294)	37.7 (336)	35.4 (296)	37.9 (336)	
Region of Canada							0.81
British Columbia	10.8 (90)	12.9 (104)	15.0 (122)	13.7 (122)	14.5 (121)	14.7 (130)	
Prairie provinces	19.7 (164)	18.6 (150)	17.8 (144)	19.3 (172)	18.4 (154)	17.8 (158)	
Ontario	40.1 (333)	39.4 (318)	37.5 (304)	36.8 (328)	37.6 (314)	38.8 (344)	
Quebec	23.2 (193)	21.6 (174)	22.8 (185)	23.5 (210)	23.2 (194)	23.0 (204)	
Eastern/Atlantic provinces	6.1 (51)	7.6 (61)	6.9 (56)	6.7 (60)	6.3 (53)	5.6 (50)	
Language survey completed							0.96
English	79.2 (658)	80.5 (650)	79.7 (646)	78.9 (704)	78.8 (659)	79.6 (705)	
French	20.8 (173)	19.5 (157)	20.3 (165)	21.1 (188)	21.2 (177)	20.4 (181)	

Note: Due to rounding, some percentages do not add up to 100%.

Abbreviations: AUDIT-C, Alcohol Use Disorders Identification Test-Concise; HWL, health warning label; NCC, nutrient content claim; ND, nutrition declaration; PNS, prefer not to say; DK, don't know.

<sup>a</sup>AUDIT-C score:  $\geq 3/4$  for women/men identifies hazardous use.

Participants in conditions with a HWL consistently had significantly lower mean ratings for perceived product appeal and higher ratings for perceived cancer risk and health concerns, compared to the reference. The presence of a HWL also significantly lowered ratings for intentions to try, buy and binge drink the alcoholic beverage and the HWL only condition also significantly reduced the intended number of cans consumed in the next 7 days as compared to the reference. Sensitivity analyses found the overall pattern of results (i.e. direction and statistical significance) was largely similar regardless of whether the original 7-point scale or binary outcome was used, with a few exceptions because of borderline significance for outcomes where the majority of responses were 4 or 'No difference' (Table S6).

Figure 3 shows pairwise contrasts between the six label conditions for the four outcomes, perceived healthiness, product appeal, perceived cancer risk and intentions to buy. The mean rating for perceived healthiness decreased as nutrition labelling elements were removed, with the lowest ratings in the conditions with a HWL + ND and HWL only (no nutrition labelling elements). Measurable decreases in mean ratings of product appeal were observed as the NCC were removed and a HWL added, and significantly lower appeal ratings were detected among conditions with versus without a HWL. A dose-response effect was detected in the mean ratings for perceived cancer risk, with ratings increasing as nutrition labelling elements were removed and a HWL was added. Significantly higher cancer risk perceptions were detected among conditions with a HWL compared to those without. Significantly lower ratings for intentions to buy were observed between conditions with a HWL versus without, with the lowest rating in the HWL only condition.

### Perceived consumer characteristics

Compared to the NCC + ND reference, participants in conditions with a ND; HWL + ND; and HWL only had lower odds of perceiving the consumer as feminine (Table 3). Participants in conditions with no NCC, no ND and no HWL; HWL + ND; and HWL had significantly lower odds of perceiving a typical consumer as a healthy weight and physically fit, as compared to the reference. Participants in the four conditions where NCC were absent had lower odds of perceiving consumers as health conscious. Moreover, participants in conditions with a HWL + ND and HWL only had higher odds of perceiving the consumer as not health conscious, as compared to the reference.

### Interactions between label condition and gender or age group

Figure 4a shows the one significant interaction between gender and label condition for perceived health concerns, with women compared to men being more likely to have health concerns in the HWL + ND and HWL conditions versus the NCC + ND reference. Figures 4b-e present four significant interactions between age group and label condition. In Figures 4b-c, ages 18/19 to 40 compared to 41 to 64 were less likely to perceive the product as 'appealing', and more likely to have 'health concerns' in the NCC + ND + HWL condition versus the reference. In Figures 4d-e, ages 18/19 to 40 versus 41 to 64 were less likely to perceive the product as harmful to health in the condition with no labelling elements and less likely to perceive a typical consumer as health conscious in conditions with no labelling elements or

**TABLE 2** Linear regression: Effect of label condition on perceived product characteristics, product health risks and intentions to consume<sup>a</sup>.

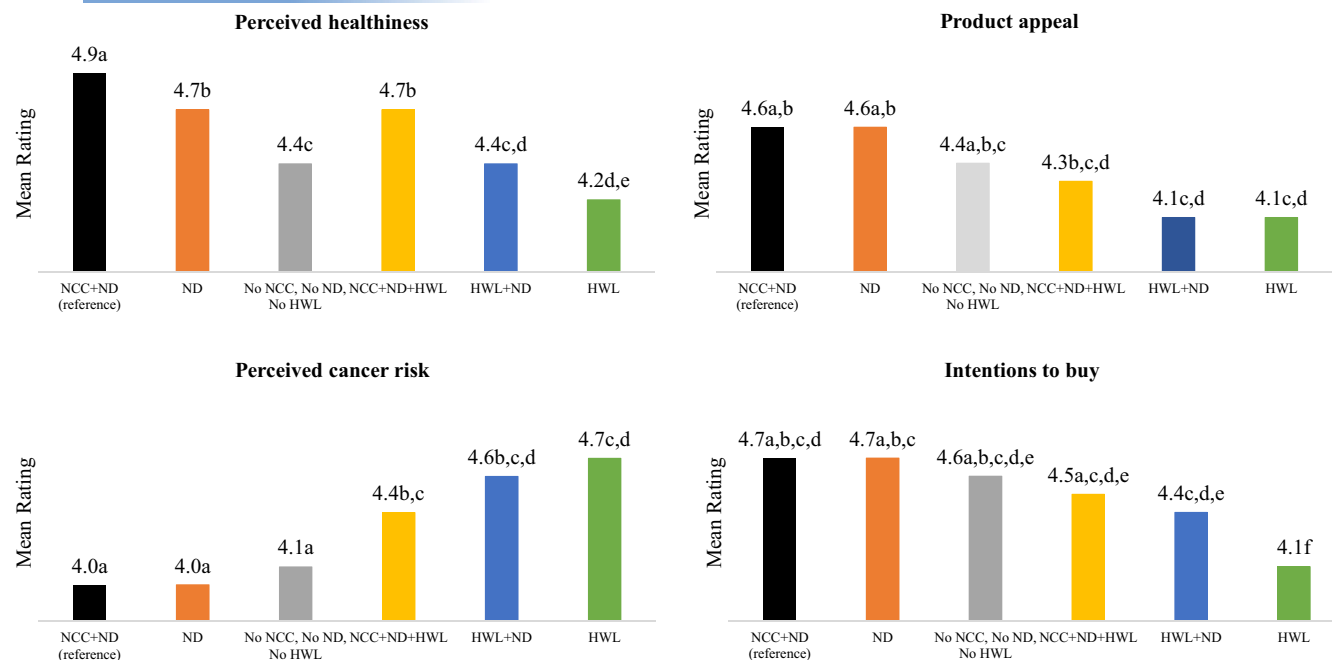
Outcome	Label condition				Interactions			
	NCC + ND (ref)	ND, $\beta$ (95% CI)	No NCC, no ND, no HWL, $\beta$ (95% CI)	NCC + ND + HWL, $\beta$ (95% CI)	HWL + ND, $\beta$ (95% CI)	HWL, $\beta$ (95% CI)	Condition $\times$ gender, P-value	Condition $\times$ age, P-value
<b>Perceived product characteristics</b>								
Healthy	ref	-0.21 (-0.33, -0.09)	-0.52 (-0.64, -0.40)	-0.25 (-0.36, -0.13)	-0.57 (-0.69, -0.45)	-0.71 (-0.82, -0.59)	0.05	0.42
Lower calories (reverse)	ref	-0.26 (-0.40, -0.12)	-0.55 (-0.69, -0.41)	0.05 (-0.09, 0.18)	-0.14 (-0.27, 0.00)	-0.66 (-0.80, -0.53)	0.36	0.14
Lower sugar (reverse)	ref	-0.36 (-0.52, -0.21)	-1.27 (-1.43, -1.11)	0.04 (-0.11, 0.19)	-0.29 (-0.44, -0.13)	-1.41 (-1.56, -1.26)	0.92	0.58
Lower alcohol strength (reverse)	ref	0.02 (-0.09, 0.12)	0.06 (-0.04, 0.17)	0.09 (-0.01, 0.19)	0.15 (0.05-0.25)	b	0.46	0.16
Appealing	ref	-0.02 (-0.16, 0.12)	-0.16 (-0.30, -0.02)	-0.31 (-0.45, -0.17)	-0.45 (-0.59, -0.31)	-0.48 (-0.62, -0.34)	0.14	0.01
<b>Perceived product health risks</b>								
Cancer risk	ref	0.00 (-0.17, 0.17)	0.09 (-0.07, 0.26)	0.39 (0.23, 0.55)	0.57 (0.41, 0.73)	0.68 (0.52, 0.84)	0.06	0.08
Health concerns	ref	-0.06 (-0.22, 0.10)	-0.09 (-0.25, 0.07)	0.76 (0.61, 0.92)	0.80 (0.64, 0.96)	0.95 (0.79, 1.10)	<0.01	<0.01
Harmful to health	ref	0.07 (-0.04, 0.17)	0.19 (0.09, 0.30)	0.04 (-0.06, 0.14)	0.17 (0.06, 0.27)	0.43 (0.33, 0.53)	0.61	0.01
<b>Intentions to consume</b>								
How likely to try	ref	0.01 (-0.17, 0.19)	-0.14 (-0.32, 0.03)	-0.28 (-0.45, -0.11)	-0.36 (-0.53, -0.18)	-0.63 (-0.81, -0.46)	0.45	0.75
How likely to buy	ref	0.05 (-0.14, 0.24)	-0.19 (-0.38, 0.00)	-0.26 (-0.44, -0.07)	-0.30 (-0.49, -0.11)	-0.59 (-0.78, -0.41)	0.15	0.64
How likely to binge drink <sup>b</sup>	ref	-0.01 (-0.19, 0.18)	-0.08 (-0.27, 0.11)	-0.35 (-0.53, -0.16)	-0.29 (-0.48, -0.11)	-0.39 (-0.57, -0.20)	0.19	0.28
How many cans/serves	ref	0.40 (-0.26, 1.07)	0.13 (-0.53, 0.74)	-0.49 (-1.14, 0.15)	-0.49 (-1.15, 0.16)	-0.72 (-1.37, -0.08)	0.38	0.58

Note: Interaction models include condition, gender, age, and interaction terms age  $\times$  condition and gender  $\times$  condition. Estimates in bold remained statistically significant at  $P < 0.05$  after the Benjamini-Hochberg adjustment for multiple comparisons.

Abbreviations: HWL, health warning label; NCC, nutrient content claim; ND, nutrition declaration;  $\beta$ , linear regression coefficient; CI, confidence interval.

<sup>a</sup>Don't know responses excluded: healthy ( $n = 4947$ ), lower calories ( $n = 4683$ ), lower sugar ( $n = 4745$ ), lower alcohol strength ( $n = 4981$ ), appealing ( $n = 5013$ ), cancer risk ( $n = 4571$ ), health concerns ( $n = 4987$ ), harmful to health ( $n = 4948$ ), how likely to try ( $n = 5024$ ), how likely to buy ( $n = 5028$ ), how likely to binge drink ( $n = 5014$ ), how many cans/serves ( $n = 4655$ ).

<sup>b</sup>Binge drink:  $\geq 4/5$  drinks for women/men on one occasion.



**FIGURE 3** Pairwise comparisons across six label conditions for perceived healthiness, product appeal, perceived cancer risk and intentions to buy. Different letters indicate significant differences between experimental conditions (Tukey–Kramer corrected  $P < 0.05$ ). HWL, health warning label; NCC, nutrient content claim; ND, nutrition declaration.

a HWL only compared to the reference. No other interactions between condition and gender or age group were significant (Tables 2 and 3).

## DISCUSSION

The findings suggest a significant link between NCC and perceptions of alcohol being relatively healthier, lower in calories, sugar and inferred health-related characteristics among consumers. Moreover, the findings indicate displaying a HWL on alcohol packaging was associated with lower product appeal, higher perceived health risks and reduced consumption intentions even in the presence of NCC. However, the effects of the HWL were mitigated when co-occurring with NCC, particularly on perceptions of calorie, sugars and alcohol content, and perceiving a typical consumer as health conscious, a healthy weight and physically fit. Notably, a HWL on its own was consistently found to be associated with less favourable alcohol product perceptions, higher perceived product health risks and the only label condition associated with intentions to consume fewer cans of the product. These findings are consistent with research on health-related claims on tobacco and NCC on packaged food [20, 26, 29, 30], as well as studies examining the influence of a HWL on alcohol use [40].

Conditions without NCC had lower perceptions of the alcoholic beverage as healthy, lower in calories, sugars and a typical consumer being health conscious. This is in line with the industry's stated intentions of using NCC on select RTD beverages to increase perceived healthiness [9] and provides evidence to support policies prohibiting the use of NCC to prevent consumers from being misled about their healthiness. Perceiving alcoholic beverages with NCC as healthy and

associated with health- and weight-related consumer characteristics is problematic because, although RTD beverages may be relatively lower in calories and sugars than other types of beverages without these claims [14, 56], these products still contain ethanol, a carcinogenic and addictive substance. RTD beverages range between 4% and 7% in ethanol volume, which is lower strength than traditional spirits and wine yet similar to beer and cider [13, 14].

Contrary to previous research, in the current study, conditions with or without NCC were not different in terms of the perceived health risks of the alcoholic beverage [31]. Instead, providing a HWL with a cancer message was associated with greater perceived cancer risk and health concerns from alcohol. A substantial knowledge deficit in alcohol-related health risks, particularly alcohol's direct and dose-response effect on cancer risk, is well documented internationally, and purportedly because of the ubiquitous presence of alcohol in society and the lack of readily accessible public health information about cancer risks from alcohol [38, 57, 58]. Research shows alcohol labels cautioning about the alcohol-cancer link can increase public awareness [4] and, as shown in this study, may be effective for shifting alcohol risk perceptions and countering the industry's health-oriented marketing. Future research testing the effects of HWLs communicating other health risks from alcohol on consumer perceptions of alcohol products is needed.

The presence of a HWL also affected participants' intentions to consume the product in the current study. Ratings for trying, buying and bingeing the alcoholic beverage were lower when nutrition labelling elements were absent and a HWL was present, with the lowest ratings in the HWL only condition. There was also a significant effect of a HWL on hypothetical intended consumption. Participants exposed to a HWL with no additional nutrition information reported

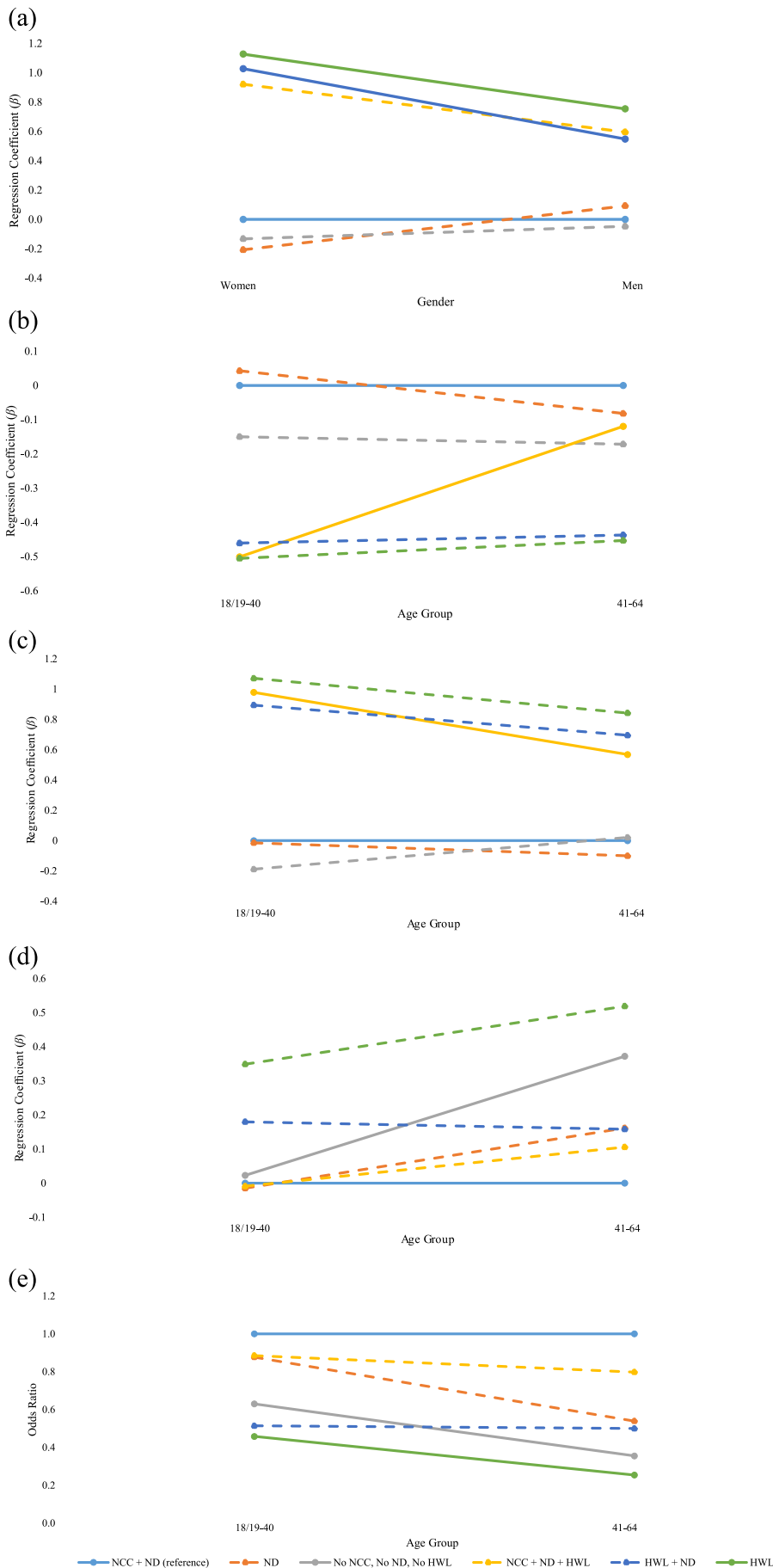
TABLE 3 Multinomial regression: Effect of label condition on perceived characteristics of typical consumer<sup>a</sup>.

Outcome	Label condition						Interactions	
	NCC + ND (ref)	ND, OR (95% CI)	No NCC, no ND, no HWL, OR (95% CI)	NCC + ND + HWL, OR (95% CI)	HWL + ND, OR (95% CI)	HWL, OR (95% CI)	Condition × gender, P-value	Condition × age, P-value
Feminine vs masculine	ref	ref	ref	ref	ref	ref	0.50	0.90
	ref	0.79 (0.51, 1.23)	0.72 (0.45, 1.14)	1.01 (0.66, 1.55)	0.70 (0.45, 1.11)	1.02 (0.67, 1.54)		
Health conscious vs not health conscious	ref	<b>0.71 (0.58, 0.87)</b>	0.80 (0.65, 0.98)	0.90 (0.73, 1.09)	<b>0.75 (0.61, 0.91)</b>	<b>0.73 (0.60, 0.90)</b>		
	ref	ref	ref	ref	ref	ref	0.37	<0.01
Healthy weight vs overweight	ref	1.40 (1.00, 1.98)	1.09 (0.77, 1.54)	1.43 (1.01, 2.01)	<b>1.58 (1.14, 2.20)</b>	<b>1.77 (1.29, 2.43)</b>		
	ref	<b>0.68 (0.55, 0.84)</b>	<b>0.48 (0.39, 0.59)</b>	0.84 (0.69, 1.03)	<b>0.51 (0.41, 0.63)</b>	<b>0.34 (0.27, 0.42)</b>		
Physically fit vs not physically fit	ref	ref	ref	ref	ref	ref	0.90	0.28
	ref	1.09 (0.78, 1.52)	0.85 (0.61, 1.20)	1.30 (0.95, 1.78)	1.13 (0.82, 1.56)	1.25 (0.92, 1.71)		
Stylish vs not stylish	ref	0.97 (0.78, 1.21)	<b>0.75 (0.59, 0.94)</b>	0.90 (0.72, 1.12)	<b>0.71 (0.56, 0.89)</b>	<b>0.59 (0.47, 0.74)</b>		
	ref	ref	ref	ref	ref	ref	0.52	0.78
Stylish vs not stylish	ref	1.10 (0.78, 1.55)	0.97 (0.69, 1.37)	1.12 (0.80, 1.56)	1.22 (0.88, 1.69)	<b>1.72 (1.26, 2.34)</b>		
	ref	0.94 (0.76, 1.18)	<b>0.65 (0.52, 0.82)</b>	0.80 (0.64, 0.99)	<b>0.59 (0.47, 0.75)</b>	<b>0.59 (0.47, 0.75)</b>		
Stylish vs not stylish	ref	ref	ref	ref	ref	ref	0.29	0.66
	ref	1.00 (0.67, 1.49)	1.30 (0.89, 1.90)	0.98 (0.66, 1.43)	1.18 (0.81, 1.72)	1.33 (0.93, 1.92)		
Stylish vs not stylish	ref	1.08 (0.87, 1.34)	1.15 (0.93, 1.42)	0.86 (0.70, 1.07)	0.87 (0.70, 1.08)	0.79 (0.64, 0.99)		

Note: Interaction models include condition, gender, age and interaction terms age × condition and gender × condition. Estimates in bold remained statistically significant at  $P < 0.05$  after the Benjamini-Hochberg adjustment for multiple comparisons.

Abbreviations: HWL, health warning label; NCC, nutrient content claim; ND, nutrition declaration; OR, odds ratio; CI, confidence interval.

<sup>a</sup>Don't know responses excluded: feminine vs masculine ( $n = 4989$ ), health conscious vs not ( $n = 4953$ ), healthy weight vs overweight ( $n = 4915$ ), physically fit vs not ( $n = 4932$ ), stylish vs not ( $n = 4949$ ).



**FIGURE 4** (a) Interaction between label condition and gender in agreeing the information on the alcoholic beverage makes them concerned about the health effects from alcohol, relative to NCC + ND condition (reference). (b) Interaction between label condition and age group in perceiving the alcoholic beverage as appealing, relative to NCC + ND condition (reference). (c) Interaction between label condition and age group in agreeing the information on the alcoholic beverage makes them concerned about the health effects from alcohol, relative to NCC + ND condition (reference). (d) Interaction between label condition and age group in perceiving the information on the alcoholic beverage as harmful to health, relative to NCC + ND condition (reference). (e) Interaction between label condition and age group in perceiving someone who chooses to drink this alcoholic beverage as more likely to be 'health conscious', compared to no difference, relative to NCC + ND condition (reference). NCC + ND (reference) label condition and conditions significantly different from NCC + ND condition (reference) are solid lines, non-significant conditions are dashed lines. HWL, health warning label; NCC, nutrient content claim; ND, nutrition declaration.

intentions to consume almost 20% fewer cans in the next 7 days, as compared to participants exposed to the NCC and ND. The population-level health gains would be appreciable if this translated to a similar reduction in alcohol use, considering alcohol-attributable health risks increase with each additional drink [23, 24, 35]. Further research is needed to better understand if displaying a HWL on alcohol containers translates to behavioural changes in alcohol use among consumers in real-world settings.

Results showed conditions with a HWL had a stronger effect on women than men for perceived health concerns about alcohol, with the strongest effects in the HWL only condition. Previous research has found gendered differences in the effects of HWLs on awareness of alcohol health risks [41–43]. Our findings are partly supportive of this literature given gender-specific effects were found for only one of three outcomes assessing perceived product health risks. Given disproportionate increases in alcohol-attributable harm in women internationally [59–61], including alcohol-attributable breast cancer cases [35], it is vital to understand if HWLs can counter potentially gender-targeted alcohol packaging and advertising.

Results do not suggest that NCC have differential effects by age. To some extent, results suggest that a HWL may have stronger effects on younger versus older when nutrition label elements co-occur on packaging, when no label elements are present, or when the HWL only is present. This is a key finding as cohorts currently at mid-life are increasing alcohol use and binge drinking, and experiencing alcohol-attributable harm at greater levels than other population subgroups [62, 63].

This study has limitations. First, experimental studies using online images of product packages are likely to underestimate the impact of package advertising and HWLs compared to ‘naturalistic’ settings where consumers can handle the package and closely scrutinize products. Second, only one fictitious brand of a RTD vodka-based soda beverage container was tested. Future research should explore other alcohol beverage types (wine, beer and other spirits) to investigate the generalizability of results. Moreover, a fictitious brand of vodka-based soda was designed for study purposes. The effects of labels may interact with specific types of brand imagery or product characteristics, including brand elements not tested here; however, this cannot account for the differences observed across experimental label conditions. Third, respondents were not recruited using probability-based sampling or in the territories and are, therefore, not representative of the population in Canada, decreasing generalizability of results. Additionally, it is difficult to calculate a response rate when recruiting from online commercial panels. Fourth, outcome measures compared the experimental product to ‘other alcoholic beverages available in stores’, and this mental representation may have introduced some subjectivity in relative comparisons. Finally, participants who self-identified their gender as non-binary were excluded from this study because of small cell sizes; therefore, results may not be generalizable to individuals that do not identify as a man or woman. Strengths of this study included a large sample size, high quality images of an alcoholic beverage container with labels developed by a graphic designer, and experimental design with randomization to conditions.

## CONCLUSIONS

This research extends existing evidence by demonstrating that the absence of health-oriented NCC on a RTD alcoholic beverage container reduces product appeal and positive product ratings among consumers, and the presence of a HWL on its own without nutrition labelling elements is most efficacious for reducing the attractiveness of an alcoholic beverage and increasing the salience of the HWL. The results provide evidence to inform two alcohol policy priorities: (1) regulations restricting the voluntary use of health-oriented nutrition advertising messages on alcohol containers; and (2) government-mandated HWLs on alcohol containers. Restricting NCC on RTD alcohol packaging could prevent consumers from being misled about the suggested health benefits from alcohol. Mandating HWLs is expected to enhance awareness of alcohol-related health risks, and potentially reduce alcohol use and alcohol-related harms.

## AUTHOR CONTRIBUTIONS

**Erin Hobin:** Conceptualization (lead); data curation (lead); formal analysis (equal); funding acquisition (lead); investigation (lead); methodology (lead); project administration (lead); resources (lead); supervision (lead); writing—original draft (lead); writing—review and editing (lead). **Justin Thielman:** Formal analysis (lead); writing—review and editing (supporting). **Samantha M. Forbes:** Formal analysis (supporting); writing—review and editing (supporting). **Theresa Poon:** Funding acquisition (supporting); project administration (supporting); software (lead); writing—review and editing (supporting). **Ariane Belanger-Gravel:** Conceptualization (supporting); funding acquisition (supporting); methodology (supporting); writing—review and editing (supporting). **Élisabeth Demers-Potvin:** Conceptualization (supporting); funding acquisition (supporting); methodology (supporting); writing—review and editing (supporting). **Ashleigh Haynes:** Conceptualization (supporting); funding acquisition (supporting); methodology (supporting); writing—review and editing (supporting). **Ye Li:** Methodology (supporting); writing—review and editing (supporting). **Manon Niquette:** Conceptualization (supporting); funding acquisition (supporting); methodology (supporting); writing—review and editing (supporting). **Catherine Paradis:** Conceptualization (supporting); funding acquisition (supporting); methodology (supporting); writing—review and editing (supporting). **Veronique Provencher:** Conceptualization (supporting); funding acquisition (supporting); writing—review and editing (supporting). **Brendan T. Smith:** Conceptualization (supporting), writing—review and editing (supporting). **Samantha Wells:** Conceptualization (supporting) writing—review and editing (supporting) **Amanda Atkinson:** Writing—review and editing (supporting). **Lana Vanderlee:** Conceptualization (supporting); funding acquisition (supporting); methodology (supporting); writing—original draft (supporting); writing—review and editing (supporting).

## AFFILIATIONS

<sup>1</sup>Public Health Ontario, Toronto, Canada

<sup>2</sup>Dalla Lana School of Public Health, University of Toronto, Toronto, Canada

<sup>3</sup>Department of Information and Communication, Université Laval, Québec, Canada

<sup>4</sup>Centre NUTRISS–Nutrition, santé et société, Institut sur la nutrition et les aliments fonctionnels (INAF), Université Laval, Québec, Canada

<sup>5</sup>Research Center of the Quebec Heart and Lung Institute, Québec, Canada

<sup>6</sup>École de nutrition, Université Laval, Québec, Canada

<sup>7</sup>Centre for Behavioural Research in Cancer, Cancer Council Victoria, Melbourne, Australia

<sup>8</sup>Melbourne School of Psychological Sciences, University of Melbourne, Melbourne, Australia

<sup>9</sup>Département d'information et de communication, Université Laval, Québec, Canada

<sup>10</sup>Canadian Centre for Substance Use and Addiction, Ottawa, Canada

<sup>11</sup>Institute for Mental Health Policy Research, Centre for Addiction and Mental Health, Toronto, Canada

<sup>12</sup>Campbell Family Mental Health Research Institute, Centre for Addiction and Mental Health, Toronto, Canada

<sup>13</sup>Department of Psychiatry, University of Toronto, Toronto, Canada

<sup>14</sup>Department of Epidemiology and Biostatistics, University of Western Ontario, London, Canada

<sup>15</sup>School of Psychology, Deakin University, Geelong, Australia

<sup>16</sup>Public Health Institute, Faculty of Health, Liverpool John Moores University, Liverpool, UK

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## DECLARATION OF INTEREST

None.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

## ORCID

Erin Hobin  <https://orcid.org/0000-0001-6335-2984>

Catherine Paradis  <https://orcid.org/0000-0003-4344-523X>

Brendan T. Smith  <https://orcid.org/0000-0003-2785-1246>

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#### SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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