Effect of alcohol health warning labels on knowledge related to the ill effects of alcohol on cancer risk and their public perceptions in 14 European countries: an online survey experiment

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Summary

Background Alcohol health-warning labels are a policy option that can contribute to the reduction of alcohol-related harms, but their effects and public perception depend on their content and format. Our study aimed to investigate the effect of health warnings on knowledge that alcohol causes cancer, the perceptions of three different message topics (responsible drinking, general health harm of alcohol, and alcohol causing cancer), and the role of images included with the cancer message.

Methods In this online survey experiment, distributed in 14 European countries and targeting adults of the legal alcohol-purchase age who consumed alcohol, participants were randomly allocated to one of six label conditions using a pseudorandom number generator stratified by survey language before completing a questionnaire with items measuring knowledge and label perceptions. Effect on knowledge was assessed as a primary outcome by comparing participants who had increased knowledge after exposure to labels with the rest of the sample, for the six label conditions. Label perceptions were compared between label conditions as secondary outcomes.

Findings 19 110 participants completed the survey and were eligible for analysis. Our results showed that a third of the participants exposed to the cancer message increased their knowledge of alcohol causing cancer (increase for 1131 [32·5%, 95% CI 29·8 to 35·2] of 3409 participants [weighted percentage] for text-only message; increase for 1096 [33·3%, 30·4 to 36·2] of 3198 [weighted percentage] for message inlcuding pictogram; and increase for 1030 [32·5%, 29·6 to 35·4] of 3242 [weighted percentage] for message including graphic image), compared with an increase for 76 (2·4%, –1·2 to 6·0) of 3018 participants who viewed the control message. Logistic regression showed that cancer messages increased knowledge compared with the control label (odds ratio $[OR]_{text\ only}$ 20·20, 95% CI 15·88 to 26·12; $OR_{pictogram}$ 21·16, 16·62 to 27·38; $OR_{graphic\text{-}image}$ 20·61, 16·19 to 26·68). Cancer messages had the highest perceived impact and relevance, followed by general health harm and responsibility messages. Text-only and pictogram cancer messages were seen as clear, comprehensive, and acceptable, whereas those including an image of a patient with cancer had lower acceptability and the highest avoidance rating of all the labels. The only identified interaction between perceptions and experimental conditions (with gender) indicated higher comprehensibility and acceptability ratings of cancer labels than responsibility messages and control labels by women, with the results reversed in men.

Interpretation Health warnings are an effective policy option to increase knowledge of alcohol causing cancer, with a generalisable effect across several countries. Europeans consider alcohol health-warning labels to be comprehensible and acceptable, with cancer-specific health warnings having the highest perceived impact and relevance.

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Introduction

Alcohol is a toxic and dependence-producing psychoactive substance causally related to injuries and communicable and non-communicable diseases, including cancer.[1] The EU has a particularly high consumption of alcohol; 2019 data show that 77% of the adult population (age >15 years) are current drinkers compared with 44% worldwide, and the total alcohol per capita consumption in 2019 was 11·0 L of pure alcohol, twice the 5·5 L world average.[2]

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Research in context

Evidence before this study

Alcohol use has a substantial health burden globally, yet many consumers are not aware of its risks. Health warnings on alcohol labels have been identified as a promising approach to increase people's awareness of alcohol harm and to potentially facilitate behavioural change. However, the results of our literature search on July 21, 2023 showed a scarcity of systematic investigation into the effect of alcohol labels on knowledge or public reactions to different topics and formats of alcohol health-warning labels in a multicountry setting. We used the following search string: [alcohol AND (label OR label*) AND (message OR information OR warning) AND (experiment* OR eval* OR effect)], to identify studies published in English from Jan 1, 2010 until July 21, 2023 that evaluated new or enhanced health warnings, using either experimental or quasiexperimental methodology, and which assessed the effect of health-warning labels on knowledge, or which compared perceptions of different topics and formats of health messages. To date, the existing literature provides limited evaluations of these issues in a multicountry general population setting, especially in non-English speaking countries. Most existing studies evaluate cancer messages, but not messages focused on other topics. When investigating the role of images embedded in alcohol health warnings, the focus is usually limited to comparing text-only messages to messages which include graphic images.

Added value of this study

To our knowledge, this study is the first multicountry large-scale study (n=19 110) to evaluate the effects and public perceptions of different topics and formats used on label messages across a broad range of European countries with different drinking patterns, with a focus on comparing messages on cancer (in three variants: text only, text plus pictogram, and text plus graphic image), general health harm, and responsible drinking. Our study suggests that brief exposure to a message about the link between alcohol and cancer significantly increased knowledge across all 14 participating countries, regardless of the cancer message variant. Cancer messages were also perceived to be most impactful and relevant, while being equally as acceptable as the other labels (with the exception of the graphic-image variant). Messages advocating for responsible drinking were not perceived to be impactful and relevant. Although some gender differences were observed in perceived clarity, comprehensibility, and acceptability of the labels among participants, the overall effect on knowledge that alcohol causes cancer was consistent across various countries and sociodemographic groups, indicating that labels serve as a universal tool for informing consumers about the health risks associated with alcohol use.

Implications of all the available evidence

The results of our study confirm the findings from previous studies that suggest that cancer messages on alcohol labels increase knowledge regarding the risk of alcohol causing cancer but expand the generalisability across several different European countries with different drinking patterns. Cancer messages are more relevant, likely to encourage discussion, and potentially deter the purchase of alcohol compared with general health-harm messages, responsibility messages, or no-message labels. Previous studies of health warnings on alcohol and tobacco labels suggest that including an image next to the text appears to be an important element, and the present findings suggest that including a warning symbol next to the cancer message on the alcohol label is sufficient to achieve high perceived impact and relevance without substantially increasing avoidance of the label or decreasing its comprehensibility and acceptability. Further research is needed on the effect of labels on behaviour or behavioural determinants in real-world settings, and to examine whether reactions change with repeated exposure.

See Online for appendix

Although population-based measures such as availability restrictions, pricing, and marketing regulations remain the most effective and cost-effective interventions,[3] improving alcohol labelling practices as part of a comprehensive policy approach is supported by WHO's Global Alcohol Action Plan 2022–30 and the European Framework For Action on Alcohol 2022–25.[4] Compared with other communication interventions, alcohol labels have the unique advantage of providing information to consumers at points of purchase and consumption, a situation that leads to repeated message exposure at each contact with the product.

Experimental research on alcohol health-warning labels (AHWLs) is scarce, predominantly conducted online, and mostly done in English-speaking countries.[5] Evaluations of the effects of AHWLs on knowledge are particularly rare, despite the labels being considered a useful informational tool.[6] The four existing evaluations show positive results, especially for cancer messages (appendix p 5).

In addition to measuring the effects of the labels on behaviour or its determinants, it is essential to consider the perceptions of the messages by the recipients, because they might mediate longer-term impact.[7] Messages with higher relevance for the recipient are also more likely to facilitate greater cognitive elaboration and processing, leading to more stable beliefs,[8] and cognitive responses such as thinking about harms, which have been associated with the effects of the labels.[9,10]

The effects and perceptions of AHWLs can be influenced by the content and format of the messages. Current research rarely compares different topics covered in the messages. Studies involving images most

commonly examine graphic depictions of diseased organs (appendix p 5). Results of those studies do not consistently point to greater effectiveness when graphic images are used, despite pictorial warnings being considered to be a gold standard in tobacco research.[11] Few studies have investigated the role of a pictogram, and research has shown that depicting lived experience of cancer might be a suitable alternative to depicting diseased organs.[12] In summary, there is a scarcity of systematic investigations regarding the effects and perceptions of different message topics, or comparisons of different types of images, across several countries.

In the current study, we investigated the effects and perceptions of different health warnings on alcohol labels.[13] We selected three main topics: responsible drinking, a message commonly used by economic operators;[14] the general health harm of alcohol, currently used by some countries in their labelling legislation (eg, Turkmenistan)[15] or as part of health-warning legislation on advertisements (eg, Sweden);[16] and cancer as a novel message in response to one of the lesser-known health harms caused by alcohol.[17] For the message on cancer, we additionally compared the inclusion of different image types adjacent to the text. The primary objectives of the study were to establish whether AHWLs have an effect on knowledge that alcohol causes cancer, to compare the perceptions of participants to different label topics and formats (pictogram or graphic image next to the cancer message), and identify whether label perceptions are influenced by any population characteristics.

Methods

Study design

This online survey experiment was done as part of the Evidence into Action Alcohol Project,[13] aiming to support the implementation of effective alcohol-related interventions in the EU, Iceland, Norway, and Ukraine. Data from a non-probabilistic convenience sample were collected via an online survey in 14 European countries (Austria, Belgium, Estonia, France, Germany, Ireland, Latvia, Lithuania, the Netherlands, Norway, Portugal, Slovenia, Spain, and Sweden), representing all major drinking patterns previously identified in the region.[18] The eligibility criteria were for the participants to be of the legal purchase age in the country (Lithuania age 20 years; age 18 years for all other countries), speaking the language of the country in which the survey was conducted, and having consumed alcohol in the past year. The survey contained an experimental component designed to assess the effect of six different conditions on knowledge difference before and after label exposure and participants' perceptions of the label, with a parallel design and an equal allocation ratio. The target sample size is described in the statistical methods. The protocol is available in the appendix (p 44), and a detailed description of the design and implementation of the study is published elsewhere.[19]

Randomisation

The participants were randomly allocated to one of the experimental groups through use of the *rand()* function in the online data collection platform DataForm (a survey interface based on the LimeSurvey community edition, version 3.28.62+230619),[20] with the randomisation fully integrated in the platform and stratified by the survey language. The function was applied as a hidden variable following the eligibility questions, masking the participants to the allocation sequence, and generated random integers between 1 and 6 (corresponding to the six label conditions) using a pseudorandom number generator, with equal allocation ratio.

Intervention

The experimental component included six label conditions: a control group with no health warning and five experimental labels with textual warnings, with or without images, displayed on the front label of the preferred beverage containers of the participants (beer can, wine bottle, or vodka bottle). The experimental labels consisted of a responsibility message, a general health-harm message, and three cancer-related messages: one text-only message informing that alcohol causes cancer, including breast and colon cancer, based on the message used in the only real-world study on AHWLs done to date but using stronger causal language;[10] a second message with an added pictogram, a warning symbol commonly associated with danger; and a third message with an additional image of a patient with cancer previously rated as highly severe, realistic, and consistent with the topic (for all messages see figure 1).[21] The labels were designed to reflect the existing practices (responsibility and general health-harm messages) and to incorporate components associated with best practices in the novel cancer message (using the colour red to attract attention and including visuals). To control for familiarity effects, labels used fictitious brands. They also maintained size uniformity regardless of the type of container, and the text size was adapted to message length.

Procedure

At the start of the online survey, participants were informed that the study focused on the provision of information using labels on alcoholic beverage containers. After providing written informed consent and completing the eligibility questions, the eligible participants were randomly assigned to one of six groups and completed a premanipulation knowledge assessment. Participants were then exposed to one of six different label conditions with the instruction "please examine the following label on the front of the container." No time constraints were applied, with participants spending a median of 9·7 sec (IQR 4·6) on the condition page.

Figure 1: **Labels as presented to the participants for the six experimental conditions**

Following label examination, participants completed the postmanipulation knowledge assessment and responded to questions aimed at measuring their reactions to the labels. The postmanipulation questions were preceded by the instruction, "now that you have examined the label, please answer the following question". At the end of the questionnaire, participants were asked to report on other sociodemographic and drinking-related variables. Following questionnaire completion, participants were debriefed about the alternative label conditions. The full questionnaire is available elsewhere.[19]

Data were collected in two waves between Oct 24, 2022, and May 24, 2023. Participants were recruited in two sample waves, the first using dissemination via social media and public health agencies, and the second via paid-for Facebook adverts. Further details on the recruitment process, including the distribution channels and recruitment procedures, are described separately.[19]

Outcome measures

For the primary outcome, the survey assessed participants' increase in knowledge of alcohol use as a risk factor for cancer by asking them to select diseases and conditions associated with alcohol consumption, including cancer among other health condition options. The question format and options were adapted from a previous study.[22] Participants were asked "which of the following diseases and conditions does alcohol consumption increase the risk of? (select all that apply)", with the possible choices being "cancer", "heart disease", "respiratory disease", and "liver disease" displayed randomly, and "I don't know" and "none" as exclusive options. Preintervention and postintervention knowledge variables were used to create a dichotomous variable measuring an increase in knowledge from the time before to the time after the measurement at the individual level, coded as "1" if participants, before the intervention, either did not select the cancer option or chose "none" or "I don't know", and selected the cancer option after intervention. All other response combinations were coded as "0", representing either no change or a decrease in knowledge.

To assess the perceptions as the secondary outcomes, individuals were tasked with rating seven items, assessing their reactions on a 5-point Likert scale from low (1, strongly disagree) to high (5, strongly agree) agreement. The item topics selected were developed on the basis of previous studies and assessed for the following perceptions:[23–26] relevance, "this label is relevant to me" (item 1); clarity, "this label is clear and easy to understand" (item 2); informativeness, "this label provides all the information I would need as a consumer" (item 3); acceptability, "this label is acceptable for alcohol products" (item 4); avoidance, "I would try to avoid thinking about the label" (item 5); perceived impact on discussion of alcohol risks with family and friends, "seeing this label would prompt me to talk to my family and/or friends" (item 6); and perceived impact on purchasing the products, "seeing this label on an alcohol product would deter me from purchasing" (item 7).

To explore the underlying dimensions and to simplify reporting, we applied Exploratory Factor Analysis (EFA), resulting in three factors (appendix p 20). This exploratory statistical technique was not part of the original protocol. The underlying response dimensions identified were as follows: factor 1, perceived impact and relevance (including item 1, item 6, and item 7); factor 2, comprehensibility and acceptability (including item 2, item 3, and item 4); and factor 3, avoidance (including item 5).

The questionnaire also assessed risk perception and intention as secondary outcomes, with the results intended for a future separate publication.

Covariates

For the primary outcome, the following covariates were considered: demographic information (age, gender, education, and country drinking pattern); alcohol consumption (level of alcohol consumption measured by AUDIT-C, and preferred drink as beer, wine, or spirits); and sample wave. For secondary outcomes, three additional covariates were included: perceived risk for personal harm; perceived risk for cancer; and perceived social norms. Country of residence was used in the sensitivity analyses. Specific wording, coding details, and rationale for selected covariates are presented in the appendix (p 13).

Poststratification weighting and final sample

Although the original protocol concentrated on experimental details, and did not specify weighting the data, in this report we aimed to provide data reflecting the population distribution of each of the participating countries to enhance the generalisability of the results. Thus, weights were calculated and applied to the study sample using standardised poststratification to approximate the distribution of the population on the basis of key sociodemographic characteristics, including gender (woman or man), age group (18–34 years, 35–54 years, and ≥55 years), and educational attainment (low, for high school or less, or high, for education beyond a secondary degree or certificate), with reference to EUROSTAT.[27] The weighting in this study served two purposes; first, to show results reflecting the population distribution of each country for outcomes, and second, to improve estimation of the regression model coefficients by correcting for heteroscedasticity or identifying average partial effects in the presence of unmodelled heterogeneity of effects.

After completing the two waves of data collection, 29 422 participants who fulfilled the inclusion criteria were randomly assigned to one of the six conditions, after which 20 183 submitted the questionnaire. Sample weights were computed for a subset of 19 601 participants with complete demographic data on gender, education, and country of residence within the 14 included countries (n=582 excluded). Out of this subset, 19 110 participants provided complete data on primary and secondary outcomes (n=491 excluded), forming the final sample for this study. A participant flowchart (appendix p 9) and the characteristics of the excluded participants (appendix p 10) are available.

Statistical analysis

On the basis of the power analysis detailed in the protocol (appendix p 44), the minimum sample size to adequately power tests for the primary outcome was 384 participants per country. However, a larger sample size of 1050 participants per country was necessary to enable country-specific analyses for some of the secondary outcomes with lower expected effect size.

The effect of label conditions on the primary outcome was assessed through adjusted logistic regressions. Given the extensive sample size used in this study, resulting in highly powered testing of hypotheses, model selection was done on the basis of improving the Bayesian information criterion and effect-size measures with a threshold of a small effect (Cohen's W >0·1).[28] The use of effect-size measures was not prespecified in the original protocol. Interactions between experimental conditions and the aforementioned covariates were assessed using Cohen's W as a measure of goodness of fit, by comparing nested models with and without the inclusion of the interaction term. To prevent overfitting, the model was only controlled for key sociodemographic variables and any other covariates with at least a small effect. No interactions or other covariates above the threshold emerged. We offer a detailed explanation and the results of the model construction, as well as sensitivity analyses for the final regression model, one restricted to participants without preintervention knowledge, and one with unweighted data, in the appendix (p 17).

To assess secondary outcomes, differences between experimental conditions in mean scores for the seven perception items were tested using a one-way ANOVA and Tukey's test for Bonferroni-corrected post-hoc comparisons. Moreover, for each of the three perception factors which resulted from the EFA, adjusted linear regression models were employed to explore the association with experimental conditions. Similarly to the primary outcome, the inclusion of variables in the final model was based on Bayesian information criterion and the effect size for small effect (Cohen's $f^2 \geq 0 \cdot 12$),[28] interactions with experimental conditions were tested, and models were adjusted for key sociodemographic variables and any other covariates with at least a small effect on each of the outcomes. An interaction above the threshold of a small effect was identified with gender for factor 2, comprehensibility and acceptability. Consequently, all analyses for this factor were stratified by gender. We offer a detailed explanation and results of the model construction, as well as sensitivity analyses with unweighted data (appendix p 23).

As an additional sensitivity analysis, the final regression models for both the primary and secondary outcomes were also fitted using the country of residence of the participants instead of drinking patterns as a covariate (appendix p 29). The significance level was set to 0·05. All analyses were computed using R software version 4.2.1.

Ethics and informed consent

Every participant in the study volunteered to participate and did not receive compensation for completing the survey. Before participating, participants provided written informed consent. The study received ethical clearance from a WHO collaborating centre in Toronto,

	Overall (n=19 110)	Women (n=9742)	Men (n=9368)
Label condition			
Control	3018 (15·6%)	1543 (15·5%)	1475 (15·8%)
Responsible drinking	3087 (16·7%)	1593 (17·5%)	1494 (16·0%)
General health harm	3155 (16·5%)	1599 (15·8%)	1556 (17·1%)
Cancer	3409 (18·1%)	1731 (18·4%)	1678 (17·8%)
Cancer with pictogram	3198 (16·5%)	1617 (16·5%)	1581 (16·6%)
Cancer with graphic image	3243 (16·5%)	1659 (16·3%)	1584 (16·7%)
Age			
18–34	11 649 (29·9%)	5684 (30·1%)	5965 (29·7%)
35–54	4881 (40·9%)	2810 (41·5%)	2071 (40·3%)
≥55	2580 (29·2%)	1248 (28·4%)	1332 (30·1%)
Highest educational attainment			
High school or less	8920 (62·0%)	3841 (57·1%)	5079 (66·7%)
Post-secondary degree or certificate	10 190 (38·0%)	5901 (42·9%)	4289 (33·3%)
Sample wave			
1st	7813 (43·3%)	5123 (54·1%)	2690 (33·0%)
2nd	11 297 (56·7%)	4619 (45·9%)	6678 (67·0%)
Country drinking pattern			
Daytime wine with meals (the Mediterranean drinking pattern)	7978 (41·7%)	4101 (40·7%)	3877 (42·6%)
Beer with and without meals (Central and Western European pattern)	6328 (33·2%)	2469 (33·1%)	3859 (33·3%)
Occasional spirits without meals (Northern European pattern)	4804 (25·1%)	3172 (26·3%)	1632 (24·1%)
Preferred type of alcoholic drink			
Beer	8876 (44·6%)	2978 (30·0%)	5898 (58·5%)
Wine	6274 (37·6%)	4518 (51·7%)	1756 (24·2%)
Spirits or liquor	3960 (17·7%)	2246 (18·3%)	1714 (17·2%)
AUDIT-C score			
Low	4783 (28·1%)	2896 (32·8%)	1887 (23·6%)
High	14 253 (71·4%)	6801 (66·5%)	7452 (76·0%)
Missing	74 (0·5%)	45 (0·6%)	29 (0·4%)
Perceived social norms of alcohol consumption			
Low acceptability	6360 (39·6%)	3687 (44·2%)	2673 (35·2%)
High acceptability	12 750 (60·4%)	6055 (55·8%)	6695 (64·8%)
Perceived personal risk for health harm related to alcohol consumption			
Low	2508 (15·3%)	1091 (12·2%)	1417 (18·1%)
High	16 560 (84·3%)	8625 (87·2%)	7935 (81·5%)
Missing	42 (0·4%)	26 (0·5%)	16 (0·3%)
Perceived personal risk of cancer related to alcohol consumption			
Low	7076 (40.8%)	3519 (38·0%)	3557 (43·5%)
High	11 957 (58·6%)	6173 (61·4%)	5784 (55·9%)
Missing	77 (0·7%)	50 (0·7%)	27 (0·7%)

Data are n (weighted %).

Table: **Sample characteristics by gender**

ON, Canada (Centre for Addiction and Mental Health, Research Ethics Board, #095/2022), and exemption on the EU level was provided by the Data Protection Office in the Department of Health of Catalonia (an WHO collaborating centre in Barcelona, Spain, DPD #21/2022).

Role of the funding source

The funder of the study had no role in the study design, data collection, data analysis, data interpretation, or writing of this report.

Results

The description of the full sample used for analysis (n=19 110), overall and by gender, is presented in the table, with sample characteristics by the experimental group available in the appendix (p 12). The sample was weighted on the basis of key sociodemographic statistics at the country level and predominantly consisted of individuals aged 35–54 years (40·9%), with a majority having a high school education or less (62·0%), with participants showing a preference for wine among

women (51·7%) and beer among men (58·5%). The full participant flowchart, including comparison by the missing data, is available in the appendix (p 9). Comparing the distribution by experimental condition between all randomly assigned participants and those included in the final sample showed no statistical difference in proportions (p=0·063; appendix p 11).

The change in prevalence of knowledge regarding alcohol consumption as a risk factor for cancer after exposure to the label, by label condition, is shown in the appendix (p 15). Before exposure to labels, between 51·2% and 54·1% of participants selected alcohol as a risk factor for cancer. After the intervention, this proportion ranged between 43·4% and 48·9% in non-cancer message conditions, and between 80·0% and 83·9% in cancer message conditions. Logistic regression models (figure 2; appendix p 18) showed that the odds of participants having an increase in the knowledge that alcohol causes cancer from before to after measurement were around 20 times higher in the three cancer labels when compared with the control condition, which corresponds to a knowledge increase for 1131 (32·5%, 95% CI 29·8 to 35·2) of 3409 participants (weighted percentage) for the text-only label, an increase for 1096 (33·3%, 30·4 to 36·2) of 3198 (weighted percentage) for the label inlcuding pictogram, and an increase for 1030 (32·5%, 29·6 to 35·4) of 3242 (weighted percentage) for the label including a graphic image (appendix p 16). In the sensitivity analysis considering only participants without previous knowledge (n=8157), this increase in knowledge after exposure to cancer labels corresponds to 66·7–72·6% of participants (appendix p 16), resulting in 45–60 times higher odds than the control condition (appendix p 19).

Responsible drinking and general health-harm messages also caused a significant increase in knowledge that alcohol causes cancer compared with the control condition; however, these increases were much smaller, representing an increase in knowledge of 3·4% (95% CI 0–6·8; n=113 of 3087) for responsible drinking and 5·5% (2·1–8·9; n=164 of 3155) for general health-harm messages. The increase in knowledge in the control condition was 2·4% (–1·2 to 6·0; n=76 of 3018). Interactions of the experimental conditions with age group, gender, education level, country drinking pattern, AUDIT-C, preferred drink, and sample wave were assessed, but no interactions were found (appendix p 17).

Results of the sensitivity analyses with unweighted data (appendix p 19) and country of residence (appendix p 29) were consistent with the primary analyses.

Responses to labels for the seven original perception items are shown (figure 3). Text-only and pictogram cancer warnings were perceived to be the most relevant, clear, and easy to understand. General health harm and cancer warnings (except for the graphic image condition) were as acceptable as the control label or responsibility message. Cancer warnings were more likely to encourage discussion on alcohol-related risks and discourage alcohol consumption than any of the other messages.

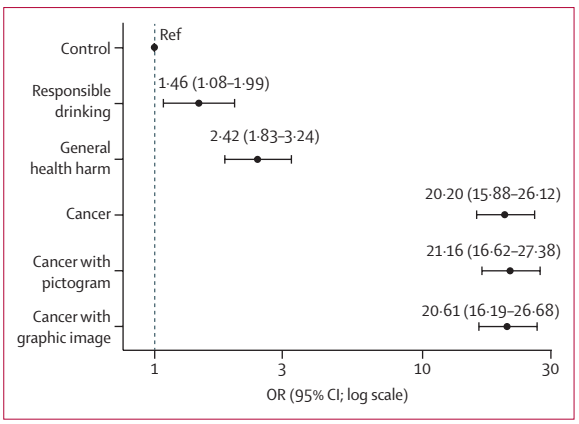

Figure 2: **Increased knowledge of alcohol as a risk factor for cancer from before to after exposure to each of the label conditions, adjusted for sex, age group, and educational attainment level (n=19 110)**
OR=odds ratio.

The responses of participants to labels for the three perception dimensions, adjusted for key socioeconomic variables and other important drinking-related factors, are shown (figure 4). The three cancer-related messages showed the highest perceived impact and relevance, followed by the general health-harm message, the responsibility message, and the control label having the lowest rating. The influence of labels on comprehensibility and acceptability was moderated by gender (appendix p 23). Women rated the cancer labels higher (ie, as clearer, more comprehensible, and acceptable) than the responsibility message or control condition, whereas men rated cancer labels lower than the responsibility message or control condition. Both the control message and the label on responsible drinking elicited the least avoidance, with general health harm and text-only and pictogram cancer messages receiving a slightly higher rating, and cancer messages with graphic images receiving the highest avoidance rating.

Discussion

Our study of 19 110 Europeans showed that the cancer messages on alcohol labels, regardless of the format, increased knowledge that alcohol causes cancer, thus replicating previous findings. What our study added, however, was testing this effect on a larger sample in a multinational context, demonstrating the generalisability of the results across 14 European countries with varying drinking patterns. Another result worth noting is the absence of interaction between the sociodemographic or drinking-related variables, and the effect of the labels on knowledge, indicating that the effect on different groups provided an equal chance of benefiting from the label information. Finally, cancer messages also had higher perceived impact and relevance compared with general health-harm and responsibility messages.

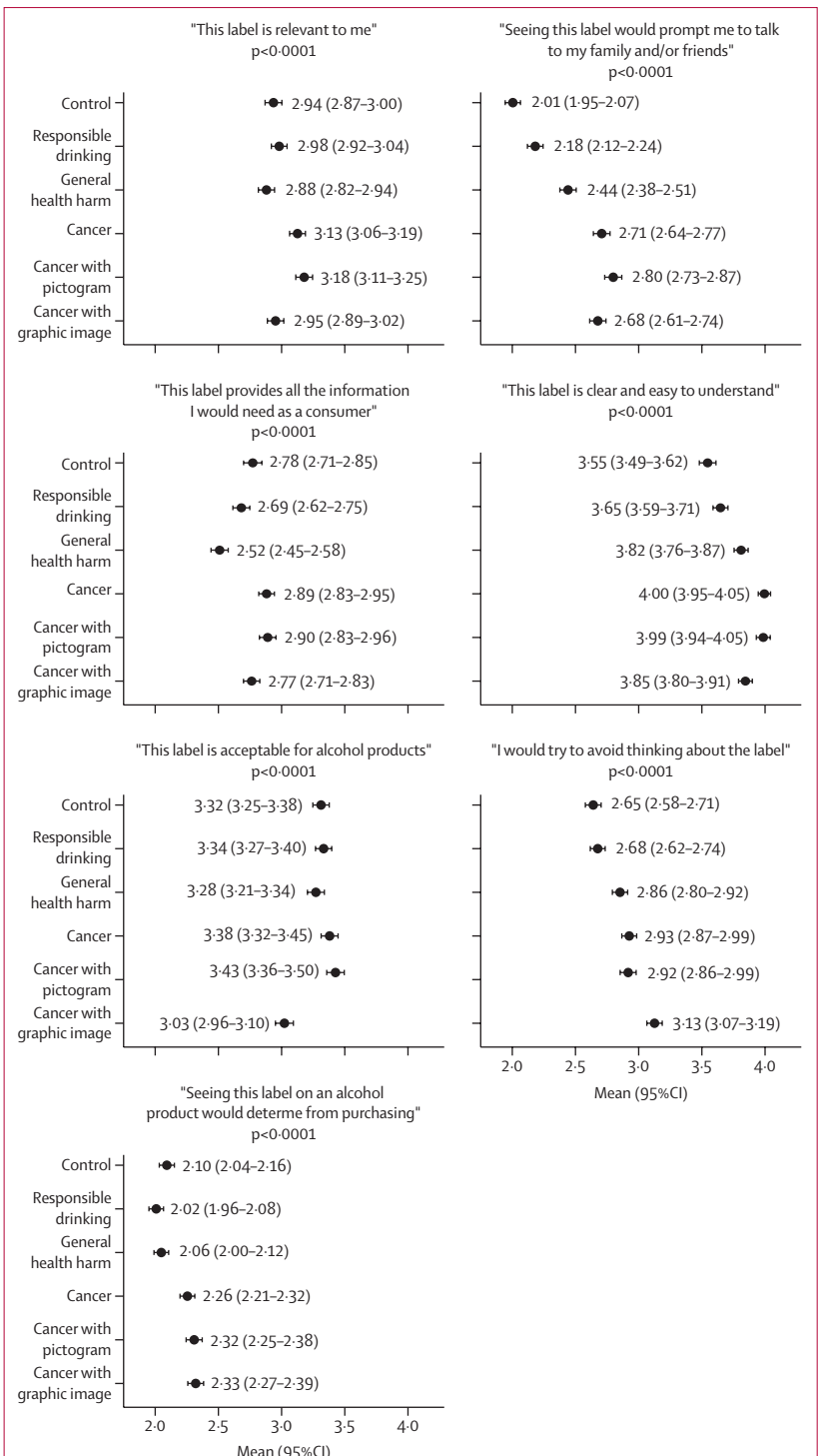

Figure 3: **Mean responses to each of the seven perception items**
1 indicates strong disagreement and 5 indicates strong agreement. p values assessed overall statistically significant differences in mean scores between label conditions as defined by an ANOVA.

The cancer messages without the graphic image were rated as more comprehensible and acceptable, and elicited less avoidance. This finding occurred despite the image depicting a patient with cancer rather than a diseased organ, and previous research indicating that patients with cancer would elicit different emotions, namely fear rather than anger.[12] Overall, these findings align with previous research (appendix p 23), which showed that messages without graphic images tend to be more acceptable than messages with graphic images, despite their similar effectiveness. A single other study directly compared text-only, pictogram, and graphic images and, despite not testing cancer-specific messages, found a similar pattern of results related to thinking about the message, with results favouring text-only or pictogram messages.[29]

We found that gender moderated the comprehensibility and acceptability dimension, with the key difference being in the control label and responsibility message ratings, which was observed in all three items within this dimension. This result suggests that men might find the current labelling practices more satisfactory than women, with women desiring more information than currently provided on the label. Previously, women have been found to be more likely than men to seek health information[30,31] and to use nutritional information on labels,[32] which could contribute to their perception of the control label information being insufficient. Gender disparities on this dimension might also be linked to individual alcohol-related experiences and expectations or environmental factors, because differences within the control group are also seen when separating the sample by country drinking pattern, level of alcohol consumption, preferred type of drink, and perceived social norms surrounding the use of alcohol. Overall, however, both cancer (except for a graphic image) and general health-harm messages were seen as acceptable to an equal extent as the other labels, which aligns with and expands on the finding that the majority of Europeans support the inclusion of health warnings on alcohol labels.[33]

Avoidance was mainly dependent on the label and was not associated with other sociodemographic or drinking-related variables. Although higher avoidance is sometimes perceived as an indicator of potential effectiveness, evidence from tobacco is not unequivocal.[9] Avoiding thinking about the label could result in reduced attention and cognitive processing of the message, which can diminish its effect, as those variables have been shown to mediate the effectiveness of alcohol labels.[10]

In the European context, a cancer message, especially when combined with a pictogram, appears to represent the optimal combination of perceived impact and relevance with comprehensibility and acceptability. Given the existing policy context, this insight can inform EU and Member State policy discussions. Our tested message specifically addressed breast and colon cancer representing the most prevalent cancer types that have low public awareness,[17,34] potentially boosting its impact and relevance compared with a general cancer message.

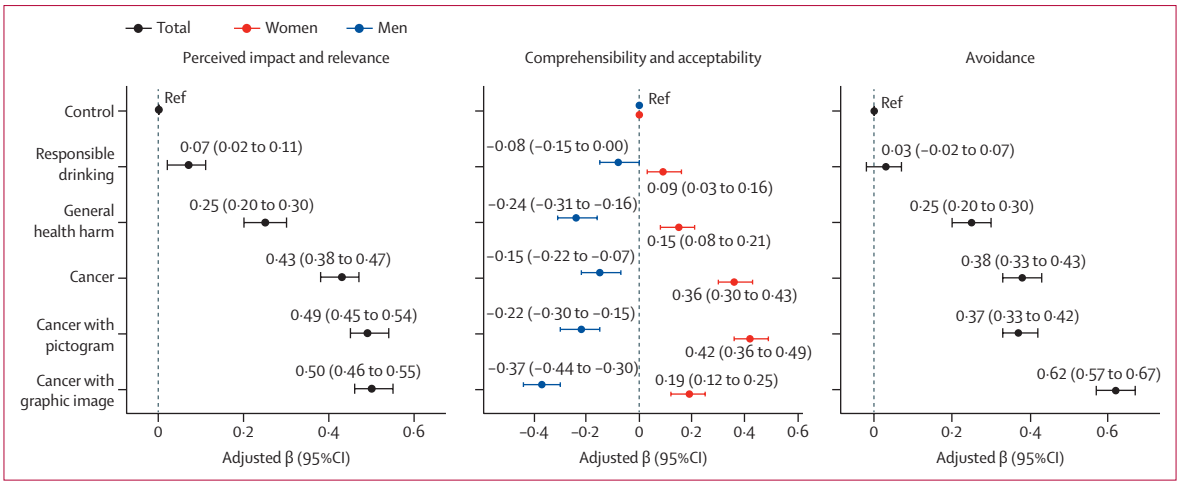

Figure 4: **Adjusted linear regression model coefficients (β) and respective 95% CI assessing the three perception dimensions by label conditions**
The perceived impact and relevance model was adjusted for age group, gender, educational attainment, sample wave, country drinking patterns, alcohol consumption (AUDIT-C score), and perceived risk for health. The comprehensibility and acceptability model was stratified by gender and adjusted for age group, educational attainment, country drinking patterns (only for women), and perceived risk for health (only for men). The avoidance model was adjusted for age group, gender, and educational attainment.

Our study also indicates that although overall both cancer and general health-harm warnings are acceptable, they are on average better received by women. Thus, further research aimed at understanding the underlying factors, practical implications, and potential gender-specific behavioural effects of health warnings is warranted. Further research is also needed to examine the effect of repeated exposure to such messages in real-world settings, and the relationship between consumer perceptions and actual impact.

A limitation of our study is that it relies on response to a brief exposure to labels in an artificial setting; the reactions of participants to the labels and the impact of the labels might evolve with repeated exposure in real-world settings—eg, the acceptability of messages might increase with increased familiarity of the labels, and thus further evaluations could be necessary to establish the most suitable message based both on label impact and public responses to it. Furthermore, when evaluating label effects on knowledge, including baseline knowledge, assessment could lead to response priming, so we could not completely control for experimental demand despite using random assignment and withholding disclosure of the study hypotheses. Further, the analytic approach of collapsing the knowledge change into a binary variable was based on the anticipated direction of the effect (knowledge increase) and did not delve into the nuances of knowledge acquisition, for example examining knowledge change in other directions. In particular, this method conservatively estimates knowledge increase, given that a substantial portion of our sample already had previous knowledge of the main outcome variable, which could by definition not be increased. However, a sensitivity analysis including only participants without previous knowledge corroborates our findings.

Another limitation of our study is the limited scope of tested labels and outcomes, testing images only with the cancer message, and using a single realistic image. Including more variations with different images, symbols, icons, and message wordings could offer deeper insights into the cognitive processes and reactions to specific aspects of the label or message. However, given the ambitious scope of the study, we purposefully selected a few messages and outcomes to fill the research gaps, while limiting the number of labels tested and the number of items in the survey to keep the participation time short and enhance the response rate. Furthermore, although we focused on certain design elements of the labels by examining the role of image in the cancer warnings, responses to all labels might have been influenced by other design choices, such as the colour or size of the labels, which we did not systematically vary, because our aim was to compare existing practice (in the case of responsibility and general health-harm conditions) with novel cancer warnings. Finally, we have included a limited number of the covariates in the assessment, leaving out some potentially relevant variables such as ethnicity.

Our study reveals that Europeans across most of the demographic and alcohol consumption-related factors consistently perceive AHWLs as acceptable, relevant, and effective. Specifically, labels linking alcohol use to specific cancers increased the knowledge of participants and were perceived as being effective and relevant. Perceived impact, relevance, and acceptability were highest when the cancer message was accompanied by a warning symbol. Considering the effects of alcohol on health, low awareness of an alcohol–cancer link, and the relevance and acceptability of the cancer message, providing such information through product labelling would reach a

large number of consumers at the points of purchase and consumption, and satisfy their right to know about the harms associated with the product they are consuming.

Contributors

DK, AT, JR, MN, and TL conceptualised the study and developed the study design and the questionnaire. DC, DK, JR, and MN supported the translation of the questionnaire into various languages and MN coordinated overall translations. DK did a literature review of the existing studies. AT implemented the questionnaire and monitored data collection. DC did the data analysis. AT, DC, and DK have directly accessed and verified the underlying data reported in the manuscript. AO assisted with the development and design of the experimental stimuli. JR, CF-B, and GG provided supervision and technical guidance. All authors contributed to the interpretation of the results. DC and DK jointly drafted the first version of the manuscript. All authors critically revised the draft manuscript and approved the final version of the manuscript. All authors had full access to all the data in the study and accept responsibility for submitting the publication. The first authors had full access to the complete dataset throughout the study and bear ultimate responsibility for the choice to submit the manuscript for publication.

Declaration of interests

AO, CF-B, GG, MN, and TL are staff members of WHO. AT, DC, DK, and JR are WHO consultants. We alone are responsible for the views expressed here and these do not necessarily represent the decisions or the stated policy of WHO. AO, CF-B, DC, DK, and MN have been funded for their work on EVID-ACTION project by the European Commission grant.

Data sharing

The data used in the study will be publicly available 12 months after the publication of this paper at DOI:10.6084/m9.figshare.25481254, to first allow for their use by the broader team involved in the survey translation and dissemination on the country level as per project collaboration agreement. The data available will include de-identified participant data and a data dictionary defining each field in the set.

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