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**Understanding the effectiveness of advertisements about the long-term harms of alcohol and low-risk drinking guidelines: a mediation analysis.**

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**ABSTRACT**

*Rationale:* Many people overestimate the amount of alcohol that increases their risk of harm and so may not perceive any need to change their drinking behaviour. Several countries have developed low-risk drinking guidelines, yet awareness of these guidelines remains low. Furthermore, mass media campaigns about alcohol-related harms may have limited impact if people do not perceive their current consumption as potentially harmful. Integrating drinking guidelines into media campaigns about alcohol’s harms can concurrently provide drinkers with information about low-risk drinking levels and compelling reasons to comply.

*Objective:* Our aim was to build understanding of the effectiveness of messages about the long-term harms of drinking and low-risk drinking guidelines, by testing the mediating effects of estimates of harmful drinking levels and attitudes towards drinking alcohol on subsequent intentions and behaviours.

*Method:* In an online experiment conducted in 2016, *n* = 1,156 Australian adult monthly drinkers were randomly assigned to view advertisements for non-alcohol products (NON-ALC; control), advertisements featuring long-term harms of alcohol (LTH), or LTH advertisements plus a guideline message (LTH+G). Immediately following exposure, we measured estimates of harmful drinking levels and attitudes towards drinking alcohol. One week later, we measured intentions to drink less and behavioural compliance with the guideline.

*Results:* Compared to NON-ALC advertisements, exposure to LTH+G advertisements increased (i) the proportion of respondents who correctly estimated harmful drinking levels, which in turn, strengthened intentions to drink less (42% of the total effect was mediated), and (ii) negative attitudes, which in turn, also increased intentions to drink less (35% mediated) and behavioural compliance (24% mediated). Compared to NON-ALC, LTH advertisements increased negative attitudes, which in turn strengthened intentions to drink less (53% mediated).

*Conclusions:* When paired with effective alcohol harm reduction television advertisements, messages promoting low-risk drinking guidelines can increase drinkers’ intentions to reduce their alcohol consumption and compliance with low-risk drinking guidelines.

**Keywords:** alcohol; alcohol harm reduction advertisements; guidelines; low-risk drinking; mediation

**HIGHLIGHTS**

 Uses experimental design with one-week follow-up to examine message effects.

 Correct estimates of low-risk drinking levels mediate effects on intentions.

 Negative attitudes towards drinking mediate effects on intentions and behaviour.

 Low-risk drinking guideline messages should be added to the end of advertisements.

**INTRODUCTION**

Many people overestimate the amount of alcohol that increases their risk of experiencing alcohol-related harm, and so may perceive no need to change their alcohol consumption ([Australian Institute of Health and Welfare (AIHW), 2017](#_ENREF_5); [Bowden et al., 2014](#_ENREF_6); [Coomber et al., 2017a](#_ENREF_12); [Holmes et al., 2016](#_ENREF_27); [Livingston, 2012](#_ENREF_33)). As part of efforts to reduce harm, many countries have developed guidelines specifying the amount of alcohol that can be consumed while still remaining at low risk of harm in the short- and/or long-term ([Kalinowski & Humphreys, 2016](#_ENREF_30)). For example, Australian guidelines issued in 2009 recommended no more than two standard drinks on any day to reduce lifetime risk of long-term harms, and no more than four standard drinks on a single occasion to reduce the risk of short-term harms (with a standard drink defined as 10g of alcohol) ([Australian Government. National Health and Medical Research Council, 2009](#_ENREF_3)). In the United Kingdom, the key recommendation is that it is safest not to drink more than 14 units of alcohol per week (with one unit defined as 8g of alcohol) ([UK Department of Health, 2016](#_ENREF_50)), and in Canada, women are advised to have no more than two standard drinks on most days and no more than 10 per week, and men are advised to have no more than three on most days or 15 per week (with a standard drink containing around 13.6g of alcohol) ([Butt et al., 2011](#_ENREF_9)). Low-risk drinking guidelines are considered important for consumers to make informed decisions about their drinking ([Casswell, 2012](#_ENREF_10); [Heather, 2012](#_ENREF_25)).

Several studies have documented limited knowledge of recommended drinking levels ([Australian Institute of Health and Welfare (AIHW), 2017](#_ENREF_5); [Bowden et al., 2014](#_ENREF_6); [Bowring et al., 2012](#_ENREF_7); [Coomber et al., 2017a](#_ENREF_12); [Holmes et al., 2016](#_ENREF_27); [Livingston, 2012](#_ENREF_33)). Low public awareness reflects the minimal effort undertaken thus far to communicate guidelines to the public ([Holmes et al., 2016](#_ENREF_27); [Wolfaardt et al., 2018](#_ENREF_58)). For instance, in the decade following the release of the 2009 Australian guidelines, promotion relied on limited news media ([Fogarty & Chapman, 2012](#_ENREF_18); [Holmes et al., 2016](#_ENREF_27); [Wolfaardt et al., 2018](#_ENREF_58)) rather than on national communication campaigns. When guidelines are covered by news media, the potential health consequences of drinking above the recommended level are often overlooked ([Wolfaardt et al., 2018](#_ENREF_58)), such that individuals are not given strong reasons for why they should want to comply with the guidelines. Conversely, when mass media campaigns designed to increase awareness of the health risks of drinking do not also communicate recommended drinking levels ([Dunstone et al., 2017](#_ENREF_15)), then individuals may believe they already drink at low-risk levels and so will not perceive a need to change their behaviour.

A more effective way to reduce alcohol harm may be to integrate the communication of guidelines into mass media campaigns aimed at increasing awareness of alcohol-related harms, so that audiences are concurrently provided with information about how much they should be drinking and compelling reasons for why they should comply ([Marteau, 2016](#_ENREF_35)). Such an approach has been successfully adopted by one state government in Australia ([Government of Western Australia, 2019](#_ENREF_21)), but this appears to be uncommon: a recent content analysis of 110 alcohol harm reduction television advertisements developed by public health agencies (and not the alcohol industry) in 10 countries found that just 10% included a guideline message ([Dunstone et al., 2017](#_ENREF_15)). Yet, in a subsequent study in which 83 of these advertisements were rated by drinkers according to their ability to motivate reduced alcohol consumption, those advertisements that did include guidelines were among the most highly rated ([Wakefield et al., 2017](#_ENREF_53)).

Our recent study provided additional evidence in support of this approach ([Wakefield et al., 2018](#_ENREF_54)). We experimentally assessed the immediate effects of adding a guideline message to the end of existing alcohol harm reduction television advertisements developed by public health agencies and found that compared to those in two control conditions (alcohol product advertising and non-alcohol product advertising), drinkers who were exposed to the Australian long-term harm guideline at the end of advertisements portraying alcohol’s long-term harms were more likely to correctly estimate how much alcohol can be consumed without an increased risk of long-term harm. Importantly, the guideline message both increased knowledge (i.e., fewer ‘don’t know’ responses) and corrected misperceptions (i.e., fewer overestimates). These effects were specific to alcohol harm reduction advertisements that carried the guideline message and were not simply a function of advertisement exposure. Furthermore, while alcohol harm reduction advertisements with and without the guideline message both increased intentions to reduce consumption over the next week, intentions were highest following exposure to advertisements carrying the guideline message. Similar effects were found when assessing impact of exposure to advertisements focused on the short-term consequences of drinking and the short-term harm guideline ([Wakefield et al., 2018](#_ENREF_54)).

The current study extends these previous findings of the immediate effects of advertisement and guideline exposure by examining sustained effects over a one-week follow-up period and mediators of these effects. Specifically, we examine the effects of exposure on intentions to reduce alcohol consumption one week after exposure, and on whether participants’ alcohol consumption in the week following exposure was compliant with the long-term harm guideline. We explore two potential mechanisms through which exposure to guideline messages may affect drinking intentions and behaviours; namely, by increasing knowledge of the amount of alcohol associated with an increased risk of harm and by increasing negative attitudes towards drinking alcohol. In this study, we focus on messages related to alcohol’s long-term harms, which include cancer and cardiovascular disease, given that these harms comprise about 70% of the burden of alcohol-attributable disease ([World Health Organization, 2014](#_ENREF_59)), and yet public awareness of these harms is low ([Christensen et al., 2019](#_ENREF_11); [Coomber et al., 2017b](#_ENREF_13); [Pettigrew et al., 2016](#_ENREF_40); [Weerasinghe et al., 2020](#_ENREF_57)).

Informing drinkers of low-risk drinking guidelines may provide them with a new anchor point for making decisions about their alcohol consumption. Anchoring is a psychological heuristic in which individuals tend to rely on the first piece of information that comes to mind (the ‘anchor’) when making decisions ([Tversky & Kahneman, 1974](#_ENREF_49)). By defining the anchor for appropriate consumption, guidelines may lead drinkers to re-evaluate their current consumption, and subsequently, to either change their consumption or intend to do so. In this study, we examined whether correctly estimating low-risk drinking levels mediated the effects of exposure to advertisements and guideline messages on subsequent drinking intentions and behaviours.

As well as encouraging drinkers to reassess their current consumption, guideline messages may also change how positively drinkers feel towards drinking alcohol. In traditional accounts of health behaviour such as the Theory of Reasoned Action ([Fishbein & Ajzen, 2010](#_ENREF_17)), attitudes are theorised to be an important determinant of behavioural intentions, and there is evidence that they account for variations in alcohol consumption ([Morgenstern et al., 2011](#_ENREF_36); [Reich et al., 2011](#_ENREF_42); [Schulz et al., 2012](#_ENREF_43)). Evidence is mixed as to whether alcohol harm reduction advertisements and guideline messages can change attitudes ([Brown et al., 2016](#_ENREF_8); [de Graaf et al., 2015](#_ENREF_14); [Glock et al., 2015](#_ENREF_19); [Goodall & Slater, 2010](#_ENREF_20); [Pavey et al., 2018](#_ENREF_39)). However, across these studies there is variation in whether attitudes were measured implicitly and/or explicitly, in the target of the attitudinal questions (e.g., specific alcohol products ([Goodall & Slater, 2010](#_ENREF_20)) or ‘responsible drinking’ ([de Graaf et al., 2015](#_ENREF_14))), and in the types of public health advertisements used. In the current study, we used an explicit attitude measure to examine whether exposure to the advertisements and guideline messages led to more negative attitudes towards drinking alcohol, and to examine whether negative attitudes mediated the effects of exposure on drinking intentions and behaviours.

We also examined whether any of the direct and indirect effects specified above varied for low- and high-risk drinkers. There is concern that low-risk drinking guidelines may backfire or simply be dismissed by heavy drinkers who rely upon their experience to determine how much they can drink ([Lovatt et al., 2015](#_ENREF_34)). In our previous study, we found that exposure to the advertisements and guidelines increased the proportion of both low-risk and high-risk drinkers who correctly estimated the amount of alcohol associated with long-term harms, even though high-risk drinkers continued to be more likely than low-risk drinkers to give an overestimate ([Wakefield et al., 2018](#_ENREF_54)). Therefore, in the current study we also tested for interactions between risky drinking status and responses to the advertisements and guidelines but based on the immediate effects reported in Wakefield et al. ([Wakefield et al., 2018](#_ENREF_54)), we did not expect substantial differences in the pattern of results for these sustained outcomes.

**MATERIALS AND METHODS**

**Participants and study design**

A sample of Australian adult participants was recruited through an online non-probability panel accredited under the International Organization for Standardization’s standards for Market, Opinion and Social Research (AS ISO 20252). Participants were eligible if they had consumed alcohol at least twice per month on average during the past year, were not currently pregnant or planning to become so, and did not work in health promotion, market research, advertising, or the alcohol industry. Quotas were applied to achieve approximately even numbers by sex and age group (18-29, 30-49, and 50-64 years).

The larger study used a between-subjects experimental design with a one-week follow-up, with *N* = 3,718 participants assigned by randomly permuted blocks to one of six advertisement conditions: (a) alcohol products (control); (b) non-alcohol products (control; NON-ALC); (c) short-term harms advertisements; (d) short-term harm advertisements, edited to include a visual and audio promotion of the short-term harm guideline; (e) long-term harm advertisements (LTH); or (f) long-term harm advertisements, edited to include a visual and audio promotion of the long-term harm guideline (LTH+G) ([Wakefield et al., 2018](#_ENREF_54)). However, in this study our focus was on determining the effects of exposure to the long-term harm guideline, when presented as part of television advertisements portraying alcohol’s long-term harms. Therefore, in the present paper we only report on the relevant conditions, (b), (e), and (f). The NON-ALC advertisements were not expected to impact outcome measures, thereby providing a control against which positive (or negative) effects of the LTH and LTH+G advertisements could be determined. The LTH and LTH+G advertisement conditions were also compared to each other, to determine the unique effects of adding the guideline message. Restricting analyses to these three conditions reduced the sample to *n* = 1,858. In addition, participants were excluded if they did not complete the follow-up survey at all (*n* = 570) or within the eligible time period of ≤14 days (*n* = 132), leaving *n* = 1,156 for analysis.

**Stimuli**

Participants each viewed four advertisements, two times each. The first and third advertisements (coffee, sugar-sweetened beverage) served as fillers to conceal the study purpose and minimise the likelihood of socially desirable responses. The second and fourth advertisements comprised the experimental advertisements specific to the assigned condition. Participants were randomly assigned to view just two experimental advertisements from a pool of four advertisements in their condition.

The four NON-ALC control advertisements promoted four popular brands in Australia for services and commodities unrelated to alcohol: banking; telecommunications; hardware; and motor vehicles. These advertisements were purchased from a marketing and media consultancy company. The LTH and LTH+G conditions both used the same pool of four alcohol harm reduction advertisements that were sourced from public health agencies in Australia and the United Kingdom. These four advertisements had scored highly in making drinkers feel motivated to reduce their consumption in a previous study ([Wakefield et al., 2017](#_ENREF_53)), and were assessed as being able to seamlessly carry the guideline message. In the LTH+G condition, a final frame was added to each of these advertisements to communicate the guideline message using text (“No more than two on any day. It’s less than you think.”) and an accompanying voiceover (“If you choose to drink, health experts recommend no more than two standard drinks on any day to reduce your risk of developing serious diseases.”). The guideline messages were developed by our research team, with input from drinkers in focus groups and from communication specialists at Cancer Council Victoria. Additional details are available in Wakefield et al. ([Wakefield et al., 2018](#_ENREF_54)).

**Procedure**

Panel members were invited to participate via email. They were informed they would be shown several television advertisements and asked to answer some questions about those advertisements; participants gave implied consent to participate by clicking through to a set of eligibility questions. Eligible participants completed demographic measures and questions about their consumption of alcohol, coffee and sugar-sweetened beverages, after which they were randomised to condition. After exposure to all four advertisements, participants in all conditions completed the same post-exposure measures (Time 1).

One week later, all participants were invited to complete a follow-up Time 2 survey, which was completed on average 8 days (*SD* 1.9, range 7-14) after Time 1. Ethical approval for the study was obtained from Cancer Council Victoria’s Institutional Research Review Committee.

**Pre-exposure measures**

*Demographic characteristics*

Participants reported their sex, age, highest level of education completed, and if they were a parent or guardian. Postcode was used to assign location (metropolitan or regional) and the socioeconomic status of participants’ residential area ([Australian Bureau of Statistics, 2013](#_ENREF_2)).

*Drinking characteristics*

Participants were shown a visual guide of the number of standard drinks in common serving sizes of different alcoholic beverages (a standard drink in Australia is defined as 10g of alcohol). They were then asked about their usual pattern of alcohol consumption based on how often in the past 12 months they had consumed specific numbers of alcoholic drinks in a day, ranging from ‘20 or more standard drinks’ to ‘less than 1 standard drink’ ([Australian Institute of Health and Welfare (AIHW), 2014](#_ENREF_4)). We used responses to this question to (i) calculate the *average number of drinks per day over the past 12 months*, and (ii) identify those drinkers whose average consumption meant they were at *low-risk of long-term harm*, due to having consumed <2 standard drinks per day on average over the past 12 months.

In addition, we measured participants’ recent pattern of alcohol consumption using the seven-day timeline follow-back measure through which participants reported how many standard drinks they consumed each day of the past week, with each day and date labelled automatically based on the date of survey ([Sobell et al., 1988](#_ENREF_46)). We used responses to this question to (iii) calculate the *average number of drinks per day in the past week*, and (iv) identify those drinkers whose past week consumption meant they were at *low-risk of long-term harm* due to having consumed <2 standard drinks per day on most days (i.e., four or more days). This variable identifying those who were at *low-* vs. *high-risk of long-term harm* based on their past seven-day consumption was used to define low-risk and high-risk drinkers for subgroup analyses.

Participants were also asked to describe the amount of alcohol they currently drink, with ‘self-perceived high-risk drinkers’ classified as those who responded that “I definitely drink more than I should” or “I probably drink more than I should”, and ‘self-perceived low-risk drinkers’ as those who responded “the amount I drink is ok” or “I could drink more than I do”. The importance of alcohol to an individual’s self-identity was assessed using responses to two questions, ‘drinking is part of who I am’ and ‘drinking is part of my personality’ (1 ‘strongly disagree’ – 5 ‘strongly agree’), which were averaged to form a measure of alcohol identity (α = 0.93).

**Mediators measured immediately post-exposure**

*Correct estimate of amount of alcohol associated with long-term harm*

Participants were asked ‘How many standard drinks of alcohol do you believe an adult could drink every day for many years without harming their health?’ ([Australian Institute of Health and Welfare (AIHW), 2017](#_ENREF_5)). Responses were recorded in whole numbers and participants could select ‘don’t know’. Participants who gave a response of zero, one or two standard drinks were classified as having given a correct estimate. For analyses, those who gave a response of more than two drinks and those who responded ‘don’t know’ were classified together as giving an incorrect estimate.

*Negative attitudes towards drinking alcohol*

Participants were asked explicitly about their attitudes towards drinking alcohol using four semantic differential items that formed a reliable scale (α = 0.87): ‘In your opinion, is drinking alcohol: bad—good, risky—safe, unhealthy—healthy, negative—positive’ (all scored on 7-point scales) (adapted from [Houben et al., 2010](#_ENREF_29)). A scale indicating participants’ negative attitudes towards drinking alcohol was created by reverse scoring these items and then taking the mean.

**Outcomes measured at follow-up**

*Intention to reduce alcohol consumption in the next month*

As part of the Time 2 survey, participants’ intentions to reduce their alcohol consumption in the next month was assessed by asking: ‘Thinking about the next month, do you plan to change the amount of alcohol you drink?’: (i) “yes, I plan to reduce my consumption and I think it will be easy”, (ii) “yes, I plan to reduce my consumption and I think it will be difficult”, (iii) “no, I don’t plan to change my consumption” and (iv) “yes, I plan to increase my consumption”. The first two responses were combined to indicate an intention to reduce alcohol consumption in the next month, with the latter two combined to indicate no intention to reduce consumption (only 3% of drinkers planned to increase their consumption).

*Alcohol consumption below the guideline*

Behavioural compliance with the long-term harm guideline was defined as consuming ≤2 drinks per day on four or more days (i.e., most days), in the week between advertisement exposure and the Time 2 survey. The number of drinks consumed was reported using the seven-day timeline follow-back method described above.

**Statistical analyses**

Pre-exposure demographic and drinking characteristics, post-exposure mediators, and follow-up outcomes were described for the overall study population (*n* = 1,156 who completed follow-up) and for subgroups by experimental condition and risky drinking status. Characteristics of these subgroups were compared using t-tests or ANOVA (continuous variables), Kruskal Wallis tests (count variables), or chi-square tests (categorical variables).

We examined the relationships between advertisement conditions and mediators, and between mediators and the intention and behaviour outcomes using logistic and linear regression models. To test the potential mediating effects of correct estimation and negative attitudes in the relationships between advertisement conditions and intention and behaviour, a mediation analysis was performed using the -Paramed- command in Stata ([Emsley & Liu, 2013](#_ENREF_16)), which uses a counterfactual framework. Using this method, two regression models were fitted: one for the outcome, conditional on advertisement condition, the mediator, and covariates; and one for the mediator, conditional on advertisement condition and covariates. Using these two regression models, the natural direct effect (the effect of the exposure (i.e., condition) on the outcome that is not mediated) and the natural indirect effect (the effect of the exposure (i.e., condition) on the outcome that is mediated through the mediator variable) were estimated ([Valeri & Vanderweele, 2013](#_ENREF_51)). The proportion of the total effect that was mediated through each mediator variable was calculated by dividing the natural logarithm of the natural indirect effect by the natural logarithm of the total effect ([Valeri & Vanderweele, 2013](#_ENREF_51)), to quantify the contribution of each mediator to the total effect. All estimates from mediation analysis were bootstrapped with 500 replications to obtain bias corrected 95% confidence intervals; if the confidence interval does not include zero, the estimate is considered statistically significant ([Hayes et al., 2011](#_ENREF_24); [Valeri & Vanderweele, 2013](#_ENREF_51)).

The advertisement condition variable (the IV) was multicategorical. Therefore, following Hayes and Preacher (2014), we created k – 1 dummy variables (where k equals the number of categories) and estimated the mediation model several times. The first execution of the model specified that NON-ALC was the reference category, the dummy variable for LTH was the exposure variable, and the dummy variable for LTH+G was a covariate. The second execution specified that NON-ALC was the reference category, the dummy variable for LTH+G was the exposure, and the dummy variable for LTH was a covariate. The third execution of the mediation model specified that LTH was the reference category, the dummy variable for LTH+G was the exposure, and the dummy variable for NON-ALC was a covariate ([Hayes & Preacher, 2014](#_ENREF_23)).

In mediation analysis, it is necessary to adjust for covariates of the exposure-mediator and mediator-outcome relationships ([Valeri & Vanderweele, 2013](#_ENREF_51)). Covariates were identified based on significant univariate relationships of potential covariates with condition or one or both mediators, and with one or both outcomes. Analyses were therefore adjusted for sex, age, average number of drinks per day in the past 12 months, consumption of <2 drinks on 4 or more days in the past week, self-perceived risky drinking status, alcohol identity, and number of days between Time 1 and 2. To determine if the indirect and direct effects of advertisement exposure on intention and behaviour through correct estimates and negative attitudes differ between low- and high-risk drinkers, we examined potential interactions using cross-product terms.

All statistical analyses were conducted using Stata/MP 14.2 ([StataCorp, 2016](#_ENREF_47)).

**RESULTS**

**Participant characteristics**

Of 1,858 participants who were assigned to one of the three relevant conditions at Time 1, 702 (37.8%) did not complete the follow-up survey (at all or within the eligible time period of <14 days). The non-completion rate was similar across the conditions (NON-ALC 35.0%, LTH 40.8%, and LTH+G 37.5%; χ2 = 4.45, *p* = .108) and the baseline characteristics of those lost to follow-up did not differ significantly between conditions (data not shown).

Participant characteristics are presented in Table 1. At baseline, median consumption was 0.9 drinks per day in the past week (interquartile range (IQR) 0.4-2.0), 84% of sample members were classified as low-risk drinkers based on past week consumption, and 31% were self-perceived high-risk drinkers. Median consumption in the past week was significantly higher among high-risk compared with low-risk drinkers (4.0 vs 0.7 drinks per day) (Supplemental Table 1).

Immediately after advertisement exposure, 71% of participants correctly estimated the number of drinks associated with long-term harm (Table 1). Low-risk drinkers were more likely to report correct estimates compared with high-risk drinkers (Supplemental Table 1). The mean score for the seven-point negative attitude scale was 4.47 (*SD* 1.11; Table 1), with more negative attitudes among high-risk than low-risk drinkers (Supplemental Table 1). The correlation between correct estimates and negative attitudes was small (*r* = 0.14).

At Time 2, 32% of participants intended to reduce their alcohol consumption in the next month (Table 1), which was significantly higher among high-risk drinkers (Supplemental Table 1). In the week between Time 1 and Time 2, 87% of participants reported consumption below the LTH guideline on four or more days (Table 1).

**Relationships between advertisement condition and mediators**

Consistent with findings reported by Wakefield et al. (2018), but replicated here using only the sub-group of participants who participated in the follow-up survey, participants exposed to LTH+G advertisements were more likely to correctly estimate the amount of alcohol associated with long-term harm compared with those in the NON-ALC control (*OR* 2.02, *95% CI* 1.46, 2.79) and LTH condition (*OR* 1.58, *95% CI* 1.12, 2.21), whereas participants exposed to LTH advertisements without a guideline message were not more likely to provide a correct estimate compared with the NON-ALC control (*OR* 1.28, *95% CI* 0.94, 1.75) (Figures 1 and 2).

Exposure to LTH and LTH+G advertisements was also associated with more negative attitudes towards drinking alcohol compared with NON-ALC control ads (*β* 0.25, *95% CI* 0.10, 0.40 and *β* 0.23, *95% CI* 0.08, 0.38, respectively), while the addition of the guidelines message (LTH+G vs LTH conditions) did not increase negative attitudes (*β* -0.02, *95% CI* -0.17, 0.13) (Figures 1 and 2).

**Relationships between mediators and subsequent intention and behaviour**

Correct estimates (*OR* 1.36, *95% CI* 1.01, 1.84) and more negative attitudes towards drinking (*OR* 1.21, *95% CI* 1.07, 1.37) were both associated with higher odds of intending to reduce alcohol consumption in the next month (Figure 1). The mediators were not associated with consumption below the guideline in the week between Time 1 and Time 2 (Figure 2).

**Direct and indirect effects of advertisement condition on intention and behaviour**

Overall, there were no direct effects of advertisement condition on intention or behaviour (Table 2). However, a significant indirect effect was observed for the LTH+G condition compared with the NON-ALC control on intentions through both correct estimates (which explained 42% of the relationship) and higher levels of negative attitudes (which explained 35%) (Table 2). Mediation analyses also indicated a significant indirect effect of the LTH+G condition compared with the NON-ALC control on behavioural compliance through negative attitudes (Table 2), which explained 24% of the relationship. A significant indirect effect was also observed for the effect of the LTH advertisements compared with the NON-ALC advertisements on intentions, but only through more negative attitudes towards drinking alcohol, which explained 53% of the relationship. When comparing LTH+G advertisements with the LTH advertisements, there was an indirect effect through correct estimates to increased intentions to drink less (explaining 16% of the effect of LTH+G advertisements on intentions; Table 2).

There was some evidence that the direct effects of LTH+G advertisements compared with NON-ALC control and of LTH+G advertisements compared with LTH advertisements on intentions were moderated by risk status (*p*-value for interaction, 0.02). There were significant direct effects on intentions for high-risk drinkers exposed to the LTH+G advertisements compared with NON-ALC control advertisements and LTH advertisements, whereas these direct relationships were not significant among low-risk drinkers (Supplementary Table 2). However, tests for moderation of the remaining direct and indirect relationships were all non-significant (*p*-values for interactions >0.05; data not shown).

**DISCUSSION**

Our study aimed to examine whether the effects of messages about the long-term harms of drinking and low-risk drinking guidelines on drinking-related intentions and behaviours are mediated through estimates of harmful drinking levels and attitudes towards drinking alcohol. Findings indicate that one important pathway through which long-term harm advertisements may affect subsequent intentions and behaviours is by increasing negative attitudes towards drinking alcohol (see Figures 1 and 2 and Table 2). Adding low-risk drinking guidelines messages to these advertisements can further strengthen intentions to reduce consumption by increasing awareness of low-risk drinking levels (see Figure 1). Specifically, compared to those who saw advertising for non-alcohol products, adult drinkers exposed to the guideline message (LTH+G condition) were more likely to correctly estimate the amount of alcohol associated with long-term harms and report more negative attitudes towards drinking alcohol. In turn, the effect of exposure to the LTH+G advertisements on intentions was significantly mediated through both correct estimates and negative attitudes (see Figure 1 and Table 2), and the effect on behavioural compliance with the guideline was mediated through negative attitudes (see Figure 2 and Table 2). The mediating effect of correct estimates appears to be specific to the addition of the guidelines message, as the effect of exposure to LTH advertisements compared to NON-ALC advertisements on intentions was mediated only through negative attitudes (see Figure 1 and Table 2). Furthermore, intentions to reduce consumption over the next month were stronger among those exposed to LTH+G advertisements compared to LTH advertisements, and a small but significant indirect effect indicated that this effect was mediated through correct estimates (see Figure 1 and Table 2).

It is interesting that direct effects of the LTH+G advertisements on intentions to reduce consumption were stronger for high-risk than low-risk drinkers (see Supplementary Table 2). However, no other direct or indirect effects were moderated by risky drinking status, indicating that overall, the advertisements and guidelines messages were similarly effective for low- and high-risk drinkers. However, given that only a small proportion of the drinkers were classified as high-risk drinkers based on their past week consumption, further research is required using a larger sample of risky drinkers.

The single dose of message exposure was insufficient to substantially increase behavioural compliance with the guideline in the week following exposure. The inability of this relatively small dose of intervention to impact behaviour likely reflects the fact that alcohol use is habitual and highly influenced by social and other external factors ([Halim et al., 2012](#_ENREF_22); [Labhart et al., 2017](#_ENREF_32); [O'Donnell et al., 2019](#_ENREF_38)). It is reassuring that effects of exposure were observed when intentions to reduce drinking were measured after one week, given that intentions are an established, albeit imperfect, predictor of subsequent behaviour change ([Sheeran, 2002](#_ENREF_44); [Webb & Sheeran, 2006](#_ENREF_56)). Mass media campaigns have been demonstrated to directly and indirectly produce changes in health-related behaviours, with particularly strong evidence for the impact of tobacco control and road safety (including drink driving) campaigns ([Wakefield et al., 2010](#_ENREF_55)). However, the success of such campaigns requires achieving adequate and sustained levels of exposure ([Hornik, 2002](#_ENREF_28); [Wakefield et al., 2010](#_ENREF_55)), and these campaigns typically have only small behavioural effects that achieve practical significance for populations when the campaign reaches mass numbers of individuals ([Abroms & Maibach, 2008](#_ENREF_1); [Noar, 2006](#_ENREF_37); [Snyder & Hamilton, 2002](#_ENREF_45); [Wakefield et al., 2010](#_ENREF_55)). Therefore, it is possible that reductions in consumption could be observed if these advertisements and guideline messages were disseminated to the public via a mass reach campaign with repeated exposure.

One strength of this study is the use of four LTH advertisements that were all developed by government or public health organisations and had previously been highly ranked by adult drinkers (including high-risk drinkers) based on their ability to motivate reduced drinking ([Wakefield et al., 2017](#_ENREF_53)). Therefore, these are the types of advertisements likely to be aired in future campaigns to raise awareness of long-term harms, ensuring the relevance and external validityof the study’s findings. We also used multiple advertisements in each condition, so the observed effects are not specific to any single advertisement and can be generalised beyond the specific advertisements tested. The guideline message was developed with input from drinkers in focus groups and from communication specialists. However, our study assessed the impact of just one guideline message (“no more than two standard drinks on any day…”), and appropriately, just one corresponding measure of correct estimates and behavioural compliance. Future research is needed to examine whether other types of low-risk drinking guidelines—for example, those that recommend weekly limits—have similar effects.

The inclusion of the one-week follow-up is an advance on many experimental tests of health communication messages that use only immediate post-exposure measures, and the results provide evidence that the effects of exposure were partly sustained for at least one week. This design also ensured the correct temporal ordering of the mediator and outcome variables, strengthening confidence in the causal claims. The study design and questionnaire minimised socially desirable responses by including filler ads and distractor questions related to consumption of coffee and sugary drinks.

***Limitations***

One limitation is that we only examined two potential mediators of the effect of the advertisements and guidelines on intentions and behaviours. Other potential mediators include beliefs about whether it is morally right or wrong to comply with recommended low-risk drinking levels ([Pavey et al., 2018](#_ENREF_39)), and negative feelings elicited by the messages ([Stautz & Marteau, 2016](#_ENREF_48)). We were only able to examine the effects of one mediator per model, however given the small correlationbetween correct estimates and negative attitudes towards drinking alcohol, we do not expect that the size of each of the indirect effects is substantially overestimated. It is possible that measuring participants’ estimates of the amount of alcohol associated with long-term harm soon after participants in the LTH+G condition were exposed to the guidelines message may have strengthened the effect of this exposure, thereby artificially inflating the estimated effect of exposure and reducing the ecological validity of the findings. Another limitation is our reliance on self-report measures of alcohol consumption. In future studies, more accurate measurement of consumption using, for example, ecological momentary assessment methods, could provide greater sensitivity for detecting even small changes in consumption patterns ([Poulton et al., 2018](#_ENREF_41)). In analyses testing for interactions by risky drinking status, we defined low-risk and high-risk drinkers using past week consumption instead of average past 12-month consumption. The measure of past 12-month consumption identifies those drinkers who consumed fewer/more than 2 standard drinks per day on average (i.e., the estimate of their total consumption over the year divided by the number of days in the year). Therefore, it may not capture the primary target audience for the guideline message, which is those whose daily consumption regularly exceeds 2 standard drinks. By comparison, the measure of past week consumption identifies those drinkers who actually drank fewer/more than 2 standard drinks on at least four of the past seven days. Assuming that, on average, an individual’s pattern of drinking over the past week would have somewhat reflected their typical recent pattern of drinking (i.e., consuming (or not) more than 2 standard drinks on most days of the week), then this past week measure may have captured those drinkers more or less likely to perceive the guideline message as being relevant to their current consumption. However, it is possible that some drinkers were misclassified as being low-risk or high-risk drinkers by this measure, due to week-to-week variability in drinking behaviours.

It is also a limitation that we did not measure participants’ baseline awareness of Australia’s low-risk drinking guidelines, although this was avoided to prevent priming respondents to these messages. Prior to advertisement exposure, participants were informed that one standard drink contains 10g of alcohol and they were shown a visual guide of the number of standard drinks in common serving sizes of different alcoholic beverages. However, given that knowledge of how much alcohol comprises a standard drink tends to be poor ([Kerr & Stockwell, 2012](#_ENREF_31)), it is possible that even those who gave a correct estimate of the low-risk drinking level may not possess sufficient understanding of what this means in practice. Recent research in Canada has shown that messages combining definitions of standard drinks with low-risk drinking guidelines are both favourably perceived ([Vallance et al., 2018](#_ENREF_52)) and most effective at increasing drinkers’ ability to accurately estimate the amount of alcohol in a standard drink and the number of standard drinks in different alcoholic beverages ([Hobin et al., 2018](#_ENREF_26)).

***Conclusions***

These results provide additional evidence supporting a campaign strategy that seamlessly incorporates low-risk drinking guideline messages into the end of effective alcohol harm reduction television advertisements, so that drinkers are concurrently provided with compelling reasons to reduce their alcohol consumption and information about the low-risk consumption level they should be aiming for. We recommend that such advertisements increasingly be used by governments and public health agencies to raise awareness of low-risk drinking levels and negative attitudes towards drinking alcohol, which in turn can increase drinkers’ intentions to reduce their alcohol consumption, and potentially, their compliance with the guidelines. Additional benefit may be gained from supplementing these advertisements with more detailed communication about the low-risk drinking guidelines and strategies for reducing consumption. Such campaigns could serve to remedy long-standing deficits in awareness of the low-risk drinking guidelines ([Australian Institute of Health and Welfare (AIHW), 2017](#_ENREF_5); [Bowden et al., 2014](#_ENREF_6); [Bowring et al., 2012](#_ENREF_7); [Coomber et al., 2017a](#_ENREF_12); [Holmes et al., 2016](#_ENREF_27); [Livingston, 2012](#_ENREF_33)), increase knowledge of the long-term health consequences of drinking above the guidelines ([Christensen et al., 2019](#_ENREF_11); [Coomber et al., 2017b](#_ENREF_13); [Pettigrew et al., 2016](#_ENREF_40); [Weerasinghe et al., 2020](#_ENREF_57)), and address persistent consumption of alcohol at high risk levels ([Australian Institute of Health and Welfare (AIHW), 2017](#_ENREF_5)).

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**Table 1.** Pre-exposure demographic and drinking characteristics, post-exposure mediators and follow-up outcomes, overall and by advertisement condition

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Overall  *n* = 1,156 | Non-alcohol (NON-ALC) control advertisements  *n* = 401 | Long-term harm (LTH) advertisements  *n* = 367 | Long-term harm + guideline (LTH+G) advertisements  *n* = 388 | *P*-value1 |
| *Pre-exposure characteristics* | | | | | |
| Sex, % male | 46.7 | 49.1 | 44.1 | 46.7 | 0.38 |
| Age, % |  |  |  |  | 0.96 |
| 18-29 years | 20.4 | 20.2 | 20.2 | 20.9 |  |
| 30-64 years | 79.6 | 79.8 | 79.8 | 79.1 |  |
| Education, % tertiary completed | 71.2 | 68.3 | 74.1 | 71.4 | 0.21 |
| Parent or guardian of child(ren), % | 54.3 | 53.6 | 55.0 | 54.4 | 0.92 |
| Location, % metropolitan | 69.5 | 68.6 | 70.0 | 69.9 | 0.89 |
| Socioeconomic status (SES), % |  |  |  |  | 0.78 |
| Low SES (high disadvantage, 0-40%) | 30.2 | 30.9 | 28.1 | 31.4 |  |
| Mid SES (mid disadvantage, 41-80%) | 44.6 | 44.4 | 46.9 | 42.5 |  |
| High SES (low disadvantage, 81-100%) | 25.3 | 24.7 | 25.1 | 26.0 |  |
| Average number of drinks per day in past 12 months, median (*IQR*) | 0.7 (0.3-1.8) | 0.8 (0.3-1.8) | 0.7 (0.3-1.8) | 0.7 (0.3-1.8) | 0.28 |
| Low-risk drinker based on average consumption over past 12 months (<2 standard drinks per day), % | 77.7 | 75.8 | 79.8 | 77.6 | 0.41 |
| Average number of drinks per day in past week, median (*IQR*) | 0.9 (0.4-2.0) | 0.9 (0.4-2.1) | 0.9 (0.3-1.9) | 1.0 (0.4-2.3) | 0.17 |
| Low-risk drinker based on past week consumption (<2 standard drinks per day on 4 or more days of the week), % | 84.3 | 84.3 | 86.6 | 82.2 | 0.25 |
| Self-perceived high-risk drinker, % | 31.1 | 32.4 | 25.3 | 35.1 | 0.01 |
| Alcohol identity (5-point scale), mean (*SD*) | 2.9 (1.1) | 3.0 (1.1) | 2.8 (1.2) | 3.0 (1.1) | 0.06 |
|  |  |  |  |  |  |
| *Post-exposure mediators* | |  | | |  |
| Correct estimates, % | 70.5 | 64.1 | 70.0 | 77.6 | <0.0001 |
| Negative attitude, mean (*SD*) | 4.47 (1.11) | 4.30 (1.03) | 4.57 (1.16) | 4.55 (1.12) | 0.0009 |
|  |  |  |  |  |  |
| *Follow-up outcomes* |  |  |  |  |  |
| Intention to reduce consumption in the next month, % | 31.7 | 31.7 | 28.3 | 34.8 | 0.16 |
| Consumption below the guideline on 4 or more days in the week between Time 1 and Time 2, % | 87.0 | 86.5 | 88.0 | 86.6 | 0.79 |

*Notes*. *IQR*, interquartile range; *SD*, standard deviation.

1 *P*-values from ANOVA (continuous variables), Kruskal Wallis test (count variables), or chi-square test (categorical variables) comparing the three conditions.

**Table 2.** Natural direct and indirect effects of advertisement condition, through post-exposure correct estimation of harmful drinking levels and negative attitudes, on next month intentions to reduce and alcohol consumption below the guideline measured at 1-week follow-up, *n* = 1,156

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Next month intention to reduce | | Alcohol consumption below the guideline | |
| Advertisement conditions and mediators | Natural direct effect  *OR* (95% *CI*) | Natural indirect effect  *OR* (95% *CI*) | Natural direct effect  *OR* (95% *CI*) | Natural indirect effect  *OR* (95% *CI*) |
| ***LTH vs NON-ALC*** |  |  |  |  |
| Correct estimates | 0.88 (0.62, 1.18) | 1.01 (0.99, 1.06) | 0.85 (0.40, 1.70) | 0.97 (0.83, 1.01) |
| Negative attitudes | 0.86 (0.60, 1.20) | **1.08 (1.02, 1.20)** | 0.82 (0.36, 1.50) | 1.00 (0.87, 1.15) |
| ***LTH+G vs NON-ALC*** |  |  |  |  |
| Correct estimates | 1.08 (0.78, 1.47) | **1.06 (1.01, 1.14)** | 1.21 (0.68, 2.29) | 1.03 (0.89, 1.15) |
| Negative attitudes | 1.08 (0.77, 1.47) | **1.04 (1.00, 1.12)** | 1.28 (0.72, 2.61) | **1.08 (1.00, 1.27)** |
| ***LTH+G vs LTH*** |  |  |  |  |
| Correct estimates | 1.23 (0.89, 1.72) | **1.04 (1.00, 1.11)** | 1.32 (0.68, 2.80) | 1.02 (0.94, 1.11) |
| Negative attitudes | 1.26 (0.91, 1.80) | 1.00 (0.96, 1.03) | 1.44 (0.72, 3.26) | 0.99 (0.91, 1.04) |

*Notes.* *OR*, odds ratio; NON-ALC, advertisements unrelated to alcohol (control condition); LTH, advertisements portraying the long-term harms of alcohol; LTH+G, advertisements portraying the long-term harms of alcohol plus low-risk drinking guideline message. All models were adjusted for covariates measured at baseline: sex, age, average number of drinks per day in the past 12 months, consumption of ≤2 drinks on 4 or more days in the past week, self-perceived risky drinking status, alcohol identity, and number of days between Time 1 and 2.

**FIGURES**



**Figure 1.** Associations between advertisement conditions, mediators, and 1-week post-exposure intention to reduce alcohol consumption in the next month, *n* = 1,156.

Advertisement conditions: (**A**) long-term harm (LTH) vs non-alcohol (NON-ALC) control advertisement condition, (**B**) long-term harm + guideline (LTH+G) vs non-alcohol (NON-ALC) control advertisement condition, and (**C**) long-term harm + guideline (LTH+G) vs long-term harm (LTH) advertisement condition.

All models were adjusted for covariates measured at baseline: sex, age, average number of drinks per day in the past 12 months, consumption of <2 drinks on 4 or more days in the past week, self-perceived risky drinking status, alcohol identity, and number of days between Time 1 and 2. Models for relationships of a mediator with the outcome were in addition adjusted for the other mediator.

\* *p* <0.05



**Figure 2.** Associations between advertisement conditions, mediators and alcohol consumption below the LTH guideline on most days (≥4 days) in the week before follow-up, *n* = 1,156.

Advertisement conditions: (**A**) long-term harm (LTH) vs non-alcohol (NON-ALC) control advertisement condition, (**B**) long-term harm + guideline (LTH+G) vs non-alcohol (NON-ALC) control advertisement condition, and (**C**) long-term harm + guideline (LTH+G) vs long-term harm (LTH) advertisement condition.

All models were adjusted for covariates measured at baseline: sex, age, average number of drinks per day in the past 12 months, consumption of <2 drinks on 4 or more days in the past week, self-perceived risky drinking status, alcohol identity, and number of days between Time 1 and 2. Models for relationships of a mediator with the outcome were in addition adjusted for the other mediator.

\* *p* <0.05

**SUPPLEMENTARY MATERIAL**

**Supplementary Table 1.** Pre-exposure demographic and drinking characteristics, post-exposure mediators, and follow-up outcomes, by risky drinking status

|  |  |  |  |
| --- | --- | --- | --- |
|  | Low-risk drinkers  (≤2 drinks on ≥4 days of the past week)  *n* = 975 | High-risk drinkers  (>2 drinks on ≥4 days of the past week)  *n* = 181 | *P*-value1 |
| Sex, % male | 43.9 | 61.9 | <0.0001 |
| Age, % |  |  | 0.001 |
| 18-29 years | 22.1 | 11.6 |  |
| 30-64 years | 77.9 | 88.4 |  |
| Education, % tertiary completed | 71.5 | 69.6 | 0.61 |
| Parent or guardian of child(ren), % | 54.6 | 53.0 | 0.71 |
| Location, % metropolitan | 71.1 | 60.8 | 0.006 |
| Socioeconomic status (SES), % |  |  | 0.17 |
| Low SES (high disadvantage, 0-40%) | 29.2 | 35.4 |  |
| Mid SES (mid disadvantage, 41-80%) | 45.6 | 38.7 |  |
| High SES (low disadvantage, 81-100%) | 25.1 | 26.0 |  |
| Average number of drinks per day in past 12 months, median (*IQR*) | 0.7 (0.3-1.2) | 3.5 (2.8-5.5) | <0.0001 |
| Low-risk drinker based on average consumption over past 12 months (<2 standard drinks per day), % | 88.8 | 17.7 | <0.0001 |
| Average number of drinks per day in past week, median (*IQR*) | 0.7 (0.3-1.4) | 4.0 (3.1-5.6) | <0.0001 |
| Low-risk drinker based on past week consumption (<2 standard drinks per day on 4 or more days of the week), % | 100.0 | 0.0 | <0.0001 |
| Self-perceived high-risk drinker, % | 22.9 | 75.1 | <0.0001 |
| Alcohol identity (5-point scale), mean (*SD*) | 2.8 (1.1) | 3.5 (0.9) | <0.0001 |
|  |  |  |  |
| *Post-exposure mediators* | | | |
| Correct estimates, % | 74.3 | 50.3 | <0.0001 |
| Negative attitude, mean (*SD*) | 4.23 (1.18) | 4.52 (1.09) | 0.002 |
|  |  |  |  |
| *Follow-up outcomes* |  |  |  |
| Intention to reduce consumption in the next month, % | 30.4 | 38.7 | 0.03 |
| Consumption below the guideline on 4 or more days in the week between Time 1 and Time 2, % | 96.2 | 37.6 | <0.0001 |

*Notes.* *IQR*, interquartile range; *SD*, standard deviation.

1 *P*-values from *t*-test (continuous variables), Kruskal Wallis test (count variables), or chi-square test (categorical variables) comparing low-risk and high-risk drinkers.

**Supplementary Table 2.** Natural direct effects of advertisement condition on 1-week post-exposure intention to reduce the amount of alcohol consumption in the next month through post-exposure correct estimation of harmful drinking levels and negative attitudes, *n* = 1,156

|  |  |  |
| --- | --- | --- |
| Advertisement conditions and mediators | Low-risk drinkers  (≤2 drinks on ≥4 days of the past week)  *n* = 975 | High-risk drinkers  (>2 drinks on ≥4 days of the past week)  *n* = 181 |
| *OR* (*95% CI*) | *OR* (*95% CI*) |
| ***LTH+G vs NON-ALC*** |  |  |
| Correct estimates | 0.96 (0.66, 1.32) | **2.18 (1.04, 5.36)** |
| Negative attitudes | 0.95 (0.68, 1.33) | 1.98 (0.89, 4.86) |
| ***LTH+G vs LTH*** |  |  |
| Correct estimates | 1.06 (0.76, 1.55) | **3.80 (1.51, 11.38)** |
| Negative attitudes | 1.09 (0.80, 1.61) | **3.56 (1.33, 9.93)** |

*Notes.* *OR*, odds ratio; NON-ALC, advertisements unrelated to alcohol (control condition); LTH, advertisements portraying the long-term harms of alcohol; LTH+G, advertisements portraying the long-term harms of alcohol plus low-risk drinking guideline message. All models were adjusted for covariates measured at baseline: sex, age, average number of drinks per day in the past 12 months, consumption of ≤2 drinks on 4 or more days in the past week, self-perceived risky drinking status, alcohol identity, and number of days between Time 1 and 2.