

Impact of Labeled Glasses in a Bar Laboratory Setting: No Effect on Ad Libitum Alcohol Consumption

Natasha Clarke  and Abigail K Rose

Aims: Information provided on glass labels may be an effective method to reduce alcohol consumption. The aim of this study was to assess the impact of glass labels conveying unit information and a health warning in reducing ad libitum alcohol consumption.

Methods: A cluster-randomized experimental study was conducted to measure the efficacy of a labeled glass in reducing alcohol consumption in a semi naturalistic bar laboratory setting, in a sample of 81 pairs ($n = 162$) of UK young adult drinkers. Pairs were randomized to receive two 340-ml glasses of beer or wine: labeled or plain (control). Alcohol consumption was assessed in an ad libitum drinking period, and urge to drink was measured at baseline and postdrinking period. Focus groups ($n = 2$) were conducted, and thematic analysis was used to gain an insight into the acceptability and the perceived effectiveness of the glasses.

Results: Mean unit consumption was 1.62 (SD \pm 0.83) units in the labeled glass condition and 1.69 (SD \pm 0.82) units in the non labeled glass condition. There were no significant effects of the labeled glasses on ad libitum alcohol consumption (95% CI -0.25 to 0.37 , $p = 0.35$), despite participants (85%) noticing the information. Qualitative analysis of focus groups indicated that although participants perceived the glasses as a useful tool for increasing awareness of units and guidelines, they were viewed as limited in their potential to change drinking behavior due to the unappealing design of the glass and a view that unit guidelines were not relevant to drinking patterns or contexts.

Conclusions: Labeled glasses did not change alcohol consumption in the current study, potentially due to ineffectiveness of this type of message in a young adult population. The information on the glasses was attended to, highlighting that glasses could be a feasible tool for providing information.

Key Words: Alcohol, Drinking, Consumption, Urge, Labeling, Alcohol Unit Labels, Labeled Glasses.

EXCESSIVE ALCOHOL CONSUMPTION increases the risk of chronic harms, including liver disease, heart disease, and some cancers (Rehm, Guiraud, Poulmais, and Shield, 2018), and acute harms, such as violence and injuries (WHO, 2018). Labeling alcohol products is one potential method to reduce excessive alcohol consumption. Globally, alcohol labels may include unit information, health messages regarding risks of drinking (e.g., while pregnant or drink-driving), or a general health risk message (International Alliance for Responsible Drinking [IARD], 2019). A unit or standard drink is generally defined as a notional drink that contains a

specified amount of pure alcohol (Mongan & Long, 2015), although official terms and definitions vary across countries (Cooper, 1999; Furtwängler and de Visser, 2013). Given the variability of percent alcohol by volume (%ABV) within beverage type, the range of standard pour sizes in licensed premises, and nonstandard pour sizes in alcohol consumed away from licensed premises, the concept and measurement of units can be confusing (Kerr William and Stockwell, 2011).

A review of studies from Australia, Canada, and Europe highlighted that awareness of the concept of a standard drink or unit had increased since 1993, but their impact on drinking behavior is unclear and requires further exploration (Kerr William and Stockwell, 2011). Many individuals overestimate how many units constitute sensible drinking and bingeing (Cooke et al., 2010), over pour units (Boniface et al., 2012), and few monitor the number of units they drink (Furtwängler and de Visser, 2017a; Wilkinson et al., 2009). For those that do monitor, alcohol intake is often measured in number of drinks rather than units (Lovatt et al., 2015). To be able to monitor and ultimately reduce alcohol consumption, individuals not only need to possess accurate knowledge of current guidelines, but also need to understand how many units are in a given drink (de Visser, Brown, Cooke, Cooper, and Memon, 2017).

In the UK in 1987, the concept of alcohol units (1 unit = 10 ml/8 g of ethyl alcohol) was introduced into the

From the University of Cambridge Institute of Public Health, (NC), Cambridge, UK; and Department of Psychological Sciences, (NC, AKR), University of Liverpool, Liverpool, UK.

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Reprint requests: Natasha Clarke, University of Cambridge Institute of Public Health, Forvie Site, Cambridge CB2 0SR, UK; Tel.: +44 (0) 12237 62565.

Email: ncc42@medschl.cam.ac.uk

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public forum as a method to monitor alcohol consumption and to encourage individuals to make informed choices about their drinking (Stockwell and Stirling, 1989). One pledge in the latest UK Government's Alcohol Strategy (HM Government, 2012) aimed at reducing alcohol-related harm was improved alcohol labeling on product packaging, including details on unit content and unit guidelines. Only alcohol strength is mandatory in the UK, but health warnings or unit content may be included through voluntary, industry-led agreements (IARD, 2019). However, evidence suggests that these labels have little impact on drinking behavior (Knai, Petticrew, Durand Mary, Eastmure, and Mays, 2015; Stockwell and Stirling, 1989; Wilkinson et al., 2009).

In 2016, new guidelines for alcohol consumption were introduced in the UK (Department of Health, 2016) recommending men and women are safest consuming 14 units a week or less. Prior to this, guidelines stated that men should not exceed 3 to 4 units per day and women should not exceed 2 to 3 per day, with a maximum of 21 units and 14 units per week, respectively (Department of Health, 2011). A recent survey of 972 UK drinkers found that 71% of participants were aware that new alcohol guidelines existed, but only 8% knew what the recommended limits were (Rosenberg et al., 2017). In a review, size, visibility, and location of the information on labels were highlighted as important factors for their potential impact (Wettlaufer, 2018).

One factor that potentially contributes to a lack of understanding regarding what a unit of alcohol is comes from the fact that a substantial amount of alcohol consumption does not involve the consumer seeing the drink's packaging (e.g., on trade consumption in pubs and bars—where drinks are often provided in glasses—covered just under 50% of total beer consumption in the UK in 2017 (The Brewers of Europe, 2018)). Additionally, despite the introduction of the new unit guidelines in 2016, a recent assessment found only 24 labels out of 320 informed consumers of the updated 14 units per week guidelines (Alcohol Health Alliance (AHA) 2018). Therefore, alcohol warnings and/or information should be available beyond the original packaging (Wilkinson et al., 2009). Additionally, research indicates that information provision strategies can be effective if the user engages with the information—which may be more likely at the point of consumption (Clarke, Field, and Rose, 2015). A study by Maynard and colleagues (2018) failed to show an effect of providing unit and calorie information on alcohol consumption, although the study was conducted in an artificial environment (a neutral laboratory) and the drink information was provided on a slip of paper. In real-life settings, information is unlikely to be presented in this format; an alternative method would be to use something relevant to the behavior (e.g., the glass). This is supported by the findings that volume information on glassware can reduce consumption rate of alcoholic beverages (Troy et al., 2016), and warning labels printed on individual cigarettes can reduce a cigarette's desirability (Moodie et al., 2019). In the first study

to investigate the influence of “unit-labeled glasses” on consumption (de Visser et al., 2017), participants received glasses with unit marks for beer, wine, and spirits and were instructed to use these glasses to pour their drinks at home. Results indicated that the glasses increased knowledge of units but there were no reported reductions in consumption; however, this study was not randomized and relied on self-report data which can be an unreliable measure of consumption (Northcote and Livingstone, 2011). Labeled glasses are yet to be evaluated in a controlled, randomized setting using an objective consumption measure.

In this paper, we report a cluster-randomized experimental study, determining the behavioral impact of a marketed labeled glass (with unit markings and a health warning) on alcohol-related outcomes (ad libitum consumption and urge to drink) compared with a non labeled glass (control). Participants were a UK young adult—majority student—population. To increase the applicability of the results to real-life drinking scenarios, we tested participants in friendship pairs (most drinking behavior in this age-group is social (NUS, 2018) and in a semi naturalistic bar laboratory. We hypothesized that drinking outcomes—amount of alcohol consumed and changes in urge to drink alcohol—would be reduced in the label, compared with the control (plain), glass condition. Two focus groups were conducted in a separate sample of participants from the same population to investigate acceptability and perceived effectiveness of the labeled glasses.

MATERIALS AND METHODS

Study Design

A mixed-methods approach was used, consisting of a between-subjects cluster-randomized experimental study and 2 qualitative focus groups.

Participants

One hundred and sixty-two young adult participants (84 females; mean age 22.21 years, $SD \pm 3.63$) were recruited in pairs (i.e., friends) and tested in a bar laboratory in the University of Liverpool. Inclusion criteria were fluency in English and at least weekly consumption of alcohol (1 UK unit = 10 ml/8 g of ethyl alcohol), to ensure there were no adverse effects of the alcohol provided. Each pair was randomly assigned to either the marketed labeled glass or a non labeled plain glass condition and could choose to consume either beer or wine, with both pairs consuming the same beverage type. Pairs consumed the same beverage to avoid matched drinking in volume for different beverage types, that is, volume of beverage provided differed for beer and wine due to differences in strength. All studies obtained ethical approval from the University of Liverpool ethics committee, and all participants provided informed consent. All participants were fully debriefed and compensated for their time.

Sample Size Calculation. As the sample was recruited in pairs and previous research shows pairs imitate drinking (Larsen, Engels, Granic, and Overbeek, 2009), we expected the data to be clustered. The design effect formula (Ukoumunne et al., 1999) was used to calculate the sample size using an intraclass correlation of 0.6 based on previous research on the consumption of alcohol after exposure to

alcohol cues versus no cues (Koordeman, Kuntsche, Anschutz, van Baaren, and Engels, 2011). We aimed for 170 participants (85 pairs), as this was the maximum that could be feasibly recruited. However, 8 participants were excluded upon arrival due to not meeting inclusion criteria, and due to available resources, we could not continue data collection. With alpha at 0.05 and power at 0.8, a sample size of 162 would detect a medium (Cohen's $d = 0.5$, 164 participants required) to large effect (Cohen's $d = 0.8$, 68 participants required).

Self-Report Measures

Alcohol Use Disorders Identification Test (AUDIT) (Saunders John et al., 2006). The AUDIT is a 10-item clinical screening tool used to identify hazardous (score 8 to 15) and harmful (score ≥ 16) alcohol use. In students, the AUDIT has been shown to have good internal consistency as a single factor (Cronbach's $\alpha = 0.82$; Shields, Guttmanova and Caruso, 2004) and high test-retest reliability (Dybek et al., 2006).

Timeline Followback Questionnaire (TLFB) (Sobell, Sobell, Klajner, Pavan, and Basian, 1986). The TLFB is a 2-week self-report measure which estimates weekly alcohol consumption in UK units and binge frequency (binge defined as: ≥ 8 units p/drinking episode in men and ≥ 6 units p/drinking episode in women) (NICE, 2010). The correlation coefficients range from 0.75 to > 0.90 (Cohen and Vinson, 1995; Sobell et al., 1986) for TLFBs (> 4 weeks), showing a relatively high test-retest reliability.

Readiness-to-Change Contemplation ruler (RTC ruler) (LaBrie et al., 2005). The contemplation ruler is a single-item continuum measuring an individuals' readiness to change their drinking behavior from 0 to 10, with 0 representing the statement "I never think about my drinking" and 10 representing the statement "My drinking has changed. I now drink less than before." The single-item ruler is highly correlated with the multiple-item RTC questionnaire ($r = 0.77$) (LaBrie et al., 2005).

Unit Glass Evaluation. Those in the labeled glass condition were asked questions regarding the glass: (a) "Did you notice the unit and warning label?" (b) "Do you think it had an effect on how much alcohol you consumed?" (c) "Do you think these glasses could be useful in getting people to drink less?" Responses to questions were "yes," "no," or "unsure." Participants were also given the opportunity to provide open-ended feedback.

Outcome Measures

Alcohol Consumption (Primary Outcome). The alcohol provided was either an 880-ml jug of beer (4% ABV [Fosters], maximum consumption = 3.6 units/28.8 g of alcohol) or a 500-ml carafe of white wine (white wine [Echo Falls light], 5.5% ABV, maximum consumption = 2.8 units/22.4 g of alcohol). Low alcohol beverages were used to ensure participants could consume a reasonably high volume in the given time period. The low alcohol wine was selected based on piloting, in which a selection of 6 light wines was rated on pleasantness and comparability to more typical stronger wines. Amount of alcohol consumed was measured in milliliters and converted to units for the primary outcome measure.

Alcohol Urge Questionnaire (Secondary Outcome) (Bohn, Krahn, and Staehler, 1995). This is an 8-item measure that assesses current craving. The 8 items cover urges and desires, intent, anticipation of positive affects, and relief of negative affects (Drummond and Phillips, 2002). Items are scored across a 7-point Likert scale, with higher scores indicating higher urge. The Alcohol Urge Questionnaire demonstrates high internal consistency in numerous studies ($\alpha = 0.91$, Bohn et al., 1995; $\alpha = 0.93$, Drummond and Phillips, 2002; $\alpha = 0.86$, MacKillop, 2006) and good test-retest reliability (Bohn et al., 1995).

Materials

Labeled Glasses. The unit measure glass was introduced as a tool by the charity "Drink Wise" to encourage individuals to calculate and monitor how many units are in a variety of drinks (see Fig. 1). The glasses were available for the public or organizations to order through the charity website. Plain (control) non labeled glasses matched the labeled glasses in terms of size and shape. The total volume of the glasses was 340 ml. The glasses display unit guidelines for both men and women—these are based on the previous guidelines of 3 to 4 units per day for men and 2 to 3 units per day for women. They also displayed a small health warning "regularly exceeding these guidelines could lead to serious health problems."

Procedure

Testing took place in a semi naturalistic bar laboratory. All participants were required to provide a zero breath alcohol reading (0.00 mg/l) prior to the study session. Participants completed the battery of questionnaires (AUDIT, TLFB, RTC, and baseline urge) before the main experimental task. Participant pairs were provided with either beer or wine (depending on the pair's preference) and either a labeled glass or a non labeled plain glass, with each pair receiving the same glass and the same beverage type. Participants were instructed to pour the alcohol into the glass and consume as much as they wanted to. To ensure this instruction was followed, participants were told that they would be filmed during the experiment. The researcher left the laboratory and returned after a 20-minute ad libitum drinking period. This time period is longer than typically given in the commonly used taste test paradigm (see Maynard et al., 2018) and is a more ecologically valid scenario. To disguise the true aims of the study, it was advertised as an "alcohol and sociability study" and participants were given a sociability task. In the task, participants were required to discuss recent media stories to create a "pub-like" conversation. Participants completed a second urge assessment and provided a final breathalyzer reading. Those in the labeled glass condition answered questions about their views of the glasses, including their perceived potential impact. If breath alcohol concentration scores were over 0.17 mg/l (half the U.K. legal driving limit), participants were advised to stay in the laboratory or signed a waiver to confirm they were aware of their level of intoxication and would not drive or operate machinery for the remainder of the day.

Data Analysis

Model diagnostics were checked (i.e., normality tests, QQ plots), and data were transformed (square rooted) to improve normality. There were no extreme outliers apparent. For descriptive characteristics, MANOVA was used to report differences between groups. For the primary outcome of units consumed, leftover drinks were measured and subtracted from total volume to calculate total volume consumed. Total consumption in UK units was calculated by multiplying the volume consumed (in Liters) with ABV. To account for clustering, within-pairs multilevel regression modeling was used for analysis, conducted in MLwiN 2.3 (Rasbash et al., 2010). Data were organized into 2 levels, with individuals nested in pairs. Level 1 predictors were drinking characteristics of individuals, and the Level 2 predictor was the condition (labeled/non labeled). We examined whether condition (labeled/plain glass) was related to units consumed (primary outcome) or change in urge (posturge—baseline urge, secondary outcome).

Focus Groups

Two focus groups were conducted at the University of Liverpool with 17 participants (8 females; mean age 21.46 [SD \pm 7.16]) to



Fig. 1. Labeled glasses, used in study 1. Labels contained daily guidelines for men and women, the number of units in common drinks of various % ABV, and a health warning: “regularly exceeding these guidelines could lead to serious health problems.”

Table 1. Study 1 Means (95% CI) and MANOVA for Participant Characteristics by Condition ($N = 162$)

Variable	Mean scores (95% CI) ^a			MANOVA	
	Labeled (82)	Non labeled (80)	Overall (162)	<i>F</i> (df)	<i>p</i>
Gender (% female)	52	51	52	–	–
Age (y)	22.06 (21.32, 22.81)	22.37 (21.65, 23.44)	22.30 (21.72, 22.88)	0.64 (1, 160)	0.43
AUDIT (0 to 40)	13.55 (12.49, 14.62)	14.71 (13.42, 16.00)	14.13 (13.30, 14.96)	1.64 (1, 160)	0.20
Weekly units (TLFB)	26.58 (22.79, 30.37)	26.25 (22.89, 29.62)	26.42 (23.91, 28.93)	0.00 (1, 160)	0.10
Weekly binge (units)	1.62 (1.37, 1.87)	1.54 (1.32, 1.75)	1.58 (1.42, 1.74)	0.23 (1, 160)	0.63
RTC ruler	3.18 (2.56, 3.79)	3.58 (3.00, 4.17)	3.38 (2.95, 3.80)	1.06 (1, 160)	0.31

AUDIT, Alcohol Use Disorders Identification Test; RTC ruler, Readiness-to-Change ruler; TLFB, Timeline Followback; Weekly binge, number of binge drinking episodes per week.

^aUnless stated otherwise.

investigate the acceptability and perceived effectiveness of the labeled glasses. Participants were young adult drinkers, and an exclusion criterion was previous participation in the experimental study. The focus group data were transcribed and coded, and key themes were identified using thematic analysis. The focus groups were divided into 2 parts, the first part focused on drinking motivations (associated with a separate study), and in the second part, participants were shown the labeled glasses and asked their opinion on these. Data related to drinking motives can be found in the Appendix S1.

RESULTS

Participant Characteristics

Descriptive statistics are presented in Table 1. MANOVA indicated groups were well-matched, not statistically differing on any factors (all $p > 0.10$). Pairs were well-matched in their self-reported weekly alcohol consumption ($r = 0.45$, $p = 0.001$).

Of the 162 participants, 2 guessed the aim of the study. When conducting the analysis with and without these

participants, findings did not differ, so they were included in the final sample.

Alcohol Consumption

There was an intraclass correlation of $r = 0.80$, $p = 0.001$, indicating that the majority of the variance was between pairs. Males consumed more alcohol ($M = 2.05$, $SD \pm 0.82$) than females ($M = 1.29$, $SD \pm 0.62$), $F(1, 161) = 44.24$, $p < 0.001$, $\eta_p^2 = 0.28$ (see Table 2). There were no significant differences between amount of wine ($M = 1.59$, $SD \pm 0.72$) and amount of beer ($M = 1.72$, $SD \pm 0.90$) consumed ($p = 0.22$). The results of the multi-level modeling indicated there was no significant main effect of condition, indicating participants did not differ in their drinking by glass type ($B = 0.06$ [95% confidence interval: -0.25 to 0.37], standard error = 0.16 , $p = 0.35$). This nonsignificant effect remained when controlling for gender and drinking characteristics (weekly consumption, AUDIT scores, and RTC).

Table 2. Primary and Secondary Outcome Means (95% CI)

	Labeled (82)	Non labeled (80)	Overall (162)
Primary outcome: Units consumed	1.62 (1.44, 1.81)	1.69 (1.51, 1.87)	1.66 (1.53, 1.78)
Secondary outcome: Change in Urge	4.48 (2.20, 6.76)	4.86 (2.76, 6.96)	4.67 (3.13, 6.20)

Alcohol Urge

Results indicated there were no significant differences between groups in urge at baseline ($p = 0.50$) (see Table 2). There was no significant main effect of condition on change in alcohol urge ($B = 0.02$ [95% CI: -0.15 to 0.19], $SE = 0.09$, $p = 0.41$). This nonsignificant effect remained when controlling for gender and drinking characteristics (weekly consumption, AUDIT scores, and RTC).

Unit Glass Evaluation

Answers indicated that the majority (85%) of participants noticed the unit and warning labels on the glass and did not believe these influenced their intake (80%). In terms of their potential for getting individuals to drink less, 35% believed they could be useful, 30% did not, 17.5% were unsure, and 17.5% of participants believed they would be useful for certain people. In the open-ended feedback, many participants commented that they disliked the design of the labeled glass, specifically that there was excessive information, and the glasses were not a typical size or shape.

Focus Groups

Thematic analysis was used to analyze the data, with NC following the 6 steps set out by Braun and Clarke (2006). Coding was carried out in NVivo. In phase 1 (familiarizing with the data), NC became familiar with the data through transcribing, repeated reading, and marking initial ideas for coding to return to in subsequent phases. Once familiar with the data, NC generated initial codes (phase 2) from the initial list of ideas. This was conducted by working systematically through the entire data set, giving attention to each data item, and identifying repeated patterns in the data. NC then searched for potential themes (phase 3), by collating the list of different codes identified across the data set. These themes were then reviewed by both authors (NC and AR) until 100% agreement was reached (phase 4). In this phase, authors assessed whether the themes were in line with the initial codes, and then, it was ensured that the themes reflected the data set as a whole. The themes were then defined and named by both authors (phase 5) before being written up (phase 6). The 5 themes identified from the data were as follows: knowledge and use of alcohol-related information, perceived impact of labels on drinking behavior, drinking context, acceptability, and unintended use.

Knowledge and Use of Alcohol-Related Information. Participants reported that they rarely kept track of their unit consumption. Although many were knowledgeable concerning current guidelines, most did not utilize this knowledge to reduce their drinking and any monitoring of consumption was “purely out of curiosity” (male). It was highlighted that using the unit system was confusing and unrealistic:

It’s a little bit complicated to work out. . . . I wouldn’t just get a shot. . . . sometimes when you order that they don’t put a single in they put a double in and you’re not sure. Wine can be different strengths, it might not always be 12% (male).

There was limited concern with reducing intake, and participants identified that guidelines were not relevant to their drinking behavior. For example, one participant felt the guidelines were only there for a certain type of drinker:

I think the guidelines are for someone who drinks every day, but doesn’t drink that much and there should be other guidelines as well for different types of drinkers (male).

Perceived Impact of Labels on Drinking Behavior. Generally, participants felt that the unit information provided on the glasses would be useful to know how much alcohol they were consuming and to monitor intake to determine how many drinks were “normal” for them. Participants did not think they would be useful for trying to consume within guidelines:

I think I would probably try and do drinks a bit more precisely. I don’t know if I would drink less, but I think it would be useful (female).

Other participants did not think unit guidelines and health risks would be taken seriously due to the regularity of viewing the message:

It’s nothing we don’t know already, and that has been communicated to us by lots of different mediums (female).

Overall, despite perceiving the glasses as unlikely to change behavior, participants believed it was beneficial to give individuals as much information as possible and that having the information was “probably more effective there in front of you” (female) as a reminder with each drink. Participants believed the glasses would be particularly beneficial for behavior change in certain populations, such as those seeking to reduce their drinking, or concerned about health risks, as well as older individuals.

Drinking Context. Participants emphasized that the potential effectiveness of the labeled glass might decrease once individuals start drinking due to the positive reward drinking provided and that good intentions might decrease with each drink:

After 6 pints, the apocalypse wouldn't be a deterrent for me. Binge drinking seems to go like that. . . that's the thing with alcohol, you can give a tonne of information, but once the intake is enough all the information is irrelevant (male).

In addition, it was suggested that the information may not be attended to due to individuals having a preexisting motive to get intoxicated:

I don't think people would pay a lot of attention. People just go out to drink. I think they'd just do that to be honest (male).

Acceptability of the Glass Labels. One view from participants regarding the glasses was that they were not aesthetically pleasing. Participants disliked the logo and the size and shape of the glass, highlighting the connection participants have between a glass and a given drink:

I wouldn't be content drinking a glass of wine from this (female).

Participants also felt the glass looked too educational, "patronising," and overloaded with information:

It is a bit too educational, that it's off putting. And a bit embarrassing so (female).

Unintended Use. Participants highlighted that there was the potential for the glass to be used in an unintended way, particularly in a student population, that is, used to exceed guidelines purposefully, at house parties, in competitions, or challenges:

I think people would use it as a challenge. . . like a club, if you're drunk and everyone's like let's see how much units you can drink (male).

DISCUSSION

The current study assessed whether glass labels—providing information on alcohol units and a health warning—would reduce consumption during a semi naturalistic drinking event. We found no evidence that labeled, compared to plain, glasses reduced ad libitum alcohol consumption or urge.

Our findings add to the existing evidence that providing unit information at the point of consumption, irrespective of how the information is presented, does not reduce alcohol consumption or drink choice (Blackwell, Drax, Attwood, Munafò, and Maynard, 2018; Maynard et al., 2018; de Visser et al., 2017). They also add to previous research that highlights alcohol units are perceived as an abstract concept that is often poorly understood (Maynard et al., 2018). The glasses displayed a health warning alongside unit information, but this was much smaller in comparison with the unit-related text. In addition, the warning did not highlight

specific health risks, and research indicates that general health warnings might be less effective than specific warnings (Pettigrew et al., 2014). Labels similar to this warning—in terms of content and size—have been shown to increase awareness, but evidence suggests they do not change behavior (Kerr William and Stockwell, 2011; Wilkinson et al., 2009). Although not measured in the current study, future research would benefit from also measuring changes in potential precursors to behavior change. For example, unit information may have an indirect behavior and may alter knowledge or attitudes toward drinking, which in the long term may lead to shifts in behavior (Marteau, 2016; de Visser et al., 2017).

The focus groups provided some insight into why unit labels might not be effective in reducing alcohol consumption. Most participants highlighted that the information could be of use for monitoring consumption but that it was unlikely to be used to consume within the guidelines, supporting findings from other focus group studies with student samples (Furtwängler and de Visser, 2017b). Additionally, although in the current study all participants were required to provide a zero breathalyzer prior to testing, participants recognized that context is important, and—once intoxicated—information may have less of an impact on behavior. It is well-known that alcohol influences cognitive processes involved in decision making and disinhibition which can increase risky behaviors (Fillmore, 2003), which may attenuate any impact of alcohol information. We would suggest that any future work assessing the effectiveness of harm reduction techniques might include assessment when the participant is sober and intoxicated.

Participants also highlighted that the glasses were not particularly aesthetic and they would be unlikely to use them in many contexts; therefore, future labeled glass designs should focus on visual appeal alongside information provision. Concerns were raised—that in real-life settings—labels could be used to drink more. This is in line with a number of studies which find that harm reduction strategies can have unintended consequences. For instance, Maynard and colleagues (2018) found that unit and calorie information could facilitate selection of higher strength drinks, while Vasiljevic and colleagues (2018) found increased consumption if alcohol was labeled as lower strength. Although this should not deter providing accurate information to consumers, development of harm reduction techniques needs to determine the potential for unwanted and harmful effects (Vasiljevic et al., 2018).

Another key point raised in the focus groups was that participants perceived unit information as confusing and guidelines as unrealistic. It is possible that presenting different types of information on labels may have increased impact on behavior. There have been recent recommendations from public health bodies for improved warnings on alcohol packaging (Royal Society for Public Health [RSPH]; 2018 Department of Health, 2018) as well as nutritional information (RSPH, 2014; WHO, 2017). A recent assessment of alcohol products found that only 1.3% of those included

provided calorie information (Petticrew et al., 2017). Although one study found no effect of providing calorie information on a slip of paper on consumption (Maynard et al., 2018), the impact of calorie or nutritional labeling in different forms—such as on packaging or glassware—should be further researched. This may be more relevant to younger populations who are more concerned over short-term, more visible, consequences (Leigh and Stacy, 2004). Other types of information may include potential negative health consequences; recently, research has shown some potential for highlighting increased cancer risk from drinking in a sample of adults older than those in the current study (mean age: 35 years) (Blackwell et al., 2018).

To our knowledge, this is the first cluster-randomized study in a semi naturalistic environment that investigates the impact of glass labels on ad libitum consumption. A strength of the study is the utilization of glasses to present information in naturalistic drinking environment. Glasses are a feasible and relatively easy tool for presenting guidelines and warnings, and it has been suggested that if alcohol is to follow in the footsteps of cigarette packaging, then the time may have come for standardized, nonbranded, measure-marked glassware with large harm reduction messages (Stead, Angus, Macdonald, and Bauld, 2014).

This study has some limitations. First, the study measured drinking over a short period, although a relatively high number of units were consumed in the time period. Future research should assess the impact of these strategies over longer periods, for instance a recent field study determined the impact of serving size on consumption over a 3-hour drinking session (Kersbergen et al., 2018). Second, participants were only exposed once to the glasses and this exposure was relatively brief. There is a possibility that the glasses may have delayed behavioral effects, with behavior change only occurring after regular exposure to relevant information. This, however, may be unlikely given that previous work has found no change in drinking with similar glasses after repeated exposure (de Visser et al., 2017). In the current study, the majority of participants indicated that they noticed the labels; however, they may not have fully engaged with the information—particularly as they were tested in pairs and were encouraged to take part in a discussion. Although we could have increased participant engagement with the glasses, we would argue that the current design is more similar to how the glasses would be engaged with in real-life scenarios. Third, the sample size was relatively small and powered to find between a medium and large effect. The effect size demonstrated in the study was very small (Cohen's $d = 0.07$ for the primary outcome) and was not statistically significant. There is a possibility that an effect of this magnitude could still have meaningful public health effects at a population level and future larger-scale studies may be able to provide a more accurate estimation of the true effect size. Finally, the sample was of university students, and although other studies have similar samples (Wigg and Stafford, 2016), younger individuals who consume alcohol at harmful

levels may not be seeking to change their drinking behavior (Longstaff et al., 2014). This is supported by low average scores on the Readiness-to-Change ruler in the current sample. Participants highlighted in the focus groups that the labeled glasses may be beneficial in other populations who are ready to cut down—it would be useful for future studies to assess impact of strategies in different populations (e.g., older drinkers and those wanting to reduce their consumption).

This cluster-randomized and novel experimental study adds to the sparse research on labeled glasses and their impact on drinking behavior. The evaluation of labeled glasses is an important focus given the recent update in unit guidelines and the continued public health emphasis on monitoring unit consumption. Glasses may be a feasible tool for presenting information, and future studies should look at the impact of labeled glasses on consumption over longer periods and with larger, more diverse samples of participants. However, in the current study, the labeled glass—including unit information and a health warning—had no impact on ad libitum consumption in students.

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AUTHOR CONTRIBUTIONS

Both authors contributed to the conception and design of the study. N.C. managed the day-to-day running of the study and testing of participants. N.C. performed the data analysis, and both authors helped with data interpretation. This manuscript was written by N.C. with input from A.R. Both authors read and approved the final version of the manuscript.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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SUPPORTING INFORMATION

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

Appendix S1. Supplementary material.