Alcohol, calories and obesity: A rapid systematic review and meta-analysis of consumer knowledge, support and behavioural effects of energy labelling on alcoholic drinks

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**Abstract**

Mandatory energy (calorie) labelling of alcoholic drinks is a public health measure that could be used to address both alcohol consumption and obesity. We systematically reviewed studies examining consumer knowledge of the energy content of alcoholic drinks, public support for energy labelling and the effect of energy labelling of alcoholic drinks on consumption behaviour. Eighteen studies were included. Among studies examining consumer knowledge of the energy content of alcoholic drinks (N=8) and support for energy labelling (N=9), there was moderate evidence that people are unaware of the energy content of alcoholic drinks (pooled estimate: 74% [95% CIs 64-82%] of participants inaccurate) and support energy labelling (pooled estimate: 64% [95% CIs 53%-73% support policy]. Six studies examined the effect of energy labelling on consumption behaviour. In these studies there was no evidence of a beneficial effect of labelling on alcohol drinking-related outcome measures. However, the majority of studies were of low methodological quality, used proxy outcome measures and none of the studies were conducted in real-world settings, resulting in a very low level of evidence and high degree of uncertainty. Further research is required to determine whether energy labelling of alcoholic is likely to be an effective public health policy.

**Key Words**: calorie labelling; alcohol; obesity; energy labelling; policy support

**Introduction**

Excessive alcohol consumption produces a large global burden on health 1 and has been found to be consistently associated with increased risk of developing a range of health conditions, including liver and cardiovascular disease 2 3. Although findings to date have been mixed, a number of studies suggest that heavier alcohol consumption may be a risk factor for weight gain and obesity 4. Amongst regular drinkers, energy derived from alcohol can make a significant contribution to daily energy intake 5. For example, a Canadian study of regular alcohol drinkers found that the average participant consumed 250 calories from alcoholic drinks per day and this accounted for 11% of their daily energy requirements 6. Furthermore, laboratory evidence suggests that individuals do not compensate in the short term for the energy content of alcohol by consuming less food 7. There is also some research which has concluded that people are unaware of the number of calories in alcoholic drinks 8, which may suggest that provision of energy information on alcoholic drinks may help consumers to reduce their alcohol consumption and daily energy intake.

At present, in the UK and EU, manufacturers do not have to provide nutritional information, such as number of calories per serving, on alcoholic drinks by law 9 10. Research also indicates that previous voluntary pledges made by the alcohol industry to provide nutritional information on alcoholic beverages have been ineffective 11. There have been calls made by public health bodies to make labelling of nutritional information on alcoholic drinks mandatory 12 and in 2020, the UK government announced an intention to consult on a mandatory calorie labelling of alcoholic drinks policy as part of their public health strategy to reduce obesity 10. The effectiveness of a mandatory calorie labelling policy in the UK will be in part determined by whether calorie information is likely to be informative for consumers (e.g. do consumers already know how many calories are in drinks?), public acceptability of the policy 13 and the effect that labelling has on consumer behaviour 14.

A number of systematic reviews have examined the effect that nutritional labelling of food products has on dietary behaviour and findings have been mixed 15 16. There is a small amount of evidence that energy labelling on food menus may decrease total energy purchased when eating out in restaurants, but due to the lack of real-world studies there is a high degree of uncertainty15. Systematic reviews have also attempted to compare the effect of different types of energy labelling on food choice. For example, physical activity equivalence (PACE) information (e.g. ‘it takes x minutes to burn off the calories in this menu item’) may be more meaningful to consumers than standard energy labelling (e.g. number of calories), but current evidence is equivocal in part because there are few direct comparisons of standard energy labelling (number of calories) and PACE labelling in the real-world17. To date, there has been no systematic review of research on energy labelling of alcoholic drinks and it is unclear the extent to which consumers are aware of the number of calories in alcoholic beverages, whether mandatory energy labelling of alcoholic drinks is acceptable (policy support) and whether energy labelling of alcoholic drinks affects consumer behaviour (e.g. reduces energy intake). Therefore, the aim of the present research was systematically review existing evidence on consumer knowledge of the energy content of alcoholic drinks, consumer support for energy labelling of alcoholic drinks and consumer effects of energy labelling of alcoholic drinks.

**Method**

**Rapid review approach.** As we conducted this research in response to an announcement of a consultation and call for scientific evidence on a mandatory calorie labelling policy by UK government, we used rapid systematic review methodology 18. Rapid reviews are used to provide timely and relevant evidence synthesises to inform policy and practice whilst maintaining the rigour and reproducibility of traditional systematic review methodology 19. Rapid reviews typically achieve this by using expedited review processes 19 20, such as limiting eligibility of research to published articles only, searching a limited number of electronic databases or by reducing the number of researchers conducting the review (e.g. cross-checking of a proportion of extraction as opposed to independent extraction by a second author).

**Eligibility criteria and study selection.** We included studies that had examined consumer knowledge of the energy content of alcoholic drinks, consumer support for energy labelling of alcoholic drinks and/or the effects of alcoholic drink energy labelling on consumption behaviour. Published journal articles were eligible for inclusion. Research reports published by public health bodies/research agencies that had not been published in an academic journal, but included a sufficient level of detail to allow eligibility to be assessed (i.e. study methodology and results section included in report) were also eligible. Due to the scope of the project we did not include dissertations or unpublished papers in abstract form, but if we did find a potentially eligible unpublished piece of research (e.g. a conference abstract) we planned to search for a subsequent published version. Due to the study outcome measures that were eligible (see below), studies that included only qualitative analyses were not be eligible for inclusion. However, if a study used a qualitative approach but also included quantitative data relating to an eligible outcome (e.g. % of participants accurately identifying number of calories in an alcoholic drink), the study was eligible for inclusion. The pre-registered protocol for the review is available at <https://osf.io/8gpm5/> and is registered on PROSPERO (CRD42020203817).

*Populations:*  No exclusion criteria on study settings or sampling method used to recruit participants were used, with the exception of excluding studies that had sampled participant groups on the basis of their professional status. For example, studies on consumer support for energy labelling of alcohol drinks that had sampled alcohol industry employees may not be representative of the general public.

*Interest/Intervention*: For studies examining consumer knowledge of the energy content of alcoholic drinks, at least one self-report measure of perceived energy content (e.g. perceived/estimated calorie content of an alcoholic drink) was required. For studies examining consumer support for energy labelling, studies were required to have included at least one self-report measure relating to policy support (e.g. ‘Do you think there should be calorie labelling of alcoholic drinks?’’). For studies that examined consumer effects of energy labelling of alcoholic drinks, studies were required to use an experimental design and examine the effect of providing energy information about alcohol drinks (e.g. calorie information added to labels) on a measure relating to alcohol or food consumption behaviour. For completeness, we also included studies that examined the effect of alcohol energy labelling on consumer knowledge of the energy content of alcohol drinks and/or support for energy labelling of alcoholic drinks.

*Comparison:* For experimental studies examining the consumer effects of energy labelling of alcoholic drinks, studies were required to include one group that provided participants with energy labelling (with or without additional nutritional information) and a comparator group allocated to not receive energy/nutrition labelling.

*Outcomes:* For studies examining knowledge of the energy content of alcoholic drinks, eligible outcome variables were directional accuracy scores (i.e. average (bi)directional difference between estimated energy content and actual content) and/or % of participants accurate (i.e. % of sampled participants that estimated the ‘correct’ amount of energy in an alcoholic drink). Measures that did not allow for a quantifiable measurement of accuracy were ineligible (e.g. extent to which participants agree whether a drink has a large number of calories), as were studies that did not report % participants accurate in isolation21 22. For studies that examined consumer support for energy labelling, eligible outcome variables were % of participants endorsing support for the policy (i.e. % selecting ‘yes’ or ‘agree’) or average level of support (i.e. score on a 1-7 scale, from no support to complete support). Measures relating to perceived efficacy of energy labelling (e.g. ‘I think most people would drink less if energy labelling was on alcoholic drinks’) are not a direct measure of policy support and were therefore ineligible. For studies examining consumer effects of energy labelling of alcoholic drinks, eligible outcome variables were objective or self-report measured alcohol or food consumption behaviour (e.g. amount of alcohol consumed) and related ‘proxy’ behavioural outcomes (e.g. self-reported consumption or purchasing intentions or hypothetical choice). Measures that were not directly related to consumption (e.g. self-reported liking or sensory evaluations of beverage) were ineligible.

**Article identification strategy.** In August 2020, we searched PUBMED and Scopus (no date limits) for published articles in peer reviewed journals. To maximise coverage of all likely relevant literature we used the following search terms: (‘Nutrition’ OR ‘Calorie’ AND ‘Labelling’) AND (‘Alcohol’ OR ‘Ethanol’ OR ‘Beer’ OR ‘Cider’ OR ‘Wine’ OR ‘Spirits’ OR ‘Cocktails’). One author conducted the initial title and abstract screening to exclude articles clearly unrelated to the review aims. Two independent authors conducted the full-text screening to determine final eligibility. For all eligible articles identified through searches, one author used forward citation tracking (Google Scholar) and searched reference lists to identify any further articles. A second author verified eligibility of articles identified through citation tracking and reference list searching.

**Data extraction.** For each study one author extracted the following information, and a second checked all extraction for accuracy: Bibliographic information, Information on country; Participant group sampled (e.g. university students, online panel, local community) and data collection setting (e.g. laboratory study), Summary information on participant age, gender, education level, alcohol drinking habits and body mass index (BMI), Whether the study examined i) consumer knowledge of the energy content of alcoholic drinks, ii) consumer support for energy labelling of alcoholic drinks and/or iii) consumer effects of energy labelling of alcoholic drinks, eligible outcome variables used, Results relating to eligible outcome variables of interest, including descriptive statistics and results of any relevant statistical analyses. For experimental studies that assigned participants to view vs. not view information about the energy content of alcoholic drinks: details of the information that participants were exposed to in each condition and procedural information on how information was presented.

**Study quality indicators.** Because eligible studies were expected to vary in design and address different research questions, we developed a review specific checklist to assess study quality and risk of bias based on existing study quality checklists and criteria 23-26. The following 10 study quality indicators were assessed: 1) Was the study sample size justified and was this justification adequate*?* 2) Was the study sample size very small (< 20 participant per group for an experimental study, < 30 participants for observational study)? 3) Was the study methodology described in sufficient detail? 4) Were study results described in sufficient enough detail to support conclusions? 5) Were outcome measures appropriate for research question? 6) Was the study methodology and analysis plan pre-registered? 7) Were potential conflicts of interest reported? 8) For experimental studies examining consumer effects of energy labelling, were randomization methods used (and described) to allocate participants to conditions?9)For experimental studies examining consumer effects of energy labelling, were efforts made to minimize participant awareness of study aims? 10) For experimental studies examining consumer effects of energy labelling, is information provided on: participant awareness of study aims? For each study, one author extracted the information and extraction was checked for accuracy by a second author. For a detailed description and examples for criteria see the Appendix.

**Study quality evaluation.** Based on the above quality criteria we rated studies as being ‘Low’, ‘Moderate’ or ‘High’ in overall methodological quality. Low quality studies were those that scored poorly on a significant number of the quality criteria. In particular, poor reporting of study methodological information or results alongside sub-optimal scoring on other study quality criteria resulted in a score of ‘Low’, as these factors make it difficult to draw conclusions from a study with confidence. ‘Moderate’ quality studies were classed as studies lacking in a small number of the individual quality criteria that could cumulatively influence confidence in conclusions, but there were major concerns over any individual study quality that have been identified that are likely to invalidate conclusions (conclusions can be made with some confidence). ‘High’ quality studies were any that scored perfectly on each individual quality criteria or had relatively minor methodological limitations that would be unlikely to invalidate conclusions (e.g. do not report a sample size justification, but have a very large sample size). Two authors independently rated each study and initial agreement was high (94%). Disagreements were resolved through discussion with a third author.

**Synthesis of evidence:** We planned to synthesise studies narratively and summarise current evidence for each study type separately. We graded the overall level of evidence for conclusions made from each study type using the GRADE approach 27. GRADE results in an overall grading of as: high, moderate, low or very low, based on considering the quality of included studies, consistency of findings, indirectness of evidence (e.g. reliance on studies using proxy measures of consumer behaviour) and imprecision (e.g. studies having relatively few participants and wide confidence intervals). After completing data extraction, we identified that there were a sufficient number of studies with similar methodology and reporting of results addressing consumer knowledge of energy content (% participants accurate) and policy support (% of participants in support of policy). We therefore meta-analysed studies with this information to provide a pooled estimate for each outcome using Generic Inverse Variance random effects models (see supplementary materials for full information). We did not meta-analyse studies examining consumer effects of energy labelling as study outcomes differed between studies.

**Results**

**Study selection.** Electronic searches of PUBMED and Scopus returned 853 articles. After removal of duplicates (N=60), 793 search records were title and abstract screened. After removal of articles unrelated to the research question, a total of 39 articles were identified for full-text screening. Of these articles, 10 were deemed eligible 28-37. See Figure 1 for exclusions. A further six eligible articles 8 38-42 were identified through forward tracking of citations, reference list searches and the authors’ knowledge. In total, 16 articles were included in the review and from these articles a total of 18 studies were deemed eligible for inclusion[[1]](#footnote-1).

**Overview of characteristics and quality of included studies.** Thirteenof the eligible articles were from published academic journals and three were reports from public health bodies/research agencies that were not published in academic journals (e.g. Alcohol Research UK). The majority of studies (n=18) included were of low methodological quality (n=13) and a minority were judged to be of moderate (n=4) and high (n=1) quality. Common reasons for low methodological quality ratings were insufficient procedural information, selective reporting of results, lack of conflict of interest information and no information concerning participant awareness of study aims in studies examining consumer effects of energy labelling. See Table A1 in the appendix for ratings of individual study quality criteria.

**Knowledge of energy content of alcoholic drinks.** Eight studies examined consumer knowledge of the energy content of alcoholic drinks. See Table 1. Studies were conducted across a range of continents (Europe, US and Australasia). All studies were rated as low quality. Knowledge of the energy content of wine was examined in three studies and the remaining five studies examined knowledge of energy content of a range of alcoholic drinks. Seven studies reported results for knowledge of energy content independent to other nutrients and a single study reported knowledge for nutritional content (including calorie content). Studies typically asked participants to estimate the number of calories in drinks using a self-report questionnaire format (e.g. ‘How many calories are in a glass of red wine?’). Across studies it was common for a sizeable proportion of participants to be inaccurate in their estimation of calorie content (38-83% of participants across studies). A sub-set of studies reported on the direction of inaccuracy (n=6). In 4/6 studies it was most common for participants to overestimate energy content (i.e. believe there were more calories in drinks than in reality) and in 2/6 studies underestimation was reported to be more common. One high quality experimental study that was designed to examine the impact of energy labels on consumer behaviour 32 included estimation of calorie content as a secondary outcome and reported data on direction of calorie estimation inaccuracy in a group of participants not exposed to energy labels; participants tended to overestimate energy content (see Table 3).

We were able to meta-analyse nine effects from six studies (see Figure 2 and online supplementary materials for more detail). The pooled proportion of participants accurately estimating energy content was 26% (95% CI: 18% - 36%), with considerably high levels of heterogeneity (I2 = 97%). Leave-one-out analyses demonstrated that results were not markedly affected by the inclusion of any one study (smallest = 24%, largest = 28%). We also examined and adjusted analyses for potential publication bias and results remained unchanged. See online supplementary materials. Based on the consistency of findings and directness of evidence, but relatively small number of mainly low-quality studies, we concluded that there is moderate evidence that people tend to be unaware of the energy content of alcoholic drinks.

**Support for energy labelling of alcoholic drinks**. Nine studies examined consumer support for energy labelling of alcoholic drinks (see Table 2). Studies were conducted across a range of continents (Europe, US and Australasia). Study quality tended to be low (n=6), with a minority of studies rated as moderate quality (n=3). Support for energy labelling of wine was examined in two studies and the remaining seven studies examined support for labelling of alcoholic drinks in general. Three studies reported on support for energy information labelling only and six studies reported on support for nutrition information (including calories) labelling. Studies typically measured support for energy labelling using a self-report questionnaire format (e.g. “it should be a requirement that nutritional information is displayed on bottles/cans/casks of alcohol”). It was common for a sizeable proportion of participants to support labelling of alcoholic drinks (41-84% of participants across studies). Four studies reported data on the number of participants supporting vs. opposing labelling. In all of these studies it was more common for participants to support rather than oppose labelling. One experimental study, which was rated as moderate quality, that examined the impact of energy labels on consumer behaviour 42 also included support for energy labelling as a secondary outcome and reported data on support for labelling in a group of participants not exposed to energy labels; the majority of participants supported labelling (see Table 3). We were able to meta-analyse ten effects from nine studies (See Figure 3 and online supplementary materials).

The pooled proportion of participants supporting energy labelling was 64% (95% CI: 53% - 73%), with high heterogeneity (I2 = 99%). Leave-one-out analysis demonstrated that results were not markedly affected by the inclusion of any one study (smallest = 60%; largest = 67%). We also examined and adjusted analyses for potential publication bias and results remained unchanged. See online supplementary materials. Based on the consistency of findings and directness of evidence, but relatively small number of mainly low-quality studies, we concluded that there is moderate evidence that people are more likely to support than oppose energy labelling of alcoholic drinks.

**Effects of energy labelling on consumer behaviour.** Six studies examined the effects of energy labelling on consumer-related behaviour (see Table 3) and as differing methodologies were adopted, we summarise studies individually. Maynard et al. 32 examined the effect of providing information about the calorie content of beer vs. no calorie content information in a group of UK participants recruited from a University setting. The main outcome measure used was the volume consumed from a glass of beer that was served during a mock taste-test in a laboratory setting. A secondary outcome measure was intended future consumption of the beer. There was no effect of labelling on beer consumption in the taste-test or on intended future consumption. We deemed the quality of the study to be high. However, the outcome measure did not involve participants choosing a drink or making decisions about how many drinks to order/consume and therefore the study was unable to measure a number of pathways by which drinking behaviour may be affected by energy labelling.

In a moderate quality study of participants from New Zealand, Walker et al. 42 examined the effect that nutrition labelling conditions (nutrition information panel vs. calories and kilojoules per serving vs. calorie and kilojoules per serving plus exercise required to burn off energy vs. no nutrition information) had on a range of self-reported intention measures (intention to purchase, number of drinks likely to purchase, intention to consume). There were no significant differences between any of the nutrition information conditions vs. no nutrition information for intended consumption or number of drinks likely to purchase. For intended purchasing, the nutrition information panel condition had a significantly higher likelihood of purchasing the displayed alcoholic beverage relative to the no information condition. The calorie and kilojoule information conditions (with or without exercise information) did not significantly differ to the no nutrition information condition.

Vecchio et al. 37 sampled Italian wine consumers and examined the amount of money participants were willing to bid (hypothetical) in a mock auction bidding task for wine products that were labelled with calorie content per glass, full nutrition information (per 100ml or per glass), guideline daily amount labelling (with key nutrients), or with no nutrition information. Participants were exposed to all label conditions (repeated-measures study). Compared to the no nutrition information, all labelling conditions (including the calorie content label condition) were associated with a significantly higher hypothetical monetary bid. Study quality was rated as low. We deemed that the outcome measure was eligible for inclusion as it may act as a proxy measure of intended purchasing behaviour. However, given the hypothetical nature of the measure and that participants were exposed to all conditions, the findings may reflect a tendency to report that any additional product information (as opposed to limited product information) increases perceived monetary value, as opposed to nutrition information increasing purchasing intentions for wine.

 In a low-quality study of US university students, Bui et al. 8 examined the effect that the inclusion of calorie information labelling (alongside other nutrition information) vs. no nutrition information labelling on a range of alcoholic drinks had on self-reported intended behaviour (‘Would the information increase or decrease the amount you would drink?’). Across all drink types, intended consumption did not differ in the labelling vs. no labelling condition.

Martinez 40 conducted two studies; examining the effect that nutrition information on a bottle of beer (vs. no nutrition information) had on self-reported future drinking intentions. The first study was of US university students and the second was of US adults recruited in a shopping mall. Both studies were rated as being low in quality and there was no significant effect of nutrition information on future drinking intentions in either study.

The majority of studies (including the one rated high-quality study) found evidence to suggest that energy labelling did not have an effect on consumer behaviour, via actual (consumption) or proxy measures (intentions) of consumer behaviour. There were some inconsistencies in findings and studies tended to use self-reported hypothetical measures (lack of directness of evidence) of alcohol consumption. As such, the overall quality of evidence supporting this conclusion was rated as very low.

**Other outcomes.** Three of the experimental studies on consumer behaviour also examined whether calorie estimates for alcoholic drinks were affected by exposure to labelling (vs. no labelling). In Bui et al. (low quality) there was no effect on calorie estimation. In Maynard et al. (high quality) provision of calorie labels had a significant effect on calorie estimation and directionally calorie estimates improved (relative to a no calorie label condition). In Walker et al. (moderate quality) participants in all nutrition label conditions had significantly more accurate estimates of calorie content than those in the no label condition. Walker et al. also examined support for energy labelling and found that this was not affected by exposure to labelling.

**Discussion**

In the present research we conducted a rapid systematic review to assess evidence from studies examining consumer knowledge of the energy content of alcoholic drinks, support for energy labelling of alcoholic drinks and experiments examining the effect of energy labelling of alcoholic drinks on consumption behaviour.

Eight studies examined consumer knowledge of the energy content of alcoholic drinks. Although study quality tended to be low, findings were consistent across studies and a substantial proportion of participants in all studies were inaccurate when asked to estimate the amount of energy (number of calories) in different alcoholic drinks. In a meta-analysis of nine effects from six studies, the pooled proportion of participants accurately estimating energy content of alcoholic drinks was 26% (95% CIs 18% - 36%). Based on these findings and the relatively small numbers studies addressing this question we graded the overall level of evidence in support of this conclusion as ‘moderate’. Across studies it was more common for participants to overestimate (more calories perceived) than underestimate (fewer calories perceived) energy content, and this is in line with other research not fitting our eligibility criteria which has found that that underestimation of the energy content of alcoholic beverages occurs in only a minority of participants21 22. Yet, this consideration may be important because it has been suggested that if consumers expect a product to have higher calories than is presented on nutrition labelling this may cause a ‘backfiring’ effect of increased consumption 43. Given the relatively small number of studies, addressing this question would therefore be informative. However, it should also be noted that directionality of misperception may not be the most important factor affecting the extent to which energy information impacts on consumer behaviour. The presence of energy information may also serve to remind or ‘prime’ consumers about the importance of limiting their energy intake 44 or allow consumers to choose lower energy drink options, neither of which rely on the assumption that consumers only change their behaviour in response to labelling because they tend to under/overestimate energy content. Future research explicitly addressing this question is recommended.

Studies included in the present review that contributed evidence to consumer support for energy labelling were from a range of countries (US, European countries, Australia, New Zealand), but tended to be of low quality. In a meta-analysis of ten effects from nine studies, the pooled proportion of participants supporting energy labelling was 64% (95% CI: 53% - 73%). Of the smaller number of studies that reported the numbers of participants supporting vs. opposing labelling, it was more common for people to support labelling than oppose it. Based on these consistent findings, but the relatively small number of studies we graded the overall level of evidence in support of this conclusion as ‘moderate’. These findings are in line with the notion that the general public are likely to support public health policies that involve information provision in order to improve health 45 46.

Six studies examined the effects of energy labelling of alcoholic drinks on consumer behaviour related outcomes. Studies tended to be of low quality and relied on self-reported proxy measures of alcohol consumption (e.g. intended consumption).Although intended alcohol consumption tends to correlate with actual consumption 47, it is well recognised that intentions will often not be followed by successful behaviour change 48 and the extent to which intentions do predict alcohol drinking are likely moderated by individual difference and contextual factors 49. Therefore, the reliance in included studies to reply on proxy measures such as intentions is a significant limitation. One high quality study examined actual consumption of alcohol, although this was conducted in a laboratory setting and the outcome measured was amount of a served beverage consumed in a mock taste-test 50. Energy labelling may impact consumer behaviour by altering drink choice or reducing the number of drinks ordered, but no studies examined this. In addition, energy labelling of alcoholic drinks may impact on consumer behaviour by affecting diet (e.g. eating less during, before or after drinking) or increase energy expenditure by increasing physical activity 51, but no studies examined this and future work addressing this is now needed. Given these considerations and the small number of largely low-quality studies conducted, we concluded that at present there is very low-quality evidence which suggests that energy labelling of alcoholic drinks does not affect consumer behaviour. However, this conclusion could be changed by contradictory findings and there a need for higher quality studies of the impact that energy labelling of alcoholic drinks has on behaviour (e.g. alcohol consumption and overall energy intake vs. expenditure). Studies tended to examine the potential effects of numeric energy information (i.e. number of calories) and therefore the conclusions of this review are limited to this type of energy labelling. However, other display formats such as physical activity equivalence (PACE: e.g. ‘it takes x minutes to burn off the calories in this drink’) may be more meaningful to consumers and therefore more likely to motivate behaviour change17.

As far as we are aware, mandatory energy labelling of alcoholic drinks has not been introduced in any of the countries in which included studies were conducted. However, an observational study compared two outlets of a restaurant chain that had implemented calorie labelling of alcoholic beverages alongside food products (based in a single US city) vs. five outlets that did not have any labelling of food or alcoholic beverages (based in three different US cities), and found no difference in calories purchased from alcoholic beverages nor the likelihood of purchasing alcoholic beverages52. Although the study had a number of limitations (e.g. outlets with vs. without energy labelling differed in geographic location and participant socioeconomic demographic profile) and the design did not examine alcoholic beverage energy labelling in isolation (food menu items were also labelled), findings are consistent with no effect of energy labelling on alcohol purchasing.

Understanding whether there are any unintended consequences of energy labelling of alcoholic drinks (e.g. meal skipping resulting in increased harm from drinking) will also be important. Although some of the studies included in the present review reported information relating to socioeconomic position (SEP) of sampled participants, outcomes were not routinely reported based on SEP. Because there is some evidence that nutrition labelling may exert a stronger influence on the behaviour of people of higher SEP and therefore create inequality 53 54, future research on the effects of energy labelling of alcoholic drinks would benefit from considering equity of intervention effectiveness. Likewise, the included studies did not allow us to examine whether effects of energy labelling may differ based on participant dieting habits, weight status (e.g. normal weight vs. obesity) or drinking habits (e.g. moderate vs. heavy drinkers). Energy labelling may be more influential on consumer behaviour among groups most concerned about their weight/calories (e.g. dieters) or more of a cause for concern among people regularly consuming large amounts of alcohol. Therefore, future research examining potential differences in these populations would be informative.

We adopted similar methodology to other rapid evidence reviews and followed best practice guidelines 18 19, but there are limitations to this approach. We searched two suitable electronic databases and it is plausible that we may have found more studies if we had searched more. To mitigate this, we conducted forward citation tracking, searched the reference list of all eligible articles and included studies reported by public health bodies but not published in journals. We retained a number of important methodological features of standard systematic reviews, including independent full-text screening of articles for eligibility by two researchers and coding of study quality by two researchers independently. We examined evidence of publication bias in the limited studies we were able to quantitatively synthesise, but given that we were unable to meta-analyse all study outcomes and we were only able to include a small number of studies which limits statistical power of formal tests of publication bias. Due to the relatively small number of eligible studies, unpublished high-quality studies may change conclusions made.

There were a number of limitations to the studies included in the review. Study quality tended to be low and this was often because of incomplete reporting of study methodology and results. Most studies did not report information on potential conflicts of interest and pre-registration of methodology and analysis plans was reported in only 1/16 studies. Four of the included studies were not published in peer-reviewed journals and instead were published and made available online by public health bodies and research institutes. However, findings from these studies were consistent with those published in journals. The present research focused on consumer behaviour, but any evaluation of the effectiveness of energy labelling of alcoholic drinks as a public health measure will require a global approach that also examines industry behaviour. For example, information provision approaches like energy labelling may not have immediate and direct effects on behaviour (e.g. the first time that a person sees energy labelling on alcoholic drinks) and instead may cause a more gradual change in knowledge, motivation and then behaviour. Furthermore, there is some evidence that the provision of nutrition information about food products may result in food manufacturers reducing the energy content of food products 55. A similar process could occur with alcoholic drink manufacturers and reductions to energy content could be achieved through introducing new products 56, or reducing existing serving size and/or alcohol content by volume (ABV). As both reductions to alcoholic beverage serving sizes 57 and ABV58 decrease alcohol consumption, industry reformulation as a result of energy labelling may be beneficial to public health.

*Conclusions*

There is a moderate level of evidence that people tend to be unaware of alcoholic drink energy content and are more likely to support than oppose energy labelling of alcoholic drinks. Studies to date have not found evidence that energy labelling of alcoholic drinks affects proxy measures of drinking behaviour. However, this conclusion is based on a very small number of studies with substantial methodological issues (very low evidential value and high level of uncertainty) and may change as a result of higher quality studies conducted in real-world settings.

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**Table 1. Studies examining knowledge of energy content of alcoholic drinks**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Study | Sampling approach | Participant information | Main review question(s) addressed | Main outcome variable(s) | Experimental manipulation | Results | Overall quality rating |
| Annunziata, 2016 (a)28 | 300 Italian wine consumersOnline and in-person surveys | 51.5%F, 48.5%MAged 18 + No BMI data48% University educatedMonthly wine drinkers | Knowledge of energy content of alcoholic drinks | Self- report questionnaire‘How many kcal are contained in a glass of red Wine?’ | N/A | 20% of sample identified correct kcal content 60% of sample underestimated kcal content. 20% of sample overestimated kcal content | Low |
| Annunziata 2016 (b)29 | 1016 wine consumers from Italy, France, Spain and the USA (east coast) Online survey | 51%F, 49%MAged 18 + No BMI data38% University educatedMonthly wine drinkers | Knowledge of energy content of alcoholic drinks | Self- report questionnaire‘How many kcal are contained in a glass of red Wine?’ | N/A | Italy: 22% of sample accurate 63% of sample underestimated Spain: ~30% of sample accurate. 50% of sample underestimatedFrance: 36% of sample accurate Direction of inaccuracy not reportedUS: 28% of sample accurate 43% of sample underestimated29% of sample overestimated | Low |
| Bui, 2008 (Pilot Study)8 | 58 US undergraduate studentsData collection method not reported | 58%F, 42%MAged 20-33No BMI infoAll University educated85% had drank alcohol in the past month | Knowledge of energy content of alcoholic drinks | Self-report measureParticipants estimated the absolutelevels of calories for standard drink sizes of beer (12oz), wine (5oz) and distilled liquor (1.5oz) Wording of question not reported | N/A | For all beverages, percent accuracy = 21%, participants overestimated the energy content, but no direct statistical comparison reported | Low |
| Grunert, 201839 | 5,395 participants from Denmark, Germany, UK, Spain, Netherlands and Poland.Online survey | ~50%F, 50%FAged 18-65No BMI info12-41% University educatedNo information on frequency of drinking any alcohol | Knowledge of energy content of alcoholic drinks | Self-report measure‘Productknowledge about nutrition was measured by asking respondents aboutthe content of calories, fat and carbohydrates of alcohol-freebeer, regular beer (between 4.5 and 5.5% alcohol), white wine, redwine, and whiskey.Answering options for calories were intervals of 50 kcals upto>300 kcals | N/A | Nutrition knowledge tended to be low, with participants on average incorrectly estimating nutritional content of drink types | Low |
| Pabst, 201935 | 21 German wine consumersFocus group | 48% F, 52%MAged 18+No BMI info76% University educatedAll consumed wine twice monthly or more | Knowledge of energy content of alcoholic drinks | Self- report measureParticipants were asked to estimate the amount of calories in a sample of wine and to write down their estimate for wine and other alcoholic beverages  | N/A | 76% of the answers were wrong. Most participants (16/21) overestimated energy content | Low |
| Vecchio, 201837 | 103 Italian wine consumersLaboratory study | 51%F, 49%MM age = 29.1 (SD 7.1)No BMI info60% university educatedAll participants consumed wine once a week or more | Knowledge of energy content of alcoholic drinks | Self-report measure Participants were asked to indicate the kcal content of different types of wine (white and sweet wine)through a multiple-choice question. Exact question wording not reported. | N/A | For white wine, 38% were incorrect in estimating kcal content, 62% were correctFor sweet wine, 69% were incorrect in estimating kcal content, 31% were correct | Low |
| GFK (Consumer research company), 201438 | 5395 European participants (Germany, Poland, Denmark, Netherlands, Spain, UK)Online survey | 51%F, 49%MAged 18 + No BMI data<85% University educatedNo info on alcohol drinking habits | Knowledge of energy content of alcoholic drinks | Self-report questionnaire“How many calories (in kcal) do you think are provided by each of the following products?” Beer, white wine, red wine, whiskey, with response options in 50kcal intervals from <50 to >300 | N/A | For all drink types 30-33% participants chose answer ‘I don’t know’. For all drink types only 6-17% of participants selected correct option.For all drink types, overestimation of calorie content was most common (50-96%) participant response | Low |
| Alcohol Research UK Report (Maynard), 201841Study 1 | 450 UK alcohol drinkersOnline study | 54%F, 46%MAged 18+ (M = 38) No BMI info65% University educated All had previously consumed alcohol | Knowledge of energy content of alcoholic drinks | Self-report measureParticipants were asked to estimate the number of calories and units in a selection of alcoholic drinks (cider, beer, alcopops, wine, gin & tonic) | N/A | Calories in alcoholic drinks were consistently over-estimated | Low |

**Table 2. Studies examining support for energy labelling of alcoholic drinks**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Study | Sampling approach | Participant information | Main review question(s) addressed | Main outcome variable(s) | Experimental manipulation | Results | Overall quality rating |
| Annunziata, 2016 (a)28 | 300 Italian wine consumersOnline and in-person surveys | 51.5%F, 48.5%MAged 18 + No BMI data48% University educatedMonthly wine drinkers | Support for energy labelling of alcoholic drinks | Self-report questionnaireSupport for more nutrition info on wine labels. Wording of question not reported | N/A | 55% reported it would be particularly useful to receive more information onnutritional and health features on wine labels | Low |
| Annunziata 2016 (b)29 | 1016 wine consumers from Italy, France, Spain and the USA (east coast) Online survey | 51%F, 49%MAged 18 + No BMI data38% University educatedMonthly wine drinkers | Support for energy labelling of alcoholic drinks | Self-report questionnaire‘How interested are you in receiving nutrition information on wine labels?’ 1 (not at all) to 5 (totally) scale | N/A | Italy: M=3.4 (SD 1.2), indicating of some interestSpain: M=2.9 (SD 1.2), indicative of some interestFrance: M=2.2 (SD 1.2), indicative of some interestUS: M=3.6 (SD 1.3), indicative of some interest | Low |
| Christensen, 201930 | 6,000 Danish participantsOnline survey | 50%F, 50%MAged 18-74No BMI info47% higher education level64% consume alcohol during a typical week | Support for energy labelling of alcoholic drinks | Self-report measureSupport for mandatory nutrition labeling on alcohol. Response options: ‘“very good suggestion”,“good suggestion” “neither good or bad suggestion”, “badsuggestion”, “very bad suggestion”, “I do not know” | N/A | 46% of participants reported that mandatory nutrition labelling was a good suggestion or very good suggestion | Moderate |
| Kypri, 200731 | 7224 Australian studentsOnline survey | No gender infoAged 17-25No BMI infoAll in higher education 90% consumed alcohol in the past year | Support for energy labelling of alcoholic drinks | Self-report measure‘It should be a requirement that nutritional information (eg, the amount of sugar and kilojoules)is displayed on bottles/cans/casks of alcohol’ Strongly agree to Strongly disagree response options | N/A | 40% strongly agreed35% agreed20% neither agreed or disagreed3% disagreed1% strongly disagreed | Moderate |
| Moore, 2010(Shape Up American! Survey)33 | 503 adult AmericansOnline survey | No gender infoAged 18 +No BMI infoNo education level infoNo information on frequency of drinking any alcohol | Support for energy labelling of alcoholic drinks | Self-report‘How Important Is It to You to Have Each of theFollowing Types of Information on an Alcoholic Beverage Label?The number of calories in each drink. Response options not fully reported | N/A | 84% of participants reported that including calorie information was either important or somewhat important | Low |
| Nikolaou, 201434 | 1440 Scottish Undergraduate studentsOnline survey | 67%F, 33%MM age = 20.3 (SD 2.9)M BMI = 23.0 (SD 4.6)All in higher educationNo information on frequency of drinking any alcohol | Support for energy labelling of alcoholic drinks | Self-report measureMultiple choice question on calorie labelling on alcohol. Wording of question not reported | N/A | Half of female participants and a third of males reported they would like to see calorie information on alcohol | Low |
| Thomson, 201236 | 1523 Australian adults Telephone interview | No gender infoAged 16 +No BMI infoNo education infoNo info on frequency of drinking any alcohol | Support for energy labelling of alcoholic drinks | Self-report measureParticipants were asked to provide level of support for including nutritional information (energy, protein, fat, carbs, sugars)on alcoholic drink labels | N/A | 76% strongly support or support. 7% neither support nor oppose. 17% strongly oppose or oppose | Moderate |
| GFK (Consumer research company), 201438 | 5395 European participants (Germany, Poland, Denmark, Netherlands, Spain, UK)Online survey | 51%F, 49%MAged 18 + No BMI data<85% University educatedNo info on alcohol drinking habits | Support for energy labelling of alcoholic drinks | Self-report questionnaire Level of agreement with “The same nutrition information (energy value, proteins, carbohydrates, sugars, fat, saturated fats, salt) should be provided for all food and drink products (alcoholic and non-alcoholic)”, with response format strongly disagree (1) to strongly agree (7) | N/A | 69% of participants agreed with statement, 16% were neutral, 14% disagreed | Low |
| Alcohol Research UK Report (Maynard), 201841Study 1 | 450 UK alcohol drinkersOnline study | 54%F, 46%MAged 18 + (M = 38) No BMI info65% University educated All had previously consumed alcohol | Support for energy labelling of alcoholic drinks | Self-report measureParticipants reported whether they agreed or disagreed with the statement “Calorie information on alcoholic drinks is a good idea” | N/A | 81% of participants agreed that calorie information on alcohol drinks is a good idea. 7% disagreed | Low |

**Table 3. Studies examining effects of labelling on consumer behaviour**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Study | Sampling approach | Participant information | Main review question(s) addressed | Main outcome variable(s) | Experimental manipulation | Results | Overall quality rating |
| Bui, 20088(Main Study) | 230 US undergraduate studentsData collection method not reported | No gender infoAged 20-36No BMI infoAll University educatedNo alcohol drinking info | Effects of labelling on consumer behaviour | Self-report measure of intended consumption for beer, light beer, wine, distilled liquor‘‘Given the informationshown on the front and the back of the mock bottle, would the availableinformation increase or decrease the amount you would drink, that is, yourconsumption level?’’ (endpoints of ‘‘would decrease consumption level’’[1] and ‘‘would increase consumption level’’ [9])Self-report measure of number of calories in beer, light beer, wine, distilled liquor | Reproduction bottles of beer, light beer, wine and distilled liquor presentedServings Facts label including information on alcoholcontent, calories, carbohydrates, fat, and serving size. vs.Standard labelling. | Intended consumption (across drink types) was significantly higher (p < .05) when serving facts labels were provided vs. standard labellingNo significant difference in calorie estimation when serving facts labels were provided vs. standard labelling | Low |
| Martinez, 201840Study 1 | 80 US undergraduate studentsLaboratory study | 75.5%F, 24.5%MM age = 18.56 (SD. 0.9)No BMI infoAll in higher educationAll under legal age of drinking, but had reported previously consuming alcohol  | Effects of labelling on consumer behaviour | Self-report measureFuture drinking intentions, adapted existing scale | Nutrition information provided next to an image of a bottle of beerVs.Nutrition information absentParticipants were instructed to write about the image to ensure attention was paid to information | No significant difference in future drinking intentions between conditions (p > .05) | Low |
| Martinez, 201840 Study 2 | 98 US previous alcohol consumers recruited from a mallOnline study | 42.6%F, 57.4%MM age = 26.5 (SD 13.3). 58.3% at or over legal drinking ageNo BMI infoNo education infoAll reported having consumed alcohol previously | Effects of labelling on consumer behaviour | Future drinking intentions, adapted scale | Accurate nutrition information provided next to an image of a bottle of beerVs.Nutrition information with decreased caloriesVs.Nutrition information absentParticipants were instructed to rate how appealing the beverage was | No significant difference in future drinking intentions between conditions (p > .05) | Low |
| Maynard, 201832 | 264 regular drinkers from UK University database Laboratory study | 50%F, 50%MAged 18 +No BMI info72% completed high schoolDrank at leasttwo units per week and no more than 35 units per week if femaleor 50 units per week if male | Effects of labelling on consumer behaviour | Laboratory measured alcohol consumptionConsumption of beet measured using bogus taste-testIntentions to consume beverage in future. Wording of question and response format not reportedKnowledge of number of calories in beverage | Calorie content of beer provided alongside other product information on a piece of paperVs.Calorie content of beer removed from piece of paper | No significant difference in beer consumption between two conditions (3% more consumed in calorie label condition, p = .35, ηp2< 0.01)No significant difference in future intended consumption of beverage between two conditions(4% increase in intentions in calorie labelling condition, p = .39)Significant difference in estimated calorie between two conditions (p < .001,ηp2 = 0.07). Participants in calorie labelling condition lower (170kcals) than participants in no labelling condition (257 kcals).  | High |
| Vecchio, 201837 | 103 Italian wine consumersLaboratory study | 51%F, 49%MM age = 29.1 (SD 7.1)No BMI info60% university educatedAll participants consumed wine once a week or more | Effects of labelling on consumer behaviour | Self-report measureHypothetical monetary auction bidding task  | Participants shown 4 wine labels: Kcal content for a glass of wine, nutrition information for 100ml, nutritional information for a glass of wine relative to guideline daily amounts, no nutrition information | Compared to the no nutrition information (€3.92) label condition, all nutrition label conditions (Kcal per glass = €4.27; Nutritional info = €4.97; Relative to daily guidelines (€4.71) were associated with an increase in hypothetical monetary bid (i.e. nutrition labels resulted in increased value of wine | Low |
| National Institute for Health Innovation (Walker) 201942 | 615 New Zealand adult alcohol drinkersOnline study | 58%F, 42%MM age = 41.2 (SD 15.1)No BMI info62% Secondary school only educationAll had purchased and consumed at least one alcoholic beverage in the past month | Effects of labelling on consumer behaviourKnowledge of energy content of alcoholic drinksSupport for energy labelling of alcoholic drinks | Self-report measureIntention to purchase the displayed product Intention to purchase was assessed on an 11-point scale, anchors of 0: “no chance or almost no chance of purchase” and 10: “certain or practically certain to purchase”Number of drinks likely to purchase of displayed product.Intention to consume the displayed product. Intention to consumer was assessed on an 11-point scale, anchors of 0: “no chance or almost no chance to consume” and 10: “certain or practically certain to consume”Self-report measureEstimated energy content of the displayed product measured in kilojoules and caloriesSelf-report measureLevel of agreement with the statement “alcoholic drinks should provide energy (kilojoule (kJ)/calorie) content information on labels”. 7-point scale, ranging from “strongly disagree” to “strongly agree”. | Participants shown one of four labels on their preferred drink type:Nutritional information panel on the back-of-bottleVs.  Energy presented per serve in kilojoules and caloriesVs. Energy presented in kilojoules and calories with an orange stopwatch icon demonstrating the amount of exercise required to burn-off the shown energyVs. No label | Each condition was compared to the no label condition. No differences observed, except the nutrition information panel label condition had a significantly higher likelihood of purchasing the displayed alcoholic beverage (5.6/11 vs. 4.8/11, p=.04). Each condition was compared to the no label condition. No differences observed for number of drinks likely to purchaseEach condition was compared to the no label condition. No differences observed for consumption intentions.Participants in all label conditions had more accurate estimates of energy content than no label condition (ps < .01)No significant differences between conditions. 51-53% agreed that alcoholic beverages should provide energy content information on labels. 17-22% disagreed. | Moderate |

1. In response to a reviewer comment during peer review, we also conducted supplementary electronic searches during October 2020, although no further eligible articles were identified (see online supplementary materials). [↑](#footnote-ref-1)