Impact on alcohol selection and purchasing of increasing the proportion of non-alcoholic versus alcoholic drinks: randomised controlled trial

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Abstract

Objective
Increasing the availability of non-alcoholic options is a promising population-level intervention to reduce alcohol consumption, currently unassessed in naturalistic settings. This study in an online retail setting aimed to estimate the impact of increasing the proportion of non-alcoholic (relative to alcoholic) drinks, on selection and actual purchasing of alcohol.

Design
Parallel-group randomised controlled trial.

Setting
Participants selected drinks in a simulated online supermarket, before purchasing them in an actual online supermarket.

Participants
Adults in England and Wales who regularly consumed and purchased beer and wine online (n=737).

Intervention
Participants were randomised to one of three groups: Higher Proportion of non-alcoholic drinks available (75%); Same Proportion (50%); Lower Proportion (25%).

Main outcome measure
The primary outcome was the number of alcohol units selected (with intention to purchase); secondary outcomes included purchasing.

Results
607 participants completed the study and were included in the primary analysis. The Higher Proportion group selected 10.0 fewer alcohol units than the Lower Proportion group (-32%; 95%CI -42%,-22%) and 7.1 fewer units compared to the Same Proportion group (-25%; 95%CI -36%,-13%), based on model results in those selecting any drinks containing alcohol (559/607). There was no evidence of a difference between the Same Proportion and Lower Proportion groups (2.9 fewer units, -9%; 95%CI -22%,5%). For all other outcomes, alcohol selection and purchasing were consistently lowest in the Higher Proportion group.

Conclusion
This study provides evidence that substantially increasing the proportion of non-alcoholic drinks - from 25% to 50% or 75% - meaningfully reduces alcohol selection and purchasing. Further studies are warranted to assess whether these effects are realised in a range of real-world settings.

Keywords: alcohol; beer; wine; selection; purchasing; availability; non-alcoholic; alcohol-free; randomised trial; RCT

Trial registration: ISRCTN:11004483; OSF: https://osf.io/qfupw
Introduction

Excessive alcohol consumption is one of four sets of modifiable behaviours - along with tobacco use, physical inactivity and unhealthy diet - that make a major contribution to the global burden of non-communicable diseases, including cancer, heart disease and stroke. Given the influence of environmental cues upon consumption and related behaviours, interventions that change physical and economic environments in which these behaviours occur have the potential to reduce alcohol consumption. Altering the availability of alcohol products has been identified as a particularly potent approach, but has typically been examined in relation to demographic, temporal or spatial restrictions (e.g., by age, opening hours, or number or density of retail outlets), and not in terms of changing the range of available products. One intervention of this kind, potentially scalable to population-level and currently untested, involves increasing the proportion of non-alcoholic (relative to alcoholic) drink options that are available to select, purchase, and ultimately consume. This can be achieved by either making more non-alcoholic options available, removing some alcoholic options, or by doing both and so retaining the same overall number of options; the latter is assessed in the current study.

The promise of so-called ‘availability’ interventions that change proportions of unhealthy (relative to more healthy) products, is highlighted by an emerging evidence base in relation to food. A Cochrane systematic review found that reducing the proportion of available food products of a certain type (e.g., unhealthy snacks) resulted in markedly reduced selection of those foods, although the included evidence was limited in both quality and quantity. More recent field trials also suggest that decreasing the proportion of higher energy or meat-based foods reduces their consumption. In terms of alcohol products, there is an absence of evidence, with no eligible studies identified in the aforementioned Cochrane review or in a recent search update. In what is, to our knowledge, the only previous study that has examined the potential of such an intervention applied to alcohol, the proportion of participants selecting an alcoholic drink decreased from 74% when one-quarter of the available drinks were non-alcoholic, to 51% when three-quarters were non-alcoholic. However, this study only measured hypothetical and mandatory selection of a single drink from a limited range of eight options. Studies using meaningful outcomes and conducted within more naturalistic contexts that include wider product ranges are necessary to inform the development and implementation of real-world interventions and policies.

There is clear interest in increasing the availability of non-alcoholic drink options, from the perspective of both consumers and policymakers. While the current market for alcohol-free beer, wine and spirits is relatively small, it is rapidly growing. In 2021, the no/low alcohol market grew by 6% globally, and in the UK, sales of non-alcoholic beer increased by 7%. In 2020, the UK Government made a commitment with the drinks industry to increase the availability of alcohol-free and low-alcohol products by 2025 although details on what this would involve have not been published. Although currently most consumers purchase no or low alcohol drinks infrequently, increased availability of these products is associated with an increase in their sales and reductions in grams of alcohol purchased. Non-alcoholic alternatives to alcohol (i.e., alcohol-free drinks and soft drinks marketed to adults) still only represent a small proportion of the market, however, which combined with their recent increase in popularity, suggests there is substantial scope for increasing their availability.

The aim of the current study was to estimate the impact of increasing the proportion of non-alcoholic drink options relative to alcoholic drink options, on the number of alcohol units that
are i) selected (with the intention to purchase) and ii) purchased. We hypothesised that increasing the availability of non-alcoholic alternatives to alcohol would reduce the number of alcohol units selected and purchased.

**Methods**

The trial was prospectively registered (ISRCTN:11004483). In addition, both the study protocol (https://osf.io/qfupw) and a detailed statistical analysis plan (https://osf.io/4yuca) were pre-registered on the Open Science Framework (OSF). The study was approved by the Faculty of Life Sciences Research Ethics Committee at the University of Bristol (reference no: 116124). Trial reporting follows CONSORT 2010 guidelines.

**Study design**

The study used a parallel-groups randomised controlled design. Individual participants were randomly allocated without stratification to one of three groups differing in the proportion (%) of non-alcoholic versus alcoholic drink options available for selection: Group 1: Higher Proportion (75% non-alcoholic, 25% alcoholic); Group 2: Same Proportion (50% non-alcoholic, 50% alcoholic); Group 3: Lower Proportion (25% non-alcoholic, 75% alcoholic).

**Setting**

The study was conducted online using simulated and real online supermarkets. First, participants completed a simulated supermarket selection task hosted on the Qualtrics online survey platform (see Figure 1). Following this, participants were required to purchase drinks in Tesco online supermarket (Tesco.com), the largest national supermarket in the UK.

**Participants**

To be eligible for the study, participants had to be adults (18+) residing in England or Wales, who consumed beer or wine regularly (i.e., at least weekly), and purchased these drinks at least monthly from Tesco.com, with a minimum spend of £20. Participants had to be willing to complete a shop at Tesco.com following completion of the selection task, book a delivery or click-and-collect slot, and send proof of purchase (their receipt) to the research team. Similar proportions of males and females of a range of ages were recruited via Roots Research (https://rootsresearch.co.uk/), one of the largest research agencies in the UK, with a high-quality panel of over 350,000 participants. Recruitment occurred between March-July 2021.

**Sample size**

As this was the first trial of this intervention to assess alcohol selection and purchasing of multiple drink options, no comparable evidence was available from which to estimate effects. Available resources allowed recruitment of around 600 participants. Assuming 15% attrition, a sample of 510 participants (170/group) was sufficient to detect an effect of d=0.3 for the primary outcome for a two-group t-test with alpha of 5% and 80% power. Using pre-testing data (~5/group), the conservative SD estimate was 12.1 (i.e., the maximum group variance observed), indicating that the sample size was sufficient to detect a difference of 3.7 alcohol units selected between groups.
Randomisation and masking

Randomised assignment of participants was completed via the default algorithm in Qualtrics with a ratio of 1:1:1. Participants were unaware of their group assignment throughout the study. The research team were blinded to allocation until participants had completed the primary outcome; the statistician completing the analysis was blinded to the allocation.

Intervention

All participants viewed a total range of 64 drink options. This comprised i) a range of beers, ciders, alcohol-free beer and cider alternatives, and soft drinks (32 options), and ii) a range of wines, alcohol-free wine alternatives, and soft drinks (32 options), modelled on the available range of products on Tesco.com. Participants viewed varying proportions of non-alcoholic and alcoholic drink options depending on their assignment. Within each range of alcoholic drinks there were the same number of beer as wine options, and within each range of non-alcoholic drinks there were the same number of soft drinks as alcohol-free options. Full details of the task, as well as the complete list of drinks are in the Supplementary Material S1. In the Typology of Interventions in Proximal Physical Micro-Environments (TIPPME)\(^3\), this is classified as an ‘Availability x Product’ intervention, while in a detailed conceptual framework specific to availability interventions\(^6\), this is categorised as a ‘Relative Availability’ intervention.

Procedure

Participants were initially provided with an information sheet, instructions, and a link to the study via email. Participants were told the study was investigating “Adult drink preferences in England and Wales” and were not made aware of the study aim. Once they had started the study task, participants were again presented with this information and provided consent. Participants were randomised and in a simulated online supermarket environment replicating Tesco.com (within Qualtrics) they were shown the available drink selection. They chose all the drinks they wanted to purchase in their next online shop at Tesco.com. They were then shown their total drink selection and price, and given the opportunity to amend their selection before continuing. Participants then completed demographic and drinking behaviour measures.

After completing the simulated online supermarket task, participants were automatically sent an email detailing their selection. They were prompted to open this email and given further instructions for completing purchasing, alongside a direct link to Tesco.com. Participants placed their selected drinks in their Tesco.com shopping basket, along with any other items, booked their delivery or collection slot, and confirmed this within 48 hours. They were sent a reminder email on their delivery/collection day and requested to send an itemised receipt to the research team within 48 hours. Up to two follow-up reminders were sent, two and four days later. Purchases were recorded from receipts, including any additional drink purchases. Substitutions by the participant or by Tesco that were explained (e.g., not in stock) were marked as the original drink they attempted to purchase. Participants were debriefed via email and reimbursed £25 (~$35) for their time taking part in the study (but not the drinks they purchased).

Outcome measures
Primary outcome

The primary outcome was the number of alcohol units selected in the context of a stated intention to purchase. A unit is a standard measure of pure alcohol in a drink with one unit being 10ml or 8g of pure alcohol. Participants were aware when selecting drinks in the task that they were required to subsequently purchase the drinks chosen and send proof of this to the research team (otherwise they were not reimbursed). Units of alcohol were calculated for all drinks that were >0% ABV, i.e., alcoholic and ‘alcohol-free’ drinks (which were defined as containing more than 0% and up to 0.5% ABV). This outcome was pre-registered as the primary outcome as it was assessed in all participants who were exposed to the intervention, and measured within the same context, i.e., the simulated online supermarket.

Secondary and additional outcomes

Secondary outcomes were the number of alcoholic and non-alcoholic drinks selected, the number of alcohol units purchased, and the proportion (i.e., percentage) of total drinks selected and purchased that were alcoholic. Additional outcomes were the total number of drinks selected, and purchased, the number of alcoholic drinks purchased, and the number of non-alcoholic drinks purchased.

Selection outcomes were assessed from the simulated online supermarket task and purchasing outcomes were assessed from receipts after shops at Tesco.com were completed. Purchasing outcomes were calculated to include (i) additional drinks from study categories only (i.e., beer, cider, wine, and adult non-alcoholic drinks), and (ii) all additional drinks (i.e., all alcoholic and non-alcoholic drinks - excluding squash, juice, tea, coffee and children’s drinks).

Other measures

Demographic characteristics. Age, gender, and highest qualification attained (‘Higher Education or professional / vocational equivalents’, ‘A levels or vocational level 3 or equivalents’, ‘GCSE / O Level grade A*-C or vocational level 2 or equivalents’, ‘Qualifications at level 1 and below’, ‘Other qualifications: level unknown’, or ‘No qualifications’). Qualifications classifications were based on UK definitions19,20.

Household members. Number of adults (aged 18+) and of children (aged <18).

Drinking behaviour risk. Alcohol Use Disorders Identification Test (AUDIT)21, a 10-item clinical screening measure for assessing risk associated with participants’ drinking behaviour (low risk drinking: score 0-7; medium/hazardous risk drinking: score 8-15; high/harmful risk drinking: score ≥16).

Baseline weekly unit consumption. Self-reported drinks consumed and purchased over the previous seven days, used to calculate the number of alcohol units as a continuous variable.

Free-text comments. Participants provided comments on the task, such as explaining their choice of drinks.

Statistical analysis
Analyses were pre-registered in a detailed statistical analysis plan (https://osf.io/4yuca).

All participants who completed the selection task were included in the primary outcome analysis. Participants who failed to complete the selection task and those whose responses were flagged as incomplete or suspicious - e.g., those that forged data (i.e., submitted fake receipts) or selected an unrealistically large number (e.g., over 100) of drinks that were not purchased – were excluded (see Figure 1 for details by group). The distribution of the primary outcome was highly skewed and zero inflated, and therefore a hurdle model was used for analysis, fitting i) a binary logistic model (part 1) to the zero and non-zero outcomes and ii) a truncated negative binomial model (part 2) to just the positive values. The model results for the positive values are therefore based only on participants who selected at least one drink containing alcohol (see Supplementary S2), with non-integer variables rounded to integer values before hurdle model analysis.

For most secondary outcomes, hurdle models were repeated as per the primary outcome model. Model results for the positive values are reported in the Results (i.e., based on values above zero) with models for the binary outcomes reported in Supplementary S3. For additional purchasing outcomes, negative binomial regression was required due to the skewed data. For the proportion outcomes (i.e., percentage of total drinks selected, and purchased, that were alcoholic), a beta binomial regression was used to model the proportion using the counts of relevant drinks selected out of the count of all drinks selected and this could accommodate the bimodal distribution observed. For these outcomes only, due to the nature of the model, any participants who did not select any drink (as appropriate for the outcome) were excluded.

Two per-protocol analyses were pre-specified, in which the primary outcome analysis was repeated for (i) participants who purchased what they selected, either with or without additional drinks (per-protocol analysis 1); (ii) participants who purchased exactly what they selected and purchased no additional drinks (per-protocol analysis 2).

For all outcomes, for the co-primary comparisons (using the Lower Proportion group as the reference group), a 5%/2 adjustment to the interpretation threshold for statistical significance was made. For the third comparisons (where Higher Proportion and Same Proportion groups were compared), a 5%/3 adjustment was made. These additional tests were calculated by refitting the same model just with different reference categories.

Patient and public involvement

The design and implementation of the study, including the plans for recruitment and measurement of the outcomes were independent of patients and the public. Patients or members of the public were not invited to comment on the study design or contribute to the writing or editing of this document for readability or accuracy. The results of the research will be shared with the general public through internet, news, popular science articles and social media.

Results

Sample characteristics
Figure 1 shows the flow of participants. In total, 737 participants were randomised, 640 of whom completed the selection task. 607 participants were included in the primary outcome analysis. The primary analysis dataset was 59.7% female and the mean age was 37.8 (SD = 11.4). Groups were well balanced on all characteristics (Table 1).

[Insert Figure 1]

[Insert Table 1]

Primary outcome

Raw primary outcome data are presented in Table 2 and modelled estimates in Table 3.

Based on model results in those selecting drinks containing alcohol (i.e., part 2 of the hurdle model), participants in the Higher Proportion group selected 10.0 fewer alcohol units than those in the Lower Proportion group (-32%; 95% CI -42%, -22%; p < .001) and 7.1 fewer alcohol units than the Same Proportion group (-25%; 95% CI -36%, -13%; p < .001). There was no evidence of a difference between the Same Proportion and Lower Proportion groups (2.9 fewer units; -9%; 95% CI -22%, 5%). In addition, part 1 of the hurdle model showed that there were significantly more zero values in the Higher Proportion compared to the Lower Proportion group (p < .001), with those in the Higher Proportion group less likely to select drinks containing alcohol; there were no differences in zero values for the other comparisons.

Secondary outcomes

Raw secondary outcome data are presented in Table 2 and modelled estimates in Table 3. See Supplementary Material S3 for full model results. For purchasing outcomes, of the 640 participants who completed the selection task, 422 (66%) went on to purchase drinks from Tesco.com. Attrition from selection to purchasing stages was very similar across the three randomised groups (with 136, 141, and 145 completing purchasing).

Results for all secondary selection and purchasing outcomes demonstrated a wholly consistent pattern of results with amounts and proportions of alcohol selected and purchased always lowest in the Higher Proportion group, although not always significantly so.

Selection

Participants in the Higher Proportion group selected 3.5 fewer alcoholic drinks than those in the Lower Proportion group (-35% reduction; 95% CI -48%, -18%; p < .001). There were non-significant reductions of 1.5 alcoholic drinks in the Same Proportion group compared to the Lower Proportion group (-15%; 95% CI -32%, -6%; p = .148) and 1.9 drinks in the Same Proportion group compared to the Higher Proportion group (-23%; 95% CI -39%, -2%; p = .03). There was no evidence of a difference in the number of non-alcoholic drinks selected between groups.

The percentage of total drinks selected that were alcoholic was lower in the Higher Proportion group (42%; 95% CI 40%, 44%) compared to the Lower Proportion group (66%; 95% CI 65%, 68%; p < .001), and lower compared to the Same Proportion group (58%; 95% CI 56%, 60%; p < .001); the percentage of total drinks selected that were alcoholic was also lower in the Same Proportion group compared to the Lower Proportion group (p < .001).
**Purchasing**

When including additional drinks that were purchased from study categories only, there was a non-significant reduction of 4.2 alcohol units in the Higher Proportion compared to the Lower Proportion group (-15%; 95%CI -28%,0%; p = .056) and a reduction of 6.8 fewer alcohol units purchased in the Higher Proportion group compared to the Same Proportion group (-22%; 95%CI -34%,-8%; p = .003). There was no evidence of a difference in alcohol units purchased between the Same Proportion and the Lower Proportion groups. There was evidence that the percentage of total drinks selected that were alcoholic was lower in the Higher Proportion group (49%; 95% CI 47%,51%) compared to the Lower Proportion group (68%; 95% CI 66%,70%; p < .001) and to the Same Proportion group (68%; 95% CI 66%,70%; p = .004); the percentage of total drinks selected that were alcoholic was also lower in the Same Proportion group compared to the Lower Proportion group (p = .003).

When including all additional drinks from any category, there was no evidence of a difference between any of the groups for alcohol units purchased. There was evidence of a difference in the percentage of total drinks selected that were alcoholic between the Higher Proportion group (43%; 95%CI 41%,45%) and the Lower Proportion group (60%; 95%CI 58%,62%; p < .001), and the Lower Proportion group and the Same Proportion group (56%; 95%CI 54%,58%; p = .015); there was no evidence of a difference between the Higher Proportion and the Same Proportion groups.

[Insert Table 2]

[Insert Table 3]

**Per-protocol analyses**

Of the 422 participants who purchased drinks, 344 participants purchased the drinks they had selected in the selection task (with 78 participants missing one or more drinks); 182 participants purchased exactly the drinks they had selected with no additional drinks. Chi-squared tests indicated that there was no evidence against assuming equal attrition occurred. Attrition was greater amongst participants with higher baseline alcohol purchasing, but modelling suggested this did not bias the comparisons between groups (Supplementary Material S4). See Table 4 and Supplementary S5 for full model results.

In participants (n = 344) who completed purchasing of the drinks they had selected, either with or without additional drinks, those assigned to the Higher Proportion group selected 7.5 fewer alcohol units than those in the Lower Proportion group (-28%; 95%CI -40%,-15%; p < .001) and 6.9 fewer units than the Same Proportion group (-27%; 95%CI -38%,-13%; p < .001). There was no evidence of a difference between the Same Proportion and the Lower Proportion groups. For purchasing, when including additional drinks from study categories only, 6.3 fewer alcohol units were purchased in the Higher Proportion group compared to the Lower Proportion group (-22%; 95%CI -34%,-7%; p = .006), and 8.8 fewer units compared to the Same Proportion group (-29%; 95%CI -40%,-14%; p < .001). There was no evidence of a difference between the Lower Proportion and Same Proportion groups and no evidence of a difference between groups for purchasing when including all additional drinks.
In participants (n = 182) who completed purchasing only of the drinks they had selected with no additional drinks, those assigned to the Higher Proportion group selected and purchased 6.7 fewer alcohol units than did those in the Lower Proportion group (-26%, 95%CI -41%, -7%; p = .009). There was no evidence of a difference for the other comparisons.

[Insert Table 4]

Full results for the additional outcomes can be found in Supplementary Material S6.

Discussion

Substantially increasing the proportion of non-alcoholic drinks relative to alcoholic drinks meaningfully reduced the amount of alcohol selected and purchased in an online supermarket context. Compared to when the majority of options were alcoholic, participants selected 32% fewer alcohol units when the majority of options were non-alcoholic, and 25% fewer alcohol units when half the options were non-alcoholic. Participants also went on to purchase significantly fewer alcoholic drinks, and more non-alcoholic drinks, when the majority of options were non-alcoholic. Importantly, the overall pattern of results was consistent for all outcomes, with amounts and proportions of alcohol selected and purchased always lowest when non-alcoholic drinks were most available, including for pre-specified per-protocol analyses. The findings of the current study are in line with a single prior study that found increasing the proportion of non-alcoholic drinks options in an online setting reduced hypothetical selection of alcohol\textsuperscript{12}. More generally, they are consistent with a growing body of studies that apply similar availability interventions to food\textsuperscript{7,8,10}, suggesting that these interventions have the potential to be usefully applied across different product contexts\textsuperscript{5}.

Strengths and limitations

This study is the first randomised controlled trial using a naturalistic setting to estimate the impact of increasing the proportion of non-alcoholic drinks. Meaningful selection and actual purchasing outcomes were assessed, with participants able to complete their typical online shop, including selecting and purchasing multiple options from a wide range of drinks.

The study had some limitations. First, while the primary selection outcome was assessed in the context of intention to subsequently purchase, and was minimally affected by attrition, there was substantial drop-out between selection and actual purchasing outcomes. However, attrition between groups was very similar by study condition, and there was sufficient power to detect effects despite this; as this was the first study looking at purchasing of alcohol in this setting, effect sizes could not be anticipated, but large effects on purchasing were observed. While substantial attrition is expected in studies of this nature because of time between selection and purchasing, more generally it may be hard to avoid for any measure of unconstrained purchasing in a real-world online supermarket. Although we are not aware of other directly comparable studies in this context, more generally, ‘cart abandonment’ – where people do not purchase items they put in their shopping cart – is common in online (including supermarket) shopping contexts\textsuperscript{22}. Future studies may be able address this through more intensive initial screening or follow-up of participants, or by forcing participants to immediately complete their online shop. However, such processes would arguably be less naturalistic, and including only the most motivated participants risks including a less representative sample.
Second, although the setting was as naturalistic as was feasible and actual purchasing outcomes were measured, the process involved two stages. Drinks were initially selected within a simulated online supermarket, before purchasing was completed in an actual online supermarket (albeit with the visual presentation of the former modelled on the latter). This meant that additional drink options were available in the real online supermarket, and participants could not be prevented from buying these if they wished to. As a result, the clearest effects on purchasing behaviour were in participants that followed the protocol as instructed and only purchased what they selected in the simulated supermarket where the intervention was implemented. To avoid this, the intervention would ideally have been implemented entirely within a real online supermarket. However, to our knowledge, this is the first study of an availability intervention to make use of such a setting (albeit in conjunction with a simulated supermarket component). This represents the most robust design used to date and could provide a useful method through which to assess interventions without requiring complex collaboration with commercial retailers. Finally, while participants were largely representative of Tesco.com shoppers they were mostly of higher socioeconomic position. The generalisability of these findings to disadvantaged populations therefore needs consideration, particularly as buying alcohol-free drinks is more likely to occur in less socially and materially deprived households.

Implications for research and policy

This study suggests that increasing the available non-alcoholic, and reducing the available alcoholic options has the potential to meaningfully reduce selection and purchasing of alcohol. Although there was some evidence of a reduction in alcohol selected and purchased when half of the options available were non-alcoholic, effects were only consistently observed when non-alcoholic drinks became the majority. Currently, supermarkets typically stock a wider range of alcoholic than non-alcoholic alternatives to alcohol, and these results suggest that if non-alcoholic options were to become the majority instead, we might expect to see substantial reductions in alcohol purchasing. As it is yet to be seen if such major changes in ranges of drinks are feasible in real-world settings, these findings are most reasonably interpreted as proof of principle, rather than able to directly inform policy options. It is plausible that this situation could rapidly change, however. For example, the recent increase in the popularity of alcohol-free drinks has led to the emergence of drinking settings reflecting this, such as an alcohol-free off licence in London. In food retail contexts there have been substantial changes seen in healthier or more sustainable ranges - such as the introduction of 50% plant-based menus suggesting that shifts of such magnitude are possible. Future studies should, however, investigate the impact of smaller and more granular alterations in proportions of non-alcoholic drinks, and in a wider range of field settings, to establish how such interventions could be used. Given the relatively large effects observed in this study, subtler interventions could elicit smaller effects that would nonetheless remain meaningful for population health, especially when considering the inherent potential for scalability across retail settings.

This intervention simultaneously increased the number of non-alcoholic drinks and decreased the number of alcoholic drinks whilst the overall number of drinks remained constant. It is unclear whether the effect is predominantly driven by one or the combination of these changes. Further studies are needed to disentangle this and investigate potential mechanisms more broadly; noting that there is some preliminary exploration of possible mechanisms in food contexts. Importantly, the overall number of drinks that participants selected and
purchased remained similar between groups, suggesting that effects were a result of shifting, rather than necessarily restricting choices. This implies overall drink sales and potentially revenues may be relatively unchanged if such an intervention were to be implemented, albeit dependent on non-alcoholic drink pricing. Increasing non-alcoholic drink availability could also ultimately lead to a greater range of alcohol-free drinks and soft drinks being manufactured, further increasing their popularity in synergistic fashion, and many alcohol companies have already committed to this. It is important to note that because many alcohol-free alternatives are marketed by the alcohol industry, this involvement has potential harms and should be monitored closely. In addition, although some of the non-alcoholic drink options in the current study contained no sugar and were generally lower in calories than the alcoholic options, many soft drinks and alcohol-free alternatives still contain a high amount of sugar and calories.

Conclusion

This randomised controlled trial is the first to date to assess the effect on selection and purchasing of increasing the proportion of non-alcoholic drinks available. The findings provide evidence that substantially increasing the proportion of non-alcoholic drinks - from 25% to 50% or 75% - meaningfully reduces alcohol selection and purchasing in an online supermarket context. While these findings highlight the potential for reducing alcohol sales at population level, further studies are warranted to assess whether these effects are realised in a range of real-world settings.

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Declarations

Availability of data and materials

Data will be available from the Open Science Framework (together with the study protocol and statistical analysis plan, already uploaded) and the University of Cambridge Research Repository upon publication.

Authors’ contributions

GJH, NC, TMM, AKMB, and MRM conceptualized and designed the study. NC coordinated the study and led on data collection and cleaning with AKMB & JF. MAP and KDL led on the statistical analysis. NC, GJH, and MAP drafted the manuscript with all authors providing critical revisions. All authors had full access to all the data in the study and accept responsibility to submit for publication.

Competing interests

All authors have completed the Unified Competing Interest form (available on request from the corresponding author) and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; and no other relationships or activities that could appear to have influenced the submitted work.

Transparency declaration

The lead author affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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Figure 1. CONSORT flow diagram.

Eligible and invited (n=1534) - Declined to participate (n=143): - Never started (n=660)

Randomised (n=737)

GROUP 1: 75% Non-Alcoholic, 25% Alcoholic
Allocated to intervention (n=219, 30% of total randomised)
  - Received allocated intervention (n=219)
  - Did not receive full intervention (drop-out)
  - (n = 25, 3%)

GROUP 2: 50% Non-Alcoholic, 50% Alcoholic
Allocated to intervention (n=205, 28%)
  - Received allocated intervention (n=205)
  - Did not receive full intervention (drop-out)
  - (n=44, 6%)

GROUP 3: 25% Non-Alcoholic, 75% Alcoholic
Allocated to intervention (n=216, 29%)
  - Received allocated intervention (n=216)
  - Did not receive full intervention (drop-out)
  - (n=28, 4%)

Aluminium

Analysis

Analysis of primary outcome (n=206)
Excluded from analysis (n=13)
Reasons for exclusion:
  - Completed the study more than once (n=1)
  - False receipt (n=1)
  - Did not select drinks without explanation (n=10)
  - Did not meet weekly drinking inclusion criteria (n=1)

Analysis of primary outcome (n=194)
Excluded from analysis (n=11)
Reasons for exclusion:
  - False receipt (n=2)
  - Did not select drinks without explanation (n=7)
  - Selected very large amounts of alcohol (>150 drinks) that they did not go on to purchase (n=2)

Analysis of primary outcome (n=207)
Excluded from analysis (n=9)
Reasons for exclusion:
  - Completed the study more than once (n=3)
  - Did not select drinks without explanation (n=5)
  - Selected very large amounts of alcohol (>150 drinks) that they did not go on to purchase (n=2)
Table 1. Characteristics of participants included in primary outcome analysis (n (%), unless otherwise stated)

| Characteristic                                | GROUP 1: Higher Proportion 75% Non-Alcoholic, 25% Alcoholic (n = 206) | GROUP 2: Same Proportion 50% Non-Alcoholic 50% Alcoholic (n = 194) | GROUP 3: Lower Proportion 25% Non-Alcoholic 75% Alcoholic (n = 207) |
|-----------------------------------------------|---------------------------------------------------------------------|------------------------------------------------------------------|------------------------------------------------------------------|
| Alcohol consumption previous week (units)\(^1\) (mean (SD)) | 27.7 (37.5)                                                        | 24.5 (22.6)                                                      | 25.9 (26.1)                                                      |
| Alcohol purchasing previous week (units)\(^2\) (mean (SD)) | 42.2 (37.5)                                                        | 37.6 (28.3)                                                      | 41.5 (37.3)                                                      |
| AUDIT score (mean (SD))\(^3\)                  | 8.9 (5.2)                                                          | 8.8 (5.4)                                                       | 8.8 (5.5)                                                       |
| - Low risk drinking (scores 1-7)              | 98 (48)                                                            | 98 (51)                                                         | 107 (52)                                                        |
| - Medium to high risk drinking scores (8 +)   | 106 (52)                                                           | 95 (49)                                                         | 99 (48)                                                         |
| Age (mean (SD))\(^4\)                         | 38.1 (11.6)                                                        | 37.6 (11.8)                                                     | 37.7 (11.0)                                                     |
| 18-39 years                                   | 132 (64)                                                           | 123 (63)                                                        | 122 (59)                                                        |
| 40 and over                                   | 74 (36)                                                            | 71 (37)                                                         | 84 (41)                                                         |
| Gender\(^5\)                                  |                                                                    |                                                                |                                                                  |
| Male                                         | 78 (37.9)                                                          | 82 (42.3)                                                      | 83 (40.3)                                                      |
| Female                                       | 127 (61.7)                                                         | 112 (57.7)                                                     | 123 (59.7)                                                     |
| Household members\(^6\)                      |                                                                    |                                                                |                                                                  |
| Number of adults in household (mean (SD))     | 2 (0.8)                                                            | 2.1 (1.4)                                                      | 2 (0.8)                                                        |
| Number of children in household (mean (SD))   | 0.7 (0.9)                                                          | 0.7 (0.9)                                                      | 1 (0.7)                                                         |
| Highest qualification\(^7\)                   |                                                                    |                                                                |                                                                  |
| No qualifications                             | 1 (0.5)                                                            | 0 (0)                                                          | 2 (1.0)                                                        |
| Qualifications at level 1 and below           | 0 (0)                                                              | 3 (1.5)                                                        | 0 (0)                                                          |
| GCSE / O Level grade A*-C or vocational level 2 or equivalents | 26 (12.6)                                                         | 18 (9.3)                                                        | 23 (11.2)                                                       |
| A levels or vocational level 3 or equivalents  | 42 (20.4)                                                          | 52 (26.8)                                                      | 36 (17.5)                                                      |
| Higher Education or professional / vocational equivalents | 137 (66.5)                                                        | 121 (62.4)                                                     | 144 (69.9)                                                     |
| Other qualification                           | 0 (0)                                                              | 0 (0)                                                          | 1 (0.5)                                                        |

Standard deviation (SD).

\(^1\) All participants in the sample explicitly reported drinking at least once a week in the screener questions. A further weekly drinking measure recorded the amount of alcohol consumed (1a) and purchased (1b) in the previous week as an overall indication of the volume of alcohol consumed and purchased weekly.

\(^2\) Heavy and binge drinking behaviours (AUDIT), scores 1-7 indicative of low-risk drinking; 8-14: hazardous alcohol consumption; 15+: moderate-severe alcohol use. Missing data for 3 participants.

\(^3\) Missing data for 1 participant.
Table 2. Primary and secondary outcomes (raw means (SD))

|                          | GROUP 1: Higher Proportion | GROUP 2: Same Proportion | GROUP 3: Lower Proportion |
|--------------------------|---------------------------|--------------------------|---------------------------|
|                          | 75% Non-Alcoholic, 25%    | 50% Non-Alcoholic, 50%   | 25% Non-Alcoholic, 75%    |
|                          | Alcoholic (n = 206)       | Alcoholic (n = 194)      | Alcoholic (n = 207)       |
| **Mean (SD)**            |                           |                          |                           |
| **Primary outcome**:     |                           |                          |                           |
| Number of alcohol units  | 17.6 (16.2)               | 25.6 (20.5)              | 29.5 (29.8)               |
| selected (with an        |                           |                          |                           |
| intention to purchase).  |                           |                          |                           |
| **Secondary outcomes**:  |                           |                          |                           |
| Number of alcoholic      | 6.4 (7.1)                 | 8.8 (9.2)                | 10.6 (14.0)               |
| drinks selected          |                           |                          |                           |
| Number of non-alcoholic  | 8.8 (15.0)                | 6.4 (10.5)               | 5.4 (13.6)                |
| drinks selected          |                           |                          |                           |
| Percentage of total      | 52% (37%)                 | 64% (34%)                | 75% (34%)                 |
| drinks selected that are |                           |                          |                           |
| alcoholic                |                           |                          |                           |
| **Secondary outcomes**:  |                           |                          |                           |
| Number of alcohol units  | 23.4 (30.4)               | 28.7 (23.3)              | 26.7 (18.6)               |
| purchased (including     |                           |                          |                           |
| additional drinks from   |                           |                          |                           |
| study categories only)   |                           |                          |                           |
| Number of alcohol units  | 28.7 (36.6)               | 30.7 (26.9)              | 29.1 (22.5)               |
| purchased (including all |                           |                          |                           |
| additional drinks)       |                           |                          |                           |
| Percentage of total      | 55% (37%)                 | 68% (32%)                | 76% (34%)                 |
| drinks purchased that are|                           |                          |                           |
| alcoholic (including     |                           |                          |                           |
| additional drinks from   |                           |                          |                           |
| study categories only)   |                           |                          |                           |
| Percentage of total      | 52% (36%)                 | 61% (33%)                | 68% (36%)                 |
| drinks purchased that are|                           |                          |                           |
| alcoholic (including all |                           |                          |                           |
| additional drinks)       |                           |                          |                           |
Table 3. Model results for primary and secondary outcomes: model estimates (95%CI), p values, percentage changes (95%CI)

|                          | Reference group: Lower Proportion | Reference group: Same Proportion |
|--------------------------|----------------------------------|---------------------------------|
|                          | (25% Non-alcoholic, 75% Alcoholic)| (50% Non-alcoholic, 50% Alcoholic) |
|                          | (n = 207)                           | (n = 194) |
| **Primary outcome:**     |                                   |                                   |
| Number of alcohol units  |                                    |                                   |
| selected (with an        |                                    |                                   |
| intention to purchase)   |                                    |                                   |
| Hurdle model part 1:     |                                    |                                   |
| binary outcomes          |                                    |                                   |
| -0.64, p = .121          | -1.36 p < .001                     | 0.72, p = .022                    |
| 95%CI -1.44,0.17         | 95%CI -2.09,-0.63                  | 95%CI 0.10, 1.34                 |
| Hurdle model part 2:     |                                    |                                   |
| non-zero outcomes        |                                    |                                   |
| -0.10, p = .178          | -0.39, p < .001                    | -0.29, p < .001                   |
| 95%CI -0.24,0.05         | 95%CI -0.54,-0.24                  | 95%CI -0.44,-.14                 |
| -9%                      | -32%                               | -25%                             |
| (95%CI -22%, 5%)         | (95%CI -42%, -22%)                 | (95%CI -36%, -13%)               |
| **Secondary outcomes:** selection |                                    |                                   |
| Number of alcoholic drinks selected | -0.17, p = .148 | -0.43, p < .001 | -0.26, p = .03 |
|                            | 95%CI -0.39,0.06 | 95%CI -0.66,-0.20 | 95%CI -0.50, -0.02 |
|                            | -15%                              | -35%                             | -23%                             |
|                            | (95%CI -32%,6%)                   | (95%CI -48%, -18%)               | (95%CI -39%, -2%)                |
| Number of non-alcoholic drinks selected | -0.27, p = .148 | -0.06, p = .735 | 0.21, p = .197 |
|                            | 95%CI -0.63,0.10                  | 95%CI -0.41, 0.29                | 95%CI -0.11, 0.53                |
|                            | -24%                              | -6%                              | 23%                              |
| Percentage of total drinks selected that are alcoholic<sup>3</sup> | (95%CI -47%, 10%) | (95%CI -34%, 34%) | (95%CI 69%, -10%) |
|---|---|---|---|
| -0.63, p < .001 (Same Proportion: 58% 95%CI 56%, 60%) | -1.27, p < .001 (Higher Proportion: 42% 95%CI 40%, 44%) | -0.54, p < .001 (Lower Proportion: 66% 95%CI 65%, 68%) |

**Secondary outcomes: purchasing**

| Reference group: Lower Proportion/More Alcoholic (25% Non-alcoholic, 75%alcoholic) (n = 145) | Reference group: Same Proportion Equal (50% Non-alcoholic, 50%alcoholic) (n = 141) |
|---|---|
| Same Proportion/ Equal (n = 141) | Higher Proportion/ Less Alcoholic (n = 136) | Higher Proportion/ Less Alcoholic (n = 136)* |
| Number of alcohol units purchased (including additional drinks from study categories only)<sup>3</sup> | 0.09, p = .263 95%CI -0.07,0.25 10% (95%CI -7%, 28%) | -0.16, p = .056 95%CI -0.32, 0.00 -15% (95%CI -28%, 0%) | -0.25, p = .003 95%CI -0.42, -0.09 -22% (95%CI -34%, -8%) |
| Number of alcohol units purchased (including all additional drinks)<sup>2</sup> | 0.06, p = .471 95%CI -0.11,0.24 7% (95%CI -10%, 27%) | -0.04, p = .658 95%CI -0.22, 0.14 -4% (95%CI -19%, 15%) | -0.10, p = .255 95%CI -0.28, 0.07 -10% (95%CI -25%, 8%) |
| Percentage of total drinks purchased that are alcoholic (including additional drinks from study categories only) <sup>3</sup> | -0.57, p = .003 (Same Proportion: 68% 95%CI 66%, 70%) | -1.09, p < .001 (Higher Proportion: 49% 95%CI 47%, 51%) | -0.51, p = .004 (Lower Proportion: 68% 95%CI 66%, 70%) |
| Proportion of total drinks purchased that are alcoholic (including all additional drinks) | -0.42, p = .015 | -0.76, p < .001 | -0.33, p = .049 |
| --- | --- | --- | --- |
| (Same Proportion: 56% 95%CI 54%, 58%) | (Higher Proportion: 43% 95%CI 41%, 45%) | (Lower Proportion: 60% 95%CI 58%, 62%) |

1 Note significance threshold is 0.0167 for a 5% alpha
2 Part 2 of the model is a negative binomial regression, therefore the back-transformed 95%CI become asymmetric
3 Beta binomial regression models used for analysis. Mean estimates (not percentage reductions) are reported.
Table 4. Per-protocol analyses: model estimates (95%CI), p values, percentage changes (95%CI)¹

| Per-protocol analysis 1: number of alcohol units selected (n=344) | Reference group: Lower Proportion/More Alcoholic (25% Non-alcoholic, 75% Alcoholic) | Reference group: Same Proportion Equal (50% Non-alcoholic, 50% Alcoholic) |
|----------------------------------------------------------------------|---------------------------------------------------------------------------------|------------------------------------------------------------------------|
| Same Proportion                                                     | Higher Proportion                                                               | Higher Proportion¹                                                      |
| -0.02, p = .780                                                     | -0.33, p < .001                                                                 | -0.31, p < .001                                                       |
| 95%CI -0.19, 0.14                                                  | 95%CI -0.50, -0.16                                                             | 95%CI -0.48, -0.14                                                  |
| -2%                                                                | -28%                                                                            | -27%                                                                  |
| (95%CI -17%, 15%)                                                 | (95%CI -40%, -15%)                                                            | (95%CI -38%, -13%)                                                  |
| Per-protocol analysis 1: number of alcohol units purchased (including additional drinks from study categories only) (n=343) | 0.09, p = .328                                                                 | 0.25, p = .006                                                       |
| Same Proportion                                                     | Higher Proportion                                                               | Higher Proportion¹                                                      |
| 0.09, p = .328                                                     | -0.25, p = .006                                                                 | -0.34, p < .001                                                       |
| 95%CI -0.09, 0.26                                                 | 95%CI -0.43, -0.07                                                             | 95%CI -0.52, -0.16                                                  |
| 9%                                                                | -22%                                                                            | -29%                                                                  |
| (95%CI -8%, 30%)                                                 | (95%CI -34%, -7%)                                                              | (95%CI -40%, -14%)                                                  |
| Per-protocol analysis 1: number of alcohol units purchased (including all additional drinks) (n=343) | 0.08, p = .414                                                                 | 0.10, p = .324                                                       |
| Same Proportion                                                     | Higher Proportion                                                               | Higher Proportion¹                                                      |
| 0.08, p = .414                                                     | -0.10, p = .324                                                                 | -0.18, p = .078                                                       |
| 95%CI -0.11, 0.27                                                 | 95%CI -0.29, 0.10                                                               | 95%CI -0.38, 0.02                                                  |
| 8%                                                                | -9%                                                                             | -16%                                                                  |
| (95%CI -11%, 31%)                                                 | (95%CI -25%, 10%)                                                              | (95%CI -31%, 2%)                                                    |
| Per-protocol analysis 2: number of alcohol units selected (maps directly onto purchasing) (n=182) | -0.04, p = .689                                                                | -0.30, p = .009                                                       |
| Same Proportion                                                     | Higher Proportion                                                               | Higher Proportion¹                                                      |
| -0.04, p = .689                                                    | -0.30, p = .009                                                                 | -0.26, p = .028                                                       |
| 95%CI -0.25, 0.17                                                 | 95%CI -0.53, -0.08                                                             | 95%CI -0.49, -0.03                                                 |
| -4%                                                                | -26%                                                                            | -23%                                                                  |
| (95%CI -22%, 19%)                                                 | (95%CI -41%, -7%)                                                               | (95%CI -39%, -3%)                                                   |

¹ Part 2 of the model is a negative binomial regression, therefore the back-transformed 95%CI become asymmetric.
² Note significance threshold is 0.0167 for a 5% alpha.