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Signs of Change: Estimating the Impact of Animal Cruelty Billboards on Plant-Based and Dairy Milk Consumption in the UK

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Supplementary Materials: Code, Data, Materials [see Index of Supplementary Materials]

Abstract

We present a field experiment to evaluate a social marketing campaign encouraging people to try plant-based milk. We ran six anti-dairy billboards for one month in a city in the UK. The billboards featured a photo of a suffering dairy cow, a link to a website with information about dairy cow suffering, and an appeal to try plant-based milk. To estimate the impact of the billboards on plant-based and dairy milk consumption, we triangulated three novel data collection methods. First, we compared changes in regional vs. nationwide sales data from two plant-based milk companies. Second, we evaluated the proportion of dairy-free orders from six cafes in the city where we ran the billboards ('Billboard City') before, during, and after the campaign. Third, we compared changes in the proportion of household waste representing plant-based or dairy milk in the Billboard City vs. another UK city with no intervention ('Control City'). Although descriptively, our results appear to be in line with some positive impact of the billboards, ultimately the study design and data were too limited to support a general claim about the impact of the billboard campaign. There were logistical challenges with each data source, as well as too many extraneous factors for the design to account for adequately. We discuss the challenges of field research, the strengths and weaknesses of each novel data collection method, and present considerations for future research.

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Keywords

field research, billboards, social marketing, intervention, plant-based milk

Non-Technical Summary

Background

There are strong environmental, public health, and ethical reasons to reduce our overall consumption of animal products. In particular, dairy production contributes to greenhouse gas emissions, land use, and water pollution disproportionately. Much of the research on reducing meat and dairy consumption uses online surveys and hypothetical interventions, but there is a paucity of field research, i.e. research approximating change in consumption based on a real intervention. Moreover, much of the research is based on self-reported consumption or intentions data, which is limited in many ways.

Why was this study done?

The goal of this study was to twofold. First, we wanted to evaluate the impact of real anti-dairy billboards on consumption of dairy and plant-based milk. Second, we wanted to evaluate three novel data collection methods which go beyond self-reported measures and could be used to triangulate evidence of an impact.

What did the researchers do and find?

We ran six anti-dairy billboards in a UK city ('Billboard City') for one month. We collected data using three methods. First, we collected sales data from the Billboard City and nationwide from two plant-based milk companies. Second, we collected cafe sales data of dairy and non-dairy options from six cafes in the Billboard City before, during, and after the billboard campaign. Third, we estimated household consumption of plant-based and dairy milk based on residential waste from recycling containers in the Billboard City and another city without billboards ('Control City'). Overall, we found some evidence of increased consumption of plant-based milk in the Billboard City compared to the Control City, but the study design and data were too limited to support a general claim about the impact of the billboards.

What do these findings mean?

Although the data from the methods described above was slightly supportive of more plant-based and less dairy consumption in the city where we ran billboards, ultimately the study was inconclusive with respect to the impact of the billboards. This is because there were too many limitations to the data we were able to collect, and too many factors that we could not control or account for when comparing consumption.

Social marketing may be an area worthy of further research, but field research on this topic is challenging. Sales data from partners who are willing and able to share it is the most worthwhile form of data of the three we collected.

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Background

Reducing Dairy is Especially Impactful and Easily Replaceable

The environmental, ethical, and public health impacts of industrialised animal agriculture are significant (Nordquist et al., 2017; Tiseo et al., 2020; Xu et al., 2021). Here, we focus on the dairy industry, where some concerns are especially acute.

The cycle of impregnation and milking raises significant ethical concerns in the dairy industry (European Commission, 2017). The routine separation of calves from their mothers causes distress (Green et al., 2020, 2021), and calves are often then raised in isolation for ~8 weeks, which causes significant behavioural deprivation (Costa et al., 2016). Dairy calves which cannot produce milk—i.e. males—are routinely killed shortly after birth (Sarfas, 2024). Milk yields have increased more than 500% since 1925 due to selective breeding, and the changes this has caused in cows has led to increased mastitis, lameness, and reproductive problems (Compassion In World Farming, 2024; Oltenacu & Algers, 2005).

Dairy cows, though subjected to unpleasant conditions, produce large quantities of milk, so each purchase contributes to only a small fraction of an animal's suffering, unlike purchasing chicken which involves the suffering of whole animals. Nevertheless, despite dairy being associated with less suffering per unit of food compared to other animal products (Mandel et al., 2022), we chose to focus on it for two main reasons.

First, the environmental impacts of dairy are severe. Dairy production contributes to global warming, acidification, eutrophication, ozone layer depletion and photochemical smog (Djekic et al., 2014). Dairy alternatives have lower environmental impacts than dairy products across almost every product (Kanyama et al., 2021). Oat protein in particular has a 50% lower footprint than dairy protein (Heusala et al., 2020). Thus, reducing dairy consumption offers substantial environmental benefits.

Second, dairy milk is easily replaceable with plant-based alternatives so focusing efforts here yields the highest chance of detecting an effect from billboards. While plant-based meat accounts for less than 2% of the meat and alternatives market, plant-based milk accounts for 15% of the dairy and alternatives market (Good Food Institute, 2023). It has been noted that plant-based milks vary in their nutritional content, with soy milk having a comparable protein and amino acid content to cow and goat milk, and significantly less sugar and fat (Moore et al., 2023). Therefore, asking people to replace milk is likely to be more realistic than meat or eggs.

Anti-Dairy Billboards as a Promising Social Marketing Intervention

Social marketing refers to the use of marketing principles, practices, and tools to affect prosocial behavioural change. In practice, this definition is broad, and could encompass anti-dairy billboards, pro-vaccine radio ads, anti-tobacco social media ads, and a range

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of other marketing campaigns aimed at achieving social ends. For example, a social marketing campaign involving billboards in low-income neighbourhoods in Milwaukee achieved an eightfold increase in parents asking their doctors about immunisations (Ngui et al., 2015). According to a systematic review of 54 interventions, social marketing interventions can be effective across a range of behaviours, target groups, and settings (Stead et al., 2007).

In particular, social marketing could be effective at reducing animal product consumption, because awareness-raising is likely to be the major task for animal advocates. Within the transtheoretical model of change (Prochaska & Velicer, 1997), the majority of the UK population are at the 'precontemplation stage' with respect to giving up animal products—i.e. they have not dismissed it as a possibility, they have just never considered it (Bryant et al., 2023). This implies that the most effective focus for mass marketing campaigns is not about winning arguments (most relevant at the contemplation stage) or recommending recipes (most relevant at the preparation and action stages), but rather prompting the majority population to move from precontemplation to contemplation by putting information in front of them on an ongoing basis.

Specific types of social marketing may be especially relevant for campaigns targeting animal product consumption, because they are able to overcome one of the key barriers to behaviour change on this issue: avoidance. As discussed by Bryant et al. (2022), two thirds of consumers admit that they do not consider farm animal suffering when they purchase meat (Signicom, 1997) and can easily be nudged towards vegetarian options with simple reminders of the animal origin of meat like changing menus to say 'cow'/'pig' rather than 'beef'/'pork' (Kunst & Hohle, 2016). Moreover, there is evidence that imagery of animal suffering—although they were the most impactful for those who saw them—was also the most-avoided imagery on the cover of leaflets (Cooney, 2014). Therefore, forms of social marketing which are difficult to avoid (e.g. billboards) overcome this key avoidance barrier.

Billboards may also enhance message legitimacy, since consumers generally regard them as useful sources of information (Nayar, 2023). There is some evidence that consumers trust billboard advertisements more than those on the television or in newspapers (Statista, 2023). Furthermore, billboards are subject to more regulatory oversight and compliance with advertising standards than online advertisements. This level of scrutiny may lend some quality and reliability to billboard messages when compared to other, less regulated forms of advertising.

There is reason to believe that, if avoidance can be overcome, animal suffering is an impactful message for meat reduction. A meta-analysis of 100 studies found that meat reduction interventions with animal-focused messages consistently reduced meat consumption with meaningfully large effect sizes and little evidence of backfiring (Mathur et al., 2021).

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Multiple Assessment Methods Beyond Self-Reporting

The meta-analysis of meat reduction interventions notes that the studies primarily relied on self-reported outcomes, had relatively short-term follow-ups (if any), and were likely subject to some degree of social desirability bias. While they tentatively conclude that animal-focused messages are likely to be impactful, they call for further research which can overcome these limitations with more direct behavioural outcomes (Mathur et al., 2021).

Reliance on self-reported consumption data and/or intended consumption data is a key limitation of research in meat reduction. Such data is subject to the fallibility of participants' memory about what they ate, ability to estimate how much they ate or what they will eat, and motivation to report eating better than they truly do. However, alternatives to self-reported food choice data are not necessarily readily available (Peacock, 2018).

Detailed retail sales data exists, but it is valuable and commercially-sensitive data, and is therefore usually expensive to acquire. There are even biomarker-based methods of verifying what somebody has eaten, but these are likely to be too expensive and intrusive for most research (Peacock, 2018). Institutional collaborations (for example, with university dining halls) are one of the most promising data collection methods which avoids self-report, but relies on strong relationships with bought-in institutional stakeholders. Therefore, in meat reduction research in general, there is a strong need for feasible and reproducible data collection methods which go beyond self-report.

All of these methods effectively produce an approximation of consumption. In each case, researchers attempt to infer the actual volume of food consumed based on individual reporting, sales data in a particular area, biomarkers associated with consumption of particular foods, or other methods—but there are limits to what each of these measures can tell us about actual consumption. If each approximation used to infer actual consumption is imperfect, it may be the case that we can derive more robust measures by using multiple concurrent methods to evaluate animal product consumption.

The Present Study

So far, we have outlined the case for reducing consumption of animal products (especially dairy), and argued that anti-dairy social marketing is a promising intervention, but that animal product reduction research tends to be over-reliant on self-report and a lack of innovative data collection methods is hindering the field.

The present study sought to address two important gaps in the research:

1. To investigate the impact of a social marketing campaign featuring anti-dairy billboards on consumption of plant-based and dairy milk.
2. To explore and document a variety of novel data collection methods for measuring animal product consumption.

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We did this in the important but challenging context of field research, and this paper presents what we learned about the methods, as well as the intervention.

Method

Procedure

This field research was conducted over three months using a quasi-experimental design to assess the impact of billboard advertising on plant-based and dairy milk consumption. Two cities, the Billboard City and the Control City, were monitored.

In the Billboard City, anti-dairy and pro-alternative dairy billboards were purchased. These billboards were brand-neutral, but included specific calls to try plant-based alternatives. The Control City did not have any billboards.

We estimated consumption of plant-based and dairy milk in the Billboard City and the Control City before and after our billboard intervention using three methods. The novelty and limitations of our data collection methods are of particular interest in this study.

First, we received data from six cafes in the Billboard City on their sales of plant-based and dairy milk drinks during the study period. Using Google searches, we compiled lists of 56 cafes in the Billboard City and 62 in the Control City. We contacted them via email or their social media pages, and identified eight in the Billboard City and three in the Control City who said they would share data. Unfortunately, not all of them followed through; we ultimately received data from six cafes in the Billboard City and none in the Control City.

Second, we received data from two plant-based milk companies on their retail sales in the Billboard City and nationwide during the study period. Plant-based milk companies were understandably reluctant to share commercially-sensitive data, and did so on the condition that we would not disclose enough information to identify them. For this reason, we cannot disclose much information about the companies who ultimately provided data. After unsuccessfully cold-contacting people we identified on LinkedIn as working at one of our list of 12 plant-based milk companies, we ultimately received data from two companies with whom we had existing professional relationships.

Third, we estimated the volume of plant-based and dairy milk bottles in communal residential garbage disposals in the Billboard City (18) and the Control City (32) before and after the intervention. This involved the authors going to blocks of apartments in each city and taking photographs of the top layer of the contents of the communal garbage disposals. The photographs were later analysed manually, which involved the authors identifying plant-based or dairy milk bottles and noting the total volume of each type of milk that they represented.

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The study received ethical approval from the University of Bath's Biomedical Sciences Research Ethics Committee. No pre-registration was posted for data collection or analysis.

Materials

In the Billboard City, billboard advertisements promoting plant-based milk alternatives were erected. These advertisements were designed to be brand-neutral, focusing instead on a general message encouraging the trial of plant-based alternatives. A representative image of the billboards can be found in Appendix 1 (see Bryant & Flores, 2025).

The content of the billboards emphasised the ethical considerations of dairy consumption, with a call to action for consumers to consider plant-based milk, directing them to a website for more information. We ran 6 billboards (2 large and 4 small as shown in Appendix 1) with consistent messages from Monday 10th April – Sunday 7th May 2023.

Billboard locations were chosen based on (a) high traffic, and (b) proximity to our data collection sources. In particular, most of our billboards were in the city centre or high-traffic roads going into the centre. Full study materials are accessible (see Bryant & Flores, 2024).

Participants

Individual participants of the study were unknowingly recruited for the study based on whether or not they were residents of each city who either 1) visited one of the cafes surveyed 2) lived in one of the suburbs surveyed for recycling bin data or 3) bought plant based milk from one of the brands we received sales data from during the study period. Data collection methods did not directly involve individual participation, but rather relied on observational data from recycling bins, coffee shop sales data, and regional sales data from plant based milk brands. This means that (a) we do not know precisely how many individuals our data represented, and (b) it was not possible to obtain participants' informed consent.

Participating plant-based milk companies were primarily recruited through industry contacts known to the authors. A more neutral recruitment method was attempted, based on identifying 12 UK plant-based milk companies and reaching out cold to relevant employees via email or social media. However, we were unable to acquire data using this method, and ultimately relied on industry contacts to share data.

Participating cafes were selected on the basis of willingness to share data. Using Google searches, we compiled lists of 56 cafes in the Billboard City and 62 in the Control City. We contacted them via email or social media, and identified eight in the Billboard City and three in the Control City who said they would share data. At the end of the

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study period, we successfully collected sales data from six cafes in the Billboard City, but unfortunately, the cafes in the Control City did not respond to our requests for data.

Analysis

For each metric (number of cafe sales, volume of milk represented by containers in bins, and volume of plant-based milk sales) and region we computed the change before and after the billboard intervention. For cafe sales, this was the total number of sales containing or not containing dairy milk, regardless of volume (i.e. a cappuccino was counted the same as a tea with a drop of milk). For the residential waste analysis, this was the total volume of plant-based and dairy milk, in litres, represented by containers in the bins at the same time of day and week before/after the intervention (i.e. no transformations to generalise to broader region). For the plant-based milk sales, this was the combined volume of plant-based milk products sold in the target region and nationwide (based on volume not value; one company provided percentage change data to the city level, while the other provided precise unit sales data to the broader region/county level).

We then took the difference between these changes across regions (known as a "differences in differences" approach). Doing this removes the confounding effects of natural fluctuations over time (e.g. hot drink sales naturally fall as the weather gets warmer), as well as natural differences between areas (the Billboard City may have higher overall purchases of plant-based milk), meaning that changes in our metrics can likely be attributed to events that occurred in the Billboard City suburbs but not the Control City suburbs, specifically during the testing period. In most cases, inferential analysis was not practical given the limited data, so we mainly report descriptive findings and figures here.

Results

Here, we present the findings from our three different data sources, the Billboard City cafes, the plant-based milk company sales data, and the residential waste data. Traffic to the website cowscry.com, which was linked on the billboards, was modest: during the month of the campaign, we recorded 170 views from 45 unique users, although we did not capture traffic data for the first day the billboards went up due to a technical error. We did not consider this modest traffic to be a problem, because (a) the main ask of the billboards was to try plant-based milk, not to visit the website, and (b) billboard viewers' attitudes and behaviours may be impacted regardless of whether they went to the website.

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Billboard City Cafe Milk Sales

First, we present data on the sales of plant-based and dairy milk at the Billboard City cafes before, during, and after the billboard campaign.

While sales of plant-based milk fell, sales of all hot drinks fell between March and May. Therefore, we analysed the percentage of all hot drinks containing plant-based milk or dairy during the billboard period.

As shown, plant-based milks accounted for 1.5 percentage points more of all sales in May compared to March. Given that the billboard campaign was aimed at promoting plant-based milks, the increase in the proportion of plant-based milk sales could be interpreted as a positive indication of the campaign's effectiveness. However, we were unable to collect similar data from our Control City, and therefore we cannot assume that this change was (a) statistically significant, or (b) unique to our Billboard City.

In summary, while the cafe sales data suggests a slight increase in the preference for plant-based milk, the change was not significant, and any causal relationship to the billboard campaign is suggestive rather than definitive.

Sales of Plant-Based Milk

Second, we present retail sales data from two UK plant-based milk companies.

Plant based milk Brand A provided us with percentage changes in sales from the baseline month (before the intervention) during the period of the intervention and the period after the intervention. Brand A provided data for the Billboard City, and nationwide.

Plant based milk Brand B provided us with precise unit sales before, during, and after the intervention, but this was at a broader regional level rather than the specific city. To maintain the companies' anonymity, we are not publishing the absolute sales numbers, but we are able to publish analyses of percentage changes.

As shown in Figure 1, sales figures from both companies appeared to show a positive effect of the billboards. In the Billboard City compared to the Control City, Brand A reported a 23 percentage point higher increase in sales during the intervention, increasing to 25 percentage points after. Brand B reported a decrease in nationwide sales during the intervention, though consumption in the Billboard City compared to the Control City remained three percentage points higher during the campaign, and four percentage points higher after the campaign. Both of these trends appear to support a positive effect of the billboards on plant-based milk sales.

Although inferential analysis was attempted using an interaction model representing time x city, the limits of data granularity rendered these tests unreliable, so they were removed.

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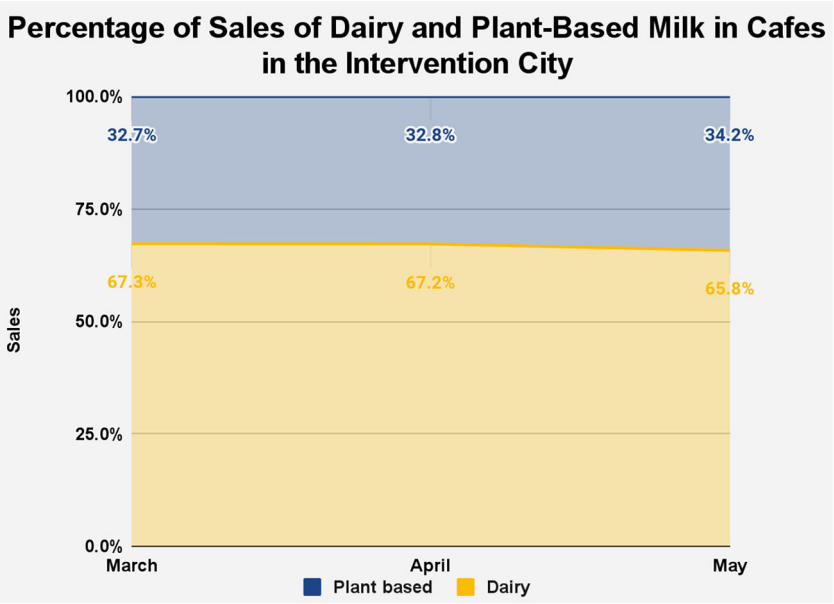
Figure 1

The Percentage of Plant-Based and Dairy Milk Sold in the Billboard City Cafes in the Study Period



Residential Waste Analysis

Third, we present the estimated percentage of milk consumed which was plant-based based on residential waste analysis (see Figure 2).

Our analysis of residential waste showed a fall in the proportion of milk coming from plant-based milk in both the Billboard City and the Control City. That said, there was a greater decrease in the Control City compared to the Billboard City—our analysis indicated that plant-based milk made up 2.2% less of all milk in the Billboard City, but 2.7% less of all milk in the Control City. This is equivalent to a 30% fall in the Billboard City, and a 49% fall in the Control City.

According to the difference-in-differences approach, this could be interpreted as evidence that the billboards had a positive impact on plant-based milk consumption in the Billboard City, since there was a lower reduction in the Billboard City than there was in the Control City.

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Figure 2

Proportionate Changes in Plant-Based Milk Sales in our Intervention Region vs. the Rest of the UK During the Study Period

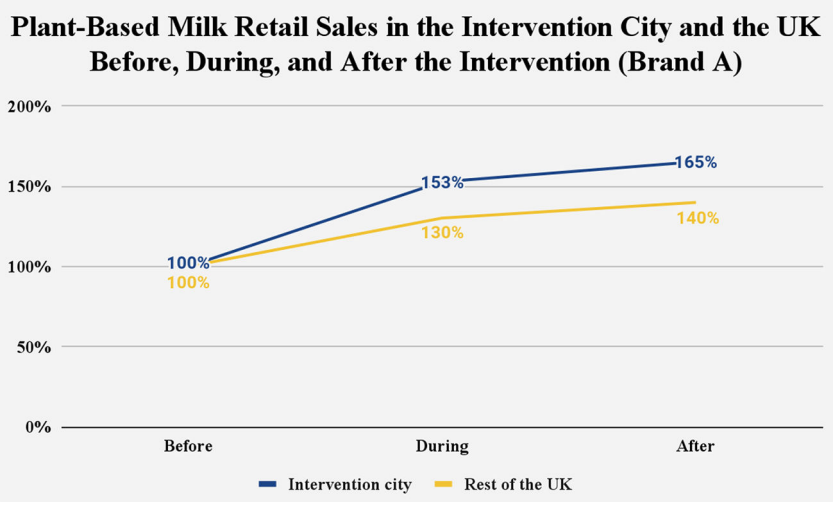
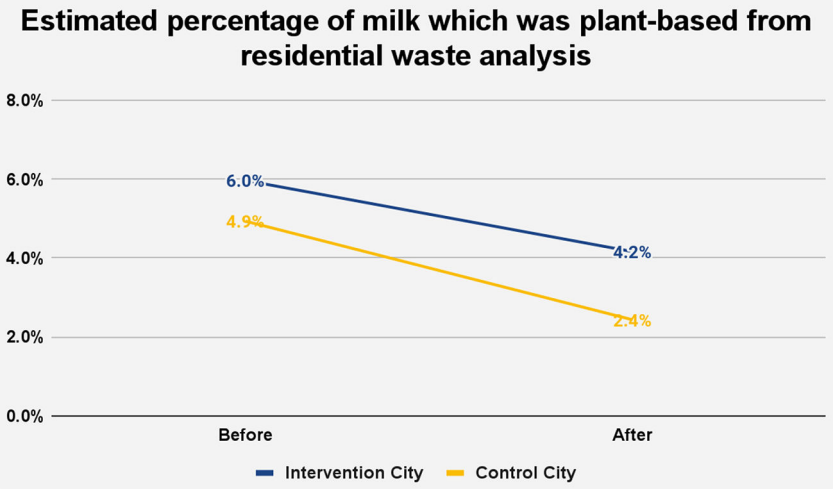


Figure 3

Change in Estimated Proportion of Milk Which was Plant-Based From Residential Waste Analysis



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As above in Figure 3, we attempted inferential analysis using an interaction model of time x city, but the limited number of data points and limited generalisability of the data meant that this approach was of limited value, and was ultimately excluded.

Discussion

Interpretation

Overall, we found descriptive results which appear to align with a positive effect of the billboards—although ultimately, various limitations of the study design and data quality mean that we are unable to draw strong inferential conclusions about the impact of the billboards. We discuss this further in the limitations section.

The major contributions of this study relate to the use of multiple novel data collection methods which go beyond self-reporting, and the use of an intervention with high ecological validity in the context of animal advocacy field research. In attempting to overcome some of the challenges of field research, we triangulated three different data collection methods.

Although we did observe each of our three data collection methods converging in support of a positive effect of the billboards, our analyses were not able to reliably show statistically significant differences in change in consumption. While our approach of triangulating multiple assessment methods lends some credence to the idea that the billboards impacted consumption, ultimately we were unable to get enough data to properly power inferential analyses or to be representative of broader market trends.

An advantage of this triangulation approach is that each assessment method is prone to different sources of potential bias, so if each source shows results in the same direction, the combined result is more robust to potential bias. We discuss the merits of the different data collection methods further in the implications section.

Part of the difficulty in gathering enough data for analysis was in stakeholder management. Relying on data from third parties such as cafes and food manufacturers means relying on these stakeholders becoming and staying sufficiently engaged to compile and send the data. This data is potentially commercially sensitive, likely requires some amount of processing to get into a form that is useful to researchers, and may require multiple levels of corporate sign-off to share, and there are few apparent benefits to stakeholders of sharing this data—since the data is anonymised, they cannot even receive public credit or acknowledgement.

Being field research, our intervention had high ecological validity at the cost of low control over confounding factors. We ran real plant-based milk advocacy billboards, which were seen by tens of thousands of people in the Billboard City. The contrary approach—lab research—can be criticised on the basis of interventions or decisions being far-removed from realistic contexts, but is more able to eliminate confounding factors.

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In this case, we could not account for factors other than our billboards which may have affected consumption in our Billboard City disproportionately in either direction

It is worth noting that this study focused explicitly on behavioural measures, with a focus on exploring novel methods of measuring animal product consumption beyond self-report. That said, there are plenty of valuable non-consumption outcomes (not measured here) which may come from this kind of advertisement, such as perceived norms, support for pro-animal policies, and low potential for backlash (Amel et al., 2017). All of these outcomes might reasonably be seen as valuable from the perspective of an animal advocate.

Implications

The study set out to investigate the impact of billboards on plant-based and dairy milk consumption, and to explore a novel approach to data collection using multiple methods.

For advocates, the evidence on the impact of the billboards on plant-based and dairy milk consumption was inconclusive. Although our descriptive findings were consistent with a positive effect of the billboards on plant-based milk market share, we do not have enough evidence to support the general efficacy of this intervention.

Notably, the cost of this intervention is not prohibitively high; the cost to run six billboards (two large and four small) for one month in busy locations in a medium-to-large UK city in 2023 was about £6,000 (approximately $7,500 USD). It is likely that a single small billboard would be less than £1,000, and in some areas, periods of 2 weeks rather than 4 weeks are available, meaning that an individual advocate could feasibly sponsor a billboard for as little as £500.

For researchers, this is an intervention which is likely to be within the budget of most research grants. While it is an intervention that is relatively straightforward to replicate and vary for experimental purposes, it is not possible to rule out an asymmetrical impact of extraneous variables.

Capturing meaningful consumption data to evaluate impact remains a challenge. In this study, we used three different data collection methods. First, getting direct sales data from plant-based companies was by far the best return on effort. This data is accurate, precise, and covers the entire country, but it is expensive data to acquire. Here, we were able to access data from two plant-based milk companies through industry contacts; without these contacts, acquiring this data would require a significant additional budget.

Second, getting sales data from cafes was more challenging, and since data is local rather than nationwide, the overall volume is far lower, effectively representing fewer transactions, meaning a lower sample size relative to plant-based milk companies. This, coupled with the additional work of compiling data provided in different formats by different cafes, meant that the cafe analysis was a worse return on our effort.

Third, estimating consumption data based on the plant-based and dairy milk bottles counted in residential garbage disposals is a good idea in theory, but difficult to execute

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well without the cooperation of a local waste disposal authority. Collecting this data manually was arduous and unpleasant work, and meant that, practically, we were only able to observe data from a specific non-randomly-selected part of each city. It also meant that reliable measurements were dependent on observing the bins at the same time of day on each occasion, which entails additional logistical planning. Hence, this method represented the worst return on our effort.

That said, consumption could be estimated much more accurately and easily from waste with the cooperation of a local waste disposal authority. In the UK, plant-based milk is almost exclusively packaged in cardboard cartons whereas dairy milk is almost exclusively packaged in plastic or glass bottles. If researchers were able to access data on the materials recycled by an entire city on an ongoing basis, detecting an increase in plant-based milk consumption could be done more reliably. Indeed, we did attempt to get cooperation from the waste disposal authorities in both cities, but in both cases received no reply.

Limitations

In conducting and analysing this study, we encountered many of the challenges of field research. Here, we address two major sets of limitations to the current study—the first relating to the design, and the second relating to the data.

First, there are limitations to note relating to the study design. We employed a difference-in-differences approach by measuring consumption before and after the intervention in our Billboard City, as well as a Control City. While this approach enabled us to account for both pre-existing differences between the cities and ongoing trends nationwide, it could not account for pre-existing divergent trends or for external confounds. In this case, external confounds could include health news which has a differential impact on consumption based on demographic differences, or regional differences in the marketing spends of plant-based milk companies or other advocacy groups. Further to the limitations of our difference-in-differences approach, we note that the follow-up time was also rather limited at one month.

Second, there are limitations relating to data quality. Although we used multiple data sources with the aim of offsetting the potential biases from each, we were unable to conduct meaningful inferential analyses for most of them. Our data sources represented the purchases of thousands—or millions—of consumers, but this was condensed into dozens of data points, representing low data granularity and yielding traditional inferential approaches to analysis underpowered. Moreover, the data sources were not randomly selected, meaning that sampling was not representative of these cities—nor can findings necessarily be generalised to other cities in the UK or elsewhere. In addition, our inability to record cafe sales data in the Control City meant that we could not conduct our planned analyses for this data, and less can be inferred about the impact of the billboards from the simple before/after analysis we were able to conduct. These limitations relating

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to the data quality may be compounded by the difference-in-differences approach, which effectively measures an abstraction of observed data.

Finally, we disclose steps taken to address potential privacy concerns about data collection methods used herein. We worked with the Biomedical Research Ethics Committee at the University of Bath to limit these risks by (a) only observing residence non-specific bins (i.e. for entire blocks of flats, rather than individual households), (b) informing residents of the study by delivering leaflets with information on how to contact the research team with any concerns (no emails were received).

Future Research

Incorporating more control and intervention sites, employing longitudinal designs to capture long-term impacts, and integrating direct consumer surveys to understand milk choice motivations could all be done to expand on this work. Additionally, exploring different messaging strategies and platforms could offer a more comprehensive understanding of the best ways to promote plant-based alternatives. Retrospectively analysing the impact of the billboards using sales data from other brands or food retailers is also possible, which could enhance these findings.

Although residential waste and local cafe sales data did not show significant effects, national sales data from one plant-based milk company revealed a significant regional sales difference. In general, national sales data provided the highest return on data quality to effort. Our novel approach provides a feasible solution to overcoming challenges in assessing the impact of dietary change interventions, albeit one which is dependent on large data budgets and/or industry connections.

Future similar research should consider the value of a pilot study. Given the overall ambition of the intervention and data collection methods, it was perhaps inevitable that logistical problems would emerge during the course of the study. It would be possible to run a similar intervention on a smaller scale—for example, sponsoring one bus stop ad and partnering with nearby shops and cafes for localised data collection. This would enable personal visits to partner outlets, which could increase the quality of data obtained.

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Competing Interests: Chris Bryant is the owner of, and Charlotte Flores is employed by, Bryant Research. Bryant Research is a private think tank which conducts social science research for animal advocacy groups and alternative protein companies, as well as grant-funded research like this. Although we are not aware of any of our sources of funding having an interest in a particular outcome of this research, it is likely that some of our clients fund or have funded billboard campaigns.

Data Availability: Data, code, and materials are available (see Bryant & Flores, 2024)

Supplementary Materials

For this article, the following Supplementary Materials are available:

- Appendices (see Bryant & Flores, 2025)
- Data, code, and materials (see Bryant & Flores, 2024)

Index of Supplementary Materials

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