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Impact of pictorial warning labels on meat meal selection: A randomised experimental study with UK meat consumers

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ABSTRACT

Meat consumption has been linked to adverse health consequences, worsening climate change, and the risk of pandemics. Meat is however a popular food product and dissuading people from consuming meat has proven difficult. Outside the realm of meat consumption, previous research has shown that pictorial warning labels are effective at curbing tobacco smoking and reducing the consumption of sugary drinks and alcohol. The present research extends this work to hypothetical meat meal selection, using an online decision-making task to test whether people's meal choices can be influenced by pictorial warning labels focused on the health, climate, or pandemic risks associated with consuming meat. Setting quotas for age and gender to approximate a UK nationally representative sample, a total of $n = 1001$ adult meat consumers (aged 18+) were randomised into one of four experimental groups: health pictorial warning label, climate pictorial warning label, pandemic pictorial warning label, or control (no warning label present). All warning labels reduced the proportion of meat meals selected significantly compared to the control group, with reductions ranging from −7.4% to −10%. There were no statistically significant differences in meat meal selection between the different types of warning labels. We discuss implications for future research, policy, and practice.

1. Introduction

1.1. Meat consumption & why it's a problem

Meat consumption is deeply ingrained in Western societies. The United Kingdom is a good example, where according to a recent YouGov poll, 72% of the UK population classify themselves as meat eaters whereas only 7% of Britons classify themselves as either vegetarian or vegan (Dabhade, 2021). At the same time, meat consumption has been linked to poorer health outcomes (Libera, Iłowiecka, & Stasiak, 2021; WCRF, 2021), worsening climate change (Allen & Hof, 2019; Domingo et al., 2021; Gomez-Zavaglia, Mejuto, & Simal-Gandara, 2020), and more recently as a contributor to pandemic infections (Dhont, Piazza, & Hodson, 2021). For example, excessive meat consumption is associated with increased risk of obesity, cardiovascular disease, infertility, diabetes, and cancer (Libera et al., 2021). In fact, the World Cancer Research Fund recommends that individuals should consume no more than three portions of meat per week for the sake of their health (WCRF, 2021), yet current consumption levels are estimated to be between 4 and 6 servings per week in the UK (Stewart, Piernas, Cook, & Jebb, 2021). Meat consumption also contributes heavily to deaths from pollution and climate change with meat production in China being linked to 90,000 pollution related deaths (Liu et al., 2021) and in the United States being linked to nearly 13,000 pollution related deaths (Domingo et al., 2021). Between 12 and 18% of anthropogenic greenhouse gas emissions can be attributed to the livestock industry (Allen & Hof, 2019; Gomez-Zavaglia et al., 2020). A recent scoping review suggests meat-free diets can reduce greenhouse gas emissions, land use, and biodiversity loss relative to standard diets (Carey et al., 2023). To help combat climate change consuming at least 20% less meat is recommended (Committee on Climate Change, 2019, pp. 136–174). In addition to the twin concerns of health and climate impacts arising from meat consumption, Covid-19 and other zoonotic diseases have also more recently been linked to meat production, factory farming, and consumption habits (Dhont et al., 2021).

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1.2. Ecolabelling of food products

One strategy that has garnered interest in the field is the use of ecolabels (environmental sustainability labels) to inform consumers of the environmental impact of food products (Thøgersen, Haugaard, & Olesen, 2010). A recent systematic review synthesising evidence on the impact of ecolabelling on the selection, purchasing and consumption of food and drink products found ecolabelling was associated with greater selection and purchasing of more sustainable products (Potter et al., 2022). Other recent studies have found mixed effects of ecolabelling, with hypothetical online studies finding a positive effect of ecolabelling (Potter et al., 2022, 2023), which failed to replicate in a field experiment (Pechey et al., 2022). However, it is important to note that these studies focused on the selection of a variety of products, not just meat. Thus, the potential for ecolabelling to exert impact on meat selection is still unclear. The impact of ecolabelling may further be improved if instead of simple information on the environmental provenance of food items, consumers are provided with warning labels on particularly environment-harming products such as meat.

1.3. Health warning labels

To date the most researched and utilised warning labels have been those communicating the potential negative health consequences of products. The most comprehensive evidence of the impact of health warning labels comes from warning labels placed on tobacco packaging. Such labels have been found to increase smokers' knowledge of the harms and risks associated with tobacco smoking contributing to smoking cessation attempts and importantly deterring youth from initiating smoking (Francis, Mason, Ross, & Noar, 2019; Hammond, 2011). Pictorial warning labels in particular have been found to perform better than text-only warning labels by attracting and holding people's attention better, garnering stronger cognitive and emotional reactions, eliciting more negative attitudes towards smoking (and the packaging), and more effectively increasing intentions to not start smoking and to quit smoking (see Noar et al., 2016, for a review). More (*vs.* less) aversive and graphic pictorial warnings were found to be more successful at deterring potential new users and encouraging smokers to seek help to quit smoking (Hammond, 2011; Noar et al., 2016). A recent meta-analysis of eye-tracking studies found novel warnings, graphic warnings, and those combined with plain-packaging were better able to capture participants' attention (Meernik et al., 2016).

More recently the impact of health warning labels has been examined in the domains of alcohol, and unhealthy foods and non-alcoholic beverages. This emerging field of research finds that such warning labels have the potential to decrease selection and worsen attitudes towards alcohol and unhealthy foods and sugar-sweetened beverages (SSBs) (for a review of experimental studies see Clarke, Pechey, Kosīte et al., 2021). For example, when warning labels outlining the dangers of drinking were placed on alcohol products, they were found to amplify risk perceptions of alcohol consumption (Staub, Fuchs, & Siegrist, 2022); and reduce selection (Clarke, Pechey, Mantzari et al., 2021; though see Clarke, Blackwell, De-Loyde et al., 2021, for an opposing finding in a naturalistic lab setting); consumption speed (Stafford & Salmon, 2017); and population-level purchasing in the field (Zhao, Stockwell, Vallance, & Hobin, 2020). Furthermore, health warning labels have been found effective at reducing both selection (Mantzari, Vasiljevic, Turney, Pilling, & Marteau, 2018; Roberto, Wong, Musicus, & Hammond, 2016; VanEpps & Roberto, 2016) and purchasing of SSBs (Hall et al., 2016), with a recent meta-analysis also showing promising results on actual consumption (Grummon & Hall, 2020).

Whilst the evidence base for health warning labels on foods is smaller, recent studies show similar effects as those described in alcohol and non-alcoholic drinks (see Ang, Agrawal, & Finkelstein, 2019; Clarke et al., 2020). As in studies on tobacco warning labels, there is evidence that these effects work via increasing negative emotional arousal, increasing people's attention to the labels, with pictorial and more graphic warning labels exerting greater effects when compared to text-only warning labels (Clarke, Pechey, Kosīte et al., 2021).

1.4. Climate warning labels

Health threats are not the only threats arising from meat consumption. Warning labels focused on the dangers of unsustainable and climate damaging meat consumption could similarly influence consumption, promoting more eco-friendly choices. There is limited research investigating the impact of climate warning labels, with most research to date focusing on ecolabels that provide information. However, such informational ecolabels do not warn the public of the adverse effects on the environment and climate change if such products are selected, purchased, or consumed (see Potter et al., 2021).

In a recent online randomised experiment of US meat eaters Taillie et al. (2021) examined the effectiveness of text-only warning labels on supermarket pre-packed meals outlining either the (a) health, (b) environmental, or (c) both health and environmental consequences of meat consumption. The labels were compared to a control condition where no warning labels were present. There were no statistically significant differences in the number of meat options chosen by participants randomised to see the health, environmental, or combined warning labels when compared to a no-label control. Participants randomised to see the health warning label were however more likely to subsequently select the meat option as most damaging to health. Additionally, those viewing the health or combined labels were more likely to perceive the textual messages contained within those warning labels as more effective when compared to the textual messages contained within the environmental warning labels.

A series of recent studies investigating the impact of shaming pictorial warning labels on behavioural intentions towards pre-packed meat products showed that participants were more likely to feel shame and guilt after encountering one of the shaming pictorial warning labels on meat packs, which in turn lowered their intentions to purchase the meat product (Kranzbühler & Schifferstein, 2023). However, in some instances shaming pictorial warning labels led to boomerang effects where participants were likely to distance themselves from such messages and the vegetarian/vegan movement. Shaming warning labels both highlight the negative impact of the labelled item, and also implicitly or explicitly criticise consumers with the aim of inducing negative emotions. An example shaming warning label may contain an image of a caged animal with the textual message "Eating meat makes animals suffer" (see Kranzbühler & Schifferstein, 2023). Health shaming labels appeared least effective at changing self-reported intentions. In contrast, animal welfare labels seemed most effective, with those messages communicating the impact of meat consumption on the environment showing medium effectiveness at changing self-reported intentions to consume meat. This series of studies however did not include a meal selection task, therefore it remains unclear if self-reported intentions arising from the shaming warning labels would also translate in decreased meat selection.

1.5. Pandemic warning labels

Whilst the evidence on climate warning labels is scant, the evidence for pandemic focused warning labels is completely absent. It is feasible however that due to the existential threat of a global pandemic this could be an effective warning. Zoonotic diseases have been linked to our farming practices (Jones et al., 2013; Karesh et al., 2012). Specifically, a recent UN report estimated that four of the seven human-mediated factors which are most likely to lead to new zoonotic diseases becoming new pandemics are tied inextricably to our livestock agricultural practices and meat consumption habits (United Nations Environment Programme and International Livestock Research Institute, 2020). It is therefore reasonable to suggest that by communicating the

risk of pandemics associated with livestock farming and thereby raising public awareness of the issue it may be possible to impact the public's meat selection and consumption.

However, the link between meat consumption and pandemics is largely underestimated and ignored; in fact, even when people are presented with credible information linking meat production and consumption to pandemics they tend to discount those links (Beggs & Anderson, 2020), and disregard and outright reject the role of meat consumption practices in triggering pandemics (Dhont et al., 2021). We still do not know what effect a focus on the link between meat consumption and risk of pandemics may have on meat selection decisions when presented at the point of choice; therefore the potential effectiveness of the pandemic warning labels used in the present study is still uncertain.

1.6. The present study

The present study assessed the impact of pictorial warning labels communicating either the (a) health, (b) climate; or (c) pandemic risks associated with meat consumption on hypothetical meat meal selection. When attempting to devise policies and interventions designed to reduce meat selection and consumption in line with IPCC (2019) and WHO (2021) recommendations it is essential to understand, not only whether pictorial warning labels are effective at changing behaviour, but also what label focus (including the framing of textual messages, and choice of images) will generate the largest effects. The pictorial warning labels used in this study were selected following a Pilot Study testing multiple potential labelling designs. The labels rated highest on negative emotional arousal in the Pilot Study were used in the present study as it was theorised they would be most effective at influencing hypothetical meat meal selection (see Kees, Burton, Andrews, & Kozup, 2006). The Pilot Study is described in more detail in the Online Supplementary Materials and can additionally be accessed on the Open Science Framework: https://osf.io/vghp6/?view_only=cce1a5426f884feba071ed33337492fd.

In addition to assessing the behavioural impact of the health, climate, and pandemic risk pictorial warning labels on hypothetical meat meal selection, we also measured perceptions of the labels and the labelled meals. Past research in the tobacco and SSB domains has found that warning labels are more effective when they induce strong negative emotional responses (Cho et al., 2018; Evans et al., 2015; Mantzari et al., 2018) thereby generating aversion and making the negative aspects of the labelled product salient. A seminal review by Pornpitakpan (2004) showed the more credible a message was the more effective it was at altering behaviour. More recently, warning labels perceived as more credible increased smokers' perceptions of the risks of smoking and led to higher intentions to quit (Evans et al., 2015). We therefore measured negative emotional arousal induced by the labels, label credibility, meal appeal, and future intentions to purchase and consume such a meal. We also included a measure of how supportive participants would be if the different types of pictorial warning labels were to be implemented as policy since public support can be crucial for policy implementation and maintenance (Cairney, 2009).

We also measured participants' current levels of meat consumption, willingness and intentions to reduce meat consumption, and personal considerations of health, environmental and pandemic risk priorities when making food decisions. Prior research has found that individuals who perceive themselves as having an environmental identity are more likely to engage in pro-environmental behaviours (van der Werff, Steg, & Keizer, 2013; Whitmarsh & O'Neill, 2010). Similarly nutritional labelling has been found more effective at promoting healthy behaviour in those already seeing their health as a priority (Cavaliere, De Marchi, & Banterle, 2017).

The protocol for this randomised experimental study was prospectively registered on OSF before any data was collected: https://osf.io/x96zg/?view_only=b80d90b117eb4a7b89858df1e863dc24. We hypothesised that:

1. Pictorial warning labels will reduce the selection of meat products in the meal selection task compared to the control group where no warning labels were shown.

Box 1
Study design showing the four experimental groups displayed on a burger meat-option as an example.

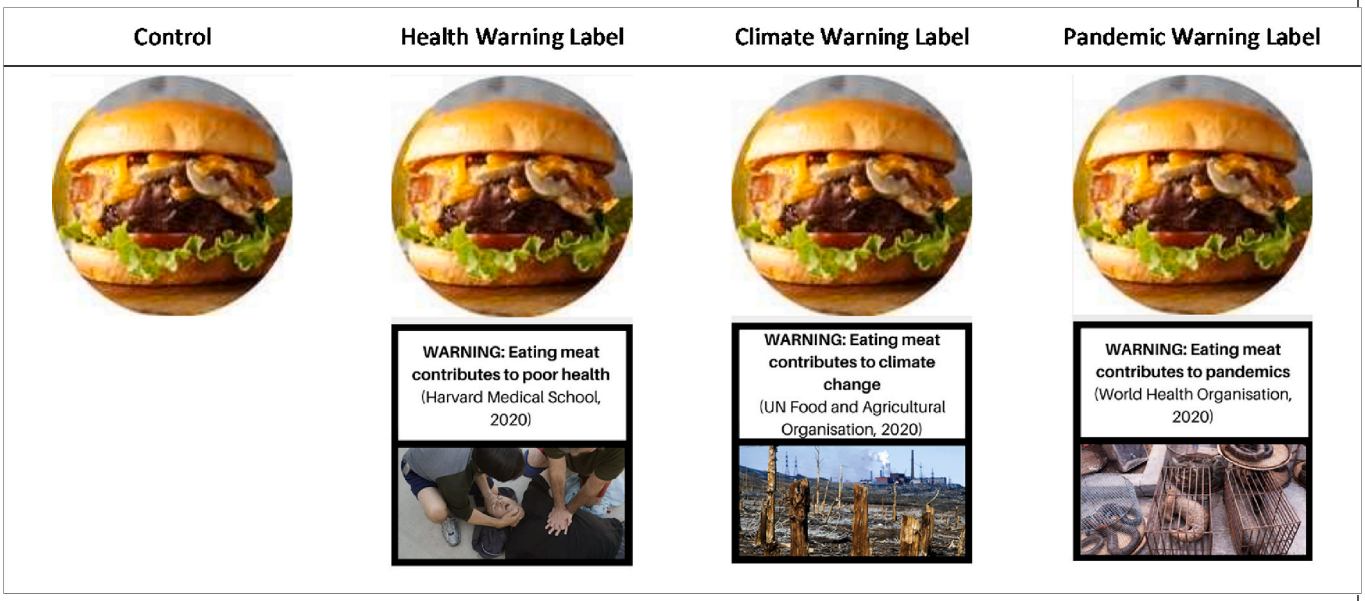


Table 1
Choice sets with four options presented in the meal selection task.

Set	Meat Meal	Fish Meal	Vegetarian Meal	Vegan Meal
Burger	Meat Burger	Fish Burger	Vegetarian Burger	Vegan Burger
Burrito	Meat Burrito	Fish Burrito	Vegetarian Burrito	Vegan Burrito
Chilli	Meat Chilli	Fish Chilli	Vegetarian Chilli	Vegan Chilli
Curry	Meat Curry	Fish Curry	Vegetarian Curry	Vegan Curry
Hotdog	Meat Hotdog	Fish Hotdog	Vegetarian Hotdog	Vegan Hotdog
Lasagna	Meat Lasagna	Fish Lasagna	Vegetarian Lasagna	Vegan Lasagna
Balls	Meat Balls	Fish Balls	Vegetarian Balls	Vegan Balls
Noodles	Meat Noodles	Fish Noodles	Vegetarian Noodles	Vegan Noodles
Omelette	Meat Omelette	Fish Omelette	Vegetarian Omelette	Vegan Omelette
Pasta	Meat Pasta	Fish Pasta	Vegetarian Pasta	Vegan Pasta
Pasta Bake	Meat Pasta Bake	Fish Pasta Bake	Vegetarian Pasta Bake	Vegan Pasta Bake
Pie	Meat Pie	Fish Pie	Vegetarian Pie	Vegan Pie
Pizza	Meat Pizza	Fish Pizza	Vegetarian Pizza	Vegan Pizza
Sausage and Mash	Meat Sausage and Mash	Fish Sausage and Mash	Vegetarian Sausage and Mash	Vegan Sausage and Mash
Shepherd's Pie	Meat Shepherd's Pie	Fish Shepherd's Pie	Vegetarian Shepherd's Pie	Vegan Shepherd's Pie
Spaghetti	Meat Spaghetti	Fish Spaghetti	Vegetarian Spaghetti	Vegan Spaghetti
Stew	Meat Stew	Fish Stew	Vegetarian Stew	Vegan Stew
Wellington	Meat Wellington	Fish Wellington	Vegetarian Wellington	Vegan Wellington
Loaf	Meat Loaf	Fish Loaf	Vegetarian Loaf	Vegan Loaf
Quiche	Meat Quiche	Fish Quiche	Vegetarian Quiche	Vegan Quiche

2. Amongst the different pictorial warning labels, health warning labels will be the most effective at reducing meat meal selection when compared to the climate and pandemic warning labels.
3. We refrained from proposing a directional hypothesis for the relative efficacy of the climate versus pandemic labels, due to the absence of prior evidence regarding these two types of pictorial warning labels.

2. Methods

2.1. Design

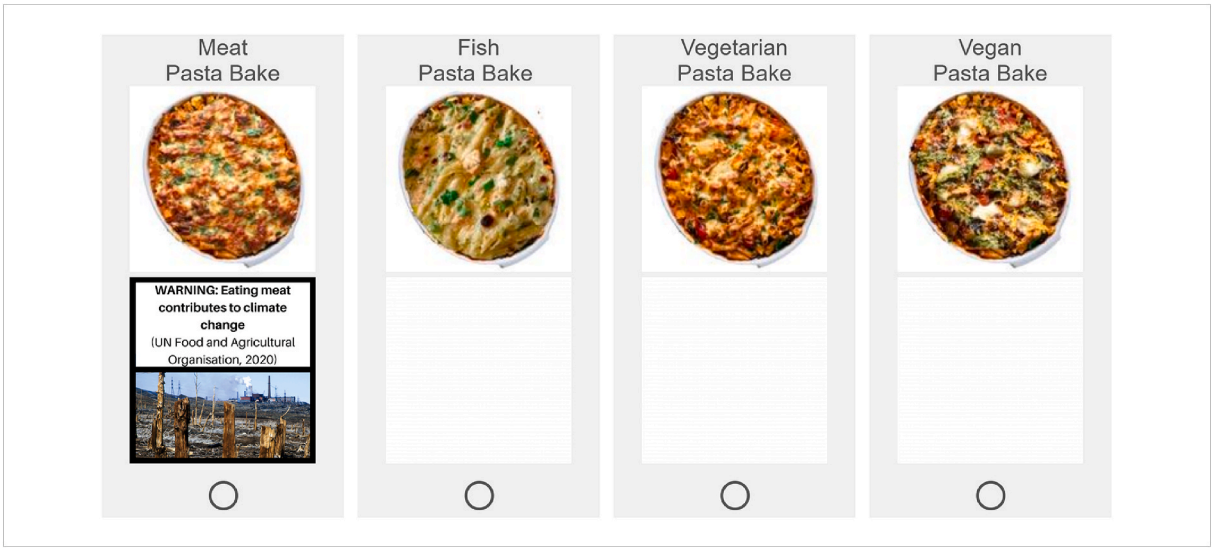
The study was a between-subjects experiment with one independent factor of four levels corresponding to the type of pictorial warning label that accompanied meat meals in a hypothetical meal selection task. Participants were randomly assigned to one of the four experimental groups (using a 1:1:1:1 ratio): health warning label, climate warning label, pandemic warning label, or control (no warning label present) [see Box 1]. Randomisation was performed by the randomiser function embedded within the Qualtrics survey software (https://www.qualtrics.com/uk/).

2.2. Meal selection task

The meal selection task consisted of 20 decision making trials, with the 20 trials appearing in randomised order across participants (see Table 1 for a full list of trials).

Prior to the meal selection task individuals were presented with images of a cafeteria and asked to imagine being in a university dining hall for dinner and being presented with four meal options to choose from (see Appendix II Online Supplementary Materials). Previous

Box 2
Example of one of the 20 meal selection trials showing a choice of pasta bakes (meat, fish, vegetarian, vegan) within the climate warning label experimental group.



research has demonstrated that presenting images of the scenario for online participants to imagine promotes more accurate and honest responses in choice experiments (Bacon & Krpan, 2018). We chose to contextualise the hypothetical meal selection in a university dining hall, since university dining halls have been proposed as prime targets for implementing sustainable dietary interventions due to their high food emissions (Graham, Russell, Holdsworth, Menon, & Barker, 2019; Lambrecht, Hoey, Bryan, Heller, & Jones, 2023). Furthermore, university dining halls with their usual offering of meat, fish, vegetarian and vegan meals presented the ideal backdrop for the hypothetical meal selection task we developed. For each trial participants were shown a set of four meal options presented from left to right respectively: meat option, fish option, vegetarian option, and vegan option; and were asked to select one option they would choose for their meal. After making a choice in each trial participants would immediately be presented with the next set of four different meal options. The four meal options were presented in the same order on screen to simulate the presentation method of the meal choices in the university dining hall/cafeteria the online experiment is based on, with the presentation from left to right, meat, fish, vegetarian, vegan. Images of meals were selected to be of similar attractiveness and each image within a set was of the same type of meal. For example, one of the sets contained four pasta bakes: a meat pasta bake, fish pasta bake, vegetarian pasta bake, and vegan pasta bake. In the warning label groups the meal choices were presented with the meat option having a pictorial warning label presented alongside the meal (see Box 2 below).

2.3. Pictorial warning labels design

The pictorial warning labels used in this study were designed after piloting a variety of textual messages and images pertaining to (a) health, (b) climate change, and (c) pandemic consequences associated with meat consumption. We conducted a Pilot Study via the survey distribution platform Prolific (n = 47). The Pilot Study enabled us to select one set of textual messages and images eliciting the highest levels of negative emotional arousal pertaining to each of the warning label types: health, climate change, and pandemic consequences associated with meat consumption (see Box 1). The wider selection of textual messages and images that were pre-tested in the Pilot Study were chosen based on prior literature of warning labels in the tobacco, alcohol, and SSB domains. The images and textual messages used in the Pilot Study were discussed with and vetted by a group of behavioural science experts. The final pictorial warning labels contained features that have been found important in enhancing the impact of warning labels in prior studies. For example, the final textual messages contained within the pictorial warning labels showed the word "Warning" prior to the health, climate, or pandemic textual warning message, based on prior findings that have found this may increase message effectiveness (Grummon & Hall, 2020). Our textual messages also contained references to the scientific sources where the warning messages pertaining to (a) health, (b) climate, and (c) pandemic consequences of meat consumption came from. In all instances the scientific sources were acclaimed, since source credibility can increase message persuasiveness (Schmidt, Ranney, Pepper, & Goldstein, 2016). The images were sourced from the World Wide Web. The Pilot Study is described in more detail in the Online Supplementary Materials.

2.4. Participants

A sample of 1001 participants were recruited from an existing panel through the survey distribution platform Prolific (www.prolific.co) between 7th and 11th October 2022. Sampling quotas were set for age and gender. The included sample of meat consumers was broadly representative of the UK adult population on gender, age, and socio-economic status (albeit with a larger representation of those in lower social grades as measured by occupational status) [see Table 2].

Table 2
Demographic characteristics of the sample.

Characteristic	Experimental Group			
	Control n = 252	Health n = 249	Climate n = 250	Pandemic n = 250
Gender				
Male	116 (46.0)	115 (46.2)	128 (51.2)	132 (52.8)
Female	135 (53.6)	131 (52.6)	121 (48.4)	117 (46.8)
Other	1 (0.4)	3 (1.2)	1 (0.4)	1 (0.4)
Age				
18-24	29 (11.5)	26 (10.6)	33 (13.3)	18 (7.2)
25-34	36 (14.3)	50 (20.3)	34 (13.7)	51 (20.5)
35-44	38 (15.1)	35 (14.2)	43 (17.2)	41 (16.5)
45-54	42 (16.7)	41 (16.6)	43 (17.2)	46 (18.5)
55-65	48 (19.1)	38 (15.4)	37 (14.9)	38 (15.3)
65+	59 (23.5)	59 (24)	60 (24.1)	56 (22.5)
Education[a]				
4 GCSE's	23 (9.1)	25 (10.0)	20 (8.0)	25 (10.0)
1 A Level	32 (12.7)	27 (10.8)	32 (12.8)	33 (13.2)
2+ A Level	50 (19.8)	54 (21.7)	46 (18.4)	45 (18.0)
University	143 (56.7)	138 (55.4)	146 (58.4)	138 (55.2)
N/A	4 (1.6)	5 (2.0)	6 (2.4)	9 (3.6)
Income[b]				
0–15.5 K	26 (10.3)	27 (10.8)	28 (11.2)	28 (11.2)
15.5–25 K	35 (13.9)	40 (16.1)	38 (15.2)	41 (16.4)
25K–40 K	69 (27.4)	78 (31.3)	65 (26.0)	80 (32.0)
40 K+	110 (43.7)	92 (36.9)	113 (45.2)	93 (37.2)
N/A	12 (4.8)	12 (4.8)	6 (2.4)	8 (3.2)
Social Grade[c]				
Low	98 (38.9)	92 (36.9)	103 (41.4)	94 (37.6)
Medium	111 (44.0)	115 (46.2)	109 (43.6)	116 (46.4)
High	36 (14.3)	31 (12.4)	33 (13.2)	32 (12.8)
N/A	7 (2.8)	11 (4.4)	5 (2.0)	8 (3.2)
Ethnicity				
White	221 (87.8)	221 (88.8)	231 (92.4)	223 (89.2)
Mixed	6 (2.4)	3 (1.2)	6 (2.4)	5 (2.0)
Asian	19 (7.5)	12 (4.8)	7 (2.8)	14 (5.6)
Black	2 (0.8)	7 (2.8)	2 (0.8)	7 (2.8)
Other	2 (0.8)	4 (1.6)	4 (1.6)	–
N/A	2 (0.8)	2 (0.8)	–	1 (0.4)
BMI[d]				
Overweight and Obese	141 (56)	137 (55)	141 (56.4)	136 (54.4)
Healthy	104 (41.3)	103 (41.4)	104 (41.6)	111 (44.4)
Underweight	7 (2.8)	9 (3.6)	5 (2.0)	3 (1.2)

Note. Figures in parentheses represent percentages unless otherwise stated.
[a] GCSEs (General Certificate of Secondary Education) are usually taken at age 15–16 in the UK; A-Levels at age 17–18.
[b] Income bands are expressed per annum.
[c] Social grade is measured using the National Readership Survey, participants indicate the occupational status of the chief income earner in their household (NRS, 2017).
[d] BMI (Body Mass Index) = mass/height^2; underweight = 18.5 or lower, overweight and obese = 25 or higher (WHO, 2010).

Sample size calculations were based on effect sizes estimated in a previous study examining the impact of warning labels on sugar-sweetened beverages (SSBs) in a hypothetical online selection task (Roberto et al., 2016). Roberto and colleagues' (2016) study was chosen as a basis for our sample size calculations, since they employed a similar hypothetical task in which they presented 20 different non-alcoholic drinks (12 SSBs and 8 non-SSBs) in an online vending-machine choice selection task. In a similar vein to our study some groups of participants saw warning labels presented on the SSBs which were contrasted to calorie information or no labels. Participants were parents who were asked to choose one drink from the hypothetical vending machine on behalf of their child. We used the effect size obtained by Roberto et al. (2016) as a starting point to conduct our own sample size calculation using G*Power (Erdfelder, Faul, & Buchner, 1996). We used the difference between the warning label group (40.4%) and the calorie information group (53.3%) as a conservative effect size originating from this study. To detect a statistically significant difference of 12.9% at 5%

significance level with 80% power we required 936 participants (234 participants per experimental group). We aimed to sample 1000 participants to account for attrition.

A total of 1270 participants were assessed for eligibility, with 89 participants screened-out because they did not consume meat, 160 screened-out for accessing the study on a mobile device (eligibility was restricted to PC and laptop devices given the need to see the meal labels in high resolution - this was communicated to all panel members within the invitation email), one participant failed the attention check question, and 19 withdrew from the study whilst taking part. The 1001 participants remaining were then randomised to one of the four experimental groups. The flow of participants through the study can be seen in the CONSORT flow diagram in Fig. 1.

2.5. Measures

2.5.1. Primary outcome

Proportion of meat meals selected was the primary outcome. This was based on the number of times participants chose a meat meal option across the 20 trials within the hypothetical meal selection task. For example, a participant selecting 10 meat meals and 10 non-meat meals would have been assigned a value of 0.5.

2.5.2. Secondary outcomes

Following the meal selection task, participants completed a series of secondary outcome measures, with reference to a burger meal option. Participants saw a burger meal according to their randomisation group, so participants in the control group answered the secondary outcomes whilst viewing a picture of an unlabelled meat burger, and the participants in the health, climate, and pandemic warning label groups answered the secondary outcomes whilst viewing a meat burger labelled with either a health, climate, or pandemic pictorial warning label respectively.

Meal appeal was assessed via four items gauging participants' current desire to consume the meal "How much would you like to eat this meal now or later on today?" (1 = not at all to 7 = very much); desire to purchase the meal "I would purchase a meal with this label on it"; likelihood of recommending the meal "I would recommend this meal to someone else"; and general meal appeal "This meal is appealing". These three items were all measured on seven-point scales anchored 1 = strongly disagree to 7 = strongly agree. The four-item scale had good reliability ($\alpha = 0.903$).

Future intentions to purchase and consume. This was measured using two items adapted from Vasiljevic, Couturier, and Marteau (2018); "How likely are you to buy/eat this meal in the next 4 weeks?" answered on scales anchored from 1 = not at all likely to 7 = very likely; ($r = 0.963$).

The following secondary outcomes were only presented to participants in the three experimental groups containing pictorial warning labels, but not in the control group:

Reactance and avoidance (defensive reactions) were assessed using two items adapted from Hall et al.'s (2016) reactance to health warnings scale. Questions assessed "Is this label annoying?" and "Are you likely to avoid this label?" (both rated on scales from 1 = not at all to 7 = very much). As in prior research these items were analysed separately.

Negative emotional arousal was assessed via three items adapted from Kees et al. (2006) and originally used in the domain of pictorial warning labelling on tobacco cigarettes. The questions asked: "How anxious/worried/uncomfortable does the label on this meal make you feel?"; ($\alpha = 0.939$). Response scales ranged from 1 = not at all to 7 = very.

Label credibility. A three-item scale contained questions about the perceived credibility of the labels: "The information presented on the label of the meal is credible/believable/trustworthy" (1 = strongly disagree to 7 = strongly agree). The scale had good reliability, $\alpha = 0.952$.

Policy support. Acceptability of a potential labelling policy was measured using a single item adapted from Mantzari et al. (2018), "Would you support or oppose a government policy requiring the label shown on this meal to be placed on food?" (1 = strongly oppose, 7 = strongly support).

Perceived influence of the label was also measured using a single item, "I would be influenced by labels that are similar to the one displayed in this study" (1 = strongly disagree, 7 = strongly agree).

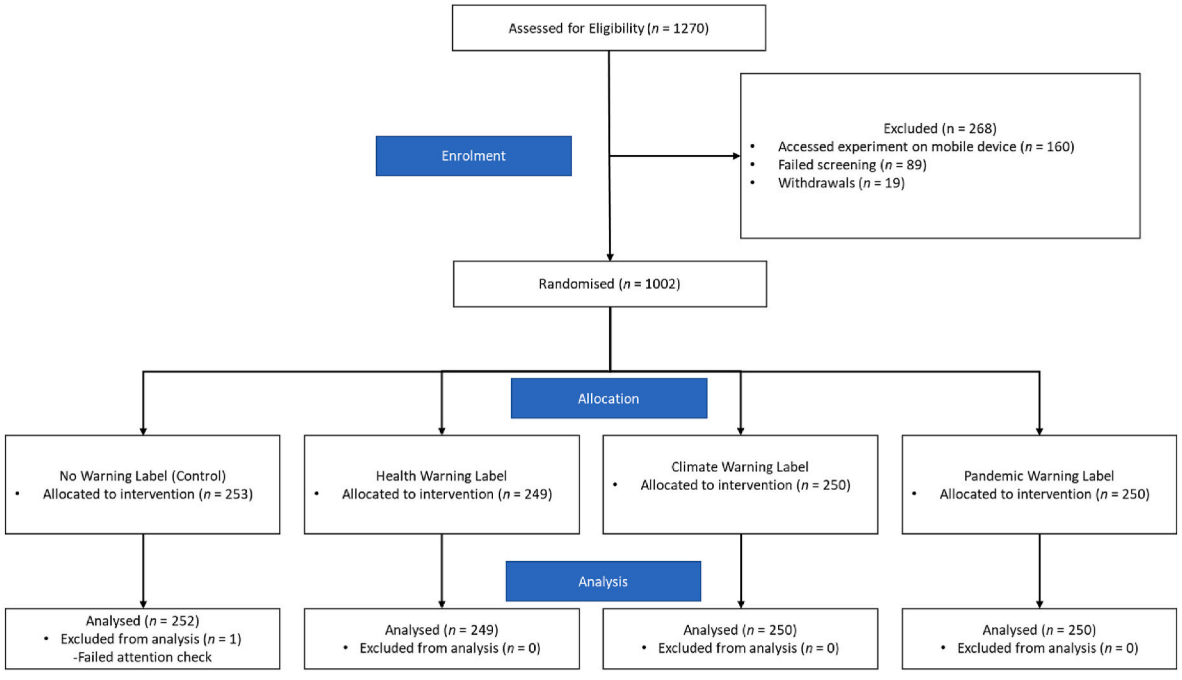


Fig. 1. CONSORT diagram of participant flow through the study.

2.6. Other measures

Demographic characteristics. The following were recorded: age, sex, ethnicity, household income, education, and social grade (see Oguz & Merad, 2013, pp. 1–16). Social grade was measured using the National Readership Survey (NRS, 2017) classification system based on occupation of the chief income earner. This classification system comprises three categories: *High* [AB (Higher and intermediate managerial, administrative and professional)]; *Medium* [C1 (Supervisory, clerical and junior managerial, administrative and professional) and C2 (Skilled manual workers)]; and *Low* [D (Semi-skilled and unskilled manual workers), E (State pensioners, casual and lowest grade workers, unemployed with state benefits only)]. We also asked for participants' height and weight to calculate their BMI.

Dietary habits. Participants responded to the question "Which of the following describes your diet most accurately?" by selecting one of the options within a comprehensive list of possible dietary options (including vegetarian, vegan, pescatarian, Mediterranean diet, etc.). This question allowed us to pre-screen and include only those participants who consumed meat.

Current levels of meat consumption and current meat restriction were assessed via two questions modified from Lentz, Connelly, Mirosa, and Jowett (2018) "On average how often do you consume meat or products that include meat?" measured on a 5-point scale (1 = never, 2 = rarely, 3 = several times a week, 4 = daily, 5 = several times a day); and "Have you already or are you currently making any efforts to reduce your personal meat consumption?" measured on a dichotomous scale (1 = yes, 2 = no). Prior to answering these questions participants were given a definition of what constitutes meat: "In the questions below, the word "meat" refers to red and white meats (e.g., beef, lamb, pork, chicken, turkey, but not fish or seafood) that are either unprocessed (e.g., chicken breast, steak) or processed (e.g., sausage, salami, meat mince, chicken nuggets)."

Willingness and intentions to restrict meat consumption in the future. A two-item scale consisting of questions adapted from Lentz et al. (2018) asking participants' for their level of agreement with the following statements: "I would be willing to reduce my meat consumption sometime in the near future", and "I intend to reduce my meat consumption in the next six months" (1 = strongly disagree, 7 = strongly agree); [$r = 0.86$].

Health, environmental, and pandemic concerns. Three questions gauged participants' concerns about health, the environment, and the risk of pandemics when making food decisions: "In general, the impact on my health/the environment/the risk of pandemics is an important factor when deciding which foods to buy and eat". All items were anchored on a seven-point scale ranging from 1 = strongly disagree to 7 = strongly agree.

Table 3
Observed and predicted means and standard deviations of the primary outcome.

	Observed *M* (*SD*)	Predicted *M* (*SD*)
Control	.639 (.247)	.657 (.379)
Health	.551 (.278)	.540 (.381)
Climate	.565 (.278)	.552 (.373)
Pandemic	.539 (.280)	.526 (.384)

Table 4
Full model coefficients, standard errors, and significance tests.

Parameter	Coefficient	*SE*	*p*	Lower CI	Upper CI
Location submodel					
b_0	.651	.078	<.001	.498	.805
b_1 (health)	−.491	.119	<.001	−.724	−.257
b_2 (climate)	−.441	.119	<.001	−.675	−.207
b_3 (pandemic)	−.548	.117	<.001	−.778	−.317
Dispersion submodel					
d_0	−.563	.105	<.001	−.768	−.358
d_1 (health)	.222	.154	.149	−.080	.524
d_2 (climate)	.309	.147	.036	.020	.597
d_3 (pandemic)	.188	.147	.201	−.101	.478

Note. A location submodel specifies the central tendency or mean of the distribution whilst a dispersion submodel refers to the variability or spread of the beta distribution. Taken together the two parameters describe the shape of the beta distribution.

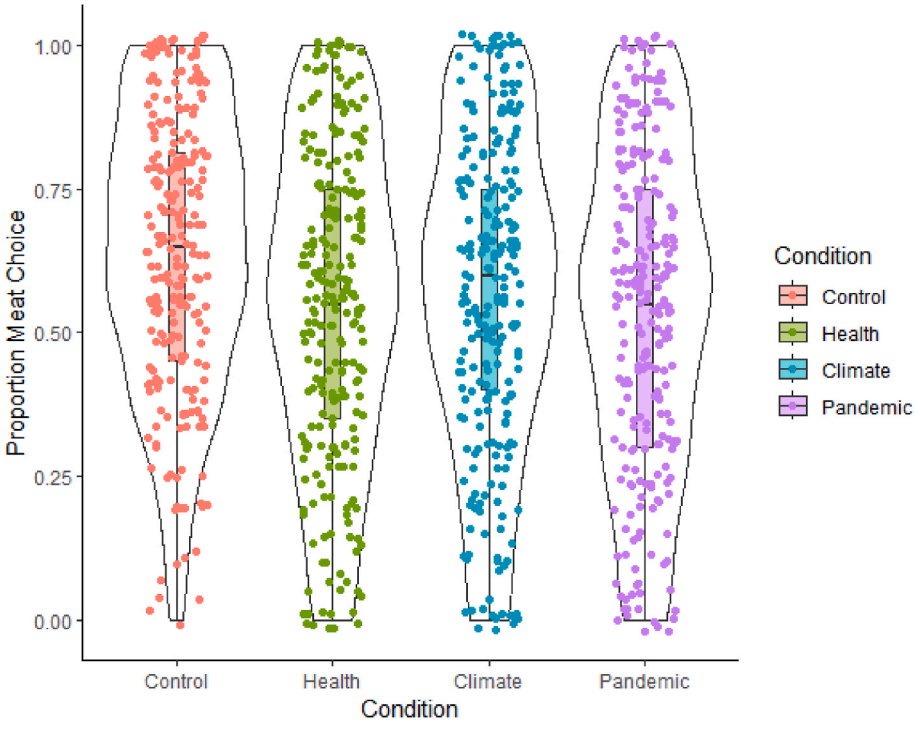


Fig. 2. Proportion of meat meals selected in the four experimental groups in the meat meal selection task.

Current hunger levels were measured to control for potential effects of hunger on meal selection. Participants self-reported their hunger on a scale from 1 = very hungry to 7 = very full by answering "How hungry do you feel right now?" (see Vasiljevic, Pechey, & Marteau, 2015).

Attention check. Participants responded to an embedded question within the experiment "This is an attention check, please select option "2" to ensure your responses are included." Selection of any value other than 2 resulted in the exclusion of the participants' data from analysis.

2.7. Procedure

Ethics approval for this research was granted by the Ethics Committee of the Department of Psychology at Durham University (PSYCH-2020-10-19T14_10_29-tpfj36). Participants belonging to a panel of the Prolific platform were invited to access the study online. At the start participants read a detailed information sheet, and after assenting to participate were asked a screening question pertaining to their current diet. Due to the aims of the study, participants who self-reported that they did not consume meat were excluded from further participation. Eligible participants then provided demographic information and answered a series of questions relating to their height, weight, current hunger levels, and concerns with health, the environment, and the risk of pandemics. Following this, participants took part in the 20 trials making up the hypothetical meal selection task. Afterwards, participants filled out the secondary outcome measures, with a picture of a burger meal shown on the screen. Participants saw the image of the burger meal with either no label if they were in the control condition, or one of the health, climate, or pandemic warning labels based on their respective randomisation for the meal selection task. Afterwards participants answered questions regarding their meat consumption, and willingness and intentions to reduce meat consumption. Upon completion of the meal selection task and subsequent secondary outcomes, participants were fully debriefed and thanked for their time. The experiment took on average 9.04 min (SD = 4.55 min) to complete.

2.8. Planned analysis

In line with our pre-registered analysis, a beta-regression was performed using SPSS version 26 to assess the impact of different pictorial warning labels on the proportion of meat meals selected (primary outcome). A beta distribution is particularly suitable for proportions that are bound at 0 (lowest value) and 1 (highest value) and consequently often deviate from normality (Smithson, Merkle, & Verkuilen, 2011; Smithson & Verkuilen, 2006; Verkuilen & Smithson, 2012). We used the scripts provided by Smithson and Verkuilen (2006). For the analysis of secondary outcomes, normal-theory regressions (see Smithson & Verkuilen, 2006) were appropriate so we employed the general linear model. We used dummy variables to represent the experimental groups (*Health:* $D_1 = 1$, $D_2 = 0$, $D_3 = 0$; *Climate:* $D_1 = 0$, $D_2 = 1$, $D_3 = 0$; *Pandemic*: $D_1 = 0$, $D_2 = 0$, $D_3 = 1$; *Control:* $D_1 = 0$, $D_2 = 0$, $D_3 = 0$). We employed percentile bootstrapping with 1000 resamples to derive parameter estimates. Additional beta regressions were run with the Health label and Climate label as reference groups to identify any statistically significant differences between the warning label groups on proportion of meat meals selected. Individual difference variables were included as potential moderators in subsequent exploratory analysis.

3. Results

3.1. Randomisation check

None of the participant characteristics shown in Table 2 differed between experimental conditions, $ps \geq .145$. This suggests that randomisation was successful. Further details can be found in Appendix III Online Supplementary Materials.

3.2. Primary outcome

Fig. 2 shows the proportion of meat meals selected in the different experimental groups across the 20 trials of the meal selection task. As anticipated, a test for deviations from normality was statistically significant, $p < .001$. Thus, we compressed the outcome variable to avoid zeros and ones (see Smithson & Verkuilen, 2006) and then proceeded to regress the primary outcome on the dummy variables representing all four experimental groups, employing beta-regression.

As can be seen in Table 3, the model had a good fit with predicted means matching closely observed means in all four experimental groups. The proportion of meat meals selected was significantly higher in the control group ($M = 0.639$) than in the health label group ($M = 0.551$), in the climate label group ($M = 0.565$), and in the pandemic label group ($M = 0.539$), all $ps < .001$. Expressed as differences in proportions, health warning labels reduced meat meal choices by 8.8%, climate warning labels by 7.4%, and pandemic warning labels by 10%. A detailed breakdown of all model parameters is shown in Table 4.

We repeated the beta regressions substituting the pandemic labelling dummy for a dummy representing the control group. The analysis yielded no evidence that pandemic warning labels were any more effective at reducing meat meal choices than climate or health warning labels, $ps > .384$.

3.3. Secondary outcomes

As shown in Table 5, there was no evidence that warning labelling impacted self-reported meal appeal or future intentions to purchase and consume a meat burger, $Fs(3,997) \leq 2.40$, $ps \geq .067$. Looking at participants' perceptions of the three different warning labels, there was no evidence that the labels differed in terms of their perceived annoyance, avoidance-elicitation, and influence, $Fs(2,746) \leq 2.97$, $ps \geq .052$. However, there was some evidence that, compared to climate and health warning labels, pandemic warning labels triggered a stronger negative emotional arousal, $F(2,746) = 10.48$, $p < .001$, $\eta^2_{partial} = 0.027$, and were also perceived to be less credible, $F(2,746) = 38.39$, $p < .001$, $\eta^2_{partial} = 0.093$. We also observed differences in policy support, $F(2,746) = 5.23$, $p = .006$, $\eta^2_{partial} = 0.014$. Specifically, support for the introduction of climate warning labels was significantly higher than support for the introduction of pandemic warning labels, $p_{\text{Bonferroni-adjusted}} = 0.005$, $\eta^2_{partial} = 0.013$. Meanwhile, policy support for the introduction of health warning labels did not differ from climate and pandemic warning labels, $ps_{\text{Bonferroni-adjusted}} \geq 0.086$. It should be noted that mean ratings of policy support were at or below the mid-point of the scale: participants neither

Table 5
Means (SDs) of secondary outcomes by experimental group.

Outcome	Control	Health	Climate	Pandemic
Meal Appeal	4.73_a	4.75_a	4.71_a	4.58_a
	(1.61)	(1.54)	(1.49)	(1.43)
Future intentions	4.10_a	4.28_a	4.12_a	3.80_a
	(2.02)	(2.09)	(2.00)	(1.96)
Annoyance		4.45_a	4.09_a	4.46_a
		(1.93)	(1.93)	(1.85)
Avoidance		3.29_a	3.38_a	3.57_a
		(1.84)	(1.73)	(1.81)
Negative Emotional Arousal		2.68_a	2.77_a	3.27_b
		(1.54)	(1.44)	(1.69)
Label Credibility		4.30_a	4.85_a	3.69_b
		(1.50)	(1.52)	(1.44)
Policy Support		3.54_{ab}	3.88_a	3.40_b
		(1.71)	(1.72)	(1.67)
Perceived Influence		3.05_a	3.38_a	3.29_a
		(1.66)	(1.71)	(1.75)

Note. All secondary outcomes were measured on seven-point Likert scales ranging from 1 to 7. Means with differing subscripts within rows are significantly different following Bonferroni adjustment.

Table 6
Full model coefficients, standard errors, and significance tests modelling the impact of age, gender and social grade as potential moderators.

Parameter	Coefficient	*SE*	*p*	$p_{Bonferroni\text{-}adjusted}$	Lower CI	Upper CI
Location submodel						
b_0	0.625	.155	<.001	<.001	.321	.929
b_1 (label)	−0.461	.184	<.001	0.147	−.822	−.100
b_2 (age)	−0.010	.005	0.02275	0.546	−.020	.000
b_3 (gender)	−0.485	.151	<.001	0.016	−.781	−.188
b_4 (low social grade)	−0.122	.177	0.248252	>.999	−.469	.226
b_5 (high social grade)	0.355	.194	0.03364	0.807	−.025	.735
b_6 *(BMI)*	.496	.144	0.000286	0.007	.213	.779
b_{1x2} (label*age)	0.008	.006	0.091217	>.999	−.003	.019
b_{1x3} (label*gender)	0.127	.190	0.091217	>.999	−.246	.501
b_{1x4} (label*low social grade)	0.101	.205	0.311148	>.999	−.301	.504
b_{1x5} (label*high social grade)	−0.247	.260	0.171056	>.999	−.757	.263
b_{1x6} *(label*BMI)*	−0.184	.176	0.14917	>.999	−.529	.160
Dispersion submodel						
d_0	−0.402	.217	0.032013	0.768	−.828	.023
d_1 (label)	0.042	.254	0.434354	>.999	−.456	.541
d_2 (age)	−0.015	.007	0.016097	0.386	−.030	−.001
d_3 (gender)	−0.446	.209	0.016462	0.395	−.855	−.037
d_4 (low social grade)	−0.035	.249	0.44433	>.999	−.524	.454
d_5 (high social grade)	0.003	.260	0.495412	>.999	−.514	.508
d_6 *(BMI)*	−0.150	.229	0.256234	>.999	−.600	.299
d_{1x2} (label*age)	0.015	.009	0.047797	>.999	−.002	.031
d_{1x3} (label*gender)	0.427	.244	0.040059	0.961	−.051	.905
d_{1x4} (label*low social grade)	−0.001	.289	0.498803	>.999	−.568	.565
d_{1x5} (label*high social grade)	0.160	.337	0.3175	>.999	−.502	.822
d_{1x6} *(label*BMI)*	0.119	.264	0.326103	>.999	−.399	.637

Table 7
Full model coefficients, standard errors, and significance tests modelling the impact of health, environmental, and pandemic concerns, current levels of consumption, and intentions to reduce consumption of meat as potential moderators.

Parameter	Coefficient	*SE*	*p*	$p_{Bonferroni\text{-}adjusted}$	Lower CI	Upper CI
Location submodel						
b_0	.881	.102	<.001	<.001	.679	1.082
b_1 (climate label)	−.302	.155	0.026	0.617	−.607	.003
b_2 (health label)	−.230	.145	0.056	>.999	−.515	.054
b_3 (pandemic label)	−.598	.163	<.001	<.001	−.917	−.279
b_4 (environment concern)	−.150	.034	<.001	<.001	−.216	−.083
b_5 (health concern)	−.049	.044	0.133	>.999	−.135	.036
b_6 (pandemic concern)	−.010	.029	0.365	>.999	−.067	.048
b_7 (current level of consumption)	.845	.123	<.001	<.001	.604	1.086
b_8 (intention to reduce consumption)	−.619	.146	<.001	<.001	−.905	−.333
b_{1x4} (climate label*environment concern)	.062	.073	0.198	>.999	−.082	.205
b_{2x5} (health label*health concern)	−.052	.099	0.300	>.999	−.247	.143
b_{3x6} (pandemic label*pandemic concern)	.023	.064	0.360	>.999	−.103	.148
b_{1x7} (climate label*current level of consumption)	.069	.157	0.330	>.999	−.239	.377
b_{2x7} (health label*current level of consumption)	−.232	.173	0.090	>.999	−.571	.107
b_{3x7} (pandemic label*current level of consumption)	−.361	.217	0.048	>.999	−.786	.065
b_{1x8} (climate label*intention to reduce consumption)	−.066	.244	0.394	>.999	−.546	.413
b_{2x8} (health label*intention to reduce consumption)	−.181	.209	0.193	>.999	−.590	.229
b_{3x8} (pandemic label*intention to reduce consumption)	.151	.232	0.258	>.999	−.303	.606
Dispersion submodel						
d_0	−.825	.143	<.001	<0.001	−1.105	−.544
d_1 (climate label)	.007	.225	0.488	>.999	−.434	.448
d_2 (health label)	.041	.204	0.420	>.999	−.360	.442
d_3 (pandemic label)	.311	.247	0.104	>.999	−.173	.796
d_4 (environment concern)	.031	.056	0.290	>.999	−.078	.141
d_5 (health concern)	−.043	.064	0.251	>.999	−.167	.082
d_6 (pandemic concern)	.081	.045	0.036	0.862	−.008	.169
d_7 (current level of consumption)	−.337	.191	0.039	0.933	−.711	.038
d_8 (intention to reduce consumption)	−.900	.311	0.002	0.046	−1.510	−.290
d_{1x4} (climate label*environment concern)	−.110	.103	0.143	>.999	−.311	.092
d_{2x5} (health label*health concern)	.069	.121	0.284	>.999	−.167	.306
d_{3x6} (pandemic label*pandemic concern)	−.011	.089	0.451	>.999	−.186	.164
d_{1x7} (climate label*current level of consumption)	.068	.236	0.387	>.999	−.396	.532
d_{2x7} (health label*current level of consumption)	−.009	.251	0.486	>.999	−.501	.483
d_{3x7} (pandemic label*current level of consumption)	.354	.314	0.130	>.999	−.261	.969
d_{1x8} (climate label*intention to reduce consumption)	.882	.442	0.023	0.552	.014	1.750
d_{2x8} (health label*intention to reduce consumption)	.605	.404	0.067	>.999	−.187	1.397
d_{3x8} (pandemic label*intention to reduce consumption)	.650	.458	0.078	>.999	−.248	1.548

supported nor opposed the introduction of climate warning labels, $t(249) = -1.14$, $p = .255$, but they opposed the introduction of health and pandemic warning labels, $t(248) = -4.22$, $p < .001$, d = 0.146 and $t(249) = -5.71$, $p < .001$, d = 0.191, respectively.

3.4. Exploratory analysis

We also conducted exploratory analyses examining age, gender, social grade, and BMI as potential moderators of the effects of warning labels on hypothetical meat meal selection (primary outcome). To reduce the number of parameter estimates, we compared the three warning label groups with the control group (control: $D_1 = 0$; warning label: $D_1 = 1$). Age was centered, and gender, social grade, and BMI were dummy coded (not female: $D_3 = 0$; female: $D_3 = 1$; low social grade: $D_4 = 1$, $D_5 = 0$; medium social grade: $D_4 = 0$, $D_5 = 0$; high social grade: $D_4 = 0$, $D_5 = 1$; underweight and healthy weight: $D_6 = 0$; overweight and obese: $D_6 = 1$). As shown in Table 6, the beta regression revealed an effect of gender, whereby female participants chose the meat meal options significantly less frequently than participants who did not identify as female ($Ms_{Observed}$ = 0.524 vs0.624; $SEs_{Observed}$ = 0.012 vs0.012), $p_{Bonferroni\text{-}adjusted}$ = 0.003. Furthermore, there was an effect of BMI whereby participants with higher BMI chose the meat meal options significantly more frequently than participants with lower BMI ($Ms_{Observed}$ = 0.533 vs 0.607; $SEs_{Observed}$ = 0.013 vs 0.011), $ps_{Bonferroni\text{-}adjusted}$ = 0.007. However, gender, age, social grade, and BMI did not moderate the effects of pictorial warning labels, $ps_{Bonferroni\text{-}adjusted} > 0.999$.

Finally, we explored whether the impact of different pictorial warning labels varies as a function of personal relevance. In particular, we probed the effects of health concerns on the impact of health warning labels, the effects of environmental concerns on the impact of climate warning labels, and the effects of pandemic concerns on the impact of pandemic warning labels. We also examined current levels of meat consumption, current efforts to reduce meat consumption, and intentions to reduce meat consumption as potential moderators. The latter two variables were highly correlated ($r = 0.602$), so we created a new variable to denote intentions to reduce meat consumption (no = 0; yes = 1). All dichotomous variables were dummy-coded and all continuous variables centered. As shown in Table 7, the beta regression revealed an effect of current meat consumption, whereby participants who reported consuming more (*vs*. less) meat also chose the meat meal option more frequently ($Ms_{Predicted}$ = .445 vs0.711), $p_{Bonferroni\text{-}adjusted} < 0.001$. In addition, participants with stronger (*vs*. weaker) intentions to reduce their meat consumption chose meat meal options less frequently ($Ms_{Predicted}$ = 0.495 vs 0.645), $p_{Bonferroni\text{-}adjusted}$ = 0.001. Finally, stronger (vs. weaker) environmental concerns were associated with reduced meat meal choices ($Ms_{Predicted}$ = 0.527 vs 0.639), $p_{Bonferroni\text{-}adjusted} <$ 0.001. However, none of the moderators examined modulated the effects of any of the three warning labels on meat meal choices, all $ps_{Bonferroni\text{-}adjusted} > 0.999$.

4. Discussion

4.1. Summary of findings

In a randomised experiment testing the impact of different types of pictorial warning labels on hypothetical meat meal selection amongst a sample of UK meat eaters we found that health, climate, and pandemic risk pictorial warning labels significantly decreased selection of meat meals when compared to the control group where no warning labels were shown. Expressed as differences in proportions, health warning labels reduced meat meal choices by 8.8%, climate labels by 7.4%, and pandemic labels by 10%. There were no statistically significant differences in the proportion of meat meals selected between the different warning label groups, meaning all warning labels performed similarly in lowering selection of meat meals compared to the status quo when no warning labels were shown.

Compared to the climate and health pictorial warning labels, pandemic warning labels triggered a stronger negative emotional arousal and were perceived to be less credible. Policy support also differed between the different types of warning labels. Support for the introduction of climate warning labels was significantly higher than support for the introduction of pandemic warning labels, but not significantly different to levels of support expressed for the introduction of health warning labels. However, ratings of policy support were at or below the mid-point of the scale; with participants neither supporting nor opposing the introduction of climate warning labels but opposing the introduction of health and pandemic warning labels.

Perceived meal appeal, annoyance, avoidance-elicitation and perceived influence of the labels did not differ between the warning label types. Female participants, those who reported consuming less meat, those with stronger intentions to reduce their meat consumption, and those with stronger environmental concerns chose meat meal options less frequently. However, there was no evidence of moderation by any of the demographic or individual difference variables.

4.2. Interpretation and implications of findings

Our findings expand the extant literature by showing that warning about the adverse effects of meat consumption on health, the climate, and pandemic risks can significantly reduce the selection of meat meals in an online cafeteria meal selection task. This finding is in line with prior literature on the impact of pictorial warning labels in the domains of tobacco (Hammond, 2011; Noar et al., 2016), alcohol (Clarke, Pechey, Kosīte et al., 2021), and food and non-alcoholic drinks (Clarke, Pechey, Kosīte et al., 2021; Grummon & Hall, 2020). To date there has only been one experimental study investigating the impact of health, climate, and combined (health & climate) warning labels on meat selection in a hypothetical online choice task with US meat consumers (Taillie et al., 2021). That study did not find any significant impact of warning labels on meat meal selection. However, the study differed from our study in the use of text-only warning labels, whilst we showed a pictorial and text warning label to our participants. Furthermore, Taillie and colleagues' (2021) study used a single choice task, whereas we asked participants to make hypothetical meal selection choices across 20 trials, thus allowing us to estimate the impact of the different warning labels on meat meal selection with greater precision. There were also other methodological differences between the studies: Taillie et al.'s study used prepacked supermarket ready meals, whilst we used hot meals presented plated as one would see them in a cafeteria/dining hall. In addition, our warning labels also provided a scientific reference to the source of the textual warning presented on the label whereas this was absent from the labels used in Taillie et al.'s study. Furthermore, the differences in results may also stem from the difference in the samples, with our sample of meat eaters coming from the UK, and in the Taillie et al. (2021) study coming from the US. Future research should examine these potential sources of variability.

Contrary to our predictions, we did not find evidence that the health warning labels were any more effective at lowering hypothetical meat meal selection when compared to the climate and pandemic warning labels. Climate warning labels were however the most supported by our participants when considering whether any of these warning labels should be enacted as policies. As can be seen in Online Supplementary Materials in our Pilot Study we found that participants considered the impact of meat consumption on climate change as most consequential when compared to the impact on human health and future risk of pandemics. Furthermore, environmental concerns, but not health and pandemic concerns, predicted the proportion of meat meals selected in our experimental task. The higher public support for the climate warning labels may stem from these considerations. This would be consistent with prior work on public support for various obesity policies, which also correlates with people's prior beliefs about the causes of obesity (e.g.,Beeken & Wardle, 2013). Notably, climate warning labels were also

rated as most credible in our study, along with health warning labels. The introduction of climate pictorial warning labels may therefore be both effective and most acceptable to the public.

Climate pictorial warning labels did not impact the selection of meat meals more than the health and pandemic warning labels. Thus factors other than credibility and acceptability may be impacting the potential effectiveness of warning labels, including the psychological distance communicated by the warning label message (Gifford, 2011; Spence, Poortinga, & Pidgeon, 2012) and attention paid to the label (Peterson, Thomsen, Lindsay, & John, 2010; Süssenbach, Niemeier, & Glock, 2013). These factors should be explored in future research.

In line with previous studies examining the impact of pictorial warnings in other behavioural domains we also found evidence that our pandemic pictorial warning labels increased negative emotional arousal. Negative emotional arousal is one potential mechanism which prior research has found may mediate the impact of the warning label on behavioural outcomes (such as selection, purchasing or consumption) pertaining to the product under investigation (see Evans et al., 2015; Mantzari et al., 2018). Future studies should further examine the role of negative emotional arousal in making pictorial warning labels on meat meals more impactful.

Compared to the climate and health pictorial warning labels, pandemic warning labels triggered a stronger negative emotional arousal and were perceived to be less credible. This finding is novel in that previous research on graphic warning labels pertaining to tobacco products has found that increased negative emotional arousal correlates with enhanced perceptions of warning credibility (Evans et al., 2015). One potential explanation why the pandemic warning labels elicited more negative emotional arousal may be that the timing of the research, which took place not long after the COVID-19 pandemic, coinciding with a time of particularly high worry about the consequences of pandemics (Hidaka et al., 2021). On the other hand, the low perceived credibility of the pandemic warning labels may be due to the relative novelty of evidence connecting meat consumption with the incidence of pandemics, and therefore low knowledge base amongst the public (see Dhont et al., 2021). Future research should disentangle these findings further.

There were no statistically significant moderations with any of the demographic indicators or individual difference measures. This is encouraging, since it suggests health, climate, and pandemic pictorial warning labelling has the potential to reduce meat selection and consumption across the whole population. This promising finding should be replicated in future research.

The present findings speak to the potential effectiveness of pictorial warning labels to impact meat meal selection in a hypothetical choice task. The findings support extant theorising of the impact of fear appeals on changing preventive behaviours. Fear appeals are persuasive messages that aim to induce fear by communicating the potential risk or harm to individuals if they do not follow the message's recommendations (see Dillard, Plotnick, Kean, Freimuth, & Edgar, 1996; Maddux & Rogers, 1983). For example, both the Health Belief Model (HBM; Hochbaum, 1958; Rosenstock, 1966, 1974) and Protection Motivation Theory (PMT; Rogers, 1975, 1983) propose that when individuals are presented with a fear appeal a series of appraisals are initiated. Individuals evaluate the perceived severity of the communicated threat, the likelihood of the threat's occurrence, and their capacity to cope with the threat. Future research could further examine the exact mechanisms by which fear appeals communicated by pictorial warning labels akin to those used in our study impact the selection of meat meals.

4.3. Strengths, limitations, and future research

This is the first experimental study to examine the impact of health, climate, and pandemic pictorial warning labels on meat selection in an online hypothetical cafeteria-based meal choice task. Our conclusions are based on the responses of a large sample of UK adult meat eaters drawn from a nationally representative sample. Our study is further strengthened by providing the first evidence of impact of pictorial (combining image and text) warning labels on meat meal selection. Our findings of the effectiveness of health, climate, and pandemic warning labels on hypothetical meat meal selection should be considered in light of how resistant to change meat consumption habits are. Recent findings suggest that when meat eaters are presented with meat and non-meat food options where visual attractiveness and meal type are held constant participants were more likely to rank order the vegetarian options as lower, and this finding was especially pronounced amongst high meat consumers (Pechey, Hollands, & Marteau, 2021). Furthermore, daily habits such as meat consumption have been found difficult to modify (Verplanken & Whitmarsh, 2021). Being able to modify behaviours especially resistant to change (such as meat meal selection and consumption) speaks to the potential impact of pictorial warning labels such as those used in our study.

We used a hypothetical meal selection task in an online setting. Whilst a recent systematic review by Potter et al. (2021) found no evidence of diverging effectiveness of ecolabels online as compared to field settings, it is important to bear in mind that in online hypothetical tasks participants may pay better attention to the stimuli they are presented with when compared to naturalistic settings such as dining halls. Our estimates of effect sizes of the impact of pictorial warning labels on hypothetical meat meal selection may therefore diverge from those that can be expected in real-world settings. Furthermore, the recent systematic review by Clarke, Pechey, Kosīte et al. (2021) suggests that larger reductions in meal/drink selection may be expected in online hypothetical when compared to field settings. Future research should therefore replicate our findings in the field (e.g., in cafeterias, dining halls, or restaurants) using objective measures of behaviour such as actual meal selection and consumption.

Policy support, label credibility, and negative emotional arousal may explain some of the impact of warning labelling, however we were limited from examining further mechanisms due to constraints on experimental duration and participants' cognitive burden. Psychological distance and attention paid to the labels may be usefully examined in future studies.

Relatedly, it remains to be seen whether the impact of pandemic warning labels wanes over time as COVID-19 is becoming endemic and less salient. Compared to environmental or health warning labels, pandemic warning label are likely to trigger more short-term considerations (see Cooper & Nagel, 2021), and the more distant people's experiences of the COVID-19 pandemic, the less likely it becomes that pandemic warning labels will elicit negative emotional reactions. By examining what factors underlie the relationship between different types of warning labels and meat consumption, we can gain greater confidence in the potential longer-term viability of different labelling options.

Animal welfare or the ethical treatment of animals has been suggested as another potential consideration which may encourage people to switch away from meat-based meals (see Hopwood, Bleidorn, Schwaba, & Chen, 2020). We chose to focus on health, pandemic, and climate change pictorial warning labels, since recent literature has suggested that animal welfare considerations may be least impactful in modifying meat meal choice (see Herchenroeder, Forestell, & Bravo, 2023; Neff et al., 2018). Examining the impact of animal welfare warning labels was therefore beyond the scope of the current study, however future research may wish to explore the impact of animal welfare warning labels on meat selection and consumption.

We wished to keep the presentation of meal stimuli for the secondary outcome measures (meal perceptions) as constant as possible to reduce potential variability in people's responses arising from differing meals. We therefore only used one potential meal type (burger) to elicit responses to the secondary outcomes. Whilst participants' responses may have been affected by the type of meal chosen, since all experimental groups answered the perception questions pertaining to the burger meal

we can be certain that differences in the secondary outcomes reflect the impact of our labelling manipulation as opposed to any extraneous variables if we had used different meal options. Future research can expand on our findings by using a greater selection of meal options to elicit meal perception ratings.

4.4. Implications for future policy and practice

This randomised experiment amongst UK meat consumers provides initial evidence for policymakers and practitioners to consider regarding the use of pictorial warning labels on meat-based meals. Whilst warning labels communicating the adverse effects of meat consumption on health, climate, and pandemic risks all performed similarly well in reducing meat meal selection in a hypothetical task, there was also greater support for the introduction of climate warning labels compared to the health and pandemic warning labels. This coupled with the finding that climate warning labels were also rated as most credible in this sample (along with health warning labels), suggests policymakers and practitioners may wish to further explore the most effective ways to communicate the impact of meat consumption on the climate when devising policies to shift meat selection and consumption amongst the public.

Declarations

Ethical statement

Ethics approval for this research was granted by the Ethics Committee of the Department of Psychology at Durham University (PSYCH-2020-10-19T14_10_29-tpfj36). Participants were provided with an information sheet outlining the details of the study before participation. They were informed of their right to withdraw at any point during or after the study and were assured that all collected data would be kept anonymous and confidential. After reading the information sheet they provided informed consent. Participants were fully debriefed about the aims of the study at the end.

Author contributions

All authors contributed to conceiving and developing the methodological design of the study, analysis of the data, drafting of the paper and revisions of the manuscript. All authors read and approved the final version of the manuscript.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

Data availability

Data availability: The dataset and associated codebook are available within the OSF project folder: https://osf.io/xh6jn/?view_only=50b1f607d5504de2b21651f0f12486c1

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2023.107026.

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