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Salt warning labels in the out-of-home food sector: online and real-world randomised controlled trials in the UK

Salt warning labels in the out-of-home food sector: online and real-world randomised controlled trials in the UK

Rebecca Evans, Jane Brealey, Natasha Clarke, Jennifer Falbe, Amy Finlay, Andrew Jones, Paula Thorp, Beth Witham, Rozemarijn Witkam, Eric Robinson

Summary

Background High salt intake increases the risk of cardiovascular disease. The salt content of many commonly consumed foods in the out-of-home food sector (eg, restaurants) is excessive, but there are few policy options to address this problem. In this study, we evaluated an emerging policy approach—high salt warning labels on packaged food and resturant menus—for which, to date, there is little supporting evidence from randomised controlled trials.

Methods These randomised controlled trials (one online study and one trial conducted in a real-world setting) were conducted in the UK. For study 1, an online study, participants (stratified by age, sex, and education to be representative of the UK adult population) were eligible if they were a current UK resident, aged 18 years or older, fluent in English, purchased supermarket sandwiches and savoury snacks, and ate out at or ordered from restaurants at least monthly. Exclusion criteria included being pregnant or breastfeeding or having major dietary restrictions. Participants were randomly assigned (1:1:1:1:1) to one of four different salt warning label conditions or to a control condition (QR code). Participants assigned to each group completed three packaged food scenarios and three restaurant ordering scenarios, all online, followed by questionnaires about the labelling and their food choices. The primary outcome was the perceived message effectiveness of salt warning labels. In study 2, the inclusion criteria were similar, except that participants who ate an out-of-home meal at least once a month were recruited. Exclusion criteria were severe dietary allergies and veganism. As in study 1, participants were stratified by age, sex, and education. Participants were randomly assigned (block randomisation with block size ~50) to receive menus with or without salt warning labels, from which they purchased and consumed lunchtime meals in a real-world restaurant. Participants then completed questionnaires. Primary outcomes were perceived message effectiveness and salt awareness. In both studies, perceived message effectiveness was measured with adapted versions of the University of North Carolina Perceived Message Effectiveness Scale. Participants in both studies were paid and masked to the study aims. Study 2 is registered with ClinicalTrials.gov (NCT06458270) and is complete.

Findings In study 1, 2549 participants were randomly assigned to one of four salt warning label groups (red triangle, n=512; black triangle, n=512; red octagon, n=509; and black octagon, n=510) or to the control group (n=506), with data collected between Feb 20, 2024, and April 2, 2024. 158 participants were excluded from analysis, resulting in a final analytic sample of 2391 (1205 [50%] female, 1181 [49%] male, and five [<1%] preferred not to say). All salt warning labels were perceived as significantly more effective at discouraging salt intake than the control, with mean perceived message effectiveness differences of 1·23 (95% CI 1·12–1·34; p <0·0001) for packaged food scenarios and 1·22 (95% CI 1·11–1·33; p <0·0001) for menu scenarios. In study 2, 465 eligible participants were randomly assigned to menus with red triangle salt warning labels next to high-salt items (n=240) or to the restaurant's standard menu (control group; n=225), with data collected between June 5, 2024, and Sept 14, 2024. Full data from 11 participants were excluded from analysis, resulting in a final analytic sample of 454 (246 [54%] female, 203 [45%] male, and five [<1%] missing). The labelled menu was rated as significantly more effective than the control menu in terms of perceived message effectiveness, with a mean difference of 1·00 (95% CI 0·79–1·18; p<0·0001). Participants assigned to the labelled menu condition were significantly more likely to think about the salt content of the meals when ordering than were participants assigned to the standard menu (odds ratio 19·50, 95% CI 8·24–46·16; p<0·0001).

Interpretation Salt warning labels on restaurant menus are a promising policy option to discourage high salt intake in the out-of-home food sector. Further real-world studies are needed to optimise potential policy to reduce actual salt intake.

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Introduction

Excess salt intake is associated with a range of negative health outcomes and is responsible for an estimated 1·89 million deaths worldwide annually.[1] In England, adults consume, on average, 40% more salt than the recommended 6 g per day.[2] This overconsumption is

Research in context

Evidence before this study

We searched PubMed for studies on the effects of nutrient warning labels published between Jan 1, 2000, and Nov 5, 2024, using the search terms ("nutrient warning label*" OR "nutrient warning*" OR "chile* food label*" OR "salt warning label*" OR "salt warning*" OR "salt label*" OR "sodium warning label*" OR "sodium warning*" OR "sodium label*"), with no language restrictions. This search identified 47 relevant articles on the basis of titles and abstracts. Front-of-pack nutrient warning labels are currently implemented mandatorily in several South American countries, including Chile, Brazil, and Mexico, as well as in Canada and Israel. Meta-analytic evidence from predominantly hypothetical or laboratory-based experiments indicated that front-of-pack nutrient warning labels are perceived to be effective by consumers and reduce the selection of less healthy products and the amount of energy and nutrients of concern (ie, salt, saturated fat, and sugar). A small amount of research has examined menu-based warning labels for items high in salt in the out-of-home food sector. In a series of online randomised controlled trials with US consumers, salt warning labels increased negative health perceptions of the food and reduced hypothetical average amounts of salt ordered (by 0·05–0·2 g per meal). Observational research in the USA suggests that implementation of salt warning labels in the out-of-home food sector is associated with decreases in salt ordered from full-service restaurants.

Added value of this study

Few randomised controlled trials have examined the effect of including salt warning labels on menus in the out-of-home food sector, and no trials have been conducted in real-world settings. In the UK, although there is government interest in food-labelling approaches, there is little research to guide policy development. In this study, with members of the public, we co-designed salt warning labels that could be used in the UK out-of-home food sector, before testing their perceived effectiveness and effects on food choice in both an online randomised controlled trial and a real-world randomised controlled trial in a restaurant setting.

Implications of all the available evidence

To our knowledge, this study is the first to show that salt warning labels on menus reduce salt ordered in hypothetical and real-world restaurant settings. Importantly, findings indicate that salt warning labels are perceived to be effective and are effective at reducing salt ordered in a UK context. Such labels should be considered by the UK Government as a public health policy in the out-of-home food sector.

partly driven by prepackaged food and meals consumed in the out-of-home food sector, much of which is high in salt.[2,3] Indeed, approximately a quarter of energy intake in the UK is from food eaten out of home, and more frequent eating out of home is associated with higher dietary salt intake.[4]

An emerging public health policy that has been adopted in several countries is the mandatory implementation of front-of-pack nutrient warning labels. This approach is distinct to health warning labels that use images and/or text to highlight the health risks associated with consumption.[5] Instead, nutrient warning labels communicate that a food item contains a high amount of energy or of a specific nutrient of concern. Front-of-pack warning labels were implemented in Chile in 2016 for packaged foods high in calories, saturated fat, sugar, and/or salt.[6] Meta-analytic evidence from predominantly hypothetical and laboratory-based experiments suggests that front-of-pack nutrient warning labels are perceived as effective by consumers. These labels also reduce the hypothetical selection of calories and nutrients of concern.[7,8] Post-implementation evaluations of Chile's front-of-pack warning label policy also suggest that it might be effective for reducing the purchase of warning-labelled items and prompting product reformulation by the food industry.[9,10]

However, front-of-pack nutrient warning labels do not address a key driver of excessive salt intake—the out-of-home food sector.[2] Recent policy developments in the USA have resulted in mandatory salt (or sodium) warnings on menus in New York City (NY, USA) and Philadelphia (PA, USA) for chain restaurant menu items exceeding the daily recommended limit (ie, ~5·75 g of salt). In multiple online hypothetical studies with US consumers, salt warning labels increased negative health perceptions of high-salt foods and reduced the hypothetical average amounts of salt ordered.[11] Observational research from New York City suggested that implementation of salt warning labels was associated with decreases in salt ordered (–1·31 g per meal [95% CI –2·32 to –0·30]), but there is little causal evidence for this policy approach.[12]

WHO has recommended menu labelling as a key measure to reduce sodium intake.[1] The UK Government has announced intentions to introduce a new food labelling policy and has set salt reduction targets for both prepackaged and out-of-home food.[13,14] Calorie labelling is already mandated in the UK out-of-home food sector, making the addition of further labels potentially easier to implement than in other countries. However, research is needed to guide policy development. To date, there is no research testing salt warning labels in a UK context and no real-world randomised controlled trials on the effect of salt warning labels on food choice in the out-of-home food sector.

In the first of our two studies, we co-designed and tested four different salt warning labels relative to a control label and to each other in an online randomised controlled trial. The highest-ranked label from the first study was then tested in our second randomised controlled trial in a real-world setting (a restaurant). Our main objectives were to assess the perceived message effectiveness of salt warning labels (both studies) and whether they encouraged consumers to think about the salt content of the meals (second study only). Further objectives included examining the effect of labels on food choice and salt selected (both studies), and salt intake (second study only).

Methods

Study design and participants

We conducted two between-subjects randomised controlled trials (study 1 and study 2) with different groups of participants. Study 1 was an online randomised controlled trial to examine the efficacy of salt warning labels for both prepackaged supermarket food (to replicate existing evidence from outside the UK[7]) and restaurant food across multiple hypothetical ordering scenarios (mixed design). Methods and analysis plans were preregistered on the open science framework. The study received institutional ethical approval from the University of Liverpool (reference 4612). No adverse events were reported during the study, and a Data and Safety Monitoring Board was not required.

Two patient and public involvement sessions at the University of Liverpool were conducted to develop and design food warning labels (appendix pp 3–4). Participants for study 1 were recruited from Prolific, an online survey platform that connects researchers with diverse prescreened participants.[15] Inclusion criteria were current UK resident, aged 18 years or older, fluent in English, purchased supermarket sandwiches and savoury snacks, and ate out at or ordered from restaurants at least monthly. Exclusion criteria were pregnant or breast-feeding, partaking in fasting or restrictive eating at time of participation, and major dietary restrictions or intolerances (eg, vegan, vegetarian, or gluten-free diets). We used stratified sampling (appendix p 2) to ensure that the sample was representative of the UK in terms of age (36% 18–39 years), sex (51% female), and education (48% with at least a university degree or equivalent).[16–18] Participants were shown an information sheet about the study and provided informed consent before completing demographic and baseline measures. Participants were paid at a rate of £6 per h.

Study 2 compared menu labelling conditions (menu with salt warning labels or standard menu) in a real-world setting. The study was conducted in Liverpool (UK), in a full-service independent pub restaurant in the city centre serving a variety of food (eg, burgers, pies, salads, and sandwiches). Methods and data analysis plans were pre-registered on the open science framework and with ClinicalTrials.gov (NCT06458270). The study received institutional ethical approval (reference 11251). No adverse events were reported during the study, and a Data and Safety Monitoring Board was not required.

Participants for study 2 were recruited via targeted social media advertisements (Facebook and Instagram) in the local area (Liverpool, UK), as well as via word of

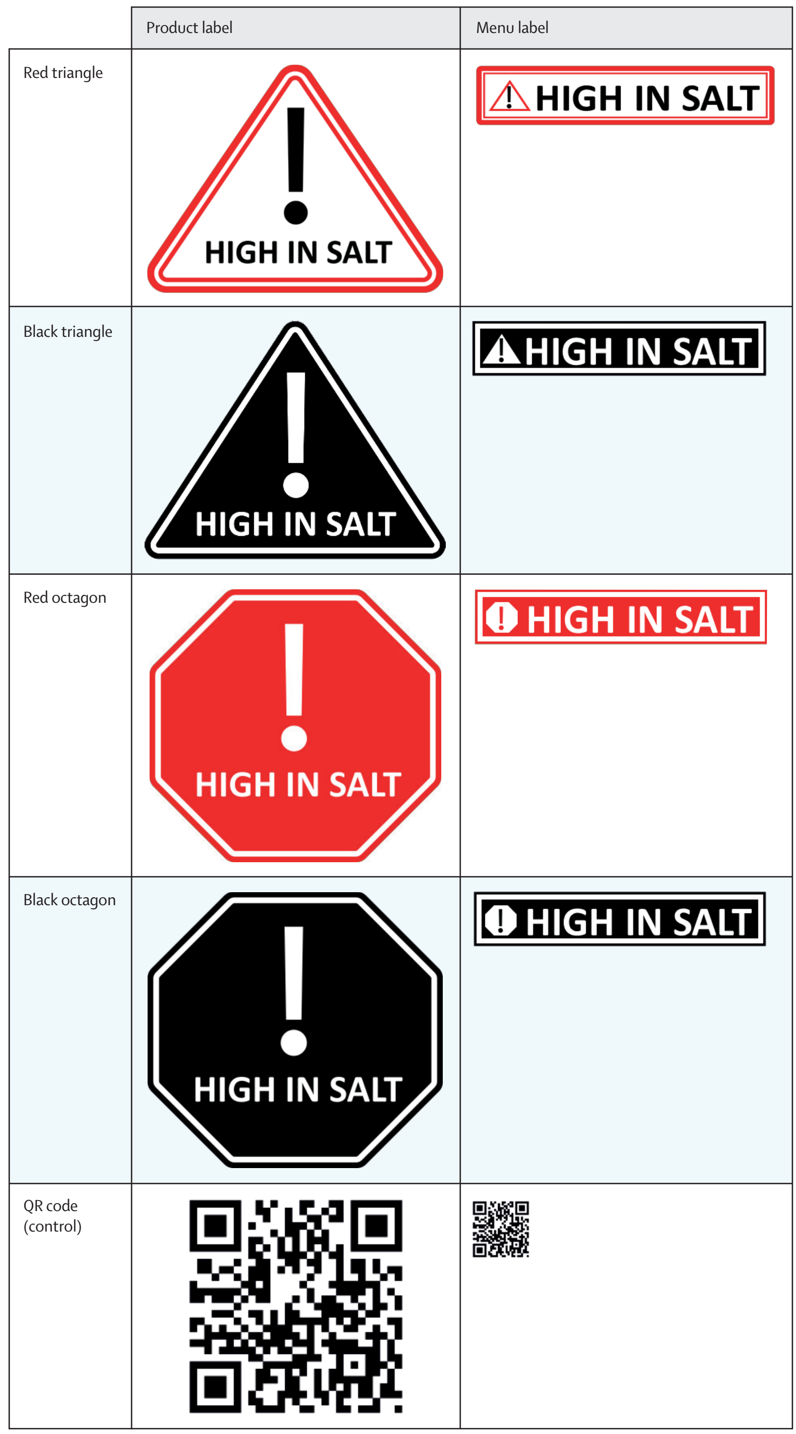

Figure 1: Corresponding product and menu labels for study 1

For **study 1's methods and analysis plans** see https://osf.io/vyh2x/?view_only=9063c20d2cd14069aeb953eda4ccac2722

See **Online** for appendix

For **study 2's methods and analysis plans** see https://osf.io/whzc8/?view_only=e97eb9ff6812457081d6d693e27bf1bd2

mouth and an existing participant database maintained by researchers at the University of Liverpool. Interested participants were asked to complete an online screening questionnaire. Inclusion criteria were UK resident, aged 18 years or older, fluent in English, and ate an out-of-home meal at least once a month. Exclusion criteria were severe dietary allergies and veganism. Potential participants registering interest online were emailed an information sheet and could bring a maximum of nine co-diners (who would also participate) to the restaurant. We aimed to recruit a sample that was approximately representative of the UK in terms of socioeconomic position (eg, education), primarily, as well as age and sex.[16–18] Before the study began, a researcher provided study information and obtained verbal informed consent from all participants. Participants each received a £25 reimbursement.

Randomisation and masking

For study 1, participants were randomly assigned (between-subjects) to one of four salt warning labelling conditions or a control condition (QR code; figure 1), in a randomisation ratio of 1:1:1:1:1, with the Qualtrics randomiser function. Participants were masked to the study aims, being told that the study was about how different people make decisions when choosing food. Success of masking was assessed by asking participants what they thought the study aims were (free text response). Investigators were masked to labelling allocation, as allocation was automatically done in Qualtrics.

For study 2, researchers used block randomisation (blocks of ~50) to assign table groups to menu conditions, allowing flexibility for table size variations.[19] Participants were masked to the study aims, being told that the study was about dining habits in restaurants. Success of masking was assessed by asking participants what they thought the study aims were (free text response). Waiting staff employed at the restaurant who had direct contact with participants (eg, to take payment) were naive to study aims, although we did not formally test masking among waiting staff.

Procedures

In study 1, participants assigned to each of the labelling conditions completed three online packaged food scenarios and three online restaurant ordering scenarios. Before completing the tasks, participants reported their sex (male, female, or prefer not to say), age, and ethnicity. Two measures of socioeconomic position were collected, highest education level and equivalised household income.[20] Baseline levels of hunger were measured with a visual analogue scale ranging from 1 to 100 (not at all to extremely). Frequencies of supermarket sandwich and snack purchase and eating at or ordering from restaurants were measured on a 5-point Likert scale (not in the past year to three times per week or more).

Scenario order was counterbalanced to control for order effects (half of the participants completed the packaged food tasks first, and half completed the restaurant tasks first). In the packaged food scenarios, participants were asked to select a sandwich, packet of crisps, and a savoury snack (food categories that have a good spread of lower and higher salt options). In the restaurant scenarios, participants were asked to choose a main course for an evening meal from each of three restaurant menus (based on popular UK restaurants of different cuisine types—Italian, Japanese, and fried chicken). In each scenario, participants chose one item from six options, half of which were high in salt. Packaged foods were classed as high in salt if they contained >1·5 g of salt per 100 g or >1·8 g per portion (as per the voluntary red traffic light threshold in the UK for packaged food[21,22]). Restaurant meals were categorised as high in salt if they exceeded 50% of the recommended daily limit for salt intake in the UK (>3 g).[23] We used a 50% threshold rather than the 100% threshold implemented in some US cities because the latter would only cover a minority (approximately 4%) of high-salt items in UK chain restaurants.[3] Reference information was included at the foot of each selection page (eg, "[Label] indicates that the [product/meal] is high in salt..."). Included food items are listed in the appendix (pp 5–10).

After completing the ordering tasks, participants were asked about their awareness of the labelling. They were then shown images of a packaged product and a menu item featuring their assigned label. Participants were asked about the perceived message effectiveness of the labelling, knowledge gained as a result of reading the label, influence of the label on their food choices, their support for mandating the labelling, and which label they would prefer for the policy. Self-reported height and weight data were then collected to calculate BMI, and the Food Choice Questionnaire[24] was administered to measure factors that might influence participants' food choices. We calculated the relative importance of the health motive by dividing the participant's absolute health motive score by their mean score on all items.[25] Finally, participants answered a question regarding study aims. Two attention checks (answering a basic question and selecting a specific response) and one consistency check (reporting highest education level twice) were included. A detailed study flow and additional measures are in the appendix (p 11 and p 13, respectively).

In study 2, participants attended one lunch session at the restaurant, from Monday to Saturday between 1200 h and 1500 h. Participants attending together were placed at the same table and had been randomly assigned to the same menu condition. Participants in the control group received the restaurant's standard menu with no labels. Participants in the experimental group received a menu with red triangle salt warning labels next to high-salt items (the two menus are in the appendix [pp 20–21]; full study flow is in the appendix pp 22–23]). The red triangle label was evaluated as it was the most highly ranked label among study 1 participants for policy preference, and there were no significant differences between this label and the other labels for perceived message effectiveness or salt content of selected food. All menu items were weighed and sent for nutritional analysis to establish salt content per 100g (nutritional information is in the appendix [p 18]). Labels were placed below menu items that exceeded 50% of the UK daily recommended salt limit (>3 g; 5 of 16 items).[23,26] Labels were the same height as the menu item text,[27] and reference text was included at the foot of the menu—ie, "(Label) indicates that the salt content of this item is higher than 50% of the daily recommended limit (6 g per day). High salt intake can increase blood pressure and risk of heart disease and stroke." Drink options (including alcohol), were presented on a separate menu.

Participants were given their assigned menu and wrote their order on a form. The researchers received training from the restaurant and acted as waiting staff; they took orders, delivered and collected meals, and took covert pre-intake and post-intake photos. After finishing their meal, participants completed questions online on study aims, meal sharing and condiments, demographics (with employment status collected in place of equivalised household income to reduce questionnaire length), salt awareness, perceived message effectiveness, and policy support. Participants then completed the Food Choice Questionnaire;[24] mean health motives score was computed, rather than relative health motives, to reduce questionnaire length. Participants then paid for their meal. The next morning, participants received an email prompting them to record all food consumed after the restaurant visit (up to midnight on the same day) using a validated dietary recall assessment tool (Intake24). Participants were reimbursed for their participation 2–3 weeks after taking part (on average).

Outcomes

For study 1, the primary outcome was perceived message effectiveness, which was measured with an adapted version of the University of North Carolina Perceived Message Effectiveness Scale.[28] Participants answered three questions with a Likert scale ranging from 1 to 5 (not at all to a great deal): "This label...(i) makes me concerned about the health effects of consuming items high in salt, (ii) makes consuming items high in salt seem unpleasant, (iii) discourages me from wanting to consume items high in salt." The mean response to the three items was calculated. The scale has been validated and is predictive of real-world behaviour.[28–32] The secondary outcome was food choice. Food choices were measured in terms of whether a labelled item was selected (no=0, yes=1; converted to a percentage) and the total amount of salt in the food selected (in g). Food choices and the amount of salt selected were calculated across across the three packaged food scenarios and the three restaurant scenarios.

For study 2, primary outcomes were perceived message effectiveness and salt awareness, and secondary outcomes were food choice and salt intake. For perceived message effectiveness,[28] questionnaire phrasing was adapted so that participants considered the statements in relation to the menu ordered from (eg, "The menu made me concerned about the health effects of consuming items high in salt"). For salt awareness, there was an additional question that was not included for study 1: "Did you think about the salt content of the meals when making your selection?" (yes/no). For food choice, ordering of a labelled item was measured as a categorical variable (yes=1, no=0) as there was only one ordering scenario. There was no limit on the number of items each participant could order. Salt intake was estimated by trained nutritionists using the salt content of the meal, consumption estimates from photos, and self-reports on meal sharing and condiments. A random 20% of photos were second-coded, with discrepancies of more than 5% resolved by a third researcher. Participant reporting of sharing and condiment use was not cross-checked and could be subject to measurement bias. Details of salt intake calculations are in the appendix (pp 18–19).

Statistical analysis

For study 1, a minimum sample of 2180 participants (436 per condition) was required to provide sufficient power (80%) to detect small between-condition effects ($d=0\cdot19$) of warning labels on perceived message effectiveness, salt content (g) of food selected, and percentage of labelled items selected (appendix p 13).[7,11] We aimed to recruit up to 2500 participants (500 per condition) to account for the potential loss of up to approximately 15% of participants due to data exclusion.

We used a mixed ANOVA to examine the effect of label condition and selection scenario on ratings of perceived message effectiveness. Label condition was the between-subjects factor, and scenario (packaged food or restaurant menu) was the within-subjects factor. Age (18–39 years and ≥40 years), sex (male or female), and education (no university degree or educated to degree level or higher) were included as covariates to account for stratification. Relative health motives were entered as a covariate as we assumed motives would be predictive of outcomes (eg, health motivated individuals might be more likely to believe that labels will change their behaviour than individuals less motivated by health).[33] ηp^2 is reported alongside ANOVAs; 0·01, 0·06, and 0·14 represent small, medium, and large effect-size thresholds, respectively.

We also used mixed ANOVAs to examine the effect of label condition and selection scenario on the proportion of labelled items selected (mean number of labelled items selected across tasks, expressed as a percentage) and salt (g) ordered. The same factor structure (ie, the between-subjects factor was label condition and the within-subjects factor was scenario) and covariates as in the primary analysis were used. Values for salt ordered were standardised (converted to Z scores) within each scenario for the analysis because of differences in the range and distribution of the salt content of items between the product and menu scenarios. The Z-score transformation was only used for statistical modelling to standardise salt ordered across scenarios. All descriptive statistics and interpretations are presented using raw salt content values to maintain real-world relevance. For both primary and secondary analyses, the population analysed excluded those participants who submitted an incomplete response, failed the attention or consistency check, or submitted implausible BMI values. Primary and secondary analyses were reconducted after removing participants who correctly guessed study aims.

	Red triangle group (n=484)	Black triangle group (n=484)	Red octagon group (n=461)	Black octagon group (n=475)	Control group (n=487)	Overall (n=2391)
Descriptives						
Age, years	44·9 (13·3)	45·2 (13·4)	45·8 (13·0)	45·2 (13·7)	44·9 (14·0)	45·2 (13·49)
Participants aged >40 years	305 (63%)	315 (65%)	311 (67%)	303 (64%)	307 (63%)	1541 (65%)
Sex						
Female	238 (49%)	244 (50%)	234 (51%)	234 (49%)	255 (52%)	1205 (50%)
Male	245 (51%)	239 (49%)	225 (49%)	241 (51%)	231 (47%)	1181 (49%)
Prefer not to say	1 (<1%)	1 (<1%)	2 (<1%)	0	1 (<1%)	5 (<1%)
Race or ethnicity						
White	421 (87%)	434 (90%)	393 (85%)	410 (86%)	431 (89%)	2089 (87%)
Asian	25 (5%)	15 (3%)	35 (8%)	25 (5%)	24 (5%)	124 (5%)
Black	18 (4%)	19 (4%)	16 (3%)	16 (3%)	15 (3%)	84 (4%)
Mixed	14 (3%)	12 (2%)	14 (3%)	20 (4%)	12 (2%)	72 (3%)
Other	6 (1%)	4 (1%)	3 (1%)	4 (1%)	5 (1%)	22 (1%)
Educated to degree level or higher	227 (47%)	232 (48%)	227 (49%)	227 (48%)	237 (49%)	1150 (49%)
Equivalised household income (£)*	20 640 (12 000–31 464)	21 538 (14 286–30 690)	21 333 (14 599–30 000)	20 785 (14 111–30 467)	21 429 (14 625–31 292)	21 037 (14 000–30 667)
Relative health motives †	6·39 (1·06)	6·30 (1·13)	6·36 (1·19)	6·25 (1·04)	6·44 (1·08)	6·35 (1·10)
BMI, kg/m²*	26·0 (23·3–29·8)	26·2 (23·3–30·0)	26·1 (22·9–29·6)	26·2 (23·4–30·0)	26·5 (23·1–30·9)	26·2 (23·1–30·1)
Living with overweight or obesity	285 (59%)	284 (59%)	275 (60%)	297 (63%)	296 (61%)	1437 (60%)
Hunger‡	41·4 (24·9)	41·1 (25·2)	41·6 (25·8)	40·3 (24·7)	40·6 (25·6)	41·0 (25·2)
Participants purchasing items at least monthly§						
Supermarket sandwiches	336 (69%)	341 (70%)	323 (70%)	306 (64%)	327 (67%)	1633 (68%)
Snack foods	450 (93%)	435 (90%)	420 (91%)	427 (90%)	443 (91%)	2175 (91%)
Restaurant foods	399 (82%)	409 (85%)	394 (85%)	395 (83%)	414 (85%)	2011 (85%)
Guessed aims of study	160 (33%)	152 (31%)	143 (31%)	160 (34%)	110 (23%)	725 (30%)
Outcomes						
Perceived message effectiveness score¶						
Product	2·96 (1·20)	2·92 (1·19)	3·08 (1·25)	2·81 (1·24)	1·71 (1·02)	2·69 (1·28)
Menu	2·98 (1·24)	2·93 (1·20)	3·09 (1·27)	2·82 (1·28)	1·74 (1·04)	2·71 (1·30)
Salt ordered, g						
Product	2·54 (0·68)	2·64 (0·67)	2·56 (0·70)	2·64 (0·67)	2·83 (0·68)	2·64 (0·69)
Menu	9·71 (2·85)	9·89 (3·02)	9·43 (2·68)	9·80 (2·79)	10·5 (2·96)	9·88 (2·88)
Labelled items selected by participants						
Product	33·2% (29·9)	36·2% (30·0)	32·0% (29·9)	36·0% (29·9)	48·7% (29·1)	37·3% (30·3)
Menu	33·4% (30·3)	35·1% (29·9)	30·6% (29·8)	35·0% (29·2)	47·3% (29·9)	36·3% (30·36)
Supported policy‖						
Product	303 (63%)	295 (61%)	299 (65%)	296 (62%)	243 (50%)	1436 (60%)
Menu	299 (62%)	288 (60%)	283 (61%)	292 (62%)	252 (52%)	1414 (59%)

Data are n (%), mean (SD), mean % (SD), or median (IQR), unless otherwise indicated. NA=not applicable. *Medians and IQRs reported for skewed descriptives. †A higher score indicates greater health-related food choice motives, relative to other food choice motives (eg, price). ‡Measured with a visual analogue scale ranging from 1 to 100. §It was not possible to screen out participants who did not purchase supermarket and restaurant foods at least monthly in Prolific; all participants had purchased supermarket and restaurant foods in the last year as a minimum. ¶A higher score represents a stronger belief that this label would discourage intake of high-salt items.‖Proportion of participants indicating that they would support or strongly support the introduction of a policy requiring this label (eg, a QR code label for the control condition).

Table 1: **Descriptive statistics and outcomes for study 1**

For study 2, a minimum sample of 260 participants (130 per condition) was needed to provide sufficient power (80%, two-tailed) to detect small-to-medium effects (*d*=0·35) of the salt warning label on perceived message effectiveness, salt ordered, and salt intake, with linear models.[7,11] Effect-size estimates had a degree of uncertainty, particularly as no previous real-world research has been conducted testing salt warning labels in a restaurant. To balance the trade-off between costs (eg, in research time) and likelihood of the study providing convincing evidence, we planned to conduct interim primary and secondary analyses once 130 participants in each condition had completed the study.[34] At the interim analysis, we found evidence of between-condition effects on perceived message effectiveness and of directional (but non-significant) effects on salt ordered, as anticipated. For salt ordered, it was estimated that approximately 450 participants (225 per condition) would be required to observe a detectable effect at p<0·025 (a conservative Bonferroni correction was applied to both primary and secondary analyses due to multiple testing), which was feasible based on our resources and recruitment timeline. Therefore, as specified in our protocol, we continued recruitment, aiming to achieve a minimum sample size of 450 by study end to provide a higher likelihood of detecting a meaningful difference.

We used a linear mixed model to examine the effect of menu condition on perceived message effectiveness. Age, sex, socioeconomic position (degree or no degree), and health motives were entered as covariates, based on study 1's findings (appendix p 13);[33] table group was included as a random effect in the model due to clustering (intraclass correlation coefficient [ICC]=0·07).

To examine the effect of menu condition on the odds of a participant considering the salt content of the meals when choosing, we used a generalised linear mixed model with the same covariates; table group was included as a random effect in the model (ICC=0·23).

Linear mixed models were also used to examine the effect of menu condition on salt ordered and salt intake,

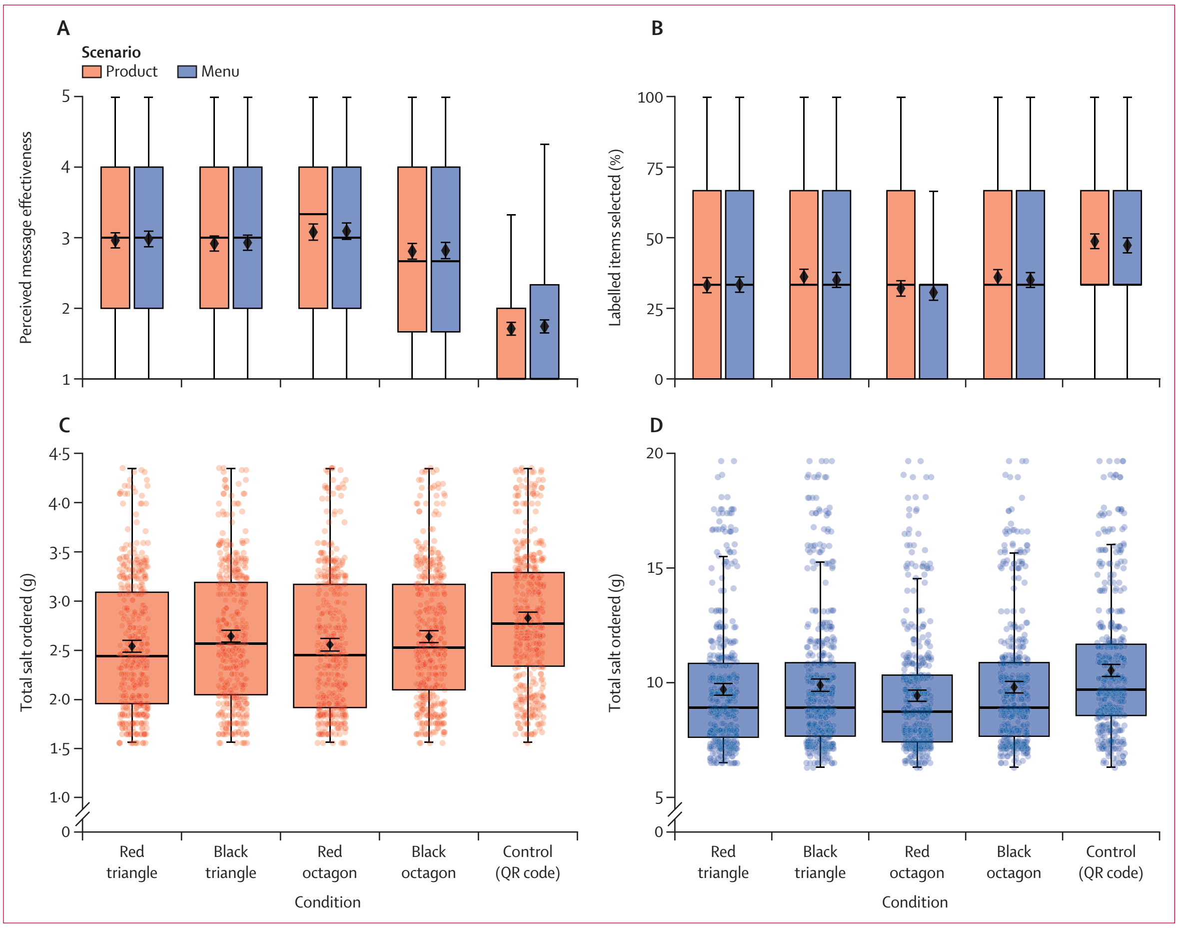

Figure 2: **Perceived message effectiveness (A), percentages of labelled items selected (B), and salt ordered in a packaged food product scenario (C) and a restaurant scenario (D) in study 1, by label condtion**

Boxes in A–D represent the IQR. Lines inside the boxes show medians; black dots inside the box show means, with error bars representing 95% CIs. Whiskers represent the range of most of the data (within 1·5 times the IQR). Coloured dots in C and D represent individual datapoints. Unstandardised salt values are shown in C and D to aid interpretation.

with the same covariates as used for the primary outcome analyses. Table group was included as a random effect in the model (ICC=0·11 for salt ordered, and ICC=0·10 for salt intake). A generalised linear mixed model was used, with the same covariates, to examine the effect of menu condition on the odds of a participant ordering a labelled item. Table group was included as a random effect in the model (ICC=0·10).

Primary and secondary analyses were reconducted after removing participants who correctly guessed study aims. We also reconducted a secondary analysis by including salt purchased in place of salt ordered as the outcome variable, to check for differences (because the ordered food was unavailable in a small number of instances). Linear mixed models were used instead of regressions (as specified in the protocol) as there was evidence of table clustering (appendix pp 25–27).

All analyses were conducted using R (version 4.3.2).

	Labelling menu group (n=238)	Control group (n=216)	Overall (n=454)
Descriptives			
Age, years *	53 (39·5–64)	51 (36–61)	52 (38–63)
Sex			
Female	140 (59%)	106 (49%)	246 (54%)
Male	95 (40%)	108 (50%)	203 (45%)
Missing data	3 (1%)	2 (1%)	5 (1%)
Educated to degree level or higher	119 (50%)	118 (55%)	237 (52%)
In full-time employment	94 (39%)	98 (45%)	192 (42%)
Race or ethnicity			
White	213 (89%)	192 (89%)	405 (89%)
Asian	7 (3%)	13 (6%)	20 (4%)
Black	2 (1%)	1 (<1%)	3 (1%)
Mixed	12 (5%)	6 (3%)	18 (4%)
Other	1 (<1%)	2 (1%)	3 (1%)
BMI, kg/m²*†	26·0 (23·5–28·7)	26·5 (23·6–30·3)	26·2 (23·5–29·4)
Living with overweight or obesity	126 (53%)	116 (54%)	242 (53%)
Eating out at least monthly‡	215 (90%)	193 (89%)	408 (90%)
Guessed aims of study	47 (20%)	0	47 (10%)
Health motives§	2·78 (0·68)	2·74 (0·64)	2·76 (0·66)
Outcomes			
Perceived message effectiveness score¶	2·32 (1·16)	1·32 (0·66)	1·85 (1·08)
Ordered at least one labelled item	107 (45%)	113 (52%)	220 (48%)
Total salt ordered, g	3·77 (1·52)	4·31 (1·63)	4·03 (1·60)
Salt intake, g	3·49 (1·45)	3·95 (1·56)	3·71 (1·52)
Salt awareness‖	115 (48%)	15 (7%)	130 (29%)
Supported policy**	151 (63%)	145 (67%)	296 (65%)

Data are n (%), mean (SD), or median (IQR). *Medians and IQRs reported for skewed descriptives. †54 participants did not provide height and/or weight data. ‡Participants' guests were not formally pre-screened for eating out at least monthly; all participants had eaten out in the last year as a minimum. §A higher score indicates greater health-related food choice motives. ¶A higher score represents a stronger belief that this label would discourage intake of high salt items. ‖The proportion of participants indicating that they thought about the salt content of menu items before making their selection. **The proportion of participants indicating that they would support or strongly support the introduction of a policy requiring salt warning labels on restaurant menus.

Table 2: **Descriptive statistics and outcomes overall and by menu condition for study 2**

Role of the funding source

The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

Key conclusions from patient and public involvement sessions regarding warning label design are in the appendix (pp 3–4). For study 1, data were collected between Feb 20 and April 2, 2024, until the required sample size was reached. 2549 of the pre-screened participants were randomly assigned to one of four salt warning label groups (red triangle, n=512; black triangle, n=512; red octagon, n=509; and black octagon, n=510) or to the control group (n=506; appendix p 12). 158 participants were excluded from analysis (n=2 for questionnaire incompleteness, n=18 for failing an attention check, n=54 for failing a consistency check, and n=84 for missing or implausible BMI values resulting from measurements provided by the participants [<10 or >60 kg/m²]). The final analytic sample included 2391 participants (table 1).

Perceived message effectiveness scores, amount of salt ordered, percentages of labelled items selected, and percentages of participants supporting a labelling policy, per scenario and group (experimental and control) in study 1 are in table 1.

The main effect of label condition on perceived message effectiveness was significant (F [4, 4758]=224·31, ηp^2=0·16; p<0·0001). Scenario did not have a significant main effect on perceived message effectiveness, and there was no condition*scenario interaction. All salt warning labels were rated as having significantly greater perceived effectiveness for changing behaviour than the control labelling, with a raw mean difference of 1·23 (95% CI 1·12–1·34; p<0·0001) for packaged food scenarios and 1·22 (1·11–1·33; p<0·0001) for menu scenarios. The red octagon label was rated as significantly more effective than the black triangle (p=0·034) and black octagon (p=0·0001; figure 2A).

The main effect of label condition on salt ordered was also significant (F [4, 4758]=23·47, ηp^2=0·02; p<0·0001). Scenario did not have a significant main effect on salt ordered, and there was no condition*scenario interaction.

All four salt warning labels resulted in significantly less salt ordered than with the control (p<0·0001 for all warning labels). This reduction was, on average, –0·26 g (95% CI –0·43 to –0·10) or –7·4% per restaurant meal and –0·08 g (–0·12 to –0·04) or –8·5% per packaged supermarket item, relative to the control, based on raw mean differences. The red octagon warning label resulted in significantly less salt ordered relative to the black triangle (p=0·020; figure 2C).

Label condition had a significant main effect on the proportion of labelled products that were selected (F [4, 4758]=49·56, ηp^2=0·04; p<0·0001). Scenario did not have a significant main effect, and there was no condition*scenario interaction. All salt warning labels significantly reduced the proportion of labelled items selected relative to the control (all p <0·0001). The red octagon label resulted in significantly fewer labelled items selected than did the black triangle (p=0·021; figure 2B).

Full results, including sensitivity and exploratory analyses, are in the appendix (pp 13–17). Findings were unchanged when adjusting for participants who correctly guessed the study aims (appendix pp 16–17). Greater health motives were associated with higher ratings for perceived message effectiveness, especially for red labels, and the red triangle was rated as more effective by participants older than 40 years than by those younger than 40 years (appendix pp 15–16). There were no other significant interactions. Awareness, perceived influence, knowledge gain, and policy support were greater for salt warning labels than for the control. Red triangle and red octagon labels were ranked most highly by participants for both policy preference and perceived effectiveness for policy, with red triangle labels preferred for menus and red octagon labels for packaged products. (appendix p 14).

For study 2, data were collected between June 5, 2024, and Sept 14, 2024, until the required sample size was reached. 465 eligible participants were randomly assigned to either the experimental condition (ie, participants received a menu with red triangle salt warning labels next to high-salt items; n=240) or the control condition (ie, participants received restaurant's standard menu; n=225; appendix p 24). Full data were removed for participants who did not meet study inclusion criteria (n=2) or were exposed to the wrong menu condition in error (n=9), resulting in a final analytic sample of n=454 (table 2). Order and intake data were excluded for participants who were told that specific menu items were unavailable before ordering (n=2). Post-meal questionnaire data were excluded for participants who did not pass the attention check (n=5), and data regarding label influence were excluded for participants who were given a version of the post-meal questionnaire that did not correspond to their condition due to researcher error (n=7).

Perceived message effectiveness scores, percentages of participants ordering labelled items, total amounts of salt ordered, salt intake, and percentages of participants indicating that they considered the salt content of menu items before making their selection are in table 2. The labelled menu was rated as having significantly higher perceived message effectiveness than the standard menu, with a raw mean difference of 1·00 (β=0·98, 95% CI 0·79–1·18; p<0·0001; figure 3A). Participants assigned to the labelled menu condition were significantly more likely to think about the salt content of the meals when ordering (odds ratio [OR] 19·50, 95% CI 8·24–46·16; p<0·0001) than were participants assigned to the standard menu.

Significantly less salt was ordered by participants assigned to the labelled menu group than by those assigned to the standard menu (β=–0·43, 95% CI –0·77 to –0·09; p=0·014; figure 3B). Participants in the labelled menu group ordered 0·54 g (95% CI –0·83 to –0·25) or 12·5% less salt than those in the control group, based on the raw mean difference.

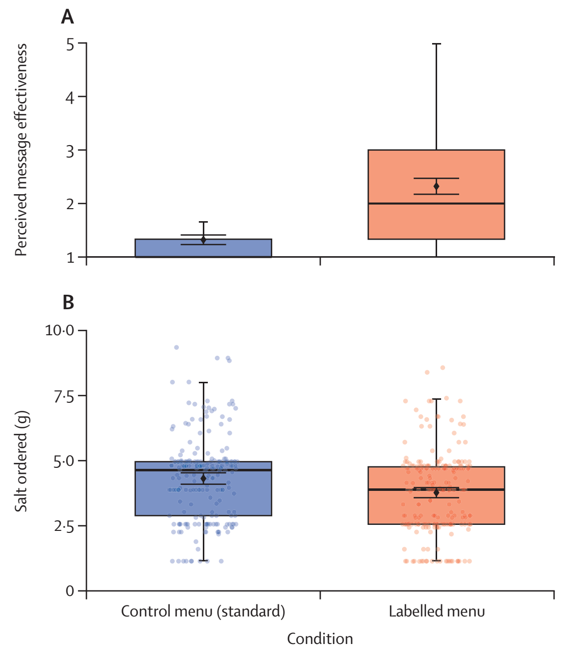

Figure 3: **Perceived message effectiveness (A) and salt ordered (B) in study 2, by menu condition**
Boxes in (A) and (B) represent IQR. Lines inside the boxes show medians; black dots inside the box show means, with error bars representing 95% CIs. Whiskers represent the range of most of the data (within 1·5 times the IQR). Coloured dots in (B) represent individual datapoints.

Menu condition had no statistically significant effect on salt consumed (β=–0·31, 95% CI –0·63 to 0·01; p=0·063), although, consistent with salt ordered, participants assigned to the labelled menu consumed 0·46 g (95% CI –0·74 to –0·18) or 11·7% less salt than the participants assigned to the control group, based on the raw mean difference. There was no significant difference between groups assigned to the two menu conditions in terms of salt added from condiments (p>0·05).

There was no statistically significant association between menu condition and the likelihood of participants choosing a labelled item (OR=0·80, 95% CI 0·51–1·25; p=0·33).

Full results, including exploratory and sensitivity analyses, are in the appendix (pp 25–27). Removing participants who correctly guessed the study aims or analysing salt purchased instead of ordered did not change conclusions (appendix p 27). Menu condition did not have a significant effect on other macronutrient intake, or later salt intake (appendix p 26), suggesting that there was no compensatory behaviour. There were no interaction effects between condition and covariates for perceived message effectiveness or salt selected (appendix p 27).

Discussion

The results of the two randomised controlled trials in this study indicated that salt warning labels on restaurant menus and packaged supermarket foods were perceived to be effective by UK consumers and reduced the amount of salt ordered in a hypothetical online setting. Results for restaurant menus were also replicated in a real-world setting. Findings on food choice were not moderated by participant age, sex, socioeconomic position, or food choice-based health motives, suggesting that salt warning labels might have equitable effects on consumer behaviour and diet.

These findings align with past research showing that nutrient warnings on packaged products and added-sugar warnings on menus are both perceived as effective in discouraging less healthy or high-sugar food choices.[35,36] In study 1, red labels performed best in terms of perceived message effectiveness and policy preference. Red is consistently used in regulatory and safety signage and can evoke a strong emotional response (eg, avoidance).[37] Our patient and public involvement work suggests that the red triangle label probably benefitted from cultural associations with UK traffic warning signs, which might have primed viewers to interpret it as more important than the other labels. Some research suggests that using warning as a marker word (eg, salt warning) leads to higher perceived effectiveness than nutrient disclosure (eg, labelling a food as high in salt), which might warrant further exploration.[29]

To our knowledge, the present study is the first to examine the effect of menu-based salt warning labels outside of the USA and the first real-world randomised controlled trial to gauge causal evidence for effectiveness. Previously, online randomised controlled trials with consumers in the USA making hypothetical food choices showed that salt warning labels decreased hypothetical salt ordered by 0·05–0·21 g per meal.[7,11] It is possible that study 2 yielded larger reductions (–0·54 g) in salt ordered relative to the US studies and study 1 (–0·26 g) due to unrestricted participant choice (ie, participants could choose as many items as they wished from a wider offering), actual rather than hypothetical choice resulting in greater use of labels to guide choice, and a higher proportion of items being labelled than in the US study (where the labelling threshold was >100% of the recommended daily limit for salt). The observed reduction in salt ordered in study 2 amounts to almost 10% of the recommended daily limit for salt intake in the UK (6 g),[23] suggesting that the introduction of salt warning labels in UK restaurants has the potential to yield substantial public health benefits. Most participants in the present studies were supportive of introducing salt warning labels as a policy in the out-of-home food sector and perceived them to be effective at discouraging salt intake.

Although an important strength of study 2 was its real-world setting, there are some limitations to be acknowledged. The amount of salt in the food ordered was significantly lower in the group allocated to the labelled menu than in the group allocated to the standard menu, but the difference in salt intake was not statistically significant. Possible explanations for this result are random variation in food waste and minor random errors in participants' self-reports of meal sharing or condiment use and/or nutritionist estimates of food intake, given that effect sizes for both outcomes were similar (~0·5 g reduction). Additionally, participant exclusions resulted in 216 participants in the control group (fewer than the interim estimate of 225 participants required); therefore, the study might have been underpowered to detect differences in salt intake. Some unlabelled items were near the threshold for being labelled high in salt, so the difference in salt content between labelled and unlabelled items was sometimes minimal, especially when multiple unlabelled items were ordered; this factor might partly explain the non-significant reduction in salt intake, although it reflects how labels would function in real-world policy. In study 2, participants were reimbursed. Although reimbursement incentivised participation, particularly for those in low socioeconomic position groups, it is possible that anticipation of a reimbursement influenced food choice. A further limitation of study 2 was that we examined the effects of salt warning labels in a single restaurant and for a lunchtime meal. Effects might differ by cuisine and meal type (eg, participants might be more likely to indulge by ordering less healthy items or more items for an evening meal than a lunchtime meal). Additionally, the control menu in study 2 did not feature a label (as it would be unusual for a real menu to feature QR codes next to menu items). Nonetheless, it is important to note that results in study 2 were similar to those obtained in study 1, in which we examined hypothetical purchasing behaviour across three different types of restaurant cuisine, for evening meals, and compared warning labels with a control label (a QR code). In study 1, use of the survey platform Prolific might have yielded a selective sample. It is also possible that some participants did not like the specific flavours and cuisines offered, which might have constrained food choice. We used ANOVA to account for the mixed design in study 1, although primary outcome variables were not all normally distributed, which is another limitation.

We cannot generalise our findings to other ethnicities as participants in study 1 and 2 were predominantly White British; nor can the findings be generalised to individuals residing outside the UK, as warning symbol interpretations are likely to be country specific. Further studies are required to ensure that any potential labelling intervention has equitable effects for different ethnicities and does not widen health inequalities. As vegetarians and vegans were excluded from study 1 and vegans were excluded from study 2, the study findings might not be generalisable to these subgroups. However, evidence suggests that there are no significant differences in dietary salt intake between omnivores, vegetarians, and vegans,[38] so it is unlikely that results would have differed had participants with these dietary restrictions been included. We also cannot generalise our findings to fast-food restaurants; post-implementation evidence for salt warning labels in New York City suggests that reductions in salt ordering were only apparent in full-service restaurants.[12]

Study 2 could inform further larger-scale randomised controlled trials in various real-world restaurant settings. Research examining the effect of other nutrient warning labels in the out-of-home food sector might also be useful, as restaurants offer a substantial number of items that exceed per-meal recommendations for calories, saturated fat, and sugar.[3] Such research would help to evaluate whether a more cohesive nutrient warning labelling policy in the out-of-home food sector would be beneficial, particularly as the introduction of a salt labelling policy might lead to compensatory increases in other nutrients (eg, saturated fat) to improve palatability.

Importantly, this study contributes evidence that could guide policy implementation in the UK.[13] If current findings were to be replicated in larger-scale, real-world randomised controlled trials, the introduction of salt warning labels that are optimised to maximise reductions in salt intake would be a promising option for the UK Government to reduce diet-related disease. Notably, the observed effects in the present research were mediated via consumer behaviour change alone. If salt warning labelling were to be introduced as a policy, industry reformulation (ie, reducing salt content of menu items) might result in additional reductions in intake.[39]

Contributors

RE: conceptualisation, data curation, formal analysis, investigation, methodology, project administration, validation, visualisation, writing—original draft, and writing—review and editing. JB: conceptualisation, data curation, investigation, validation, resources, and writing—review and editing. NC: conceptualisation, resources, and writing—review and editing. JF: conceptualisation, writing—review and editing. AF: conceptualisation, investigation, validation, and writing—review and editing. AJ: conceptualisation, resources, writing—review and editing. PT: data curation, investigation, and writing—review and editing. BW: data curation, investigation, and writing—review and editing; RW: conceptualisation, resources, and writing—review and editing. ER: conceptualisation, funding acquisition, methodology, project administration, supervision, validation, and writing—review and editing. For study 1, RE, ER, and AF accessed and verified the data. For study 2, RE, JB, and ER accessed and verified the data. All authors were permitted access to all the raw data in the study, and all authors accept responsibility for the decision to submit the manuscript.

Declaration of interests

JF declares funding from The National Institute of Food and Agriculture of the US Department of Agriculture, Center for Science in the Public Interest, Bloomberg Philanthropies, and National Institutes of Health, all outside of this work. All other authors declare no competing interests.

Data sharing

The study protocols and anonymised datasets are available at https://osf.io/vyh2x/ (study 1) and https://osf.io/whzc8/ (study 2).

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