**The influence of calorie and physical activity labelling on snack and beverage choices**

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**Abstract**

**Background**: Much research suggests nutrition labelling does not influence lower energy food choice. This study aimed to assess the impact of physical activity based and kilocalorie (Kcal) based labels on the energy content of snack food and beverage choices made.

**Methods**: An independent-groups design, utilizing an online questionnaire platform tested 458 UK adults (87 men), aged 18-64 years (mean: 30 years) whose BMI ranged from 16-41 kg/m2 (mean: 24 kg/m2). Participants were randomized to one of four label information conditions (no label, Kcal label, physical activity label [duration of walking required to burn the Kcal in the product], Kcal and physical activity label) and were asked to choose from higher and lower energy options for a series of items.

**Results**: Label condition significantly affected low vs. high-energy product selection of snack foods (p<.001) and beverages (p<.001). The physical activity label condition resulted in significantly lower energy snack and beverage choices than the Kcal label condition (p<0.001). This effect was found across the full sample and persisted even when participants’ dietary restraint, BMI, gender, socioeconomic status, habitual physical activity, calorie and numerical literacy were controlled.

**Conclusion**: The provision of physical activity information appeared most effective in influencing the selection of lower Kcal snack food and beverage items, when compared with no information or Kcal information. These findings could inform the debate around potential legislative policies to facilitate healthier nutritional choices at a population level.

**Keywords**: nutrition labelling, exercise, food choice, energy intake, snack choice, beverage choice

# Introduction

Global rises in overweight and obesity have been related to a myriad of factors, owing to the complex nature of weight gain, which incorporates environmental, lifestyle, physiological, and cognitive elements among others, (Bellisle & Blundell, 2013; Booth, Pinkston, & Poston, 2005; Marti, Moreno-Aliaga, Hebebrand, & Martinez, 0000). In 2014, over 60% of UK adults were overweight or obese, (England, 2014). Numerous public health policies have been designed to address this problem, often with the dual aims of encouraging product reformulation and altering the food environment to facilitate healthier nutritional choices. For example, in 2011, as part of the Department of Health’s voluntary Responsibility Deal programme, some manufacturers pledged to implement energy (kilojoules, kJ; kilocalories, Kcal) labelling on food and non-alcoholic drinks in out of home settings, (D. o. Health, 2013a). Subsequently, a number have also pledged to adopt and implement the UK Governments’ 2013 recommended Front of Pack (FoP) Nutrition Labelling Scheme, (D. o. Health, 2013b), which uses colour coding of the nutrient content (e.g. red to indicate that a product is high in an undesirable nutrient), in addition to the full mandatory (“back of pack”) nutrition declaration which reports on the energy, fat, saturates, carbohydrate, sugars, protein and salt levels in the item, (Ministers, 2013). Studies have shown that calories and fat are most frequently cited as the most important nutrition information consumers seek about a product, with the back of pack label used as the main source for this information, but critically few consumers actually consult the back of the pack, (Storcksdieck genannt Bonsmann, et al., 2010). Simple FoP labelling is understood by consumers, (Grunert & Wills, 2007) and would enable rapid evaluation of purchase options at the point of sale, thus supporting more informed decision making, (Brownell & Koplan 2011) and perhaps a more promising avenue for public health policy.

Several studies have suggested that, when incorporated into a menu in a restaurant setting, nutrition labelling does encourage the selection of lower energy items, thereby reducing the total chosen energy content of a meal, (Avcibasioglu & al., 2011; Bassett, et al., 2008; Bollinger, Phillip, & Sorensen, 2011; Brissette, Lowenfels, Noble, & Spicer, 2013; Downs, Loewenstein, & Wisdom, 2009; Krieger, et al., 2013; Pulos & Leng, 2010; Roberto, Larsen, Agnew, Baik, & Brownell, 2010; Wisdom, Downs, & Loewenstein, 2010). However, other studies have found similar interventions to only be successful in slim women, (Temple, et al., 2011), those high in dietary restraint, (Girz, Polivy, Herman, & Lee, 2012), or not at all, (Downs, Wisdom, Wansink, & Loewenstein, 2013; Dumanovsky, Huang, Bassett, & Silver, 2010; B. Elbel, Gyamfi, & Kersh, 2011; Brian Elbel, Kersh, Brescoll, & Dixon, 2009; Finkelstein, Strombotne, Chan, & Krieger, 2011; Harnack, et al., 2008; Holmes, Serrano, Machin, Duetsch, & Davis, 2013; Swartz, Braxton, & Viera, 2011; Tandon, et al., 2011). There is a notable lack of empirical research regarding the influence of FoP nutrition labelling on food choice, but it has been suggested that consumers find typical FoP information to be too detailed, (Feunekes, Gortemaker, Willems, Lion, & van den Kommer, 2008) and therefore confusing, (Brownell & Koplan 2011; Grunert & Wills, 2007). As a result, the information is often ignored, (Magnusson, 2010), particularly in low socioeconomic status groups, (Variyam, 2008) and in those with poor nutrition knowledge, (Grunert, Wills, & Fernández-Celemín, 2010; Guthrie, Fox, Cleveland, & Welsh, 1995; Li, Miniard, & Barone; Misra, 2007; Rasberry, Chaney, Housman, Misra, & Miller, 2007). This may be due, at least in part, to the notion of calories (Kcal) being interpreted as too abstract a concept to understand or utilize as part of total daily energy intake, (Blumenthal & Volpp, 2010; Fitch, et al., 2009). Similarly, with FoP, the volume of information may overwhelm understanding of the message. Given that consumers spend an average of 6 seconds looking at food before making a purchase decision, (Hamlin, McNeill, & Moore, 2015), it is clear that more visible, simple and tangible forms of FoP labelling might be more impactful, (Fitch, et al., 2009). Indeed, recent research suggests that consumers pay little attention to the nutritional information of regularly purchased goods, and instead efforts to provide visual information may be a more effective means of encouraging healthier food choices without cognitive burden (FSA, 2016).

The Royal Society for Public Health, (Royal Society for Public Health: Vision, 2016) has recently called for ‘activity equivalent’ calorie labelling to be placed on food packaging, alongside current FoP information, showing the amount of physical activity required to burn off the caloric content of the product. The RSPH have also called for more research into the efficacy of this approach as data are extremely limited, (Royal Society for Public Health: Vision, 2016). However, it has previously been shown that providing activity equivalent information for sugar-sweetened beverages at point of sale reduced the odds of purchase among low-income Black adolescents in the US, (Bleich, Herring, Flagg, & Gary-Webb, 2011). Such labelling has also been shown to reduce the energy selected from a hypothetical fast food menu (Dowray, Swartz, Braxton, & Viera, 2013). However, in order to evaluate the potential utility of physical activity labels for encouraging healthier food choice at a population level, it is important to understand not only whether these labels are more effective than no label at all, but also whether they are more effective than a standard Kcal label, and, finally, whether or not a combination of Kcal and physical activity labelling may be additionally effective. Thus the current proof-of-concept study aimed to elucidate the impact of an energy (Kcal) label, a physical activity label and a Kcal and physical activity label, relative to no label, on hypothetical snack and beverage choices (higher energy vs. lower energy snack) in a forced choice questionnaire paradigm. We hypothesised that all labels would lead to a greater selection of lower energy snack and beverage items, but that a physical activity label would be particularly effective due to the simplicity and concrete nature of the message.

# Methods and Materials

## *Design*

An independent-groups design was used within a forced choice questionnaire paradigm. Participants were randomized to one of four label information conditions (no label, Kcal label, physical activity label [duration of walking required to burn the kilocalories in the product], Kcal and physical activity label) and were asked to choose from higher and lower Kcal options for a series of snack food and beverage items (Figure 1).

## *Participants*

A sample size calculation was conducted based on a small to moderate effect size of the labeling condition (*f*=.15), we conservatively estimated this to be lower than the effect size (*f*=.18) found by Dowray et al., (Dowray, et al., 2013). Assuming an alpha of .05 and for 80% power with four experimental conditions and three correlated dependent variables (estimated correlation r=.7) power indicated a sample size of 392 participants (n=98 in each group). 555 participants took part online, of which 458 completed all required sections. Cases in which no choice was made for a beverage or product were not included in the final analysis. Only adult volunteers currently residing in the UK were accepted onto the study, in order to ensure that the stimuli depicted snack and beverage items that the participants were likely to be familiar with. All participant demographics can be seen in Table 1, with data demonstrating that the groups were well matched on all variables. Physical activity, SES quintile, numeracy and literacy score breakdown by group can be seen in supplementary tables 1-3.

**Table 1**. Participant demographic information and appetite VAS (M = Male, F = Female; BMI = Body Mass Index; Diet Status: N = Not dieting, P = Partial dieting, S = structured dieting) by group (Energy = Kcal; PA = Physical Activity); all mean scores are ±SD).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Label Type** |  |  |  | **p** |
|  | No Label | Kcal | PA | Kcal + PA |  |
| **Gender** | 93 (F) 28 (M) | 95 (F) 20 (M) | 96 (F) 16 (M) | 87 (F) 23 (M) | >0.05 |
| **Age** | 30.8 (±11.47) | 28.45 (±9.49) | 30.66 (±11.93) | 29.95 (±11.21) | >0.05 |
| **BMI** | 23.62 (±4.50) | 23.89 (±4.26) | 24.13 (±4.72) | 23.81 (±4.04) | >0.05 |
| **Restraint** | 2.75 (±0.83) | 2.87 (±0.87) | 3.01 (±0.91) | 2.75 (±0.83) | >0.05 |
| **Diet Status** | 75 (N) 40 (P) 6 (S) | 56 (N) 49 (P) 9 (S) | 55 (N) 52 (P) 5 (S) | 66 (N) 42 (P) 1 (S) | >0.05 |
| **Hunger** | 34.34(±27.10) | 37.15(±26.31) | 29.59(±22.61) | 35.10(±26.59) | >0.05 |
| **Thirst** | 41.29(±25.85) | 45.36(±25.20) | 40.98(±25.58) | 40.54(±23.91) | >0.05 |

## *Test Stimuli*

The foods and beverages depicted were all packaged snacks and café-style items, which have been shown to be most consistent at derailing dieting efforts, (Urbszat, Herman, & Polivy, 2002; Vohs & Heatherton, 2000) as well as being commonly consumed as snacks in the UK. Specifically, the items covered a range of foods, specifically five different food types (breakfast bar, café muffin, biscuits, chocolate bar and crisps) and five different beverage types (cola, sports drink, milkshake, café coffee and fruit juice). For each food or beverage type, participants were provided with higher Kcal and lower Kcal equivalent food pairs (e.g. latte and cappuccino) and were required to choose one. All options were matched for type and brand to ensure selections were not based on brand preference. The serving shown was based on manufacturer instructions of portion size.

The labels were designed to provide simple information to minimize the likelihood of confounds based on the type of label shown (including ability to understand the label and liking of the label; see Figure 1 for examples of the label designs). All energy information was provided as the number of Kcal in the item as taken from the FoP or from the online nutritional information (for the café products). Physical activity information was provided as minutes required to walk off the Kcal in the product. This was calculated using the energy expenditure of a 72kg adult walking at a rate of 30 minutes per mile (3.2 Kcal/min) as assessed by dividing total Kcal in the item by the energy expenditure rate. This was based on Dowray et al., (Dowray, et al., 2013). Walking was selected to ensure the physical activity information provided was relatable to the larger population. The order in which the various products were displayed to participants was fully randomized, as was the position of the items on the screen (whether the lower or the higher Kcal item was shown on the left).

## *Data collection*

The study was approved by the University of Liverpool Institute of Psychology, Health and Society research ethics committee in August 2015 and data were collected between January and February 2016. Prior to completing the food choice measure, participants were asked to report their hunger and thirst on visual analogue scales (VAS), anchored with “not at all” on the left and “extremely” on the right. Participants were then asked to choose one of two food items (across five food pairs) and one of two beverage items (across five beverage pairs), resulting in 10 selections in total. Depending on randomisation participants were either shown the foods and beverages with no label, a Kcal label, a physical activity label or a label with both Kcal and physical activity information (please see Figure 1). After food and beverage selections were complete, participants were required to provide basic demographic (gender, age) information. In addition, consistent with Dowray et al., (Dowray, et al., 2013), the questionnaire collected data on variables that could explain variations in the energy selections made by participants within and across label groups. These included dietary restraint (Dutch Eating Behaviour Questionnaire - Restraint subscale [DEBQ-R], (van Strien, Frijters, Bergers, & Defares, 1986), calorie literacy (a three item measure which assesses consumer understanding of daily energy requirements,(Bleich & Pollack, 2010)), basic numeracy (3 items, (Schwartz, Woloshin, Black, & Welch, 1997)); habitual level of physical activity, whether or not the participant was actively dieting to try to lose weight, and BMI (calculated from self-reported height and weight as kg/m2). Participants were also asked to enter their residential postcode. Postcodes for those participants residing in England were used to calculate the index of multiple deprivation (IMD) using the English Indices of Deprivation 2010, (Government, 2011) as a marker of socioeconomic status (SES). Upon completion participants were given the option of being entered into a prize draw to win one of five £100 online shopping vouchers or one of ten £10 vouchers.



**Figure 1**. Example images from the forced choice questionnaire task. Participants either received no label (a), Kcal label (b), physical activity label (duration of walking required to burn the Kcals in the product; c), or Kcal and physical activity label (d).

## *Statistical Analysis*

A Poisson regression analysis was conducted to analyse the effect of condition on total number of low calorie choices made by participants. Specifically, condition was added as a predictor to the regression model with “no label” as a reference category, i.e. statistics for the effects of the three remaining label types Kcal, exercise and Kcal +exercise on choice are compared to no label. Furthermore, we added gender as an addition categorical predictor in the model and both and BMI and the DEBQ restraint subscale as continuous predictors of low calorie food choice. Finally, we also included the interaction terms between condition and gender, BMI and DEBQ restraint to explore if any of these individual differences significantly moderated the effect of the labelling condition on choice. Additional analyses by item Kcal content was conducted and is provided as supplementary material (supplementary table 4).

# Results

## *Effects of label condition on the energy content of selected items*

Pearson’s Χ2 goodness of fit index revealed that the count data satisfied the assumption of equidispersion (Χ2/df = 1.004). The likelihood ratio Χ2 was highly significant (Χ2 (11)= 129.50, p<.001) suggesting that the regression model was well fitted to the data.

Table 2 shows the effects of each predictor individual on low calorie food choice.

 As there that no interactions were significant (conditionXGender, Wald Χ2 (3) = 0.94, p=.816; conditionXDEBQ-restraint, conditionXGender, Wald Χ2 (3) = 2.17, p=.5.38; conditionXBMI , Wald Χ2 (3) = 1.22, p=.749), suggesting none of these variable moderate the effect of the label so the individual comparisons have been excluded from the table. As can be seen in table one the exercise and exercise+Kcal label both produced significant increases in low calorie food choices in comparison to no label. The Kcal label only did not significantly increase low calorie food choices compared to no label. Although gender and BMI was not associated with choice it is notable that self-report restraint was associated with increase low calorie choice.

Further analysis to explore if there is a difference between Kcal only and the exercise and excercise+Kcal labels revealed a trend towards a significant difference between Kcal and exercise (B=0.64, SE 0.35, = 3.40 p=.065, OR = 1.90, 95%CI = 0.96 to 3.77), and no difference between Kcal and exercise+Kcal (B=0.48, SE 0.37, Wald Χ2= 1.74, OR = 1.62, 95%CI = 0.79 to 3.34). Please see supplementary material for further analyses on energy content selection of the items provided.

Table 2: Individual predictors from the Poisson regression analysis.

Variable B(SE) Wald Χ2 p OR 95%CI

Exercise+Kcala 0.74 (0.37) 3.95 .047 2.10 1.01 to 4.37

Exercisea 0.90 (0.36) 6.45 .011 2.46 1.23 to 4.94

Kcala 0.26 (0.37) 0.48 .488 1.30 0.62 to 2.69

Gender 0.04 (0.11) 0.10 .749 1.04 0.84 to 1.28

DEBQ-R 0.24 (0.05) 19.19 <.001 1.266 1.14 to 1.41

BMI 0.01 (0.01) 1.87 .172 1.01 0.99 to 1.03

a in comparison to no label; df for Χ2 = 1

# Discussion

The present proof-of-concept study aimed to assess the influence of different types of label information (no information, energy (Kcal) information, physical activity information, or Kcal and physical activity information) on hypothetical snack and beverage choices (high Kcal vs. lower Kcal). The analysis indicated that providing any label increased the selection of low Kcal items over the higher Kcal alternatives, but that the physical activity label was most effective at increasing selection of low Kcal foods and beverages over their higher Kcal counterparts relative to the no label control. Interestingly, the physical activity label also resulted in significantly higher selection of the lower energy products than the Kcal label. This was evident across the entire participant sample, and was irrespective of individual factors such as gender, BMI, restraint, diet status, calorie literacy, numerical literacy, general physical activity levels and SES. To our knowledge, this is the first study to show such effects for physical activity labels and provides tentative evidence of a promising avenue for public health research and policy in this area.

A wealth of previous research indicates that providing nutritional information on menu items helps to encourage hypothetical selection of lower energy alternatives, (Avcibasioglu & al., 2011; Bassett, et al., 2008; Bollinger, et al., 2011; Brissette, et al., 2013; Downs, et al., 2009; Krieger, et al., 2013; Pulos & Leng, 2010; Roberto, et al., 2010; Wisdom, et al., 2010), but some studies have found that this information only influences choice in certain groups, (Girz, et al., 2012; Temple, et al., 2011) or, conversely, has no effect at all, (Downs, et al., 2013; Dumanovsky, et al., 2010; B. Elbel, et al., 2011; Brian Elbel, et al., 2009; Finkelstein, et al., 2011; Harnack, et al., 2008; Holmes, et al., 2013; Swartz, et al., 2011; Tandon, et al., 2011). It has been suggested that these inconsistent findings may be explained by consumer difficulty in interpreting abstract messages such as a ‘calorie’ as a unit of energy that translates to physical weight gain, (Dowray, et al., 2013). Instead, offering more concrete alternatives such as physical activity requirements may be a more efficacious means of presenting this information and encouraging lower Kcal food selections. The current data support this idea with more participants opting for the lower energy products over their higher energy alternatives. Recent research suggests that reducing additional Kcal intake by 100Kcal/day would address weight gain in 90% of the adult population ((Hill, Wyatt, & Peters, 2012). As the present research found a stronger effect with physical activity information alone, this suggests that combined information (Kcal and physical activity) may be a form of ‘information overload’. Indeed, previous research suggests that providing too much information can lead to poor nutritional choices due to individuals feeling confused (Cowburn & Stockley, 2005; FSA, 2016), and time constraints preventing individuals from attending to the additional information (Grunert et al., 2010). This leads to individuals instead opting for familiar choices due to habitual use of such items which therefore result in less cognitive demand (van Herpen & van Trijp, 2011). Indeed, nutritional information panels of habitually used items are most often neglected by individuals (FSA, 2016) possibly owing to learned responses of unhealthy, higher energy items as being rewarding, lending a positive valence to such items and encouraging further selection. Thus, a simpler approach may be more effective as was found here. The label manipulation successfully altered food and beverage choice, even though the items selected for the present experiment were chosen based on their high likelihood of being recognized by a UK participant pool.

Indeed, unlike previous research which focused on hypothetical menu choices, (Dowray, et al., 2013), the current study featured foods and beverages which are readily available in both café environments and supermarkets and are consumed frequently in the UK. The inclusion of beverages, which, to our knowledge, have never been researched in this way, were also important as the energy content of drinks are generally underestimated, (Chandon & Wansink, 2007) and poorly compensated for by the body (see (Malik, Schulze, & Hu, 2006) and (Rogers, et al., 2016) for a review). A further strength of the current study was the measurement of additional factors that may influence food choice behavior, such as calorie literacy. Of the literature that does include knowledge of nutritional information, much suggests that lower knowledge is related to poorer food choices, (Drichoutis AC, Lazaridis P, & RM, 2006 ; Kim, Nayga, & Capps, 2001; Satia, Galanko, & Neuhouser, 2005; Variyam, 2008). However, importantly, the data reported here indicate that the physical activity label was particularly efficacious in driving lower Kcal food and beverage selections across the entire sample, irrespective of calorie literacy or indeed any other factor (gender, BMI, restraint, diet status, numerical literacy, general physical activity levels and SES). Therefore, this has promise as a potential public health intervention with impact on those groups that most need support in making lower energy choices, and are typically hard to reach with other public health strategies, for example, those in low SES groups who often have lower nutritional knowledge and health literacy, (Cowburn & Stockley, 2005).

Despite these promising initial findings, there are a number of limitations to the present trial. Given the hypothetical nature of the product choice measure employed (consistent with much of the existing literature in this area), we cannot assume that the choice decisions made online would translate to real world choice and consumption. Indeed, some research suggests that intentions do not always translate to behaviours, (Ajzen, Brown, & Carvajal, 2004). In addition, our BMI calculations were based on self-reported weight and height which may reduce accuracy as individuals, particularly those who are overweight or obese, tend to underreport weight (Gorber, Tremblay, Moher, & Gorber, 2007). However, this underreporting tends to be minimal and data comparable to face-to-face assessment, (Lassale, et al., 2013; Pursey, Burrows, Stanwell, & Collins, 2014). We did not include a measure of liking or familiarity for the options presented, as much research suggests that liking of items does not always translate to wanting and vice versa (Berridge, 2009; Finlayson, King & Blundell, 2008), thus we reasoned that this may not influence selection of the choices presented. However, it may have been pertinent to include such measures in the present research as it is also possible that pre-existing preferences also influenced choices, not to mention habitual use and consumption as products known to a UK audience were used in the current experiment. Future studies should seek to incorporate these measures. It can nevertheless be argued that the effects of the labels were so robust here that we can be confident that these preferences did not drive the main findings reported.

## *Conclusions, implications and future directions*

It is clear that future research should seek to replicate these findings in a real-world food and beverage choice situation. However, as frequent snacking has increasingly become a normative eating behavior in most Western societies (Cooke & Papadaki, 2014), the present research provides promising initial evidence to support the use of physical activity labelling on pre-packaged foods as a public health policy to support lower energy food choice.

This is particularly pertinent as the effects seen here were consistent across the sample, irrespective of the individual characteristics of the participants. The explanation for these effects may simply be that activity equivalent information is meaningful, not abstract, and does not require future planning or memory of previously consumed meals i.e. cognitive demands are low. Indeed, much nutritional labelling requires a basic understanding of calorie and nutrition needs followed by incorporation of previously consumed foods and foods yet to be consumed to estimate energy needs or percentages of guideline daily amounts before the choice to eat the item is made. Much literature indicates memory for previously consumed meals is poor, (Davidson, Kanoski, Walls, & Jarrard, 2005; Higgs, 2005) and it is unlikely that such thought processes occur when consuming snacks, which are usually most commonly omitted when assessed in food diaries (Briefel, Sempos, McDowell, Chien, & Alaimo, 1997; C.D., 1996; Livingstone, et al., 1990). The use of physical activity labels may also have the additional benefit of encouraging greater physical activity (R. S. f. P. Health, 2015), by acting as a reminder to be active or by indicating to the consumer the extent of physical activity required to expend the caloric value of their preferred foods.

Further research is required to assess the effects of these labels in the context of choice followed by consumption of these items to understand if intentions transfer to behaviours. In particular, future research using ecologically valid settings (such as supermarkets) is needed. Additionally, exploring the influence of these messages over time would be vital to assess if these effects are sustained and whether physical activity is bolstered by such labels. It is also important to understand the role of habitual product use, preference and liking of these items and how they may be affected with such labels, if at all. Future research assessing the particular efficacy of the exercise label over the exercise and Kcal label is also warranted to understand whether participants are indeed experiencing an overload of information, and prefer the simpler information provided by concrete equivalents, as has been suggested by recent research (FSA, 2016).

Overall, participants provided with label information reduced higher energy food and beverage selection irrespective of individual characteristics. This effect was most predominantly seen when a simple physical label was presented, this was more effective at driving lower energy choices than a Kcal label, a Kcal and physical activity label or no label. Physical activity labelling should be considered as a public health policy initiative that, in the context of an obesity epidemic, could make it simpler for consumers to make lower energy, informed food choices.

# Declarations

## List of Abbreviations

Body mass index, BMI; Dutch Eating Behaviour Questionnaire – Restraint, DEBQ-R; front of pack, FoP; index of multiple deprivation, IMD; kilojoules, kJ; kilocalories, Kcal; socio-economic status (SES), visual analogue scales, VAS.

### Ethical Approval

Ethical approval was granted by the University of Liverpool Research Ethics Committee and conforms to the standards expressed in the Helsinki Declaration. All responsibility regarding the recruitment, running, management and financial arrangements was carried out by the authors.

### Data handling and quality assurance

All research undertaken complied with the Data Protection Act. Personal data was anonymised and stored securely on an encrypted platform. This was only accessible to the authors. All data was anonymised before analysis using separate codes. All information provided was treated as confidential. The University of Liverpool is the custodian of the data and will ensure compliance with the Data Protection Act. Data and all appropriate documentation will be stored for a minimum of 5 years.

### Availability of data and materials

Data are available upon request.

## Competing interests

UM and PC have received funding to their Institution from The American Beverage Association. EJB declares no conflicts of interest.

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## Author’s contributions

EJB and UM were responsible for the conception and design of the research. PC conducted the data analysis and drafted the Results section of the manuscript. UM drafted the manuscript. All authors edited and UM revised the manuscript. All authors approved the final version.

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Not applicable.

## Research Governance

### Transparency Statement

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

### Research dissemination

Data analysis was conducted according to an analysis plan and the results were only planned to be published in peer-reviewed scientific and open access journals and/or presented at scientific conferences. All data collection, analysis, interpretation and writing of the report was conducted by the authors.

# References

Ajzen, I., Brown, T. C., & Carvajal, F. (2004). Explaining the Discrepancy between Intentions and Actions: The Case of Hypothetical Bias in Contingent Valuation. *Personality and Social Psychology Bulletin, 30*, 1108-1121.

Avcibasioglu, P., & al., e. (2011). An exploratory investigation of college students' attitudes toward california's new menu-labeling law. *Journal of Applied Business Research, 27*, 7.

Bassett, M. T., Dumanovsky, T., Huang, C., Silver, L. D., Young, C., Nonas, C., Matte, T. D., Chideya, S., & Frieden, T. R. (2008). Purchasing Behavior and Calorie Information at Fast-Food Chains in New York City, 2007. *American Journal of Public Health, 98*, 1457-1459.

Bellisle, F., & Blundell, J. E. (2013). Satiation, satiety: concepts and organisation of behaviour. . In B. J. Bellisle F (Ed.), *Satiation, satiety and the control of food intake: theory and practice.* (pp. 3-11).

Berridge, K.C., (2009). ‘Liking’ and ‘wanting’ food rewards: Brain substrates and roles in eating disorders. *Physiology & Behavior, 97*(5), 537-550. doi: <http://dx.doi.org/10.1016/j.physbeh.2009.02.044>

Bleich, S. N., Herring, B. J., Flagg, D. D., & Gary-Webb, T. L. (2011). Reduction in Purchases of Sugar-Sweetened Beverages Among Low-Income Black Adolescents After Exposure to Caloric Information. *American Journal of Public Health, 102*, 329-335.

Bleich, S. N., & Pollack, K. M. (2010). The publics' understanding of daily caloric recommendations and their perceptions of calorie posting in chain restaurants. *BMC Public Health, 10*, 1-10.

Blumenthal, K., & Volpp, K. G. (2010). ENhancing the effectiveness of food labeling in restaurants. *JAMA, 303*, 553-554.

Bollinger, B., Phillip, L. a., & Sorensen, A. (2011). Calorie Posting in Chain Restaurants. *American Economic Journal: Economic Policy, 3*, 91-128.

Booth, K. M., Pinkston, M. M., & Poston, W. S. C. (2005). Obesity and the Built Environment. *Journal of the American Dietetic Association, 105*, 110-117.

Briefel, R. R., Sempos, C. T., McDowell, M. A., Chien, S., & Alaimo, K. (1997). Dietary methods research in the third National Health and Nutrition Examination Survey: underreporting of energy intake. *The American Journal of Clinical Nutrition, 65*, 1203S-1209S.

Brissette, I., Lowenfels, A., Noble, C., & Spicer, D. (2013). Predictors of Total Calories Purchased at Fast-food Restaurants: Restaurant Characteristics, Calorie Awareness, and Use of Calorie Information. *Journal of Nutrition Education and Behavior, 45*, 404-411.

Brownell , K. D., & Koplan , J. P. (2011). Front-of-Package Nutrition Labeling — An Abuse of Trust by the Food Industry? *New England Journal of Medicine, 364*, 2373-2375.

C.D., S. (1996). Differences in reported macronutrient composition of the diet in overweight and lean individuals are dependent on validity of reported energy intakes. . *Proceedings-Nutrition Society of London, 55*, 232A-232A.

Chandon, P., & Wansink, B. (2007). The Biasing Health Halos of Fast-Food Restaurant Health Claims: Lower Calorie Estimates and Higher Side-Dish Consumption Intentions. *Journal of Consumer Research, 34*, 301-314.

Cooke, R., & Papadaki, A. (2014). Nutrition label use mediates the positive relationship between nutrition knowledge and attitudes towards healthy eating with dietary quality among university students in the UK. *Appetite, 83*, 297-303.

Cowburn, G., & Stockley, L. (2005). Consumer understanding and use of nutrition labelling: A systematic review. *Public Health Nutrition, 8*, 21-28.

Davidson, T. L., Kanoski, S. E., Walls, E. K., & Jarrard, L. E. (2005). Memory inhibition and energy regulation. *Physiology & Behavior, 86*, 731-746.

Downs, J. S., Loewenstein, G. a., & Wisdom, J. (2009). Strategies for Promoting Healthier Food Choices. *American Economic Review,, 99*, 159-164.

Downs, J. S., Wisdom, J., Wansink, B., & Loewenstein, G. (2013). Supplementing Menu Labeling With Calorie Recommendations to Test for Facilitation Effects. *American Journal of Public Health, 103*, 1604-1609.

Dowray, S., Swartz, J. J., Braxton, D., & Viera, A. J. (2013). Potential effect of physical activity based menu labels on the calorie content of selected fast food meals. *Appetite, 62*, 173-181.

Drichoutis AC, Lazaridis P, & RM, N. J. (2006 ). Consumers' use of nutritional labels: a review of research studies and issues. *Academy of marketing science review, 1*.

Dumanovsky, T., Huang, C. Y., Bassett, M. T., & Silver, L. D. (2010). Consumer Awareness of Fast-Food Calorie Information in New York City After Implementation of a Menu Labeling Regulation. *American Journal of Public Health, 100*, 2520-2525.

Elbel, B., Gyamfi, J., & Kersh, R. (2011). Child and adolescent fast-food choice and the influence of calorie labeling: a natural experiment. *Int J Obes, 35*, 493-500.

Elbel, B., Kersh, R., Brescoll, V. L., & Dixon, L. B. (2009). Calorie Labeling And Food Choices: A First Look At The Effects On Low-Income People In New York City. *Health Affairs, 28*, w1110-w1121.

England, H. S. f. (2014). UK and Ireland prevalence and trends (Obesity). In P. H. England (Ed.).

Feunekes, G. I. J., Gortemaker, I. A., Willems, A. A., Lion, R., & van den Kommer, M. (2008). Front-of-pack nutrition labelling: Testing effectiveness of different nutrition labelling formats front-of-pack in four European countries. *Appetite, 50*, 57-70.

Finlayson, G., King, N., & Blundell, J. (2008). The role of implicit wanting in relation to explicit liking and wanting for food: Implications for appetite control. *Appetite, 50*(1), 120-127. doi: <http://dx.doi.org/10.1016/j.appet.2007.06.007>

Finkelstein, E. A., Strombotne, K. L., Chan, N. L., & Krieger, J. (2011). Mandatory Menu Labeling in One Fast-Food Chain in King County, Washington. *American Journal of Preventive Medicine, 40*, 122-127.

Fitch, R. C., Harnack, L. J., Neumark-Sztainer, D. R., Story, M. T., French, S. A., Oakes, J. M., & Rydell, S. A. (2009). Providing Calorie Information on Fast-Food Restaurant Menu Boards: Consumer Views. *American Journal of Health Promotion, 24*, 129-132.

Foods Standards Agency; (FSA). (2016). Understanding NI Consumer Needs Around Food Labelling. TNS BMRB Research.

Girz, L., Polivy, J., Herman, C. P., & Lee, H. (2012). The effects of calorie information on food selection and intake. *Int J Obes, 36*, 1340-1345.

Gorber, S. C., Tremblay, M., Moher, D., & Gorber, B. (2007). A comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review. *Obesity Reviews, 8*, 307-326.

Government, D. f. C. a. L. (2011). The English Indices of Deprivation 2010. In D. f. C. a. L. Government. (Ed.).

Grunert, K. G., & Wills, J. M. (2007). A review of European research on consumer response to nutrition information on food labels. *Journal of Public Health, 15*, 385-399.

Grunert, K. G., Wills, J. M., & Fernández-Celemín, L. (2010). Nutrition knowledge, and use and understanding of nutrition information on food labels among consumers in the UK. *Appetite, 55*, 177-189.

Guthrie, J. F., Fox, J. J., Cleveland, L. E., & Welsh, S. (1995). Who uses nutrition labeling, and what effects does label use have on diet quality? *Journal of Nutrition Education, 27*, 163-172.

Hamlin, R. P., McNeill, L. S., & Moore, V. (2015). The impact of front-of-pack nutrition labels on consumer product evaluation and choice: an experimental study. *Public Health Nutrition, 18*, 2126-2134.

Harnack, L. J., French, S. A., Oakes, J. M., Story, M. T., Jeffery, R. W., & Rydell, S. A. (2008). Effects of calorie labeling and value size pricing on fast food meal choices: Results from an experimental trial. *International Journal of Behavioral Nutrition and Physical Activity, 5*, 1-13.

Health, D. o. (2013a). Public Health Responsibility Deal: F1. Out of Home Energy (kJ/Kcal) Labelling. In D. o. Health (Ed.).

Health, D. o. (2013b). Public Responsibility Deal F7(a). Front of Pack Nutrition Labelling. In D. o. Health (Ed.).

Health, R. S. f. P. (2015).

van Herpen, E., & van Trijp, H.C.M. (2011). Front-of-pack nutrition labels. Their effect on attention and choices when consumers have varying goals and time constraints. *Appetite*, 57(1), 148-160. doi: http://dx.doi.org/10.1016/j.appet.2011.04.011

Higgs, S. (2005). Memory and its role in appetite regulation. *Physiology & Behavior, 85*, 67-72.

Hill, J. O., Wyatt, H. R., & Peters, J. C. (2012). Energy Balance and Obesity. *Circulation, 126*, 126-132.

Holmes, A. S., Serrano, E. L., Machin, J. E., Duetsch, T., & Davis, G. C. (2013). Effect of different children’s menu labeling designs on family purchases. *Appetite, 62*, 198-202.

Kim, S.-Y., Nayga, R. M., & Capps, O. (2001). Food Label Use, Self-Selectivity, and Diet Quality. *Journal of Consumer Affairs, 35*, 346-363.

Krieger, J. W., Chan, N. L., Saelens, B. E., Ta, M. L., Solet, D., & Fleming, D. W. (2013). Menu Labeling Regulations and Calories Purchased at Chain Restaurants. *American Journal of Preventive Medicine, 44*, 595-604.

Lassale, C., Péneau, S., Touvier, M., Julia, C., Galan, P., Hercberg, S., & Kesse-Guyot, E. (2013). Validity of Web-Based Self-Reported Weight and Height: Results of the Nutrinet-Santé Study. *J Med Internet Res, 15*, e152.

Li, F., Miniard, P. W., & Barone, M. J. The facilitating influence of consumer knowledge on the effectiveness of daily value reference information. *Journal of the Academy of Marketing Science, 28*, 425-436.

Livingstone, M. B., Prentice, A. M., Strain, J. J., Coward, W. A., Black, A. E., Barker, M. E., McKenna, P. G., & Whitehead, R. G. (1990). Accuracy of weighed dietary records in studies of diet and health. *BMJ, 300*, 708-712.

Magnusson, R. (2010). Obesity prevention and personal responsibility: the case of front-of-pack food labelling in Australia. *BMC Public Health, 10*, 662.

Malik, V. S., Schulze, M. B., & Hu, F. B. (2006). Intake of sugar-sweetened beverages and weight gain: a systematic review. *The American Journal of Clinical Nutrition, 84*, 274-288.

Marti, A., Moreno-Aliaga, M. J., Hebebrand, J., & Martinez, J. A. (0000). Genes, lifestyles and obesity. *Int J Obes Relat Metab Disord, 28*, S29-S36.

Ministers, U. H. (2013). Guide to creating a front of pack (FoP) nutrition label for pre-packed products sold through retail outlets. In W. a. S. D. o. H. English (Ed.).

Misra, R. (2007). Knowledge, Attitudes, and Label Use among College Students. *Journal of the American Dietetic Association, 107*, 2130-2134.

Pulos, E., & Leng, K. (2010). Evaluation of a Voluntary Menu-Labeling Program in Full-Service Restaurants. *American Journal of Public Health, 100*, 1035-1039.

Pursey, K., Burrows, T. L., Stanwell, P., & Collins, C. E. (2014). How Accurate is Web-Based Self-Reported Height, Weight, and Body Mass Index in Young Adults? *J Med Internet Res, 16*, e4.

Rasberry, C. N., Chaney, B. H., Housman, J. M., Misra, R., & Miller, P. J. (2007). Determinants of Nutrition Label Use Among College Students. *American Journal of Health Education, 38*, 76-82.

Roberto, C. A., Larsen, P. D., Agnew, H., Baik, J., & Brownell, K. D. (2010). Evaluating the Impact of Menu Labeling on Food Choices and Intake. *American Journal of Public Health, 100*, 312-318.

Rogers, P. J., Hogenkamp, P. S., de Graaf, C., Higgs, S., Lluch, A., Ness, A. R., Penfold, C., Perry, R., Putz, P., Yeomans, M. R., & Mela, D. J. (2016). Does low-energy sweetener consumption affect energy intake and body weight[quest] A systematic review, including meta-analyses, of the evidence from human and animal studies. *Int J Obes, 40*, 381-394.

Royal Society for Public Health: Vision, V. a. P. (2016). Introducing “activity equivalent” calorie labelling to tackle obesity. In R. S. f. P. Health (Ed.).

Satia, J. A., Galanko, J. A., & Neuhouser, M. L. (2005). Food nutrition label use is associated with demographic, behavioral, and psychosocial factors and dietary intake among African Americans in North Carolina. *Journal of the American Dietetic Association, 105*, 392-402.

Schwartz, L. M., Woloshin, S., Black, W. C., & Welch, H. G. (1997). The Role of Numeracy in Understanding the Benefit of Screening Mammography. *Annals of Internal Medicine, 127*, 966-972.

Storcksdieck genannt Bonsmann, S., Celemin, L. F., Larranaga, A., Egger, S., Wills, J. M., Hodgkins, C., & Raats, M. M. (2010). Penetration of nutrition information on food labels across the EU-27 plus Turkey. *Eur J Clin Nutr, 64*, 1379-1385.

Swartz, J. J., Braxton, D., & Viera, A. J. (2011). Calorie menu labeling on quick-service restaurant menus: an updated systematic review of the literature. *International Journal of Behavioral Nutrition and Physical Activity, 8*, 1-8.

Tandon, P. S., Zhou, C., Chan, N. L., Lozano, P., Couch, S. C., Glanz, K., Krieger, J., & Saelens, B. E. (2011). The Impact of Menu Labeling on Fast-Food Purchases for Children and Parents. *American Journal of Preventive Medicine, 41*, 434-438.

Temple, J. L., Johnson, K. M., Archer, K., LaCarte, A., Yi, C., & Epstein, L. H. (2011). Influence of simplified nutrition labeling and taxation on laboratory energy intake in adults. *Appetite, 57*, 184-192.

Urbszat, D., Herman, C. P., & Polivy, J. (2002). Eat, drink, and be merry, for tomorrow we diet: Effects of anticipated deprivation on food intake in restrained and unrestrained eaters. *Journal of Abnormal Psychology, 111*, 396-401.

van Strien, T., Frijters, J. E. R., Bergers, G. P. A., & Defares, P. B. (1986). The Dutch Eating Behavior Questionnaire (DEBQ) for assessment of restrained, emotional, and external eating behavior. *International Journal of Eating Disorders, 5*, 295-315.

Variyam, J. N. (2008). Do nutrition labels improve dietary outcomes? *Health Economics, 17*, 695-708.

Vohs, K. D., & Heatherton, T. F. (2000). Self-Regulatory Failure: A Resource-Depletion Approach. *Psychological Science, 11*, 249-254.

Wisdom, J., Downs, J. S. a., & Loewenstein, G. (2010). Promoting healthy choices: Information versus convenience. *American Economic Journal: Applied Economics*, 164-178.