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Food and the consumer: could labelling be the answer?

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Extensive research into the impact of nutrition labelling across Europe has shown that many consumers can effectively use a nutrition label to rank a food for healthiness. The present paper considers observational and laboratory evidence which has examined the impact of nutrition labelling (on food packaging and at point of purchase) on dietary behaviour. In addition, the potential counterproductive effects of foods bearing ‘healthy’ nutrition labels are examined. The observational evidence provides a useful insight into the key characteristics of nutrition label use. Those most likely to engage with nutrition labels are more likely to have a diet related disease and/or be on a weight loss diet and have a good overall diet quality. Experimental evidence, while limited, suggests that serving size information may be overlooked by consumers. In fact, there may be a tendency among consumers to overeat foods that are perceived to be healthier. The findings from the present paper suggest that if nutrition labelling is to be considered a strategy to facilitate consumers in managing their energy intake, it must coincide with salient, consistent and simple serving size information on the front of food packages and at the point of purchase. There is a clear need for more experimental research using robust methodologies, to examine the impact of nutrition information on dietary intake. In the meantime, there should be greater attention given to portion size within national dietary guidance.

Nutrition labelling: Food choice: Obesity: Consumer: Portion size

The provision of clear nutrition information for consumers is a population-based public health strategy aimed at facilitating a healthy diet. The increasing prevalence of overweight and obesity in the UK and beyond has renewed government attention on the format and regulation of nutrition labelling. Consequently, there is presently a global move towards mandatory nutrition labelling on pre-packaged food products, along with improvements to existing policy on nutrition labelling. For example, the US Food and Drug Association are presently reviewing the existing format of the Nutrition Facts Panel, mandated on packaged foods under the Nutrition Labelling and Education Act since 1994⁽¹⁾. A stronger focus on energy and inclusion of serving size information more reflective of normal consumption is presently being considered⁽²⁾. In the European Union (EU), nutrition labelling was harmonised under the Nutrition Labelling Directive in 1990⁽³⁾, but to date has not been compulsory, unless a nutrition claim is

made; albeit, 85 % of food products sold in the EU presently carry back of pack nutrition information⁽⁴⁾. The 1990 directive will be repealed from December 2016 (or since December 2014 for foods already bearing nutrition information) by Regulation (EU) 1169/2011 on the provision of food information to consumers⁽⁵⁾. The new regulation stipulates the nutrients and order in which these should be presented on the back of the pack. Energy (both in kJ and kcal) must be provided along with the amounts of fat, saturates, carbohydrates, sugars, protein and salt. Nutrition information must be given per 100 g/ml and can additionally be given per portion or per consumption unit and as percentage of reference intakes (RI; formerly known as Guideline Daily Amounts). Information on other nutrients (e.g. vitamins and minerals) must also be declared if present in significant amounts. Additional forms of expression and presentation of the nutrition declaration, such as colours, graphical forms or symbols are permitted on a voluntary

Abbreviations: CL, calorie labelling; EI, energy intake; EU, European Union; FoP, front of the pack; RI, reference intakes.

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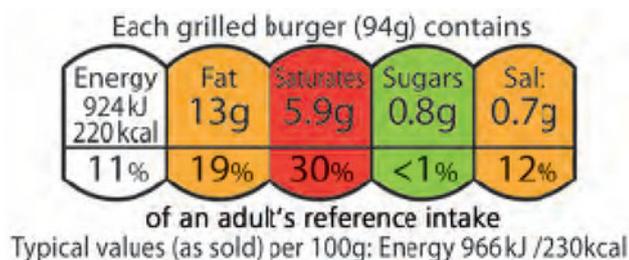


Fig. 1. (colour online) The UK's front of pack label launched in June 2013^(6,7). This label combines an acceptable portion size indication; the amount of each nutrient and energy value (kJ and kcal) present in a portion of the product; percentage of reference intake information; and red, amber and green colour coding.

basis on the front of the pack (FoP) under certain conditions.

An audit of 37 000 foods in five product categories across the EU found that approximately 48 % of products carry a FoP label⁽⁴⁾. Many variations of formats exist across countries, including colour-coded labels (e.g. traffic lights), health logos based on specific nutritional criteria (e.g. the keyhole scheme implemented in Nordic countries) and simple, non-colour coded displays of the key nutrients with RI. Following a widespread national consultation which included food industry and health organisations^(6,7), the UK became the first EU member state to launch a consistent FoP labelling scheme in June 2013. The UK label is a hybrid scheme which combines traffic light colour coding (red, amber and green) with nutrient amounts (fat, saturated fat, salt, sugar and energy) as well as %RI (Fig. 1). Notably, concern has been expressed within the EU regarding the potential effects of the hybrid label on the free movement of goods. As a result, the European Commission are presently examining the compatibility of the label with the EU law. Nevertheless, under the UK Department of Health's public health responsibility deal relating to nutrition labelling, twenty-three organisations, including all the major supermarkets, have now pledged to incorporate the hybrid label on their food packaging⁽⁸⁾. Given that own brand products now account for 54 % of UK supermarket sales⁽⁹⁾, the support for this label from the major supermarkets is imperative. Furthermore, these supermarkets are among seventeen companies who have also signed up to the associated pledge to promote awareness of the label to UK consumers via in store information and promotion, website information and magazine articles⁽¹⁰⁾. Nutrition labelling is also increasingly moving beyond packaged goods. The disclosure of energy content on restaurant menus (calorie labelling (CL)), mandatory in the USA since 2010⁽¹¹⁾, is a further policy lever to provide consumers with an informed food choice when eating out of the home. In the UK and Ireland, promising pilot work in this area has been conducted and there is strong support for CL by UK and Irish food businesses as well a high demand from consumers^(12,13). For example, presently, forty-five chain companies in the UK (representing approximately 70 % of national high street food outlets, including fast

food restaurants, takeaways, sandwich and coffee shops and all the major supermarkets) have pledged to incorporate energy values onto their menus in many outlets under the related responsibility deal⁽¹²⁾.

Nutrition labels are viewed by consumers as a highly credible source of information and there is strong observational evidence for a positive relationship between their use and diet quality⁽¹⁴⁾. However, experimental evidence into the impact of nutrition label use and subsequent food intake is limited, with some studies proving evidence of a counterproductive effect of foods perceived to be healthier^(15,16). The present paper considers observational and laboratory evidence on the impact of nutrition labelling on consumer food choice and on dietary behaviour. In addition, evidence regarding the potential impact of CL will be considered.

Observational data

Observational data, mostly from the USA, have identified several characteristics associated with nutrition label use including that it increases with age, is higher in women and normal weight individuals and increases with education^(17–22). Extensive research into the impact of food labelling across the EU has shown that many consumers can effectively use a nutrition label to rank a food for healthiness^(19,23). In addition, consistency and simplicity have modest but meaningful effects on facilitating consumer attention to the label, for example the addition of a FoP label or health logo^(24–27). Consumers rate their use of nutrition labels as high; across the EU for example, up to 60 % of consumers indicate regular use of nutrient information on a food label. However, information such as price and use by date is more commonly referred to (approximately 90 % in both cases)⁽²⁸⁾. A study based on in-store observations involving over 2000 consumers in three major UK retailers, found that 27 % of UK shoppers 'always' looked specifically at the nutrition information on the label, with RI and the back of pack nutrition label the main sources consulted⁽¹⁹⁾.

Evidence suggests that consumer use of nutrition labels is largely driven by consumer belief in the importance of a healthy diet^(20,29,30) as well as motivation⁽³¹⁾. Those consumers who frequently consult nutrition information are observed to have higher dietary intakes of fibre and iron compared with those who rarely or never use the information⁽³²⁾. In addition, estimated energy intake (EI) among those reporting use of serving size information is on average 627 kJ (150 kcal) less per day than non-users⁽³³⁾. Those who report trying to lose weight compared with those who do not are shown to be three times more likely to read nutrition labels⁽³⁴⁾. Similarly, high nutrition label use is shown to be positively related to a lower fat intake, higher fruit and vegetable intake, higher nutritional knowledge and greater tendency to read serving size information^(21,34). Nutrition labels may be particularly effective for consumers who are actively seeking information on particular nutrients due to personal relevance^(18,20,35). For example, individuals with type 2 diabetes, hypertension, hyperlipidaemia or any combination of these three diseases were found to

read food labels significantly more than individuals with no such concern (71 v. 60 %) (18). Furthermore, in the latter study, the odds of reading food labels when advised by a health professional to reduce EI or weight, was 50 % higher than in those without health professional intervention. Of note, the nutrients of most relevance to these individuals were those related to their disease; namely fat in the case of hyperlipidaemia and salt in the case of hypertension. A strong association between nutrition label use and perceptions of the benefits of a low-fat diet among 1450 US adults has been reported (20). Those who stated that consumption of a low-fat diet was very important to their health were almost ten times more likely to read the nutrition label compared with those who rated a low-fat diet as unimportant. Similarly, in a representative sample of US adults (n 4024), individuals with high intakes of fat, saturated fat or cholesterol were found to be less likely to search for such information on a food label than those with low intakes of these nutrients (29). In the latter study, the lower the nutrition label use, the less importance was placed on the nutrition information provided and the poorer the individual's diet. The cumulative evidence from these studies provides a useful insight into the potential link between dietary behaviour and label use. Moreover, the data provide useful information on the key characteristics of nutrition label use.

Experimental evidence

In contrast to the observational data, the direct impact of nutrition labelling on food intake under controlled conditions has not been extensively examined. Studies have mainly focused on consumption of a single food product (36,37) or single meal occasion (38) or have been conducted within a restaurant setting to test the effects of CL (39). The impact of nutrition labelling in combination with education on subsequent EI at lunch has been explored (40). Participants (n 47; age 18–50 years) were exposed to one of two video groups (a nutrition labelling educational video or a non-nutrition labelling related video) after which they were offered a buffet style lunch under one of two labelling conditions (nutrition labels with standard US Department of Agriculture nutrition facts panel or no nutrition labels). Although no effect of the video information on food choice was found, participants who were exposed to nutrition information about the buffet food items consumed significantly less energy at the lunch than those for which food items were not labelled. Notably, exposure to nutrition labelling increased selection of less energy dense products by the women only. In contrast, a further study found no differences in EI according to exposure to energy density information among 40 normal-weight women (age 18–45 years) (41). The women consumed breakfast, lunch and dinner in a laboratory on three separate days during which the energy density of the entree dish at each meal was either high, medium or low (5.23, 6.28 or 7.32 kJ/g, respectively). Subjects were assigned to either the information group (in which they received information on the energy density of the entree dish with each meal), or to the no-information

group (in which they did not receive any nutrition information). No differences between information groups in food intake across the three levels of energy density were observed. Nevertheless, consumption of the low-energy dense dishes in general resulted in a significantly reduced EI compared with consumption of the high-energy dense dishes. Similarly, fat and EI following consumption of fat-free 'potato chips' v. regular 'potato chips' with and without nutrition information has been examined (42). For the no-information condition, both types of product were presented in bags simply labelled 'potato chips'. In the information condition, the bags containing the healthier and regular products were labelled as 'fat-free potato chips' or 'potato chips', respectively, and both had a corresponding US Nutrition Facts Panel. No differences in energy or fat intake were observed according to information condition. However, overall fat intake was found to be significantly reduced following consumption of the low-fat product. In addition, this resulted in a significantly reduced fat intake over 24 h compared with consumption of the regular product. Such data provide evidence for the benefits of reduced fat/energy products in improving dietary quality.

Further experimental data suggest that serving size information may be overlooked by consumers. For example, in a sample of US adults (n 216; age 18–72 years), portion size self-served and consumed of a breakfast cereal was examined according to three conditions of a FoP logo (consisting of a green tick and including energy per serving and per pack) (37). Consumer knowledge and perceptions relating to various aspects including energy and perceived healthiness were also examined. Participants were randomly assigned to one of three study conditions: no label (control condition); label with servings per pack and energy (Kcal) per serving (condition two) and label with servings per pack, suggested energy per serving and suggested serving size (condition three). The study found that almost twice as many participants were able to accurately identify the amount of kcal per serving in the two label conditions relative to the control condition, supporting evidence regarding the ability of consumers to competently interpret simple portion size information from a food label (28). Given the addition of serving size information on the third label condition, the authors predicted that participants in that group would consume the least amount of cereal, i.e. in line with the suggested serving size information provided. However, while NS, there was a trend towards greater portion size consumption in condition three compared with the control condition and condition two (232.6 g v. 219.2 g and 219.9 g, respectively) suggesting that participants in condition three ignored the serving size information provided. Moreover, cereal consumed overall equated to almost twice the recommended serving size.

Nutrition labelling: counterproductive effects?

Food portion sizes, particularly of high-energy dense foods, have increased significantly over time, particularly in the USA (43), with similar trends observed across Europe (44). A wider range of portion sizes are now available and this has added to confusion amongst consumers



about what constitutes an appropriate food portion size⁽⁴⁵⁾. Furthermore, consumers tend to increase their food and EI when presented with large food portions^(46–48). However, just 30 % of European consumers indicate that they seek out serving size recommendations provided on food packaging, in contrast to a much greater proportion who seek out ingredients and nutrient values as referred to earlier (60 % in both cases⁽²⁸⁾). These issues are further exacerbated by the fact that foods labelled as ‘healthy’ seem to elicit a significant underestimation of energy content, resulting in inappropriate portion size perceptions^(15,49), an effect shown to be driven by dietary restraint⁽⁵⁰⁾. The proposed explanation is that perceived healthiness is associated with expectations about energy content, such that foods perceived as ‘healthy’ induce less consumption guilt, thus providing a license to overeat, commonly termed as the ‘health halo’ effect⁽¹⁶⁾. This hypothesis has been tested under both natural and laboratory conditions, using typically consumed foods equal in energy density but differing in perceived healthiness such as M&M v. granola⁽¹⁶⁾ and low fat v. standard coleslaw⁽¹⁵⁾. For example, it has been shown that when iso-energy dense foods were labelled as regular v. low fat, EI increased in the low fat condition during a single consumption occasion by up to 50 %⁽¹⁶⁾. Importantly, these patterns are strongly affected by weight status, with overweight individuals particularly receptive to such cognitive cues. In support of this a further study has shown that when participants (n 47; age 18–65 years) were exposed to three iso-energy dense meals (chicken curry) labelled as low fat/low energy, high fat/high energy or standard, the participants associated less guilt with consumption of the low-fat/low-energy meal, and consumed 28 g more of this meal compared with the standard labelled meal, resulting in an additional 3 % (162 kJ) EI. Notably this result was driven by the overweight subjects. In addition, participants reported a significantly higher rating of taste for both the standard and the high fat/high energy labelled meal compared with the low fat/low energy labelled meal⁽³⁸⁾. In contrast, further research showed that the use of a nutrition logo did not result in increased consumption and had no effect on the rating of taste of a sweet pastry product among a similar sample of females⁽³⁶⁾ suggesting that different food types may elicit different responses.

Under the EU Food Information for Consumers regulation (EU 1169/2011), back of pack nutrition information must be displayed per 100 g/ml, while per serving amounts may be provided as a voluntary addition⁽⁵⁾. In an online survey involving over 13 000 adults across six EU countries (Germany, UK, Spain, France, Poland and Sweden), the addition of nutrient information per portion on a range of typically consumed food products greatly increased the accuracy with which participants were able to determine an appropriate portion size compared with when the information was only provided per 100 g⁽²⁸⁾. Furthermore, within the same sample, it was found that portion size information had a significant impact on participants perceptions of the healthiness of the product⁽⁵¹⁾. For example, participants were asked to rate the healthiness of three pairs of typically consumed foods (biscuits,

sandwiches and yoghurts) based on nutrient values presented for three different portion size information conditions (per 100 g, per typical portion or per half typical portion). The impact of Guideline Daily Amounts information was also tested. In line with previous research, participants were able to distinguish between more and less healthy products using the nutrition information provided. However, in the case of biscuits, when the nutrient composition was displayed per 100 g (providing 223 kJ/535 kcal), consumers rated the product as significantly less healthy than when it was displayed per typical portion (18 g; providing 402 kJ/96 kcal) or half typical portion (9 g; providing 201 kJ/48 kcal). For sandwiches on the other hand, participants rated the product with the 100 g label only (providing 669 kJ/160 kcal) as significantly more healthy than when provided with information per typical portion (250 g; providing 1674 kJ/400 kcal) or half typical portion (125 g; providing 834 kJ/200 kcal). These data provide evidence for the importance of nutrition information to be displayed per portion as well as the mandated per 100 g/ml. Thus the standardisation of serving size information on a food label, presently not mandated in the EU, is an important consideration.

Menu labelling

Since the implementation of mandatory CL in the USA⁽¹¹⁾ numerous observational and experimental studies have been conducted in various settings to assess its impact on food choice and EI, many of which have shown positive effects^(39,52–54). However, a recent extensive review of the related literature reported no clear patterns due to a lack of comparability across studies. Thus the effectiveness of CL as a weight management strategy is inconclusive⁽⁵⁵⁾. Nevertheless, the data to date provide a useful insight into the main predictors of CL use which, in common to food packaging nutrition label use, include sex (higher in females^(52,56)), being on a weight loss diet⁽⁵⁷⁾ and having a high level of nutrition knowledge⁽⁵⁸⁾. Moreover, the data have provided evidence that consumer awareness of CL has increased over time. For example self-reported awareness among US consumers of the presence of energy on menus increased significantly from 25 % 3 months pre-regulation in 2008, to 64 % 3 months post-regulation⁽⁵⁹⁾. Furthermore, cross-sectional surveys carried out 1 year before and 18 months after the 2008 regulation observed a small but significant reduction in energy intakes in some fast food establishments surveyed⁽⁶⁰⁾. While increased awareness of nutrition labelling does not necessarily result in greater application⁽²⁴⁾, the increase over time is encouraging, and with continued promotion and food business support, a consistent positive impact of CL may begin to emerge. Indeed, provision of nutrition information within a worksite cafeteria, in combination with education and increased exposure to low-energy dense food products, resulted in an improved dietary intake in overweight and obese adults over a 3-month period⁽⁶¹⁾. Such data show promise for a positive impact of the sustained provision of nutrition information at the point of purchase. Moreover, the latter study shows that a combination of familiarity with surroundings, exposure to healthier food

products and raised awareness via education may be key drivers in its impact.

Conclusion

There is consistent observational evidence to suggest that nutrition information displayed on food packaging may facilitate healthier food choices. Experimental evidence, while limited, suggests that serving size information may be overlooked by consumers, and that there may be a tendency to overeat foods that are perceived to be healthier. Given that provision of per serving nutrient values remains unstandardised in the EU, the renowned widespread consumer misinterpretation of appropriate portion size could continue. If nutrition labelling is to be considered an effective weight management strategy, it must coincide with salient, consistent serving size information. There is a need for more experimental research in this area using robust methodologies, to examine the direct impact of nutrition and serving size information on dietary intake over time. In the meantime, there should be greater focus on serving size recommendations within national dietary guidance.

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Conflicts of Interest

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Authorship

M. A. K. reviewed the literature and wrote the manuscript. M. M. C. and M. B. E. L. provided guidance and commented on drafts of the review.

References

1. Nutrition Labeling and Education Act (1994) United States Food and Drug Administration. Available at <http://www.fda.gov/iceci/inspections/inspectionguides/ucm074948.htm> (accessed 16 December 2014).
2. Food and Drug Administration. Department of Health and Human Services (2014) Food Labeling: Revision of the Nutrition and Supplement Facts Labels; Proposed Rule. Section 79. Available at <https://www.federalregister.gov/articles/2014/03/03/2014-04387/food-labeling-revision-of-the-nutrition-and-supplement-facts-labels> (accessed 16 December 2014).
3. Regulation (EU) No 90/496/EEC. Council directive of 24 September 1990 on Nutrition Labelling for Foodstuffs. Available at <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:31990L0496> (accessed 2 April 2015).
4. Bonsmann SSG, Celemin LF, Larranaga A *et al.* (2010) Penetration of nutrition information on food labels across the EU-27 plus Turkey. *Eur J Clin Nutr* **64**, 1379–1385.
5. Regulation (EU) No 1169/2011 of the European Parliament and of the Council of 25 October 2011 on the Provision of Food Information to Consumers. Available at <http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:304:0018:0063:EN:PDF> (accessed 2 April 2015).
6. Department of Health (2013) Front of pack Nutrition Labelling: Joint Response to Consultation. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/216997/response-nutrition-labelling-consultation.pdf (accessed 10 December 2014).
7. Department of Health (2013) Guide to Creating a Front of Pack (FoP) Nutrition Label for Pre-packed Products Sold through Retail Outlets. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/300886/2902158_FoP_Nutrition_2014.pdf (accessed 19 December 2014).
8. Department of Health (2014) Public Health Responsibility Deal. F7 (a): Front of Pack Nutrition Labelling. UK. Available at <https://responsibilitydeal.dh.gov.uk/pledges/pledge/?pl=44> (accessed 11 December 2014).
9. Nielsen UK. UK Shoppers Turn to Premium Supermarket Own Brands. Available at <http://www.nielseninsights.eu/articles/uk-shoppers-turn-to-supermarkets-premium-own-brands> (accessed 11 December 2014).
10. Department of Health (2014) Public Health Responsibility Deal. F7 (b): Front of Pack Nutrition Labelling. Available at <https://responsibilitydeal.dh.gov.uk/pledges/pledge/?pl=45> (accessed 11 December 2014).
11. Patient Protection and Affordable Care Act (2010) Nutrition Labelling of Standard Menu Items at Chain. Public Law; Section 4205 (111–148). Available at <http://cspinet.org/new/pdf/nationalmllaw.pdf> (accessed 16 December 2014).
12. Department of Health (2014) Public Health Responsibility Deal. F1: Out of home calorie labelling. Available at <https://responsibilitydeal.dh.gov.uk/pledges/pledge/?pl=8> (accessed 12 December 2014).
13. Food Safety Authority of Ireland (2012) Calories on Menus in Ireland. Report on a national consultation. Available at https://www.fsai.ie/news_centre/press_releases/calories_on_menus_report/04072012.html (accessed 17 December 2014).
14. Campos S, Doxey J & Hammond D (2011) Nutrition labels on pre-packaged foods: a systematic review. *Public Health Nutr* **14**, 1496–1506.
15. Faulkner GP, Pourshahidi LK, Wallace JMW *et al.* (2014) Perceived ‘healthiness’ of foods can influence consumers’ estimations of energy density and appropriate portion size. *Int J Obes* **38**, 106–112.
16. Wansink B & Chandon P (2006) Can “Low-Fat” nutrition labels lead to obesity? *J Mark Res* **43**, 605–617.
17. Cowburn G & Stockley L (2005) Consumer understanding and use of nutrition labelling: a systematic review. *Public Health Nutr* **8**, 21–28.
18. Post RE, Mainous AG, Diaz VA *et al.* (2010) Use of the nutrition facts label in chronic disease management: results from the national health and nutrition examination survey. *J Am Diet Assoc* **110**, 628–632.
19. Grunert KG, Wills JM & Fernandez-Celemin L (2010) Nutrition knowledge, and use and understanding of nutrition information on food labels among consumers in the UK. *Appetite* **55**, 177–189.
20. Neuhouser ML, Kristal AR & Patterson RE (1999) Use of food nutrition labels is associated with lower fat intake. *J Am Diet Assoc* **99**, 45–50, 53.



21. Graham DJ & Laska MN (2012) Nutrition label use partially mediates the relationship between attitude toward healthy eating and overall dietary quality among college students. *J Acad Nutr Diet* **112**, 414–418.
22. Stran KA & Knol LL (2013) Determinants of food label use differ by sex. *J Acad Nutr Diet* **113**, 673–679.
23. Bonsmann SSG, Celemin LF, Grunert KG *et al.* (2010) Food labelling to advance better education for life. *Eur J Clin Nutr* **64**, S14–S19.
24. Grunert KG & Wills JM (2007) A review of European research on consumer response to nutrition information on food labels. *J Public Health* **15**, 385–399.
25. Hersey JC, Wohlgenant KC, Arsenaault JE *et al.* (2013) Effects of front-of-package and shelf nutrition labeling systems on consumers. *Nutr Rev* **71**, 1–14.
26. Food Standards Agency (2009) Comprehension and Use of UK Nutrition Signpost Labelling Schemes. Available at <http://webarchive.nationalarchives.gov.uk/20131104005023/http://www.food.gov.uk/multimedia/pdfs/pmreport.pdf> (accessed 17 December 2014).
27. Mejean C, Macouillard P, Peneau S *et al.* (2014) Association of perception of front-of-pack labels with dietary, lifestyle and health characteristics. *PLoS ONE* **9**, e90971.
28. European Food Information Council (2011) Consumer Response to Portion Information on Food and Drink Packaging – A Pan-European Study. Available at <http://www.eufic.org/article/en/page/FARCHIVE/expid/forum5-Consumer-response-portion-information-food-drink-packaging/> (accessed 16 December 2014).
29. Lin CTJ, Lee JY & Yen ST (2004) Do dietary intakes affect search for nutrient information on food labels? *Soc Sci Med* **59**, 1955–1967.
30. Roberto CA, Bragg MA, Seamans MJ *et al.* (2012) Evaluation of consumer understanding of different front-of-package nutrition labels, 2010–2011. *Prev Chronic Dis* **9**, 120015.
31. Bonsmann SSG & Wills JM (2012) Nutrition labeling to prevent obesity: reviewing the evidence from Europe. *Curr Obes Rep* **1**, 134–140.
32. Variyam JN (2008) Do nutrition labels improve dietary outcomes? *Health Econ* **17**, 695–708.
33. Ollberding NJ, Wolf RL & Contento I (2010) Food label use and its relation to dietary intake among US adults. *J Am Diet Assoc* **110**, 1233–1237.
34. Satia JA, Galanko JA & Neuhauser ML (2005) Food nutrition label use is associated with demographic, behavioral, and psychosocial factors and dietary intake among African Americans in North Carolina. *J Am Diet Assoc* **105**, 392–402.
35. Kang HT, Shim JY, Lee YJ *et al.* (2013) Reading nutrition labels is associated with a lower risk of metabolic syndrome in Korean adults: the 2007–2008 Korean NHANES. *Nutr Metab Cardiovasc Dis* **23**, 876–882.
36. Steenhuis IHM, Kroeze W, Vyth EL *et al.* (2010) The effects of using a nutrition logo on consumption and product evaluation of a sweet pastry. *Appetite* **55**, 707–709.
37. Roberto CA, Shivaram M, Martinez O *et al.* (2012) The smart choices front-of-package nutrition label. Influence on perceptions and intake of cereal. *Appetite* **58**, 651–657.
38. McCann MT, Wallace JMW, Robson PJ *et al.* (2013) Influence of nutrition labelling on food portion size consumption. *Appetite* **65**, 153–158.
39. Roberto CA, Larsen PD, Agnew H *et al.* (2010) Evaluating the impact of menu labeling on food choices and intake. *Am J Public Health* **100**, 312–318.
40. Temple JL, Johnson K, Recupero K *et al.* (2010) Nutrition labels decrease energy intake in adults consuming lunch in the laboratory. *J Am Diet Assoc* **110**, 1094–1097.
41. Kral TVE, Roe LS & Rolls BJ (2002) Does nutrition information about the energy density of meals affect food intake in normal-weight women? *Appetite* **39**, 137–145.
42. Miller DL, Castellanos VH, Shide DJ *et al.* (1998) Effect of fat-free potato chips with and without nutrition labels on fat and energy intakes. *Am J Clin Nutr* **68**, 282–290.
43. Young LR & Nestle M (2002) The contribution of expanding portion sizes to the US obesity epidemic. *Am J Public Health* **92**, 246–249.
44. Steenhuis IHM, Leeuwis FH & Vermeer WM (2010) Small, medium, large or supersize: trends in food portion sizes in The Netherlands. *Public Health Nutr* **13**, 852–857.
45. Faulkner GP, Pourshahidi LK, Wallace JMW *et al.* (2012) Serving size guidance for consumers: is it effective? *Proc Nutr Soc* **71**, 610–621.
46. Levitsky DA & Youn T (2004) The more food young adults are served, the more they overeat. *J Nutr* **134**, 2546–2549.
47. Rolls BJ, Roe LS & Meengs JS (2007) The effect of large portion sizes on energy intake is sustained for 11 days. *Obesity* **15**, 1535–1543.
48. Kelly MT, Wallace JMW, Robson PJ *et al.* (2009) Increased portion size leads to a sustained increase in energy intake over 4 d in normal-weight and overweight men and women. *Br J Nutr* **102**, 470–477.
49. Carels RA, Konrad K & Harper J (2007) Individual differences in food perceptions and calorie estimation: an examination of dieting status, weight, and gender. *Appetite* **49**, 450–458.
50. Lemmens SG, Born JM, Rutters F *et al.* (2010) Dietary restraint and control over “wanting” following consumption of “forbidden” food. *Obesity* **18**, 1926–1931.
51. Raats MM, Hieke S, Jola C *et al.* (2014) Reference amounts utilised in front of package nutrition labelling: impact on product healthfulness evaluations. *Eur J Clin Nutr*. Epublication ahead of print version.
52. Gerend MA (2009) Does calorie information promote lower calorie fast food choices among college students? *J Adolesc Health* **44**, 84–86.
53. Morley B, Scully M, Martin J *et al.* (2013) What types of nutrition menu labelling lead consumers to select less energy-dense fast food? An experimental study. *Appetite* **67**, 8–15.
54. Ellison B, Lusk JL & Davis D (2014) The impact of restaurant calorie labels on food choice; results from a field experiment. *Econ Inq* **52**, 666–681.
55. Kiszko KM, Martinez OD, Abrams C *et al.* (2014) The influence of calorie labeling on food orders and consumption: a review of the literature. *J Commun Health* **39**, 1248–1269.
56. Krieger JW, Chan NL, Saelens BE *et al.* (2013) Menu labeling regulations and calories purchased at chain restaurants. *Am J Prev Med* **44**, 595–604.
57. Girz L, Polivy J, Herman CP *et al.* (2012) The effects of calorie information on food selection and intake. *Int J Obes* **36**, 1340–1345.
58. Auchincloss AH, Young C, Davis AL *et al.* (2013) Barriers and facilitators of consumer use of nutrition labels at sit-down restaurant chains. *Public Health Nutr* **16**, 2138–2145.
59. Dumanovsky T, Huang CY, Bassett MT *et al.* (2010) Consumer awareness of fast-food calorie information in New York City after implementation of a menu labeling regulation. *Am J Public Health* **100**, 2520–2525.
60. Dumanovsky T, Huang CY, Nonas CA *et al.* (2011) Changes in energy content of lunchtime purchases from fast food restaurants after introduction of calorie labelling: cross sectional customer surveys. *Br Med J* **343**, d4464.
61. Lowe MR, Tappe KA, Butryn ML *et al.* (2010) An intervention study targeting energy and nutrient intake in work-site cafeterias. *Eat Behav* **11**, 144–151.