Public Health Nutrition: 21(15), 2776–2781 doi:10.1017/S1368980018001702

Short Communication

Can front-of-pack labels influence portion size judgements for unhealthy foods?

Zenobia Talati[1,*], Simone Pettigrew[1], Bridget Kelly[2], Kylie Ball[3], Bruce Neal[4,5], Helen Dixon[6], Trevor Shilton[7] and Caroline Miller[8,9]

[1]School of Psychology, Curtin University, Kent Street, Bentley, WA 6102, Australia: [2]Early Start, School of Health and Society, University of Wollongong, Wollongong, New South Wales, Australia: [3]Institute for Physical Activity and Nutrition, School of Exercise and Nutrition Sciences, Deakin University, Geelong, Victoria, Australia: [4]The George Institute for Global Health, UNSW Sydney, Sydney, New South Wales, Australia: [5]Imperial College London, London, UK: [6]Centre for Behavioural Research in Cancer, Cancer Council Victoria, Melbourne, Victoria, Australia: [7]National Heart Foundation, Perth, Western Australia, Australia: [8]Population Health Research Group, South Australian Health and Medical Research Institute, Adelaide, South Australia, Australia: [9]University of Adelaide, School of Public Health, Adelaide, South Australia, Australia

Submitted 13 December 2017: Final revision received 24 May 2018: Accepted 25 May 2018: First published online 18 July 2018

Abstract

Objective: By clearly conveying the healthiness of a food, front-of-pack (FOP) labels have the potential to influence the portion size considered appropriate for consumption. The present study examined the how the Daily Intake Guide (DIG), Multiple Traffic Lights (MTL) and Health Star Rating (HSR) FOP labels affect judgements of appropriate portion sizes of unhealthy foods compared with when no FOP label is present.

Design: Respondents viewed mock packages of unhealthy variations of pizzas, cookies, yoghurts and cornflakes featuring the DIG, MTL, HSR or no FOP label, and indicated the portion size they believed should be eaten of each food on a single occasion.

Setting: The survey was completed on the respondent's personal computer.

Subjects: A total of 1505 Australian adults provided 4166 ratings across 192 mock packages relating to four product categories: pizza, yoghurt, cornflakes and cookies.

Results: Compared with no FOP label, the HSR resulted in a small but significant reduction in the portion size selected as appropriate for consumption of pizzas and cornflakes ($P < 0{\cdot}05$). The MTL resulted in smaller portions of cornflakes being selected compared with no FOP label ($P < 0{\cdot}05$).

Conclusions: Respondents perceived smaller portion sizes as appropriate for some, but not all, of the foods tested when FOP labels with more interpretative formats (HSR, MTL) appeared on-pack compared with no FOP label. No effect was found for the less interpretive FOP label (the DIG). Interpretive FOP labels may have the potential to influence portion size judgements, albeit at modest levels.

Keywords
Food label
Portion size
Daily intake
Traffic light
Health star

Substantial increases globally over the last 40 years in the proportion of people who are overweight or obese have been partially attributed to larger portions of food being more readily available and more widely consumed[1–3]. Reducing portion sizes, particularly for unhealthy foods, may thus be an effective way to decrease total energy intake at the population level[4,5]. However, little is known about how to achieve this, and much of the research on portion sizes has focused on energy intake when a person is served food by a third party[6–9]. The limited research on self-serve portions suggests people are poor at judging appropriate portion sizes[10] and tend to serve larger portions than would be consistent with dietary guidelines[1,2,11].

Awareness of the adverse nutritional profiles of foods may prompt consumption of smaller portions. This is

*Corresponding author: Email zenobia.talati@curtin.edu.au

particularly important for unhealthy foods because reducing portion size can have a large effect on overall energy intake[4,12]. Front-of-pack (FOP) labels that offer a simplified summary of a food's nutritional value are one way to provide this information. Consumers generally attend to FOP labels more than other sources of on-pack nutrition information[13] and FOP labels can increase the accuracy of product healthiness judgements[14].

FOP labels that provide nutrient-level information with little interpretation, such as the Daily Intake Guide (DIG), are reportedly difficult for consumers to interpret[15–17]. Providing an interpretation of nutrient information (e.g. by using colours and/or text to indicate high, medium and low levels of nutrients, as seen in the Multiple Traffic Lights (MTL) system) increases understanding[18,19], but can still require consumers to integrate multiple points of information[17]. Some FOP labels provide an interpretation of the overall nutritional value of a food via a graded summary system. For example, the Australian and New Zealand Health Star Rating (HSR), introduced in 2014, rates products on a scale from 0·5 to 5 stars and details the amounts of key nutrients per 100 g. FOP labels such as this may be easy for a wide range of consumers to understand since they offer information at a glance[14,17].

A recent review reported mixed findings from a number of studies examining whether the MTL, Guideline Daily Amount or labels containing only serving size information reduced, increased or did not affect consumption[20]. Another recent study of young adults tested the effect of two label types (an energy-only label and the HSR) and found no significant differences in participants' food selection behaviours[21]. More studies testing a wider range of FOP labels in more diverse samples are needed to assess whether FOP labels can influence portion sizes, particularly for unhealthy variants of commonly consumed foods. As such, the aim of the present study was to assess how FOP labels that differ according to interpretive content affect the portion size that is deemed appropriate for consumption of unhealthy foods. Previous research with Australian consumers has found that the HSR and the MTL are easier to understand than the DIG[17,22]. It was hypothesised that, compared with no FOP label, smaller portions would be considered appropriate when more interpretive FOP labels (HSR and MTL) were applied to unhealthy foods while a less interpretive FOP label (the DIG) would not result in smaller portion sizes being considered appropriate.

Methods

The data analysed herein were collected as part of a larger study (*n* 2058) assessing adults' and children's perceptions of packaged foods. Various food packaging attributes for four product categories (pizza, yoghurt, cornflakes and cookies) were manipulated and fully crossed (to ensure no association between any of the independent variables[23]) and each participant was randomly presented with eight unique mock packages (from a suite of 576 that included healthy and unhealthy variants) to view and rate individually. The present paper reports on data relating to adults' portion size judgements for the 192 unhealthy mock packages tested as part of the larger study. The focus on unhealthy products reflects the particular importance of portion size decisions for these types of products[4,12]. Ethics clearance was obtained from a university human research ethics committee.

Sample

An online survey was completed by Australian respondents recruited through an ISO-accredited web panel provider (PureProfile). Recruitment quotas were set relating to age, gender and postcode-based categories of socio-economic status, with respondents further screened to ensure they regularly consumed at least two of the four foods shown in the survey. The present paper reports findings for the 1505 adults who provided portion size estimates for unhealthy mock packages in the main study. These respondents had an equal gender split, a skew towards those from neighbourhoods of low socio-economic status (48 %) to reflect the higher level of diet-related conditions among this group[24,25] and 16–17 % of the sample in each of the following age categories: 18–25 years, 26–35 years, 36–45 years, 46–55 years, 56–65 years, ≥66 years. Across all participants, the 192 mock packages showing unhealthy varieties of foods were rated a total of 4166 times.

Stimuli

The mock packages were created by a graphic designer to feature the DIG, the MTL, the HSR or no FOP label. The specific product categories were chosen because they tend to be frequently purchased[26], exhibit large differences in healthiness[27] and consumers often attend to the nutrition information on these foods[13]. The nutritional profiles for the products were based on unhealthy versions available in the Australian marketplace. Figure 1 shows the FOP labels used on the mock packages and their nutrient profiles. The serving sizes listed in the DIG and MTL (the HSR does not specify serving size) were the same across these FOP labels within food type and were based on serving sizes commonly used by manufacturers of these foods.

Procedure

The survey began with demographic questions to assess respondents' eligibility to participate based on the quotas. Respondents indicated the frequency with which they bought and consumed each food. They then rated the mock packages on various dimensions and could view the Nutrition Information Panel by clicking a link below

https://doi.org/10.1017/S1368980018001702 Published online by Cambridge University Press

		Food type			
		Cookies	Cornflakes	Pizza	Yoghurt
Label condition	No label				
	Daily Intake Guide				
	Multiple Traffic Lights				
	Health Star Rating				
Nutrient profile (100 g)	Energy (kJ)	2010	1630	1147	536
	Fat, total (g)	20·0	<0·1	18.0	6·9
	Fat, saturated (g)	10·3	0·1	10·2	4·0
	Sugars (g)	36·7	24·0	6·5	10·0
	Sodium (mg)	265	725	850	46

Fig. 1 (colour online) Front-of-pack (FOP) labels used on each food type, by label condition, in an online survey conducted among 1505 Australian adults to determine if FOP labels influence portion size judgements for unhealthy foods; data collected February–April 2016

the pack image. Immediately after viewing each package, respondents were shown a new screen with images of different portion sizes of the product sourced from an online image database[28] and asked 'If you were going to eat this product, how much should you eat at one time?'. Text appeared below each image describing the portion size in grams accompanied by a graphic illustrating an intuitive measurement. For pizzas and cookies, eight options (depicting 1–8 slices of pizza and 1–8 cookies) were shown and scored from 1 to 8. For yoghurts and cornflakes, four options (depicting 100 g, 200 g, 300 g and 400 g servings and 15 g, 30 g, 45 g and 60 g servings, respectively) were shown and scored from 1 to 4. Fewer options were provided for yoghurt and cornflakes because they are amorphous foods[29] with no defined shape or standard unit of measurement, and thus it is difficult to pictorially convey small graduations in portion size. In all instances, respondents could select a 'no amount' option of the serving size images if they thought the food should not be eaten at all.

Analyses

To ensure the results were relevant to those who would consume the product, data from respondents who indicated in the pre-screening that they never ate a particular food were excluded from analyses (7 % of all observations). Two-tailed χ^2 analyses were run comparing the frequency of 'no amount' responses in each FOP label condition with the no FOP label condition. The data set was then split according to food type and responses where a serving size greater than 'no amount' were chosen were analysed using linear mixed-effects models with FOP label condition as the fixed effect, respondent ID as the random effect, and age, gender, socio-economic status and BMI as covariates. These demographic variables were included as covariates (as per previous research)[30–34] to better understand the effects of FOP labels after demographics were taken into account. This was followed with planned comparisons of the DIG, MTL and HSR conditions with the no FOP label condition.

Results

There was a significantly smaller proportion of respondents indicating that no amount of the product should be eaten in the no FOP label condition (9 %) compared with the DIG (12 %, $P=0{\cdot}04$), MTL (13 %, $P=0{\cdot}033$) and HSR (15 %, $P=0{\cdot}001$). Figure 2 presents the mean portion sizes perceived to be appropriate for each food type depending on the FOP label used. A small but significant main effect of FOP label on portion size was found for pizzas ($F_{(3193{\cdot}9)}=2{\cdot}80$, $P=0{\cdot}041$) and cornflakes ($F_{(3336{\cdot}6)}=3{\cdot}80$, $P=0{\cdot}010$). Significantly smaller portion sizes were selected when the HSR was present compared with no FOP label on pizzas ($\text{mean}_{\text{NoFOPlabel}}=2{\cdot}64$ slices, $\text{SE}_{\text{NoFOPlabel}}=0{\cdot}09$ *v.* $\text{mean}_{\text{HSR}}=2{\cdot}44$ slices, $\text{SE}_{\text{HSR}}=0{\cdot}09$ slices, $P=0{\cdot}013$) and cornflakes ($\text{mean}_{\text{NoFOPlabel}}=198$ g, $\text{SE}_{\text{NoFOPlabel}}=5$ g *v.* $\text{mean}_{\text{HSR}}=180$ g, $\text{SE}_{\text{HSR}}=5$ g, $P=0{\cdot}001$). The MTL only led to smaller portion sizes being selected for pizzas ($\text{mean}_{\text{NoFOPlabel}}=2{\cdot}64$ slices, $\text{SE}_{\text{NoFOPlabel}}=0{\cdot}09$ slices *v.* $\text{mean}_{\text{MTL}}=2{\cdot}36$ slices, $\text{SE}_{\text{MTL}}=0{\cdot}10$ slices, $P=0{\cdot}043$) compared with no FOP label. Given that a 1-point difference in portion size on the scale was represented by 1 slice of pizza (645 kJ) and 15 g of cornflakes (244 kJ), the average differences reported above are equivalent to a decrease of 44–129 kJ per serving with the HSR (for cornflakes and pizzas respectively) and 181 kJ with the MTL (for pizzas). Across all foods, the portion sizes selected with a DIG

https://doi.org/10.1017/S1368980018001702 Published online by Cambridge University Press

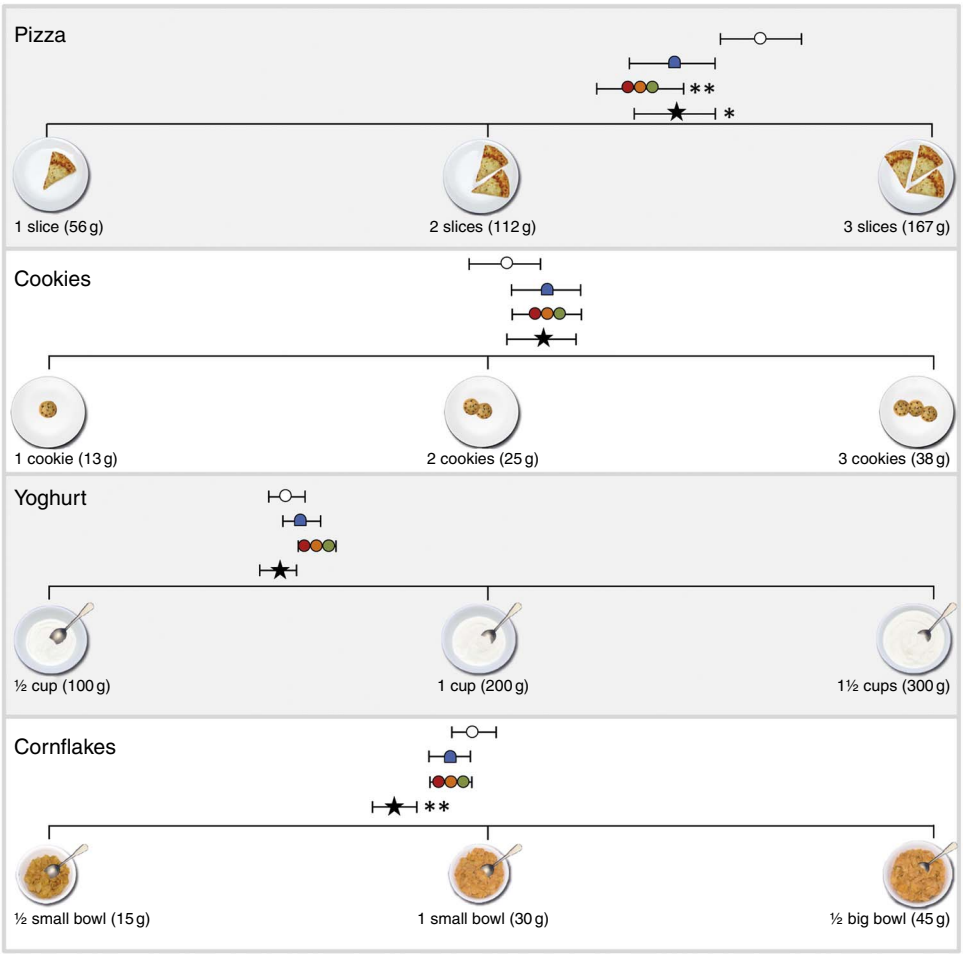

Fig. 2 Mean portion size perceived as appropriate for each individual food type, by front-of-pack (FOP) label condition (○, no FOP label; ∩, Daily Intake Guide; ●●●, Multiple Traffic Lights; ★, Health Star Rating), in the online survey conducted among 1505 Australian adults to determine if FOP labels influence portion size judgements for unhealthy foods; data collected February–April 2016. Values are means with their standard errors represented by horizontal bars (4166 ratings across 192 mock packages). Note: the pizza and cookies data were scored on an 8-point scale while the yoghurt and cornflakes data were scored on a 4-point scale. Significant differences with respect to the no FOP label condition: $^{*}P < 0{\cdot}05$ and $^{**}P < 0{\cdot}01$

present were not significantly different from those selected when no FOP label was present. No significant differences were found between the no FOP label and FOP label conditions for cookies or yoghurt.

Discussion

Across all FOP label conditions tested in the present study, significantly more respondents indicated that they should consume no amount of the unhealthy products compared with the no FOP label condition. This suggests that consumers were more aware that the foods were unhealthy when the FOP labels were shown. Among those who did express a desire to consume some amount of the product, self-reported appropriate portion size estimates varied for some products (cornflakes and pizzas) across different FOP label conditions. Respondents may have attended more to the nutrition information when selecting the appropriate portion size for these foods. This outcome is consistent with past research showing that people are less likely to consult FOP labels on yoghurt and confectionery than ready meals and breakfast cereals[13] and can be reluctant to use FOP labels on discretionary products[17].

Although respondents were more likely to report that they should eat no amount of unhealthy food across all FOP labels, this effect was stronger among the interpretive FOP labels (the HSR and MTL) and only these FOP labels resulted in smaller portion sizes being selected for some foods compared with the no FOP label condition. Difficulty interpreting the nutrient-level information in the DIG[14,15,17,35] may have hindered some respondents when estimating how much less of the product they should consume. The smaller portion sizes selected for pizzas and cornflakes when the HSR was present support the idea that an easy-to-understand summary of nutrition information is a more effective prompt than less

https://doi.org/10.1017/S1368980018001702 Published online by Cambridge University Press

interpretive nutrition information in guiding consumers to lower their perceptions of how much of an unhealthy product they should consume. While the differences were small (i.e. 44–181 kJ), when aggregated across many eating situations and many consumers they may constitute meaningful differences at the population level.

The amount of food considered appropriate to eat will be determined to a large extent by individual-level factors such as age, gender and general appetite. These demographic factors were accounted for as covariates in the model. One limitation of the present study was the focus on self-reported estimates of appropriate portion sizes of foods rather than measuring actual selected portion sizes. Real-life consumption behaviours are complex and can also be influenced by factors such as package size, health claims, perceived healthiness and the type of food being consumed[36–39]. Nevertheless, these findings offer a foundation on which future research can build to better assess the effects of FOP labels on consumption patterns.

Conclusion

To conclude, the results of the present study suggest that more interpretive FOP labels may have the potential to favourably influence portion size judgements for unhealthy foods, albeit at modest levels. Efforts to encourage individuals to reduce their servings of unhealthy foods may usefully instruct consumers to use FOP labels as a guide when estimating appropriate portion sizes, as well as utilising other forms of nutrition education to optimise outcomes.

Acknowledgements

Financial support: This work was funded by an ARC Linkage grant (LP130100428) with additional cash and in-kind support provided by the following partner organizations: the South Australian Health and Medical Research Institute, the National Heart Foundation, Cancer Council New South Wales and Cancer Council Victoria. The funders had no role in the design, analysis or writing of this article. *Conflict of interest:* None. *Authorship:* S.P., B.K., K.B., B.N., H.D., T.S. and C.M. designed the study. Z.T. and S.P. ran the study. Z.T. analysed the data. Z.T. and S.P. prepared the manuscript and all authors reviewed the manuscript. *Ethics of human subject participation:* This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Curtin University Ethics Committee. Written informed consent was obtained from all subjects.

References

1. Nielsen S & Popkin B (2003) Patterns and trends in food portion sizes, 1977–1998. *JAMA* **289**, 450–453.
2. Smiciklas-Wright H, Mitchell DC, Mickle SJ *et al.* (2003) Foods commonly eaten in the United States, 1989–1991 and 1994–1996: are portion sizes changing? *J Am Diet Assoc* **103**, 41–47.
3. Young LR & Nestle M (2003) Expanding portion sizes in the US marketplace: implications for nutrition counseling. *J Am Diet Assoc* **103**, 231–240.
4. Ledikwe JH, Ello-Martin JA & Rolls BJ (2005) Portion sizes and the obesity epidemic. *J Nutr* **135**, 905–909.
5. Steenhuis IH & Vermeer WM (2009) Portion size: review and framework for interventions. *Int J Behav Nutr Phys Act* **6**, 58.
6. Rolls BJ, Roe LS, Kral TVE *et al.* (2004) Increasing the portion size of a packaged snack increases energy intake in men and women. *Appetite* **42**, 63–69.
7. Rolls BJ, Roe LS & Meengs JS (2007) The effect of large portion sizes on energy intake is sustained for 11 days. *Obesity (Silver Spring)* **15**, 1535–1543.
8. Rolls BJ, Roe LS & Meengs JS (2006) Reductions in portion size and energy density of foods are additive and lead to sustained decreases in energy intake. *Am J Clin Nutr* **83**, 11–17.
9. Devitt AA & Mattes RD (2004) Effects of food unit size and energy density on intake in humans. *Appetite* **42**, 213–220.
10. Young LR & Nestle M (1998) Variation in perceptions of a 'medium' food portion: implications for dietary guidance. *J Acad Nutr Diet* **98**, 458–459.
11. Bryant R & Dundes L (2005) Portion distortion: a study of college students. *J Consum Aff* **39**, 399–408.
12. Livingstone MBE & Pourshahidi LK (2014) Portion size and obesity. *Adv Nutr* **5**, 829–834.
13. Grunert KG, Wills JM & 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.
14. Hersey JC, Wohlgenant KC, Arsenault JE *et al.* (2013) Effects of front-of-package and shelf nutrition labeling systems on consumers. *Nutr Rev* **71**, 1–14.
15. Watson WL, Kelly B, Hector D *et al.* (2014) Can front-of-pack labelling schemes guide healthier food choices? Australian shoppers' responses to seven labelling formats. *Appetite* **72**, 90–97.
16. Emrich TE, Mendoza JE & L'Abbé MR (2012) Effectiveness of front-of-pack nutrition symbols: a pilot study with consumers. *Can J Diet Pract Res* **73**, 200–203.
17. Talati Z, Pettigrew S, Kelly B *et al.* (2016) Consumers' responses to front-of-pack labels that vary by interpretive content. *Appetite* **101**, 205–213.
18. Antúnez L, Giménez A, Maiche A *et al.* (2015) Influence of interpretation aids on attentional capture, visual processing, and understanding of front-of-package nutrition labels. *J Nutr Educ Behav* **47**, 292–299.e1.
19. Roberto CA, Bragg MA, Schwartz MB *et al.* (2012) Facts up front versus traffic light food labels: a randomized controlled trial. *Am J Prev Med* **43**, 134–141.
20. Brown HM, Rollo ME, Vlieger D *et al.* (2018) Influence of the nutrition and health information presented on food labels on portion size consumed: a systematic review. *Nutr Rev.* Published online: 14 May 2018. doi: 10.1093/nutrit/nuy019.
21. Brown HM, Vlieger N, de, Collins C *et al.* (2017) The influence of front-of-pack nutrition information on consumers' portion size perceptions. *Health Promot J Aust* **28**, 144–147.
22. Talati Z, Pettigrew S, Ball K *et al.* (2017) The relative ability of different front-of-pack labels to assist consumers discriminate between healthy, moderately healthy, and unhealthy foods. *Food Qual Prefer* **59**, 109–113.

23. Talati Z, Pettigrew S, Dixon H *et al.* (2017) Protocol for a randomized trial assessing consumer evaluations of prepackaged foods that systematically vary by nutrition information and product attributes. *BMC Nutr* **3**, 3.
24. Australian Bureau of Statistics (2011) *Census of Population and Housing: Socio-Economic Indexes for Areas (SEIFA), Australia*: Canberra: ABS.
25. Giskes K, Avendano M, Brug J *et al.* (2010) A systematic review of studies on socioeconomic inequalities in dietary intakes associated with weight gain and overweight/obesity conducted among European adults. *Obes Rev* **11**, 413–429.
26. Penton Media, Inc. (2015) Data table: supermarket categories by dollar, unit sales. *Supermarket News*, 28 July 2015. http://www.supermarketnews.com/center-store/2015-data-table-supermarket-categories-dollar-unit-sales (accessed June 2018).
27. The George Institute (2016) FoodSwitch. http://www.foodswitch.com.au/ (accessed March 2016).
28. Blechert J, Meule A, Busch NA *et al.* (2014) Food-pics: an image database for experimental research on eating and appetite. *Eat Behav* **5**, 617–626.
29. Subar AF, Crafts J, Zimmerman TP *et al.* (2010) Assessment of the accuracy of portion size reports using computer-based food photographs aids in the development of an automated self-administered 24-hour recall. *J Am Diet Assoc* **110**, 55–64.
30. Hoefkens C & Verbeke W (2013) Consumers' health-related motive orientations and reactions to claims about dietary calcium. *Nutrients* **5**, 82–96.
31. Verbeke W, Scholderer J & Lähteenmäki L (2009) Consumer appeal of nutrition and health claims in three existing product concepts. *Appetite* **52**, 684–692.
32. Wansink B & Chandon P (2006) Can 'low-fat' nutrition labels lead to obesity? *J Mark Res* **43**, 605–617.
33. Wong CL, Arcand J, Mendoza J *et al.* (2013) Consumer attitudes and understanding of low-sodium claims on food: an analysis of healthy and hypertensive individuals. *Am J Clin Nutr* **97**, 1288–1298.
34. Wong CL, Mendoza J, Henson SJ *et al.* (2014) Consumer attitudes and understanding of cholesterol-lowering claims on food: randomize mock-package experiments with plant sterol and oat fibre claims. *Eur J Clin Nutr* **68**, 946–952.
35. Pettigrew S, Talati Z, Miller C *et al.* (2017) The types and aspects of front-of-pack food labelling schemes preferred by adults and children. *Appetite* **109**, 115–123.
36. Ordabayeva N & Chandon P (2016) In the eye of the beholder: visual biases in package and portion size perceptions. *Appetite* **103**, 450–457.
37. Faulkner GP, Pourshahidi LK, Wallace JMW *et al.* (2012) Serving size guidance for consumers: is it effective? *Proc Nutr Soc* **71**, 610–621.
38. 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 (Lond)* **38**, 106–112.
39. Wansink B (2004) Environmental factors that increase the food intake and consumption volume of unknowing consumers. *Annu Rev Nutr* **24**, 455–479.