Queensland Government

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Standards Management Officer
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Dear Sir / Madam

Submission – Consultation paper – Labelling Review Recommendation 17: Per serving declarations in the nutrition information panel

Thank you for the opportunity to provide a submission on the call for submissions regarding Labelling Review Recommendation 17: Per serving declarations in the nutrition information panel.

This submission provides technical advice and comments related to this issue. The submission does not represent a Queensland Government position, which will be a matter for the Queensland Government should notification be made by the FSANZ Board to the Australia New Zealand Ministerial Forum on Food Regulation.

Responses to the nine questions for submitters are provided below.

Question 1: How does your organisation use per serving information in the nutrition information panel (NIP) on food labels?

- The Queensland Government has healthy food and drink supply strategies for schools, sporting clubs and healthcare facilities. Each of these strategies has criteria to distinguish between 'amber' and 'red' food and drinks. Products are classified on the energy, saturated fat, sodium and/or fibre per serving. End-users of these strategies (e.g. canteen convenors and volunteers, foodservice staff) use the 'per serving' information in the NIP to assess whether a product can be supplied in schools, sporting clubs and healthcare facilities.

- NIPs are essential education tools in assisting consumers to make healthier choices and providing information to consumers with medical conditions, e.g. blood pressure. Nutrition education resources used in Queensland typically include information on reading food labels and refer to the 'per serving' information.

- The resources to support the Australian Dietary Guidelines include information on reading labels. Although it is recommended to use the 'per 100g' information to choose products with less fat, sugar and salt, for fibre it is recommended to choose products with more than 3g per serve. This information is reproduced in a number of Queensland Government resources and is used by clinical dietitians and other health professionals when educating clients.

Question 2: Are there any particular food categories or types of food packages (e.g. single serve packages) for which per serving information is particularly useful? If so, what are they? Explain why the information is useful.

- As indicated for Question 1, to classify whether products are eligible to be supplied in schools, sporting clubs and healthcare facilities, the 'per serving' information in the NIP is used. This is specific to the following food and drink categories:
  - Sugar-sweetened drinks
  - Sugar-sweetened ices (e.g. slushies, ice blocks and ice confections)
  - Snack food bars and savoury snacks
  - Sweet and savoury biscuits
  - Ice-creams and dairy desserts
  - Cakes, muffins, slices, and other sweet pastries
  - Commercial, frozen or freshly prepared ready to eat meals, mixed hot food or plated dinners.

  Without the 'per serving' information, canteen convenors, volunteers, and foodservice staff would not be able to properly assess whether products in the above categories are appropriate.

- For single serve packages (particularly snack foods and drinks) and for foods that have a well-defined unit of consumption (e.g. serving of 2 slices of bread), the 'per serving' information is particularly useful. The 'per serving' information means that:
  - it is easy for consumers to monitor the amount of energy, fat, or other nutrients they are consuming;
  - consumers are aware of the number of serves in the package and can check whether their portion size matches the manufacturer's serving size, which helps determine whether they are over-consuming; and
  - there is no need for potentially difficult calculations using the 'per 100g' information.

Question 3: The Labelling Review recommendation suggests that the per serving information be voluntary unless a daily intake claim is made. Do you support this approach? Give reasons.

- Concern is raised supporting such an approach. More than 35% of Queensland adults always or almost always use nutrition information panels, with 20% of Queensland adults always or almost always using the 'per serving' information when shopping.[1]

- As a significant number of food manufacturers include a daily intake claim on their products, it is unclear which products and how many products would not include the 'per serving' information in this scenario.

- If food manufacturers remove the daily intake claim at a later date and the 'per serving' information is voluntary, changes to the NIP may occur increasing the variability of NIP formats and leading to consumer confusion.

[1] Queensland Health. (2011) *Self-reported health status 2011: fruit and vegetable consumption and factors associated with intentions to increase consumption, Queensland*. Queensland Health: Brisbane.

- The lack of standardised serving sizes in Australia (which is outside the scope of this consultation paper), creates further confusion, for example:
  - unrepresentative serving sizes that do not align with the Australian Dietary Guidelines;
  - variability of serving size within product categories (e.g. breakfast cereals – Uncle Toby's Plus™ is 40g serving size and Vita Brits™ is 33.3g, Sanitarium Weetbix™ is 30g, Kellogg's Cornflakes™ is 30g and Just Right™ is 45g); and
  - variability within different size packaging of the same product (e.g. Maltesers™ in 40g pack the serving size is 40g, while for 65g, 100g, 155g, 360g and 520g pack sizes, the serving size is 25g).

- Given the variability in serving sizes, from a product comparison perspective the 'per serving' information is less relevant, as the 'per 100g / 100mL' information enables consumers to make meaningful comparisons between products. However, this is not the best solution to address the problem of inconsistent serving sizes that are often very different to the recommended serving sizes in the Australian Dietary Guidelines. Other strategies need to be considered to address this issue.

Question 4: As noted in Section 4, there is currently variation in the format of NIPs on food labels because of voluntary permissions for the use of %DI labelling and the option to include a third column for foods intended to be prepared or consumed with at least one other food. If per serving information in the NIP was voluntary this would result in more variability in the format of NIPs across the food supply. Do you think this would be a problem? Why/why not?

- Greater variability in NIP formats would be a concern for consumers and enforcement agencies. Research has indicated that choosing the healthier product or correctly identifying the amount of energy is more difficult when using different NIP formats.[2]

Question 5: If per serving information in the NIP was voluntary, do you think the inclusion of per serving information in the NIP should be mandatory when a nutrient content claim about vitamins, minerals, protein, omega-3 fatty acids or dietary fibre is made? Give reasons.

- It would be necessary to mandate the 'per serving' information in the NIP in this scenario. Nutrient content claims (specifically good / excellent source statements) for dietary fibre, omega-3 fatty acids, protein, vitamins and minerals are allowed in Standard 1.2.7 on the condition that they meet a certain quantity per serving. To enable consumers to verify the claim and to avoid potentially difficult calculations to determine intake of these nutrients using the 'per 100g' information, it is important that this information appears in the NIP.

Question 6: If per serving information in the NIP was voluntary, do you think the inclusion of per serving information in the NIP should be mandatory in any other specific regulatory situations? Explain your answer.

- As for the nutrient content claims situation in Question 5, the 'per serving' information in the NIP should be mandated in the following situations as the information is necessary to verify the following claims:
  - for high level health claims about beta-glucan, calcium, folic acid, and phytosterols / phytostanols which are allowed on the condition that the product meets a certain quantity per serving (Standard 1.2.7);

[2] Lando AM and Lo SC. (2013) Single-larger-portion-size and dual-column nutrition labelling may help consumers make more healthful food choices. *Journal of the Academy of Nutrition and Dietetics*, 113(2): 241-250.

- for general level health claims about folic acid, beta-glucan, EPA, DHA, energy, phytosterols / phytostanols, and potassium which are allowed on the condition that the product meets a certain quantity per serving (Standard 1.2.7);
- for claims made about cholesterol; or saturated, trans, polyunsaturated, monounsaturated fatty acids; or omega-3, omega-6 or omega-9 fatty acids where the amount of trans, polyunsaturated and monounsaturated fatty acids per serve must be declared in the NIP (Standard 1.2.8); and
- for claims on small packages that require the 'per serving' information (Standard 1.2.8).

- If the 'per serving' information was voluntary, it would also need to be mandated for products displaying the Health Star Rating per pack (when presented as a single serving) or per 'reference portion' (when presented as a multi-pack) rather than per 100g to allow consumers to verify the information presented in the Health Star Rating icons. While the Health Star Rating is a voluntary scheme and not mandated by the Food Standards Code, it is important to provide consumers with an opportunity to verify the information.

- Although it is not mandatory for quick-service restaurants to provide a NIP on their products, some businesses (e.g. McDonalds) do this voluntarily. For those businesses that do include the NIP and are required to display information about the kilojoules per item on in-store and online menus (currently mandated in NSW, ACT and SA) it is necessary to have the 'per serving' information in the NIP. This would allow consumers to verify kilojoule information presented on packaging, websites and other materials.

Question 7: What additional studies examine consumer use and understanding of per serving information in the NIP on food labels? Provide a copy of studies where possible.

A rapid scan found the following papers that may be of interest, which are attached to this submission. It is suggested that FSANZ undertake a more comprehensive search for studies to inform the assessment of recommendation 17.

- Roberto CA and Khandpur N. (2014) Improving the design of nutrition labels to promote healthier food choices and reasonable portion sizes. *International Journal of Obesity*, 28: S25-33.
  - The focus is on USA nutrition facts panel (NFP) and it describes issues with consumer use of the NFP as well as concerns about the NFP (serving size label inconsistencies, concerns about consumer numeracy and literacy, and level of complicated information). The reference list also contains studies that may be of interest to FSANZ.

- Lando AM and Lo SC. (2013) Single-larger-portion-size and dual-column nutrition labelling may help consumers make more healthful food choices. *Journal of the Academy of Nutrition and Dietetics*, 113(2): 241-250.
  - The focus is on USA nutrition facts panel (NFP) and possible changes to improve consumer use. For products that are consumed at a single occasion but have more than one recommended serving (e.g. larger drinks), dual-column labelling (serving size and nutrients per pack) or single-column labelling (nutrients per pack) are recommended.

- Vanderlee L et al. (2012) Consumer understanding of calorie amounts and serving size: implications for nutrition labelling. *Canadian Journal of Public Health*, 103(5): 327-331.
  - The focus is on Canadian nutrition facts table and front-of-pack labelling. Consumers are more likely to underestimate energy content with per serving information compared with per pack information with both the nutrition facts table and front-of-pack labelling. Nearly 100% of participants correctly identified energy per container using the nutrition facts table versus nearly 85% when using front-of-pack labelling.

- Campos S, Doxey J and Hammond D. (2011) Nutrition labels on pre-packaged foods: a systematic review. *Public Health Nutrition*, 14(8); 1496-1506.
    - International review of nutrition labels. It notes that nutrition labels that require calculation with respect to nutrient amounts and serving sizes are confusing to many consumers, particularly those with lower literacy levels and educational attainment.

Question 8: From your perspective, what are the advantages and disadvantages of per serving information in the NIP being voluntary? Provide evidence where possible.

- Advantages include:
    - Less information in the NIP may simplify it and make it easier for consumers to make comparisons between products.

- Disadvantages include:
    - Some consumers may have difficulty in determining how much of a food represents 100g / 100mL. If the per serving information wasn't mandatory, an education strategy would be required to provide easy-to-understand information for consumers.
    - Without 'per serving' information it is harder for consumers to monitor the amount of energy, fat, and other nutrients they are consuming.
    - Some consumers may over-consume products if they do not have the 'per serving' information.
    - The 'per serving' requirements for %DI labelling, for the Health Star Rating System and for some of the nutrient content and health claims in Standard 1.2.7 would lead to different NIP formats. Different NIP formats make it more difficult for consumers to choose the healthier product or correctly identify the amount of energy in a product.
    - Research indicates that in educating clients to read labels nutrition professionals use criteria to guide whether a product is a healthy choice.[3] For some nutrients the most common criteria is per 100g, however for energy in snack foods and fibre content, the 'per serving information' is most commonly used. If the per serving information was voluntary, different criteria as well as new resources to help consumers read labels would be required.
    - Changes to state-based healthy food and drink guidelines would be required if the 'per serving' information was not available for all products, which would need to be factored into a cost-benefit analysis. This will result in:
        - significant investment for State Governments, canteen associations and other non-government organisations to change the criteria;
        - confusion for canteen convenors, volunteers and foodservice staff who have been using the guidelines during the last decade;
        - a lengthy re-education of end users;
        - an impact on the food industry as some permissible products may not be allowed once assessed against the 'per 100g' rather than the 'per serving' criteria; and
        - food manufacturers reformulating products to maintain their status as permitted products in schools, sporting clubs and healthcare facilities.
    - There are a number of situations where the 'per serving' information is currently required in the Food Standards Code and so there would be costs associated with changing it if the 'per serving' information was made voluntary, for example additional consultation. It is not clear whether there would be a benefit to outweigh the cost of these changes.

[3] Pratt IS, Muhlmann L and Erickson H. (2012) Label reading nutrient criteria: a survey of Australian nutrition professionals. *Nutrition and Dietetics*, 70: 54-58.

- For jurisdictions and the Imported Food Program of the Department of Agriculture, the greater variability in the NIP format resulting from making the 'per serving' information voluntary is likely to introduce greater complexity into the monitoring and enforcement of food labelling requirements.

Question 9: Do you think the declaration of the amount of energy and nutrients per serving in the NIP should be voluntary? YES / NO / UNCERTAIN. Give reasons and evidence to support your view. If you are UNCERTAIN, please indicate what information you would need in order to form a view.

- For the reasons outlined in the response to Question 8, it is not considered that NIPs should be voluntary. The consultation paper does not provide any evidence of whether changing the status of the 'per serving' information to voluntary will be beneficial for consumers or industry. There does not appear to be any clear benefit for removing the 'per serving' information in the NIP and there are more advantages for maintaining the status quo.

- Further information that would be useful includes:
  - Australian consumers' use and understanding of the per serving information;
  - the number of food manufacturers that will change NIPs to remove the 'per serving' information, and the number of products that will be changed; and
  - cost and regulatory burden for industry to remove the 'per serving' information from existing products, and to include the 'per serving' information on new products if voluntary.

Should you require further information in relation to this matter, please contact Food Safety Standards and Regulation, Department of Health on (07) 3328 9310 or at foodsafety@health.qld.gov.au

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Consumer Understanding of Calorie Amounts and Serving Size: Implications for Nutritional Labelling

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ABSTRACT

Objective: Increased consumption of sugar-sweetened beverages has contributed to rising obesity levels. Under Canadian law, calories for pre-packaged foods and beverages are presented by serving size; however, serving sizes differ across products and even for the same product in different containers. This study examined consumer understanding of calorie amounts for government nutrition labels and industry labelling schemes.

Methods: A national sample of 687 Canadian adults completed an online survey. Participants were randomized to view images of Coke® bottles that displayed different serving sizes and calorie amounts. Participants viewed either the regulated nutrition information on the "back" of containers, or the voluntary calorie symbols displayed on the "front" of Coke® products. Participants were asked to determine how many calories the bottle contained.

Results: Across all conditions, 54.2% of participants correctly identified the number of calories in the beverage. Participants who viewed government-mandated nutrition information were more likely to answer correctly (59.0%) than those who saw industry labelling (49.1%) (OR=5.3, 95% CI: 2.6-10.6). Only 11.8% who viewed the Coke® bottle with calorie amounts per serving correctly identified the calorie amount, compared to 91.8% who saw calorie amounts per container, regardless of whether information was presented in the Nutrition Facts Table or the front-of-pack symbol (OR=242.9, 95% CI: 112.1-526.2).

Conclusions: Few individuals can use nutrition labels to correctly identify calorie content when presented per serving or using industry labelling schemes. The findings highlight the importance of revising labelling standards and indicate that industry labelling initiatives warrant greater scrutiny.

Key words: Nutrition labelling; food labelling; nutrition policy; comprehension; front-of-package labelling

La traduction du résumé se trouve à la fin de l'article.

Can J Public Health 2012;103(5):e327-e331.

Obesity is a growing public health problem. In Canada, more than two thirds of adults are overweight or obese.[1] Excess energy intake is a main driver behind the obesity epidemic.[2] Increased consumption of sugar-sweetened beverages, including soft drinks, is a potentially important contributor to increased energy intake.[3] Sugar-sweetened beverages are characterized by high caloric content with little to no nutritional value.[1] In North America, beverages are often sold in large containers holding several times the recommended serving. An American study suggested that actual soft drink portion sizes exceeded the federally recommended standard portion sizes by 35-103%.[4]

Nutrition information on pre-packaged foods is mandatory in most high-income countries.[5] In Canada, the Nutrition Facts Table must appear on the back or side of all pre-packaged food items and is the primary source of nutrition information for Canadian consumers.[6,7] The Nutrition Facts Table uses serving size labelling, which displays the nutrition information for a single serving of the product. Serving size labelling aims to address "portion distortion", a phenomenon whereby individuals perceive large portion sizes as appropriate amounts to eat at a single eating occasion.[8] Current Canadian labelling regulations allow a range of serving sizes to be displayed for different items. For example, servings of non-carbonated and carbonated beverages can range from 250 mL to 375 mL, and are selected at the discretion of the manufacturer.[9] Several studies have shown that consumers have difficulty interpreting serving size information.[10,11] A cross-sectional study examining health label literacy found that difficulty with serving sizes and incorrect calculations were the primary reason for errors in interpreting nutrition content.[12] A recent study found that only 37% of individuals could correctly identify the amount of carbohydrates in a 20-oz multiple-serving beverage container.[13] Qualitative research commissioned by Health Canada also indicates that inconsistent serving sizes for similar products are a point of confusion for Canadians in trying to understand the Nutrition Facts Table.[14] Across studies, lower levels of comprehension have been associated with lower income, education, literacy and numeracy skills.[5,12,13]

Front-of-package labelling has been introduced as a simplified method of informing consumers about the calorie and nutrient content of packaged foods. Several large food and beverage companies have recently launched large front-of-package campaigns. One such initiative is the *Clear of Calories* campaign, launched by the American and Canadian Beverage Associations and implemented by leading companies, including *The Coca-Cola Company*

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Conflict of Interest: None to declare.

Table 1. Sample Characteristics (N=687)

	Experimental Conditions				
	FOP/serving	**FOP/ container**	**Nutrition Facts/serving**	**Nutrition Facts/container**	**Overall**
	n=153	n=183	n=171	n=180	N=687
	% (n)	**% (n)**	**% (n)**	**% (n)**	**% (n)**
Sex					
Female	77.1% (118)	73.8% (135)	77.2% (132)	77.2% (141)	76.6% (526)
Male	22.9% (35)	26.2% (48)	22.8% (39)	22.8% (39)	23.4% (161)
Age (years)					
18-34	32.0% (49)	32.8% (60)	34.4% (59)	29.4% (53)	32.2% (221)
35-44	49.7% (76)	51.4% (94)	52.6% (90)	55.0% (99)	52.3% (359)
≥45	18.3% (28)	15.8% (29)	12.9% (22)	15.6% (28)	15.6% (107)
BMI*					
Underweight	2.6% (4)	1.6% (3)	4.7% (8)	2.8% (5)	2.9% (20)
Normal	49.7% (76)	41.0% (75)	47.4% (81)	51.4% (93)	47.3% (325)
Overweight	23.5% (36)	33.9% (62)	26.9% (46)	22.8% (41)	26.9% (185)
Obese	23.5% (36)	21.3% (39)	19.9% (34)	20.6% (37)	21.3% (146)
Not reported	0.7% (1)	2.2% (4)	1.2% (2)	2.2% (4)	1.6% (11)
Education					
High school or less	30.1% (46)	24.6% (45)	15.2% (26)	25.6% (46)	23.7% (163)
Certificate or diploma	42.5% (65)	39.3% (72)	48.0% (82)	36.7% (66)	41.5% (285)
Bachelor's Degree	17.6% (27)	27.3% (50)	23.4% (40)	22.8% (41)	23.0% (158)
University degree greater than bachelor's degree	9.2% (14)	7.7% (14)	13.5% (23)	14.4% (26)	11.2% (77)
Not reported	0.7% (1)	1.1% (2)	0% (0)	0.6% (1)	0.6% (4)
Income					
<$40,000	22.9% (35)	23.5% (43)	19.9% (34)	23.9% (43)	22.6% (155)
$40,000 - $80,000	36.6% (56)	34.4% (63)	34.5% (59)	29.4% (53)	33.6% (231)
>$80,000	32.0% (49)	32.2% (59)	39.8% (68)	34.5% (62)	34.6% (238)
Not reported	8.5% (13)	9.8% (18)	5.8% (10)	12.2% (22)	9.2% (63)
Ethnicity					
White	73.9% (113)	71.6% (131)	77.2% (132)	77.2% (139)	75.0% (515)
Other	24.8% (38)	26.8% (49)	22.2% (38)	21.7% (39)	23.9% (164)
Not reported	1.3% (2)	1.6% (3)	0.6% (1)	1.1% (2)	1.2% (8)

FOP = Front-of-package, industry-led voluntary labelling; Nutrition Facts = government-mandated labelling.
* BMI categories: Underweight = BMI <18.5; Normal weight = BMI 18.5-24.99; Overweight = BMI 25-29.99; Obese = BMI ≥30.

Table 2. Estimation of Calorie Content by Experimental Condition (N=687)

	% Underestimated % (n)	**% Overestimated % (n)**	**% Correct % (n)**
Labelling Condition			
Front of Package per serving	71.9% (110)	21.6% (33)	6.5% (10)
FOP *per container*	5.5% (10)	9.8% (18)	84.7% (155)
Nutrition Facts *per serving*	73.7% (126)	9.9% (17)	16.4% (28)
Nutrition Facts *per container*	0% (0)	0.6% (1)	99.4% (179)
Overall	35.8% (246)	10.0% (69)	54.2% (372)

and *PepsiCo*.[15] The voluntary program prominently displays calorie and serving size information on the front label of beverage containers. In Canada, some beverages are labelled with the calorie content of the entire bottle, while others are labelled per 250 mL or 355 mL serving, similar to the information presented in the Nutrition Facts Table.

To date, there is no published evidence examining consumer understanding of these industry labelling schemes in Canada. The current study sought to examine calorie estimation of beverage products with various serving sizes. The study examined consumers' ability to correctly identify calorie content in beverages when presented with calories per serving or per container of actual Coke products. The study also examined potential differences in consumer understanding when the consumer is shown the government-mandated Nutrition Facts Table on the back of containers, versus the front-of-pack labelling scheme currently appearing on Coke® products. Finally, the study examined individual differences in consumer understanding by socio-demographic factors.

METHODS

Sample description

A total of 687 participants from a national sample of Canadians were recruited using an online commercial panel consisting of over 400,000 consumers through Global Market Insite, Inc. (GMI, Bellevue, Washington).[16] Invitations to participate in the web-survey were emailed to panel members over the age of 18; the invitation did not indicate the nature or purpose of the study.[16] The current study was part of a larger study on the marketing of children's food products, and was completed online. Participants were eligible for the study if they were over the age of 18, a parent of at least one child between 4-10 years of age, and the primary shopper for their household. This study received ethics clearance from the University of Waterloo Office of Research Ethics.

Study protocol

Participants were randomized to view a Coke® beverage in one of four labelling conditions: 1) a 591 mL bottle with front-of-package calorie information *per serving*, 2) a 591 mL bottle with front-of-package calorie information *per container*, 3) a 591 mL bottle with the Nutrition Facts Table *per serving*, and 4) a 591 mL bottle with the Nutrition Facts Table *per container.*

Measures

Demographics

Demographic information of participants included sex, age (18-34, 35-44, and ≥45), education (high school or less, certificate or diploma, bachelor's degree, or university degree or certificate greater

Figure 1. Experimental labelling conditions

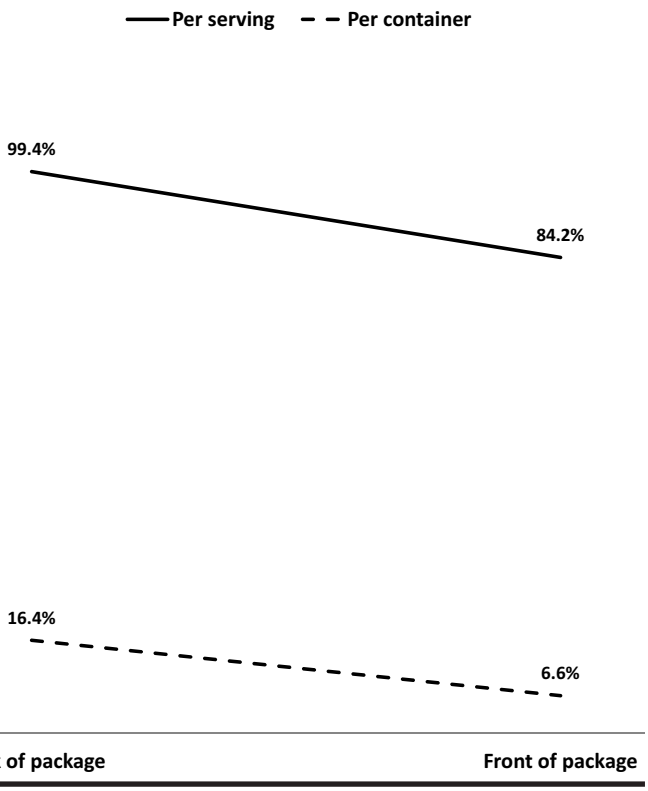
Condition 1: FOP *per serving.*

Condition 2: FOP *per container.*

Condition 3: Nutrition Facts *per serving.*

Condition 4: Nutrition facts *per container*

Figure 2. Estimation of calorie content: Serving size vs. location on package (% correct)



than a bachelor's degree), ethnicity (White or other) and income (<$40,000, $40,000-$80,000, or >$80,000 annually). Self-reported height and weight were collected to calculate body mass index (BMI) using categories defined by the World Health Organization.[17]

Nutritional Knowledge, Understanding of Nutrition Labels and General Health

Nutrition label use was assessed by the question, "When shopping for food, do you usually look at the nutrition information provided on the package?", with a 5-point Likert scale (1=never; 5=always). *Perceived nutritional knowledge* was examined using the statement, "I am knowledgeable about health and nutrition issues", using a 5-point Likert scale (1=strongly agree; 5=strongly disagree). A measure of *perceived general health* was assessed by asking, "In general, how would you rate your overall health?", with a 5-point Likert scale (1=poor; 5=excellent).

Calorie Content

Participants were asked "How many calories are in this bottle of Coke®?", with an open response field in which participants could fill in a number of calories. This question was asked while the image of the Coke® bottle and calorie information were displayed on the screen.

Analysis

Chi-square tests were used to test for demographic differences between experimental conditions. Logistic regression modelling was used to test for differences in the proportion of individuals who responded correctly. Two outcomes were used: an exact response (260 calories) and a more lenient "range" measure, where a correct response was defined as a response within a 10-calorie range above or below the correct answer (1=correct response; 0=incorrect response). Patterns of significance were the same for both outcome measures; therefore results are reported only for exact correct responses. Odds ratios (OR) and 95% confidence intervals (95% CI) are reported. Labelling location (front-of-package=0, Nutrition Facts Table=1), serving size portion (entire container=0, single serving=1), socio-demographic variables (age, sex, education, BMI, ethnicity, income), perceived nutrition knowledge, label use and perceived general health were included in the regression model. All analyses were conducted using SPSS v.20 (IBM Corp., Somers, NY).

RESULTS

Sample characteristics are shown in Table 1. There were no significant differences between conditions for any demographic measures.

Across all four conditions, 54.2% (n=372) of participants correctly identified the exact number of calories in the entire beverage container and 61.0% (n=419) were able to identify the number of calories within a 10-calorie range of the correct answer. Of the entire sample, 35.8% underestimated and 10% overestimated the calorie content.

Table 2 shows the proportion of correct responses, underestimation and overestimation for each experimental condition. Figure 2 also illustrates the overall effect of labelling conditions on correct estimation of calorie content of the container. Participants were able to correctly identify the exact calorie content of the entire beverage container 59.0% of the time when presented with the back-of-package Nutrition Facts Table, and 49.1% of the time when viewing the front-of-package industry labelling. In conditions with *per container* labelling, 91.8% of participants correctly identified the calorie content of the bottle, compared to 11.8% of participants who saw *per serving* labelling.

A logistic regression model was conducted to test for differences in the proportion of participants who could correctly identify the calorie amount between experimental conditions (where 0=incorrect calorie amount and 1=correct calorie amount), adjusting for age group, sex, BMI, education level, income, ethnicity, perceived nutritional knowledge, frequency of label use, and perceived general health. Both portion labelled (serving vs. container) and type of label (Nutrition Facts Table vs. industry label) were significant. Participants who viewed calories per container were significantly more likely to correctly estimate the calories per container compared to those who viewed the calories per serving (OR=242.9, 95% CI: 112.1-526.2, p<0.001). Those who viewed the government-mandated Nutrition Facts Table were significantly more likely to answer correctly than those who saw voluntary front-of-package labelling (OR=5.3, 95% CI: 2.6-10.6, p<0.001). There were no significant overall differences in correctly estimating calorie content for the demographic measures age, sex, education, BMI, ethnicity, income, nutrition label use and perceived nutritional knowledge or health.

DISCUSSION

Overall, almost half of participants were not able to correctly identify the calories in commonly consumed beverage containers when viewing nutrition labels. In addition, approximately one in ten Canadian parents of children ages 4-10 could correctly identify calorie content when the serving size was less than the entire container. This was true regardless of whether they viewed the government-mandated Nutrition Facts Table on the back of containers or the front-of-pack calorie labels voluntarily provided by manufacturers. There was slightly improved performance with the use of the Nutrition Facts Table compared to the front-of-package labelling in both *per serving* and *per container* conditions. This likely reflects consumer familiarity with the Nutrition Facts Table, as it has been mandatory in Canada since 2003.

Several factors could account for the high proportion of incorrect responses. First, the "per serving" information on the Coke® containers was written in very small and often blurry text. Prior to the study, we visited several stores and were unable to find bottles with more legible calorie labels, suggesting that this is likely representative of challenges consumers face. Second, respondents who attempted to use the serving size information may have had difficulty calculating the total number of calories due to poor numeracy skills, as higher numeracy rates have previously been associated with higher label comprehension.[14] This is unlikely in this study, as the education level of the sample was higher than that of the general Canadian public. Finally, the serving size used on the many beverage containers may be counter-intuitive to consumers. The existing regulations in Canada allow the same product to display different serving sizes when sold in different containers. For example, at the time of the study, Coke® products were labelled as *per serving* for 591 mL bottles, and *per container* for 355 mL cans. As a result, a higher calorie number was posted on cans (160 calories) than on the larger bottle container (110 calories per serving). At the time of the study, the 591 mL container included 2.4 servings; however, many respondents may have assumed that the labelled amount was for the entire container. Previous research has found that less than 40% of individuals correctly acknowledged multiple servings in multi-serving food and beverage products.[11,18] This is consistent with the current findings: more than 40% of participants who viewed the "110 calories per serving" label estimated the content of the bottle to be 110 calories. This suggests that labelling per serving may systematically lead consumers to underestimate the calorie content of products, and this may contribute to higher levels of consumption.

Strengths and limitations

The sample was limited to parents of children aged 4-10 years. In addition, the online survey did not allow participants to pick up and examine the container. This may have reduced the accuracy of calorie estimates; however, the study also served to focus attention on the calorie information and likely resulted in increased attention and scrutiny than would be typical in a naturalistic setting. Finally, the online sample had somewhat higher-than-average levels of education and income compared to the general population.[19] Previous research has noted that those with higher levels of income and education generally perform better on nutritional labelling tasks.[13] Poor performance on this task among a more educated sample suggests that the accuracy of calorie estimates could be even lower in the general population. Strengths of the study include the use of a large national sample and the use of actual product labels currently available on the Canadian market. The between-conditions experimental design is also a considerable strength in terms of drawing inferences about the impact of different labelling formats.

CONCLUSION

Nutrition labels are only one of many approaches that will be required to address obesity at a population level. However, for this approach to be effective, consumers must be able to easily identify and understand information on product labels. The current study suggests that government-mandated nutrition labelling practices are confusing to Canadians. Very few individuals were able to use the information in the Nutrition Facts Table to calculate calorie content when there was more than one serving per container. Voluntary industry measures appear to be even less effective and can lead to dramatic underestimates of calorie intake.

Given steadily increasing rates of obesity, these findings highlight the need for substantive changes to the nutrition labelling of pre-packaged food and beverages in Canada. The findings suggest that providing calorie amounts for the entire container can dramatically increase the accuracy of calorie estimates. For products that clearly include multiple servings and for which serving sizes equivalent to the entire container are not appropriate, more intuitive labelling should be considered. An alternative is dual-column labels, which display nutritional information for one serving of a product in addition to information for the entire package.[20] At the very least, serving sizes should be standardized within product categories. Finally, voluntary industry labelling should be subjected to greater scrutiny to ensure that the labels enhance rather than reduce consumer understanding of nutrition information.

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RÉSUMÉ

Objectif : La hausse de la consommation des boissons édulcorées au sucre contribue à l'augmentation des niveaux d'obésité. En vertu de la loi canadienne, le nombre de calories dans les aliments et les boissons préemballés est indiqué par portion, mais les portions diffèrent d'un produit à l'autre, et même pour des produits identiques conditionnés dans des emballages différents. Nous avons examiné la compréhension par les consommateurs du nombre de calories sur les étiquettes nutritionnelles du gouvernement et sur celles de l'industrie.

Méthode : Un échantillon national de 687 Canadiennes et Canadiens adultes a répondu à un sondage en ligne. Des participants sélectionnés au hasard ont visionné des images de bouteilles de Coke® affichant des portions et un nombre de calories différents. Les participants ont vu soit l'information nutritionnelle réglementée au « dos » du contenant, soit les symboles de calories affichés sur le « devant » du produit Coke®. Nous avons demandé aux participants de calculer combien de calories contenait la bouteille.

Résultats : Globalement, 54,2 % des participants ont correctement calculé le nombre de calories dans la boisson. Ceux qui ont visionné l'information nutritionnelle exigée par le gouvernement étaient plus susceptibles de répondre correctement (59 %) que ceux qui ont vu l'étiquetage de l'industrie (49,1 %) (RC=5,3, IC de 95 % : 2,6-10,6). Seulement 11,8 % des participants ayant vu la bouteille de Coke® indiquant le nombre de calories par portion ont correctement calculé les calories, contre 91,8 % des participants ayant vu la bouteille indiquant le nombre de calories par contenant, peu importe si l'information était présentée dans le tableau « Valeur nutritive » ou dans le symbole sur le devant de l'emballage (RC=242,9, IC de 95 % : 112,1-526,2).

Conclusion : Peu de gens savent se servir des étiquettes nutritionnelles pour calculer correctement le nombre de calories lorsque l'information leur est présentée par portion ou sur les étiquettes créées par l'industrie. Il est donc important de réviser les normes d'étiquetage, et les initiatives d'étiquetage de l'industrie mériteraient un examen approfondi.

Mots clés : étiquetage nutritionnel; étiquetage aliments; politique nutritionnelle; compréhension; étiquetage sur le devant de l'emballage

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PROCEEDINGS ARTICLE

Improving the design of nutrition labels to promote healthier food choices and reasonable portion sizes

CA Roberto[1,3,4] and N Khandpur[2,3]

Accurate and easy-to-understand nutrition labeling is a worthy public health goal that should be considered an important strategy among many to address obesity and poor diet. Updating the Nutrition Facts Panel on packaged foods, developing a uniform front-of-package labeling system and providing consumers with nutrition information on restaurant menus offer important opportunities to educate people about food's nutritional content, increase awareness of reasonable portion sizes and motivate consumers to make healthier choices. The aims of this paper were to identify and discuss: (1) current concerns with nutrition label communication strategies; (2) opportunities to improve the communication of nutrition information via food labels, with a specific focus on serving size information; and (3) important future areas of research on nutrition labeling as a tool to improve diet. We suggest that research on nutrition labeling should focus on ways to improve food labels' ability to capture consumer attention, reduce label complexity and convey numeric nutrition information in simpler and more meaningful ways, such as through interpretive food labels, the addition of simple text, reduced use of percentages and easy-to-understand presentation of serving size information.

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INTRODUCTION

In the past four decades, obesity in both adults and children has increased dramatically.[1,2] The rapid rise is thought to be due largely to changes in the food and physical activity environments, given the relative stability of the population's gene pool over this time. Energy-dense, nutrient-poor foods are conveniently available and heavily marketed.[3–7] In addition, the past two decades have seen a proliferation of restaurants, increased snacking, decreased family meals and greater consumption of meals prepared outside the home.[8–11] The growth in portion sizes of packaged and restaurant food have been implicated in increasing obesity prevalence.[12,13] Portions of French fries, hamburgers and sugar-sweetened beverages have more than doubled in size,[12,14] and a robust body of research has found that people consume more when served larger portions.[15–17]

The USDA's 2010 Dietary Guidelines advise Americans to control total caloric intake and reduce sodium, saturated fat, *trans* fat, cholesterol and added sugar consumption.[18] The provision of clear and accurate nutrition information is one important way to help consumers adhere to these guidelines and make informed choices. Nutrition labels on food packaging and restaurant menus offer one of the best ways to disseminate and make salient such information at the point-of-purchase, when it is arguably most likely to influence purchasing behavior. In addition, required disclosure of nutrition information can incentivize food manufacturers to improve the nutrient profile of their products.[19]

Recent global food policy efforts have focused on providing consumers with greater access to easy-to-understand nutrition information. In the United States, the Food and Drug Administration (FDA) has expressed interest in updating the Nutrition Facts Panel (NFP) on packaged foods to improve its clarity[20] and undertook an initiative[21] to recommend a uniform, front-of-package (FOP) labeling system that could be adopted by the food and beverage industries.[22,23] In addition, a menu labeling mandate, included as part of the 2010 Patient Protection and Affordable Care Act,[24] will require chain restaurants with $\geqslant 20$ locations to provide calorie information on restaurant menus at the point-of-purchase.

Although a growing number of studies have examined effective ways to communicate nutrition information through the NFP and newer labeling initiatives, there is still much to learn. In addition, fewer studies have focused specifically on educating consumers about appropriate serving and/or portion sizes via nutrition labels. Therefore the aims of this paper were to identify and discuss: (1) current concerns with nutrition label communication strategies; (2) opportunities to improve the communication of nutrition information via food labels, with a specific focus on serving size information; and (3) important future areas of research on nutrition labeling as a tool to improve diet. In this paper, serving size refers to the amount of a food recommended for consumption in one sitting, while portion size refers to the actual amount of food a person portions out for consumption in one sitting.[25] Portion size and serving size are related concepts, but they exert different influences on the amount of food consumed. In this paper, we discuss the ways in which serving size information can influence consumer perceptions of appropriate portion sizes, which in turn influence the amount consumed.[13,14]

THE NFP ON PACKAGED FOODS

The passage of the Nutrition Labeling and Education Act of 1990 required the provision of standardized nutrition information through the NFP on most packaged foods in the United

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States.[26] Although some nutrition information on the NFP can vary based on the food product, the standard label includes information about serving size, kilocalories (kcal; calories) and calories from fat, total, saturated and *trans* fat, cholesterol, sodium, total carbohydrates, dietary fiber, sugars and protein. The NFP also displays information for certain vitamins and minerals. Nutrient amounts are presented in grams and milligrams accompanied by percentages derived from recommended daily allowances or daily values (based on a single serving for a 2000 kcal diet).[26,27]

Consumer use of the NFP

Across studies, approximately half of American adults report using the NFP when making food-purchasing decisions, suggesting it is an important source of information for consumers.[28–31] More specifically, 54% of adult respondents in the 2008 Health and Diet Survey reported using the NFP 'often' when buying a product for the first time, and $>60\%$ reported they 'often' or 'sometimes' accessed information about calories and serving size.[28] In a similar sample of adults, 53% reported using the NFP 'always or almost always' when making food-purchasing decisions.[29] However, objectively measured viewing of the NFP with eye-tracking technology suggests these self-reported estimates of label usage may be inflated.[32] Graham and Jeffery[32] found that only 9% of 203 adult participants viewed the NFP calorie content during a food purchasing task, despite 33% self-reporting that they 'almost always' used it when food shopping.[32] Similarly, although 31% reported 'almost always' looking at the total fat content on the NFP, the eye-tracking data revealed that $<1\%$ actually did.

Although intended for use by the entire population, nutrition labels are more likely to be used by those who are well-educated, Caucasian, female and/or young adults[33] as well as by those with healthier eating habits, higher incomes and greater nutrition knowledge.[33,34] A greater proportion of non-NFP users tend to be overweight, Black or Hispanic, unmarried and male.[29] Unfortunately, it is not uncommon to find low NFP use among population groups who stand to benefit most from it.[35] Design limitations of the current NFP might partially explain why it is an under-utilized source of nutrition information. There is, however, evidence that people with chronic disease (that is, hypertension, diabetes, heart disease) report greater nutrition awareness and food label use compared with those without chronic disease.[36]

Addressing concerns about the NFP

The problem of serving size label inconsistencies. All of the nutrient information presented on the NFP hinges upon the listed serving size. Serving size labels are created by food manufacturers based on Reference Amounts Customarily Consumed (RACC) Per Eating Occasion described in common household measurements appropriate to the type of food.[26,37,38] The RACC were originally determined by the FDA based on Nationwide Food Consumption Surveys conducted in the late 1970s and 1980s. In instances when survey data were inadequate, other sources were considered, including dietary guidance recommendations and serving sizes used by manufacturers, grocers and other countries. One concern with continuing to use the RACC is that stated serving sizes of commonly consumed items, such as cereal and punch, have been found to be substantially less than what is realistically portioned out by consumers.[39,40]

Another concern is that serving sizes for packaged food can vary over a wide range. Current guidelines state that one unit of a food commodity can be considered a single serving if it weighs between 67% and 200% of the RACC.[37] Usually the nutrition information for a food containing $\geqslant 200\%$ of the RACC is based on a single RACC serving, and the package indicates the number of servings it contains. However, a packaged food container weighing $>200\%$ of the RACC can also be considered a single serving if the food manufacturer believes that the entire container can reasonably be eaten during a single eating occasion.[38] Although in 2004 the FDA encouraged food manufacturers to label foods usually consumed in one sitting as a single serving, there has not been a formal mandate to do so.[26] Given the increase in portion sizes over time, it is unclear whether the RACC should also be overhauled to reflect what consumers are actually eating or if an increase in the RACC would inadvertently promote further overconsumption; these questions warrant further study.

The current FDA guidelines allow food manufacturers flexibility to define the amount of a single serving of their product.[41] This means that two very similar products could appear to have different nutritional profiles depending on the serving size.[41] For example, Mohr *et al.*[41] identified that the RACC for a regular candy bar (typically consumed in one sitting), is 40 g. At the time, they found that this was the serving size listed for the Endangered Species Brand Milk Chocolate and Peanut Butter bar. However, one serving of a 3 Musketeers Bar and a Milky Way Bar was listed as 23 g (57.5% of the RACC), and thus a serving of those candy bars appears to be half the calories of a serving of the Endangered Species bar.[41] These kinds of discrepancies in serving size within the same food category have been documented for products, such as granola bars, yogurt, soup and candy bars.[41]

Mohr *et al.*[41] call this kind of serving size manipulation 'health framing', because consumers who view items with smaller serving sizes are prone to incorrectly perceive the product as healthier than a comparable product with a larger serving size. In one study, Mohr *et al.*[41] randomized 151 participants from an Internet panel to view a pizza and soup product where the unit weight of the product and product serving sizes were manipulated. The study revealed that health framing (presenting smaller serving sizes) reduced the anticipated guilt of consuming the product and increased the intent to purchase the product. This effect was moderated by level of dietary concerns; health framing led those with high dietary concerns to experience significant reductions in anticipated guilt. This suggests that those most concerned with nutrition, and therefore more likely to read the NFP, might also be most vulnerable to the negative effects of health framing. The results from this study indicate that health framing might influence consumers at the point-of-purchase to buy a specific product or choose that product over similar ones. However, it is unknown whether such health framing impacts consumers at the point of consumption. It is possible that the smaller serving size advocated on the packaging influences consumers to eat less. Alternatively, the health frame might create an initial health halo that persists, which could translate into greater consumption;[42] these are important questions for future research to address.

Concerns about consumer numeracy and literacy. National and international surveys have found that >90 million Americans have limited literacy skills,[43] which raises concerns about the amount of numeric and technical information on the NFP. Several studies have documented consumer difficulty understanding quantitative information presented on food labels, especially with respect to serving size information[44–46] and the percentages of recommended daily amounts.[47–50]

Serving size calculations. In one study, portion size estimation skills of primary care patients were assessed by asking them to serve an amount of three foods and one beverage that represented what they thought a single standard serving was for each of the products. Then patients were told what the actual serving size was and were asked to serve that specific amount. The sample consisted primarily of women, half of whom reported having previous nutrition and portion size education. The results revealed that higher literacy (but not numeracy) was associated with greater accuracy when portioning out a single serving of the foods/beverage.[44] In another study of 90 health center patients,

86% of the respondents assumed that a unit of packaged food was a single serving even if it contained multiple servings and incorrectly equated calories from a single serving with the caloric content of the entire package.[45] After some assistance and prompting from research staff to re-evaluate incorrect answers, people improved only slightly, with 63% of the participants still confusing calories per serving with total calories in the package. Participants in this study who had low levels of education were more prone to incorrectly apply information from the NFP to estimate calories contained per package.[45]

A study conducted by Rothman *et al*.[46] also examined patients' ability to read and understand nutrition information on food labels. Only 32% of patients could accurately calculate the number of carbohydrates that would be consumed when drinking a 20-oz. bottled beverage containing 2.5 servings. Only 22% of patients could determine total carbohydrates when presented with nutrition information for two slices of low-carb bread.[46] Across study tasks, people consistently made errors when trying to mathematically manipulate serving size information to draw a conclusion about a food's nutritional profile. In this study, low numeracy and literacy skills were also significantly associated with poor understanding of nutrition labels. Finally, another study found that as little as 10.5% of college students could correctly describe serving size from the NFP after viewing different food labels.[51] The results from these studies highlight the difficulty people have manipulating and using the numeric information presented on labels with respect to serving size, particularly for foods containing multiple servings.

Addressing serving size inconsistencies through labeling. One proposed way to address the confusion around serving size is to change the NFP design to include two columns: one that contains nutrition information for a single serving and one that contains nutrition information for the entire container, particularly if it is a packaged food or beverage typically consumed in one sitting.

A study by Antonuk and Block[52] randomized undergraduate students to either a single- or dual-labeled NFP appearing on a package of 50 M&Ms they could eat while watching a short video. The study found that non-dieters exposed to the dual-column NFP reduced their consumption of M&Ms; dieters M&M consumption did not differ between groups. Although dieters ate significantly fewer M&Ms compared with non-dieters when exposed to the single-column label, the dieters and non-dieters in the dual-column group did not significantly differ in the amount of M&Ms consumed. These results suggest that the dual-label column approach has the potential to encourage healthier eating behavior.

In addition, Lando and Lo[53] conducted an online study examining the dual-column NFP format. Approximately, 9500 participants recruited from an Internet panel were randomized to one of the 40 study arms. The study used a 10 (label format) $\times$ 2 (product category: frozen meal or a bag of chips) $\times$ 2 (healthy versus less healthy food) design. The tested labeling formats presented nutrition information as either: (i) two servings per container with nutrient information listed per serving in a single column (five different versions), (ii) two servings per container with a dual column: one column listing nutrient information per serving and the other listing information per package (three different versions), or (iii) one serving per container, with nutrient information listed per serving in a single column (two different versions). The different label versions also involved the removal of calories from fat and/or enlarged font for calories. The current NFP, with two servings per container, served as the control.

Results revealed that participants rated products as less healthful when they were labeled with one serving per container. Relative to the current NFP, participants could more accurately determine the nutrient content of a product when it was labeled with a single column containing one serving or when information was presented in dual columns (per serving information in the first column and information per package in the second column). When products had the same NFP format, there were no significant differences in participants' ability to select the more healthful of the two products. However, when comparing products with different NFP formats, the greatest proportion of participants could accurately identify the more healthful product (75%) and calories per container (68%) when a dual-column label was compared with a two servings, single-column label (the current NFP format). Enlarging the font size for calories and removing 'calories from fat' did not independently affect label usability.

The findings from these two studies suggest that the addition of a second column presenting nutrient and calorie information for an entire package, rather than per serving, might be more helpful for the consumer. However, such a format would mean adding more information to an already complex and busy label. Therefore, the option of a single column for products typically consumed in one sitting, with the serving size based on the entire package, might be preferred. However, before adopting this new labeling scheme for the NFP, additional research should compare the dual- and single- column labels to even simpler presentation formats that provide less information and use creative methods to interpret the information for the consumer, including Traffic Light labels or other graphical displays. Such labeling schemes must also be tested during real-world shopping trips.

Reducing the amount of complicated information on the NFP. Taylor and Wilkening[26] explain that great care was taken when designing the original NFP to consider research 'about comprehension, legibility, and literacy, taking into account the needs of the elderly and others with sight limitations.'[54] For example, specific design elements were added to improve usability, such as the inclusion of lines between nutrients, the removal of punctuation marks, the use of larger type and upper and lower case letters, instead of only uppercase, and the bolding of important nutrient information. The NFP is also displayed in a box with a white background to make it stand out from the food packaging.

Although designed to be easy-to-use, infrequent use of the NFP, particularly by certain demographic groups, might be partially explained by the large amount of complicated information presented on the label. In Graham and Jeffery[32] eye-tracking study, most consumers typically only viewed the top five lines of the label, suggesting that much of the additional information may rarely get read, except perhaps by highly nutrition-conscious consumers. The bottom half of the label also presents additional information about grams/milligrams of nutrients based on a 2000 versus 2500 kilocalorie diet. As the FDA discusses altering the NFP to improve usability, it would be worth considering whether all of this information should remain or if a better approach is to include less but more meaningful and salient information. The small font of the NFP has also been cited as a deterrent to its use.[34]

Another concern with the NFP is the use of percentages, which were originally included to put the nutrition information in the context of an overall daily diet and enable easy comparison across nutrients.[26] However, research has found that consumers have trouble understanding and using percentages on food labels.[47–50] One solution proposed by the Center for Science in the Public Interest is the inclusion of high/med/low text next to nutrient amounts to aid understanding of the percentage of daily values.[55] The inclusion of such text has been found to improve FOP label understanding, especially among groups of lower socioeconomic status and education levels.[49] In FDA online educational materials (see Figure 1), consumers are informed that $< 5\%$ of a nutrient is 'low' and $> 20\%$ of a nutrient is 'high.' These criteria could also be used as the basis for text indicators and/or text could replace percentages entirely. FDA online materials also use different colors

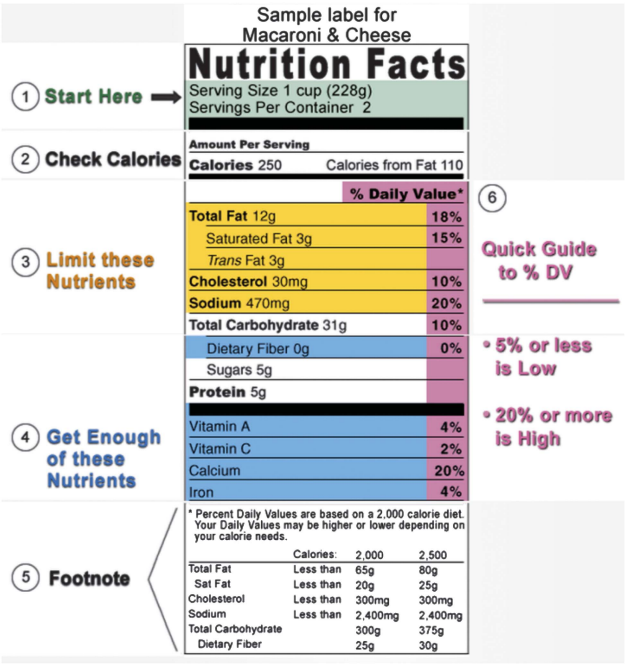

Figure 1. The Nutrition Facts Label overview presented on the US Food and Drug Administration website. Republished here with permission from the US Food and Drug Administration. http://www.fda.gov/. Available from: http://www.fda.gov/food/ingredientspackaginglabeling/labelingnutrition/ucm274590.htm. Accessed June 2013.

and text to educate consumers about the nutrients that should be limited (for example, total fat, cholesterol, sodium) and those consumers must 'get enough of' (for example, dietary fiber, vitamins).[56] These kind of text labels might further aid NFP comprehension and should be studied. NFP clarity might also be improved by sacrificing technical accuracy to communicate more effectively with the consumer. For example, 'dietary fiber' could be listed as 'fiber'[55] and 'sodium' as 'salt.' Overall, more research is needed to identify strategies to communicate complicated nutrition information to consumers in meaningful ways, rather than relying exclusively on numeric data (for example, kcal, grams, milligrams, percentages). This is especially important given that those with low literacy and/or numeracy skills have particular difficulty comprehending the NFP.

FOP NUTRITION LABELS

Improving FOP labeling systems

FOP nutrition labels that display key information in an easy-to-understand format have been proposed as one solution to address the limitations of the NFP and its difficulty capturing consumer attention. Countries worldwide have implemented or are considering implementing different FOP labeling systems (see Figure 2 for sample FOP labels). The Netherlands has adopted the Choices logo, which is a single summary checkmark symbol that appears on products meeting certain standards for low levels of sodium, added sugar, saturated fat, *trans* fat and caloric content.[57] Fiber and portion size are also considered when appropriate for the group of products. In the United Kingdom, a Multiple Traffic Light labeling system that uses red, yellow and green symbols to alert consumers to low/med/high levels of saturated, fat, sodium and sugar per serving appears on some food products.[58]

The advantage of a Traffic Light labeling system is that it moves beyond traditional information-based approaches by interpreting complicated numeric information for the consumer and harnesses the power of automatic associations between red and 'stop' and green and 'go.'[59] Australia has also recently announced the adoption of a Health Star Rating system, where healthier foods receive more stars, which the food industry has 2 years to voluntarily adopt.[60] In contrast, FOP labels on products in the United States are not mandated or standardized. This has led to a confusing array of FOP labels developed by different entities.[61] Several years ago, the FDA announced an initiative to address the lack of a uniform FOP labeling system. As part of these efforts, the Institute of Medicine prepared two reports on the topic that recommended an interpretive, graded symbol that awards food and beverages 0–3 points based on levels of saturated and *trans* fat, sodium and added sugars.[22,23] It was also recommended that kcals be listed in household measure serving sizes. A review of the extant research literature suggested that FOP labels hold promise as a way to improve consumer understanding of nutrition information and encourage healthier food purchases.[62]

The most recent voluntary industry attempt at a uniform FOP labeling system in the United States has been the Facts Up Front label introduced by the Grocery Manufacturers Association and the Food Marketing Institute. This label displays nutrition information per serving for kcals, saturated fat, sodium and sugars. Manufacturers who voluntarily adopt this scheme can also choose to highlight two 'nutrients to encourage', such as fiber, potassium or vitamin A.[63] From a health communications perspective, the design of the Facts Up Front label raises some concerns. The symbol contains a lot of confusing numeric information, including grams and milligrams and percentage of daily values. In addition, it is small and monochrome and does not include any interpretive text.

One Internet-based study examined consumer understanding of different versions of the Facts Up Front symbol relative to versions of the UK's Traffic Light label.[64] Seven hundred and three adult participants were randomized to either a no label control group or one of the four FOP labels. Two versions of the Traffic Light label were tested. Both included kcal per serving and text (high/med/low) indicating amounts of saturated fat, sodium and sugars per serving, but one version also had information about protein and fiber. Two versions of the Facts Up Front label were tested as well, one of which displayed information about nutrients to encourage (for example, vitamins, protein, fiber). Participants briefly viewed a public service announcement about each labeling system and then completed a quiz asking them to identify which of two products was higher or lower in different nutrient amounts. The Traffic Light and Facts Up Front labels that included nutrients to encourage performed the best on the nutrient comparison quiz. However, when asked to evaluate the nutrient profile of individual products, those viewing Traffic Light labels far outperformed the other label groups, while those who viewed Facts Up Front labels were more likely to underestimate the amounts of saturated fat and sugar. Another similar Internet-based study found that a Traffic Light label that was augmented by an icon of male/female figures and the text '2000 calories per day' further improved consumer understanding of nutrition information relative to a Traffic Light label without the 2000 calorie text.[65] Such icons might be useful, because they provide information that puts calories per serving in context. Another possibility is that the inclusion of a graphic with male/female figures did a better job capturing consumer attention.

The beverage industry has also launched their Clear on Calories initiative, which displays FOP labels with kcals per container.[66] However, total kcals per container is only displayed on bottles that are $\leqslant 20$ oz.; those >20 oz. display kcals per serving and differ depending on whether the drink is a juice (calories are listed per 8 oz. serving) or other beverage (calories are listed per 12 oz. serving).

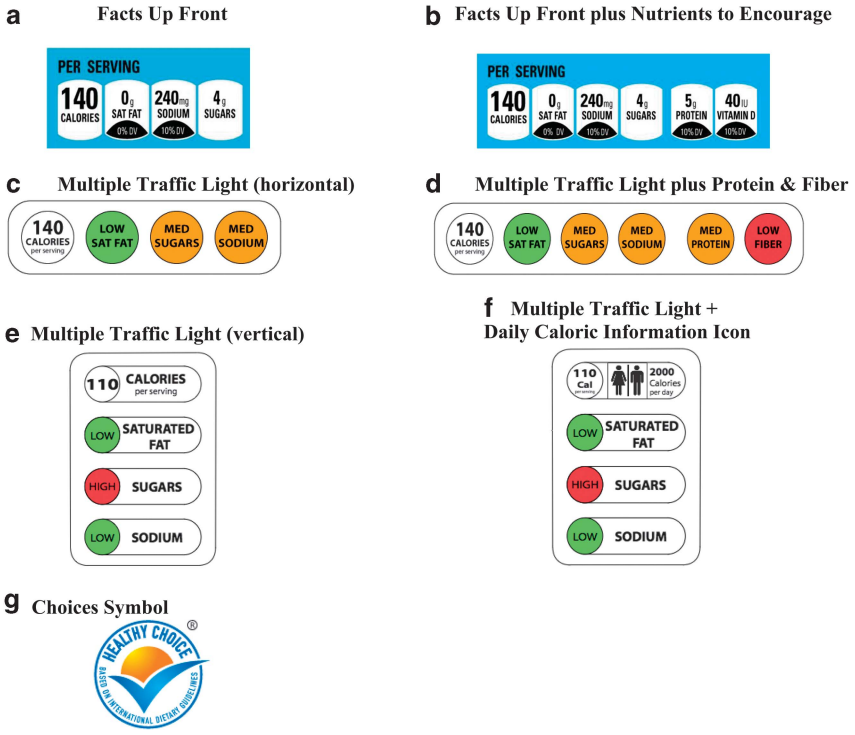

Figure 2. Different FOP nutrition labels. (**a**) Facts Up Front. (**b**) Facts Up Front plus Nutrients to Encourage. Republished here with permission from the Grocery Manufacturers Association. http://www.gmaonline.org/. Available from: http://www.fmi.org/industry-topics/health-wellness/facts-up-front. Accessed June 2013. (**c**) Multiple Traffic Light (horizontal). (**d**) Multiple Traffic Light plus Protein and Fiber. (**f**) Multiple Traffic Light+Daily Caloric Information icon. (**e**) Multiple Traffic Light (vertical). Republished here with permission from the British Heart Foundation. http://www.bhf.org.uk/. Available from: http://www.cdc.gov/pcd/issues/2012/12_0015.htm. Accessed June 2013. (**g**) Choices symbol. Republished here with permission from the Choices Programme. http://www.choicesprogramme.org/. Available from: http://www.cdc.gov/pcd/issues/2012/12_0015.htm. Accessed June 2013.

One study by Vanderlee *et al.*[67] randomized 687 Canadian consumers to a Coca-Cola bottle that displayed either an FOP label or a nutrition facts table with kcals per serving or kcals per container. Across study groups, 54.2% of participants correctly identified kcals in the entire container, while 35.8% underestimated them. People who saw kcals per container labels versus per serving were significantly more likely to correctly estimate the kcals per container. One limitation was that the sample population was well-educated, limiting the ability to generalize the study findings. More research is needed to understand the influence of the Clear on Calories labels and whether consumer knowledge as well as behavior is influenced when kcals are presented for the entire bottle versus per serving, even when the bottle is >20 oz.

Serving size information on FOP labels

FOP labels might also represent an opportunity to educate consumers about appropriate serving sizes, but many FOP labeling systems do not present serving size information. Few studies have been conducted to examine how serving size information on an FOP label might influence consumer perceptions and behavior. In one lab-based study, participants were invited to try a cereal for breakfast.[40] Two hundred and sixteen participants were randomized to one of the three FOP labels based on the Smart Choices FOP labeling system briefly introduced on some food products in the United States in 2009. The rectangular symbol included the words 'Smart Choices' along with a check mark and information about kcals per serving and servings per package. The three FOP label conditions were: (1) no label control group; (2) the Smart Choices label with the text: 120 calories per serving, 11 servings per package; or (3) the Smart Choices label with the text: 120 calories per ¾ cup serving and 11 servings per package. Participants answered focus group questions about their perceptions of the cereal and poured and ate it for breakfast.

There were no differences in the amount of cereal and milk poured and consumed during the breakfast meal. However, across conditions, participants were pouring almost twice the recommended serving on average. The label groups also did not differ in perceptions of cereal taste, healthfulness or likelihood to purchase the cereal. Those who viewed the FOP labels with calorie information were better able to more accurately estimate the kcals per serving than control participants. Although the label had little impact on behavior, improving people's ability to estimate calories has value given research demonstrating people's difficulty estimating the caloric content of foods consumed outside the home.[68,69] It is possible that the label in this study might have had a limited effect, because the serving size amounts were perceived as unrealistic and not representing what people actually consume. Another possibility is that presenting serving size information in cups or similar measurement units might still be difficult for people to visualize, especially for individuals who cook infrequently. Only one, relatively unhealthy cereal, was tested in this study, and the sample was composed largely of individuals of high socioeconomic status, limiting the generalizability of the findings.

These results suggest that labels with serving size information might not influence food consumption and the inclusion of serving size information might make the label overly complicated. Therefore, future research should examine how serving size information on FOP labels might influence consumer understanding, perceptions and behaviors. Another challenge is to come up with meaningful serving size units that can be easily conveyed on food packaging. Some professional weight loss

treatments educate people about serving and portion sizes using familiar everyday objects (for example, a deck of cards represents a 3 oz. serving of meat, a large handful is a cup of dry cereal),[70] but little research has examined these kinds of strategies on food packaging.

Other possibilities to help people consume smaller portions are to use salient cues that interrupt mindless overeating. For example, Geier *et al*.[71] found that people ate the least number of potato chips from a can when a red chip appeared every 7 chips compared with a red chip appearing every 14 chips or cans with no red chips at all. Food companies could experiment with package design that has clear indicators of pre-portioned servings. Other ways to help consumers serve appropriate portion sizes might be to have markers on the outside of food packaging that denote serving size amounts (that is, a 20-oz. bottle of soda could have rings around the outside indicating the points at which one has consumed one and then two servings). More experiments on these kinds of portion size indicators would be valuable.

Lots of FOP labels currently exist and should be compared against one another in both lab and field trials. Sales data from supermarkets that have implemented shelf-tag labeling systems as well as data from cafeterias willing to introduce labeling schemes would be especially valuable in determining optimum labeling formats. An additional area for future research is examining how FOP labels/graphics might be designed to influence children's food choices or interactions with parents when shopping. Although most nutrition labels are designed for adults, much of the food marketing with which they compete is child-targeted. Finally, when considering the optimum design for an FOP label, it is important to think about label elements that might promote the greatest industry reformulation of products. Data on the Choices logo in the Netherlands suggests that the introduction of the symbol encouraged reformulation of food products and the introduction of healthier foods and beverages.[72] Single-summary logos or interpretive symbols, such as Traffic Lights or health stars, would likely promote greater reformulation than labels like Facts Up Front that lack a clear evaluative component to help consumers interpret the numeric information.

Nutrition labeling of restaurant meals

Menu labeling. The most significant step in nutrition labeling of restaurant foods has been the pending nation-wide introduction of menu labeling, which is part of the Patient Protection and Affordable Care Act.[24] Menu labeling requires chain restaurants to post calorie information for entire food items at the point-of-purchase. Research on the influence of menu labeling on consumer purchases is mixed, with some studies showing no effect of menu labeling[73–75] and others finding that labeling encouraged reductions in kcals purchased and/or consumed.[76–82] Menu labeling is a major step forward to educate the public about kcals in restaurant food, which people have great difficulty estimating.[68,69] However, in its current form it relies on presenting numeric information to inform and/or influence food choices. Given the mixed findings on menu labeling, newer research is examining ways to maximize its effectiveness. One randomized, controlled lab-based study found that adults viewing calorie labels on menus during a dinner meal ordered and ate fewer kcals at the meal.[78] However, the inclusion of a label on the menu that placed calorie information in context by indicating that the recommended daily caloric intake for adults is 2000 kcal prevented participants from eating more after a dinner meal. Menus with calorie labels, but no contextual label, did not have this effect. This highlights the importance of anchoring caloric information and, in general, making numeric nutrition information more meaningful by putting it in contexts consumers can more easily understand.

The future of nutrition labeling research should be focused on developing and testing numeric and non-numeric ways to more effectively convey nutrition information. One example is a study conducted in a hospital cafeteria, which found that a Traffic Light labeling system promoted purchases of green, healthier items and decreased purchases of red, less healthy items.[83] Those with lower education levels also benefited most from the Traffic Light labeling system.[84] The impact of restaurant calorie labels might also be improved by overlaying Traffic Lights to denote lower calorie items or smaller portions and/or by rank-ordering the calories from low-to-high to facilitate information processing.[85] In addition, Bleich *et al*.[86] found that presenting calorie information for a sugary drink as an exercise equivalent (50 min to burn a 250-kcal beverage) significantly reduced purchases of sugar-sweetened beverages among adolescents. The increased use of digital menu boards at fast-food chain restaurants would allow for easier implementation and experimentation with different nutrition label formats.

Although most studies on menu labeling have not examined specific influences on portion size, Vermeer *et al*.[87] assessed the impact of portion size and Guideline Daily Amount (GDA) on Dutch consumers' ($n = 89$) portion size choice and intake of soft drinks while at the movies. They conducted the study on 2 days (one control and one experimental). For the experimental condition ($n = 48$), consumers could select between five different portion sizes (200, 250, 400, 500, 750 ml cups that ranged from 0.8 to 3 servings) of a soft drink. The soft drinks were accompanied with portion size information and caloric GDA labels that use percentages to put the calories in the context of the overall daily diet. In the control condition ($n = 41$), consumers had the same choice of portion sizes but only got ml information. In all, 37.5% of the consumers chose the 250- or 200-ml cups, but labeling did not impact portion size decisions or the amount of liquid consumed. However, the study was limited by the offering of free beverages and a small sample with a limited number of regular soft drink consumers. Nonetheless, the results suggest that offering smaller portions is more effective than trying to use the percentage GDA labeling to reduce portion size choices.

Other restaurant labeling strategies. There are also other labeling strategies that could be leveraged to influence decisions about portion size. Ayindoglu and Krishna[88] conducted a series of five experimental studies to evaluate the impact of qualitative size labels (small, medium, large) on size estimation and consumption of food. Across the five studies, between 58 and 82 university students were recruited and presented with different servings of snacks (pretzels, nuts, sandwiches, cookies) that were accompanied by various size labels. When a larger food item was labeled 'down' toward a smaller size, consumers perceived the food amount to be less. The perceived amount consumed from a package labeled 'small' was also lower than the amount actually eaten; these effects were more marked when people were under competing cognitive demands. In addition, participants who were given a snack labeled 'medium size' ate more than those given the same snack labeled 'large size.' Additionally, provision of information on serving size did not lessen the effect of size labels. That is, large sizes were perceived as small if they were labeled small, even in the presence of serving size information in grams. However, consumers concerned about their health were less likely to rely on size labels.

This study revealed that consumers will continue to eat large amounts of food when a label is switched from 'large' to 'small,' but they will feel that they have not eaten too much, a phenomenon the authors call 'guiltless gluttony.'[88] A study conducted by Just *et al*.[89] found similar results. They used prepared foods (spaghetti and salad) and found that consumers wasted more food when a large portion was called a 'double-size' than when the large portion was called 'regular'. Similarly, individuals left more salad on their plate when it was labeled 'regular' versus 'half-size.' These results suggest that there might

be promising opportunities for restaurants to experiment with differentially labeling healthy foods with smaller size labels to promote increased consumption, while serving smaller portions of less healthy foods but labeling them as 'large.' Such labels might also be leveraged for packaged foods typically consumed in one sitting, rather than presenting numeric serving size information.

Summary of recommendations to improve nutrition labels

Updating the NFP, developing uniform FOP labeling symbols and providing consumers with nutrition information on restaurant menus offer important opportunities to educate people about the nutritional content of their food and motivate consumers to make healthier choices. Although government agencies have worked to design easy-to-understand nutrition labeling systems, there is always room for improvement based on scientific advances. Requiring the NFP on packaged foods in the United States was a major step forward in informing consumers and making people aware of the importance of nutrition. However, much of the nutrition information presented to the public has taken the form of numeric data, some of which requires mathematical manipulation to use effectively.

Future research on nutrition labeling should focus on designing better numeric and non-numeric strategies to convey nutrition information to the public through the NFP, FOP labels and menu labeling. These efforts should focus on ways to improve food labels' ability to capture consumer attention, reduce the complexity of labels and identify ways to convey nutrition information in meaningful units. Current efforts to update the NFP should specifically focus on addressing confusion around serving size. Research suggests that consumers would benefit from the NFP and FOP labels displaying nutrition information for an entire container for those foods and beverages typically consumed in one sitting. Efforts should also be made to standardize serving sizes for these items. In addition, data are needed to determine whether serving sizes should continue to be based on the original RACC or should be updated to match current consumption norms. Additional ways to improve and/or supplement labeling should be tested further, including designing food packaging with salient cues that alert consumers to serving size amounts, adding text to food labels to improve understanding of numeric data and examining non-numeric strategies to convey nutrition information on packaged and restaurant foods.

Accurate and easy-to-understand nutrition labeling is a worthy public health goal that should be considered an important strategy among many to address obesity and poor diet. At a minimum, labeling provides consumers with information they are entitled to, and as labeling interventions are being pursued, they should be implemented in the most useful and cost-effective manner. Even if food labeling results in only small changes in caloric or other nutrient intake, this can lead to meaningful change on a population level.[90] Modeling studies also suggest that nutrition labeling strategies, such as FOP labels on packaged foods, are more cost-effective than other interventions and treatments for obesity.[86] Finally, well-designed labels have the potential to 'nudge'[91] consumers by altering the context in which people make decisions about food choices and consumption without limiting those choices or altering economic incentives. However, labels also have the potential to 'nudge' the food industry to reformulate foods and offer healthier alternatives, which might be the most powerful impact of labeling interventions.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Nutrition labels on pre-packaged foods: a systematic review

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Abstract

Objective: To review research on consumer use and understanding of nutrition labels, as well as the impact of labelling on dietary habits.
Design: A systematic review was conducted by searching electronic databases. Relevant articles were screened by two reviewers and included if they met inclusion criteria, including eight methodological criteria. A total of 120 articles were included in the review, including cross-sectional surveys (*n* 96), experimental designs (*n* 17), 'natural experiments' (*n* 7) and longitudinal population-based surveys (*n* 2).
Setting: Articles covered seven jurisdictions: USA (*n* 88), Europe (*n* 12), Canada (*n* 9), Australia and New Zealand (*n* 4), Norway (*n* 2), Thailand (*n* 1) and Trinidad (*n* 1).
Subjects: Participants were from a wide range of age groups, socio-economic strata and geographical regions.
Results: Nutrition labels on pre-packaged foods are among the most prominent sources of nutrition information. Nutrition labels are perceived as a highly credible source of information and many consumers use nutrition labels to guide their selection of food products. Evidence also shows a consistent link between the use of nutrition labels and healthier diets. However, the use of labels varies considerably across subgroups, with lower use among children, adolescents and older adults who are obese. Research also highlights challenges in terms of consumer understanding and appropriate use of labelling information.
Conclusions: Nutrition labels on pre-packaged foods are a cost-effective population-level intervention with unparalleled reach. However, to capitalize on their potential, governments will need to explore new formats and different types of information content to ensure that nutrition information is accessible and understandable.

Keywords
Nutrition
Labels
Food products
Policy

The prevalence of overweight and obesity is increasing at an alarming rate[1,2]. Globally, approximately 1·6 billion adults are overweight and over 400 million are obese[2]. Although obesity is more common in high-income countries, increases in obesity have occurred in many low- and middle-income countries, particularly among urban populations[2]. The increasing prevalence of overweight and obesity places a considerable burden on public health, including increases in CVD, diabetes, arthritis, sleep and breathing disorders, depression, as well as functional limitations[3]. Diet is also estimated to account for approximately 30% of cancers in industrialized countries, making it the second largest modifiable risk factor after cigarette smoking[4]. The economic burden of overweight and obesity is considerable, with direct health-care costs in the billions for most Western countries[5].

Nutrition labelling on food products has emerged as a prominent policy tool for promoting healthy eating[6]. As a health education intervention, mandatory nutrition labels have broad reach and are present at the point of purchase, as well as when food is prepared or consumed[7]. The display of nutritional information on pre-packaged foods is mandatory in most high-income countries. In the USA, the Nutrition Labelling and Education Act of 1990 mandates that pre-packaged foods carry a nutrition label, with exceptions for foods intended for immediate consumption[8]. In Canada, mandatory nutrition labelling was first implemented on pre-packaged foods in December 2005 and became mandatory on virtually all pre-packaged foods in 2007[8–10]. Nutrition labelling on pre-packaged foods remains voluntary in the European Union, except in the case of health claims, although mandatory regulations are under development[11] (see Fig. 1 for examples of nutrition labels in the USA, Canada, Australia and the UK).

There is a large and growing evidence base on the impact of nutritional labels, including six literature reviews between 1991 and 2007[6,12–16]. The most recent reviews have focused on specific geographical areas, including European

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Canada

Nutrition facts/Valeur nutritive
Serving 1¼ cup (30 g) / Portion de 1¼ tasse (30 g)

Amount per serving / Teneur par portion	Cereal / Céréales	With 1/2 Cup 2% Milk / Avec 1/2 tasse de lait 2 %
Calories / Calories	110	180
	% Daily Value / % valeur quotidienne	
Fat / Lipides 0 g†	0 %	4 %
Saturates / saturés 0 g + Trans / trans 0 g	0 %	8 %
Cholesterol / Cholestérol 0 mg	0 %	3 %
Sodium / Sodium 220 mg	9 %	12 %
Potassium / Potassium 30 mg	1 %	7 %
Carbohydrate / Glucides 26 g	9 %	11 %
Fibre / Fibres 1 g	4 %	4 %
Sugars / Sucres 2 g		
Starch / Amidon 23 g		
Protein / Protéines 2 g		
Vitamin A / Vitamine A	0 %	8 %
Vitamin C / Vitamine C	0 %	0 %
Calcium / Calcium	0 %	15 %
Iron / Fer	30 %	30 %
Vitamin D / Vitamine D	0 %	25 %
Thiamin / Thiamine	45 %	50 %
Riboflavin / Riboflavine	50 %	60 %
Niacin / Niacine	8 %	15 %
Vitamin B_6 / VItamine B_6	10 %	15 %
Floate / Folate	8 %	10 %
Vitamin B_{12} / Vitamine B_{12}	0 %	25 %
Pantothenate / Pantothénate	6 %	15 %
Phosphorus / Phosphore	2 %	10 %
Magnesium / Magnésium	0 %	8 %
Zinc / Zinc	0 %	6 %

† Amount in cereal / Dans les céréales.

INGREDIENTS: FLAKED MILLED CORN, SUGAR/GLUCOSE-FRUCTOSE, MALT (CORNFLOUR, MALTED BARLEY), SALT, NATURAL COLOUR, VITAMINS (THIAMIN HYDROCHLORIDE, NIACINAMIDE, PYRIDOXINE HYDROCHLORIDE, FOLIC ACID, d-CALCIUM PANTOTHENATE), IRON, BHT ADDED TO PACKAGE MATERIAL TO MAINTAIN PRODUCT FRESHNESS. CONTAINS TRACES OF SOYBEANS.

INGRÉDIENTS : MAÏS MOULU EN FLOCONS, SUCRE/GLUCOSE-FRUCTOSE, MALT (FARINE DEMAÏS, ORGE MALTÉE), SEL, COLORANT NATUREL, VITAMINES (CHLORHYDRATE DE THIAMINE, NIACINAMIDE, CHLORHYDRATE DE PYRIDOXINE, ACIDE FOLIQUE, d-PANTOTHÉNATE DE CALCIUM), FER, POUR CONSERVER LA FRAÏCHEUR DU PRODUIT, DU BHT A ÉTÉ AJOUTÉ AU MATÉRIEL D'EMBALLAGE, CONTENT DES TRACES DE SOYA.

USA

Nutrition facts

Serving size 1/2 cup dry (40 g)
Servings per container: 13

Amount per serving

Calories 150	Calories from Fat 25
	% Daily value*
Total Fat 3 g	4 %
Saturated Fat 0·5 g	2 %
Trans Fat 0 g	0 %
Cholesterol 0 mg	0 %
Sodium 0 mg	0 %
Total Carbohydrate 27 g	9 %
Dietary Fiber 4 g	15 %
Sugars 1 g	
Protein 5 g	
Vitamin A	0 %
Vitamin C	0 %
Calcium	0 %
Iron	10 %

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

	Calories:	2,000	2,500
Total Fat	Less than	65 g	80 g
Sat Fat	Less than	20 g	25 g
Cholesterol	Less than	300 mg	300 mg
Sodium	Less than	2,400 mg	2,400 mg
Total Carbohydrate		300 g	375 g
Dietary Fiber		25 g	30 g

Australia

NUTRITION INFORMATION

Servings per package: 3
Serving size: 150 g

	Quantity per serving	Quantity per 100 g
Energy	608 kJ	405 kJ
Protein	4.2 g	2.8 g
Fat, total	7.4 g	4.9 g
– saturated	4.5 g	3.0 g
Carbohydrate, total	18.6 g	12.4 g
– sugars	18.6 g	12.4 g
Sodium	90 mg	60 mg
Calcium	300 mg (38 %)*	200 mg

* Percentage of recommended dietry intake

Ingredients: Whole milk, concentrated skim milk sugar, strawberries (9 %), gelatine, culture, thickener (1442).

United Kingdom

Nutrition information
Typical values per 100 g

Energy	245 kJ/58 kcal
Protein	4.6 g
Carbohydrate	7.2 g
of which sugars	6.5 g
Fat	1.2 g
of which saturates	0.2 g
Fibre	0.2 g
Sodium	0.1 g

Fig. 1 Examples of nutrition labels on pre-packaged foods

countries[6,15] and Australia and New Zealand[16], with the exception of Cowburn and Stockley, who reviewed literature up to 2002 across a broader geographical area[14]. The findings of these reviews are generally consistent: self-reported use of nutrition labels was found to be prevalent[6,12–16]; however, consumers often report

difficulty in interpreting quantitative information contained in labels[6,13,14,16]. Some consumers found different nutrition label formats confusing[15] and generally preferred graphical information to the traditional label[12]. Label use was more prevalent among the female population[6,13–15], and could be predicted by health awareness[13], income[6,14–16] and education level[6,13–16]. Finally, one review concluded a positive effect of nutrition labels on diet[14].

The evidence base and regulatory practice have grown considerably in the 7 years since the last systematic review was conducted. Several countries have implemented mandatory nutrition labelling legislation within this time. Furthermore, many of the previous reviews did not include studies on the link between label use and diet[6]. In light of this, the current systematic review aims to examine the existing body of evidence regarding the prevalence of consumer use and understanding of nutrition labels, as well as the impact of nutrition labelling on consumer dietary habits.

Methods

Inclusion criteria

The present review was restricted to studies that examined consumer behaviour related to nutrition labels on pre-packaged foods, published in English in peer-reviewed journals or research reports completed on behalf of government agencies. Studies were included if they examined the prevalence or determinants of nutrition label use, or if they measured consumer knowledge, understanding, perceptions or format preferences related to nutrition labels. Articles that examined the relationship between nutrition label use or legislation and consumer diet were also included. Articles that only examined health claims, food safety labelling, brand naming, package design or shelf labelling were excluded, as were articles that focused on labelling at the point of purchase.

Search strategy

Electronic searches were conducted using the following databases: MEDLINE, CSA Illumina Social Sciences Subject Area (covering forty-six databases); Web of Science (including Science Citation Index Expanded (SCI-EXPANDED) – 1900–present); and the Cochrane Library. Additional searches using the reference lists of relevant articles were also conducted.

The initial search generated a total of 23 801 citations, of which 1450 titles appeared to meet the inclusion criteria and were reviewed. Of these abstracts, 247 were selected for article retrieval. Following review of the full-text articles, 109 were excluded on the basis that they did not meet the inclusion criteria. The remaining 138 articles were assessed using a data extraction form and were rated on eight methodological criteria (see Table 1).

Table 1 Methodological evaluation criteria for including articles in the review

Criterion	Possible outcomes
1. Is the research question well stated?	Y/N
2. Is the sample/population identified and appropriate?	Y/N
3. Are the inclusion/exclusion criteria described and appropriate?	Y/N or N/A
4. If applicable, is the participation rate reported and appropriate?	Y/N or N/A
5. Is the same data collection method used for all respondents?	Y/N
6. Are important baseline variables measured, valid and reliable?	Y/N or N/A
7. Is the outcome defined and measurable?	Y/N
8. Is the statistical analysis appropriate?	Y/N or N/A

Y, yes; N, no; N/A, not applicable.

Studies were included in the review if they met all of the eight criteria. This led a total of 120 articles being included in the review.

Results

The 120 articles selected for review originated from seven jurisdictions: the USA (*n* 87), Europe (*n* 13), Canada (*n* 9), Australia and New Zealand (*n* 4), Norway (*n* 2), Germany (*n* 1), Thailand (*n* 1) and Trinidad (*n* 1), as well as one study jointly from the UK and the USA, and one including participants from the Netherlands, Germany, France and the UK. Cross-sectional surveys were the most common study design (*n* 96), followed by experimental designs (*n* 19), 'natural experiments' (*n* 7) and longitudinal population-based surveys (*n* 2). Thirteen of the surveys were based on nationally representative samples and thirty were conducted with individuals who reported being the primary food shopper for their household, or who were approached while shopping for food at the point of purchase.

Prevalence of label use

Of the 120 studies reviewed, sixty-five reported the frequency with which consumers attended or used nutrition labels on pre-packaged foods[12,15–79]. Among studies targeted at the general population, the prevalence of self-reported label use was generally high (e.g. 82 % in New Zealand[64], 52 % in Canada[80], 47 % in the EU[69] and 75 % in the USA[18]) according to the most recent nationally representative data in each country. Definitions of label 'use' varied across studies, complicating comparisons. For example, several studies defined users as those who cite nutrition labels as a source of nutrition information, rather than other sources such as health-care practitioners[32,43,44]. Studies also used different time frames for label use, including 'ever' use *v.* use in the past 1 month[12] or 12 months[53]. Overall, these studies indicate that use of nutrition labels among the general population is generally high and typically above 50 %.

Age

A majority of studies found that middle-aged or younger adults were more likely to use nutrition labels than were older individuals[25,32,37,42,44,47,69–74,80–84], with several exceptions[20,30,35,85,86]. For example, a large survey of the nutrition perceptions of Americans found that older participants tended to trust nutrition labels as a source of accurate nutrition information to a less extent than younger respondents[44].

Six articles examined the impact of nutrition labels on adolescents[36,54,87–90]. Of these, two studies indicated that use of nutritional labels was low among adolescents[54,90]. Only one 2004 study of youth at an urban primary care clinic in the USA reported a self-reported prevalence rate: 22% reported 'always' reading nutrition labels, 57% 'sometimes' and only 22% reported 'never' reading them[36]. Evaluations of a 2006 US web-based nutrition intervention in adolescents found no improvement in food label use as a result of the intervention[88]; however, a similar 2008 study found that web-based interventions increased adolescents' use of labels[89]. A single qualitative study examined the use of nutrition labels among children. The majority of US children in grades 3–6 had difficulty using nutrition labels and could not categorize healthy foods on the basis of label[91].

Gender

Women report using labels significantly more often than men in a majority of studies that include both genders[25,30,33,35,42–44,46,53,59,64,69,70,72–74,76,80,82,85,92,93]. Women were also more likely to report that nutrition labels had influenced their food choices[53] and to trust nutrition labels[44]. Similar rates of nutrition label use have been documented among women of different levels of income and socio-economic status[34,38,51,55,57]. Only four studies reported no significant difference between male and female participants' use of nutrition labels[17,46,94,95].

Income/education

Most studies have concluded that individuals with lower income are less likely to use nutrition labels[27,62,82,96], with only two studies finding the opposite effect[67,86] and one reporting no significant effect of income[35]. Individuals with lower income were also more likely to have lower levels of nutrition knowledge[86,94], which were associated with label non-use[50,63,80,97]. Similar effects have been observed for education levels: individuals with greater education have reported greater use of nutrition labels in most studies[17,30,41,42,44,62,63,67,70,73,76,80,86,92,93,96,97], with only two exceptions[35,94]. Seven studies targeting socio-economically disadvantaged populations reported variable rates of nutrition label use, ranging from 20% to 74%[23,38,39,41,51,61,92], although these rates were typically lower than those reported for the general population.

Mixed findings were observed with respect to the effect of employment[67,76,94,96], job satisfaction[69] and rural *v.* urban habitation on label use[35,37,62,82,98,99]. Only one study of older Americans in 1990 directly compared rural with urban groups, with no significant difference in label use[43]. Larger households and those with children were found to more likely use labels[41] and support their mandatory implementation[35,37], as were married couples[27].

Race/ethnicity

A majority of studies have found that Caucasian participants are significantly more likely to use nutrition labels than are other ethnic groups[21,39,71,100], with one study of African-American adults in North Carolina reporting high levels of use[30]. Studies with Latino adults in the USA also reported lower rates of label use[23,51]. For example, a study comparing ethnic groups in the USA found that only half of the proportion of Latinos, compared with their African-American and 'white' respondents, had 'ever used' labels[39]. Low rates have also been observed among ethnic minorities in New Zealand[61]. Racial/ethnic differences have also been observed with respect to the type of information sought from nutrition labels[25]. For example, Latinos were found to be more likely to check dietary fibre and Na information[72].

Health behaviours

A wide range of studies have examined the association between label use and health practices. Individuals with healthier eating habits report greater use of nutrition labels, either as a result of personal preference[25,30,50,53,80] or because of the requirements of a health-related diet[25,37,41,43,64,67,68,76,86,96,101]. Greater use has also been reported by individuals more concerned with dietary guidelines[32,33,35,41,53,63,86,94,96] and by those who place greater emphasis on the nutritional quality of food while shopping[35,68,72,94,96,98,102]. Nutrition and label knowledge[17,31,35,59,80,86,98,103], nutrition education[19,40,41] and knowledge of diet–disease relationships[17,29,31,33,60,71,72,82] or of specific diseases[29] have also been associated with label use, with few exceptions[69,85,94]. Weight control[30,33] and diagnosis of a disease[30,41,53,69,79,82,104–106] have also been associated with greater label use.

Grocery shopping habits have been identified as being a strong predictor of nutritional label use. Consumers who spend more time, or report having more time to shop for groceries, were more likely to be label users[86,96,98], and lack of time was consistently reported as a reason for non-use[17,33,37]. Shoppers who placed less emphasis on price[67,86,96] were more likely to use nutrition labels, although one study reported no association[35]. The importance of taste was positively related to label use in three studies[35,94,96] and was negatively related by two others[63,86]. Meal planning[68,72,86] and grocery spending were other variables related to use[62].

Among health behaviours not directly related to nutrition, using supplements, exercising regularly and not smoking were associated with the use of nutrition labels[19,30,40,68,85].

Attitudes/perceptions towards nutrition labels

Many consumers have reported that nutrition labels are an important source of information[22,60,101,107,108], although ingredients and health claims may be perceived as more important[108]. Most consumers were willing to use information if it was provided on the label[97], although consumers' beliefs about the healthiness of foods did not necessarily depend on information on the label[109]. There was, however, popular support for mandatory labelling in studies, although conflicting findings have been found for consumers' willingness to pay extra for nutrition information[81]. Positive attitudes were higher among individuals reporting greater use of labels[56,59,85,108,110]; however, negative attitudes were also prevalent in the literature[41,48,111,112]. Many consumers believed that serving sizes and health claims were misleading and were sceptical of the compliance of labels to regulatory law[85,113]. The credibility of manufacturers' health claims was rated poorly, especially when these claims contradicted nutrition information on the label[59,85,114–116]; however, in one case, health claims helped consumers to choose more nutritious products[117]. Trust in labels also predicted use[44,60,69], and was greater among younger respondents and among those with higher levels of education[44].

Comprehension and understanding of nutrition labels

Studies suggest that consumers generally find nutrition labels to be useful[17,54,59,85], although consumers in the USA[118] and Australia[26] report a desire for simpler presentation of information[26,49,118]. In one case, Australian participants requested more detailed information[26]. Following the Nutrition Labeling and Education Act in the USA, which implemented a consistent label format in 1993, 80 % of consumers thought that the label was more helpful and the proportions of those seeking more information declined, except with respect to cholesterol information[28].

There is mixed evidence with respect to the ease[30,80,93] or difficulty of using nutrition labels[26,107,118]. Frequent label use was associated with better understanding in general[69,98,119], with other studies providing mixed results[56,120]. Younger participants[53], as well as those with higher education[52,53], income, literacy and numeracy[52], were more likely to report understanding nutrition labels. One longitudinal study found that self-reported awareness of nutrition terms, but not understanding, improved between 1984 and 1994 in Canada[32].

Several studies reported a good understanding of nutrition labels based on consumers' performance on tasks requiring them to retrieve or manipulate information[56,95,121]. Understanding was greater in younger[110], female, educated and white participants[121], and was also related to knowledge[95,122,123], perceived understanding[95], attitude towards and motivation to use the nutrition label[95,123], as well as frequent label use[69,98,119]. Self-reported understanding is generally high among lower-income groups[38,41,51]; however, with the exception of one sample of individuals eligible for a US food supplementation programme[41], most showed poor performance on items measuring their ability to use the label, especially when calculations were required[38,51]. Low perceived self-efficacy in using the label was also reported by women on social assistance[113].

A variety of studies indicate that many consumers have difficulty with the quantitative information presented on labels, especially with respect to recommended daily amounts, per cent daily values, serving sizes or other forms of reference information on the label[17,21,31,52,54,81,85,120,124]. This difficulty was common among diabetics[106], chronic kidney disease patients[79], older adults[81,110,125], adolescents[54], infrequent label users[17] and those with less education[81].

Other tasks that were reportedly confusing for consumers included comparisons between products[52], determination of energy per serving and per package[126] and comprehension of E-numbers representing additives[42]. For example, 24 % of consumers in Trinidad read nutrition labels without understanding them[46], and this was listed as a reason for non-use among many groups of consumers[37,46,93,125]. Several studies conducted among females in the USA and UK have also provided mixed evidence, showing that most participants could locate nutrition information, but had difficulties with per cent daily value and information on food claims[34,55,57]. Frequent label reading, better education, better self-assessments of diet quality, health status and nutrition knowledge were related to these skills[55]. Educational interventions targeting label knowledge and understanding have generally shown positive results in a range of sub-populations[21,22,54,125,127,128], including among low-income and literacy groups[92].

Label format and content

Compared with 'traditional' nutrition labels with quantitative information on nutrient content, several studies have reported greater effectiveness for labels using graphics and symbols[129–131], adjective labels[132] and labels with minimal numerical content[76]. For example, information accompanied by graphics helped consumers to better apply reference information, especially consumers who had not seen labels before[61]. The use of well-recognized health symbols[7,106] and 'traffic lights' may be particularly effective[64,133,134]. For example, traffic light symbols – which typically display green, amber or red labels to indicate whether foods contain low, medium or high amounts of contents such as fat, saturated fat, sugars – have been found to increase consumer ability to identify healthier food options and consumer attention in general[133,135,136].

Research also suggests that placing nutrition information on the front of packages is more effective than information positioned on the side or back of packages[15,87,137].

Front-of-pack (FOP) labels may disproportionately benefit those with low-nutrition education and knowledge of nutrition labels[15]. For example, in a 2009 study conducted in Australia, consumers supported the idea of FOP labelling, especially when it is consistent across products and manufacturers[134]. Simple energy information on the FOP was also well received in a 2007 study conducted in Germany, The Netherlands, France and the UK[135]. Preliminary evidence suggests that FOP labels may also promote healthier food purchasing behaviours, although additional research is needed[7,15].

Evidence is mixed with respect to the level of detail or complexity of information favoured by consumers. More detailed information was favoured by some consumers[76,79,131], especially non-label users[17], whereas frequent users preferred less detail[17]. Simplified labels have been shown to promote more accurate nutrition judgements of unhealthy products[74,84,119] and improved performance on diet-related tasks[121,131], even when daily reference values were added[121]. The use of reference information, such as per cent daily value, is often welcomed by consumers[122,133,134]; however, many struggle to apply the quantitative values[7,124,138]. Labels presenting information in two columns side-by-side have also been shown to reduce food consumption by non-dieters when compared with a version presenting information as a single, longer column[139]. Consumers have also expressed a desire for nutrient information listed in the context of a healthy diet[93,131]; larger, more legible print[37,130]; simpler terms[76]; explanations of terms or nutrients[37,93]; the use of colour and a consistent appearance across nutrition labels[93].

Types of nutrition information sought by consumers

Consumers tend to look more closely at nutrients they wish to avoid[93]. To this end, the nutrients most commonly sought were fat[26,28,37,42,49,53,73,79,85,97,108,115,118], energy content[28,37,53,79,97,118], protein[49,79,97,118], cholesterol[28,97], carbohydrates[42,118], vitamins and minerals[97,118], types of fat[42,97], serving size[85], additives[42,73] and Na information[42,97,118]. Low-fat dieters were more likely to look at fat information[42,53,98], and younger[67,73] female participants were more likely to look at energy than men[59,67]. Cholesterol was most often looked at by older[50,67,98], suburban participants who believed in a diet–disease relationship[98] and had high cholesterol[53], and less often looked at by white, well-educated individuals with low cholesterol intake[98]. Those with experience reading labels were more likely to use carbohydrates and fibre information[59], and younger individuals were more likely to use vitamin and mineral information[67].

Similar to the general population, adolescents were most likely to seek fat and energy information[87]. A range of studies have also examined information sought by a range of other sub-populations, including low-income women[38,41], Latino populations[72] and diabetes patients[106].

The impact of nutrition labels on diet

Observational studies have consistently found an association between use of nutrition labels and healthier diets[70–72,82,103,140,141]. Several studies have reported an association between label use and lower fat consumption[70–72,82,140,141]. Label users are also more likely to eat healthier varieties of foods[140], and to have reduced Na[72,103], cholesterol[63,72] and energy intakes, coupled with increased fibre[72,142], Fe[143] and vitamin C intakes[70]. Cross-sectional associations between label use and healthier diets are also related to socio-economic status[142], education[71,82], age[71,72] gender[36,72] and ethnicity/race[71,72].

Three longitudinal studies in the USA have evaluated the implementation of new nutrition labels on dietary patterns. In the USA, the 1990 Nutrition Labeling and Education Act came into effect in 1994 and required nutrition labels on all pre-packaged foods. A study comparing nationally representative surveys of consumers in 1989 and 1995 found that frequent label users in 1995 had a significantly greater probability of consuming a low-fat diet than both non-label users in 1995 and frequent label users in 1989[74]. In addition, fat intake among less-educated respondents decreased significantly during the 'pre–post' study period[74]. A second study found that BMI of nutrition label users fell significantly following implementation of the Act, with the greatest change among those with the highest BMI score[104]. In addition, low-fat and low-Na food purchases increased significantly following the impact of new labels, although the same effect was not observed for low-energy choices, or healthy nutrients such as vitamins and minerals[116].

Evidence from five experimental studies is generally consistent with cross-sectional and longitudinal findings. Two experiments compared consumption of low-fat with energy-dense foods by randomizing participants to either a blind or information condition[144,145]. Both studies found that, although participants tended to consume greater amounts of reduced-energy food in terms of food weight, total energy intake was significantly lower among those who consumed reduced-energy food[144,145]. Only one study showed this effect on daily energy consumption, as opposed to short-term intake during the study[145]. Participants who received nutrition information consumed more of the low-energy version of the food[144]. A third experiment found no differences in participants' satiety after consuming fat-free compared with regular potato chips, irrespective of the provision of information[146]. Finally, providing nutrition information also increased healthier purchase intentions and accurate perceptions of nutrient content[147].

Discussion

Research conducted to date indicates that nutrition labels on pre-packaged foods are among the most prominent

sources of nutrition information. Evidence also suggests that consumers perceive nutrition labels to be a highly credible source of information, and many consumers report using nutrition labels to guide their selection of food products.

The use of nutrition labels varies considerably across population subgroups. Use is particularly high among individuals with health conditions and special dietary requirements – those with the greatest need for nutritional information. However, label use is notably lower among children, adolescents and older adults. More research targeting these populations is needed, given their increased prevalence of obesity[1,148], nutrient deficiencies[149] and chronic disease[149–153]. Individuals with lower socio-economic status are also less likely to use nutrition labels, which is particularly problematic given that low socio-economic status is associated with an increased risk of being overweight and obese[154].

The evidence in this review shows a consistent link between the use of nutrition labels and healthier diets. The causal nature of this association is likely bidirectional: nutrition labels may promote healthier eating, whereas individuals with healthier diets are more likely to seek out nutritional labels in the first place. However, there is sufficient evidence from a range of study designs to conclude that providing nutrition information on packages has a positive impact on diet. In countries such as the USA, government agencies and non-government organizations have estimated the impact of mandatory nutrition labelling to be in the range of billions of dollars[104], although the magnitude of benefit and the extent to which it varies across different types of nutrition labels and population subgroups cannot be estimated with any precision from the existing evidence base.

Research to date also highlights the need to balance the complexity of information presented on labels with consumers' ability to process this information in a quick and meaningful manner. Nutrition labels that require calculations with respect to nutrient amounts and serving sizes are confusing to many consumers, particularly those with lower education and literacy skills[96]. Educational interventions aimed at improving the understanding of nutrition labels have shown promise and a broader application of these interventions may provide one potential solution[92,155]; however, the evidence highlights the need to improve the ways in which nutrition information is presented to consumers on food packages.

Future research should examine the effectiveness of using symbols, images and different graphical layouts to a greater extent. Indeed, there is growing evidence regarding the consumer-friendly nature symbols used by the industry, as well as the greater impact of FOP labels, compared with labels on the side or back of packages. These formats may be more consumer-friendly in part because nutrition information is more accessible and in part because of a widespread desire for more 'prescriptive' information that identifies 'healthier' food from less-healthy options. Indeed, an expert panel commissioned by the UK Food Standards Agency recently concluded that FOP formats are effective and the strongest FOP label is one that combines the use of words 'high, medium and low', traffic light colours and percentage of Guideline Daily Amount, in addition to levels of nutrients in a portion of the product[156].

More generally, there is increasing evidence that labelling regulations need to take the entire package into consideration to maximize their effectiveness. Industry 'health claims' are regulated to different extents across jurisdictions and the use of FOP symbols, which imply healthier alternatives, is largely unregulated. Ideally, consumers would use nutrition labels to help interpret health claims; however, in practice, many consumers rely solely on health claims[108]. Indeed, there have been mixed reports as to whether consumers can determine whether claims are truthful[56,114,120,157].

Limitations

This review is subject to several limitations. First, it is possible that relevant articles were not included in the review, given the rapidly evolving evidence base. Attempts were made to minimize this limitation by using a comprehensive searching strategy and a systematic selection process using two independent reviewers and inclusion criteria. Second, the articles included in this review were disproportionately from high-income Western countries, and from North America in particular. Therefore, it is unclear as to what extent the findings in this review apply to jurisdictions with different labelling regulations and in much different cultural and geographical contexts. Additional research on the impact of nutrition labels in low- and middle-income countries should be considered a priority. Even among the Western countries included in this review, there are important differences in labelling regulations that were not fully examined. The diversity in study protocols, measures and samples also presents challenges in terms of comparing studies. We have tried to note major differences wherever possible; however, it is likely that methodological differences between studies account for at least some of the variability in the findings. Finally, much of the evidence on the impact of nutrition labels is based on self-report data, which may over-report the use of nutrition labels, meaning that other factors, such as greater awareness of the link between nutrition and chronic disease, may be responsible for population-level changes over time that have been attributed to nutrition labels.

Conclusions

Population-level interventions and changes to the food environment are necessary to halt the rising health and economic burden from obesity. The evidence to date

indicates that nutrition labels on pre-packaged foods are a cost-effective population-level intervention with considerable reach. In order to capitalize upon the potential of nutrition labels, governments will need to explore new formats and different types of information content to ensure that nutrition information is accessible and understandable. A number of jurisdictions are in the process of developing new formats and revising labelling standards, such as the European Union[158]. There is an immediate need for evidence to inform these regulatory developments. Regulators should also consider expanding the scope of mandatory nutrition labelling. In the vast majority of jurisdictions, nutrition labelling regulations are limited to pre-packaged food products and do not apply to foods served in restaurants or fast-food outlets, which account for a significant proportion of dietary intake in many high-income countries[159,160]. Mandatory display of nutrition information on menus and menu boards of food outlets may be a promising means of increasing the impact of nutrition labelling regulations[161] and harmonizing nutrient information across information channels.

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Single-Larger-Portion-Size and Dual-Column Nutrition Labeling May Help Consumers Make More Healthful Food Choices

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ABSTRACT

Background The Food and Drug Administration is considering changes to the Nutrition Facts label to help consumers make more healthful choices.

Objective To examine the effects of modifications to the Nutrition Facts label on foods that can be listed as having 1 or 2 servings per container, but are reasonably consumed at a single eating occasion.

Design Participants were randomly assigned to study conditions that varied on label format, product, and nutrition profile. Data were collected via an online consumer panel.

Participants/setting Adults aged 18 years and older were recruited from Synovate's online household panel. Data were collected during August 2011. A total of 32,897 invitations were sent for a final sample of 9,493 interviews.

Intervention Participants were randomly assigned to one of 10 label formats classified into three groups: listing 2 servings per container with a single column, listing 2 servings per container with a dual column, and listing a single serving per container. Within these groups there were versions that enlarged the font size for "calories," removed "calories from fat," and changed the wording for serving size declaration.

Main outcome measures The single product task measured product healthfulness, the amount of calories and various nutrients per serving and per container, and label perceptions. The product comparison task measured ability to identify the healthier product and the product with fewer calories per container and per serving.

Statistical analyses performed Analysis of covariance models with Tukey-Kramer tests were used. Covariates included general label use, age, sex, level of education, and race/ethnicity.

Results Single-serving and dual-column formats performed better and scored higher on most outcome measures.

Conclusions For products that contain 2 servings but are customarily consumed at a single eating occasion, using a single-serving or dual-column labeling approach may help consumers make healthier food choices.

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NUTRITION INFORMATION IS REQUIRED ON MOST packaged foods and this information must be provided in a specific format as defined by the Food and Drug Administration (FDA) in the Code of Federal Regulations.[1] The main features of the label format include the serving size and number of servings per container, the number of calories per serving, the amount per serving in grams (or micrograms) of key macronutrients, and a percent daily value to help consumers understand how much 1 serving of the particular food contributes to a daily diet. Research has shown that most consumers use labels as least some of the time[2] and that when presented with Nutrition Facts (NF) labels, consumers can make more healthful choices.[3,4]

In response to the continued high levels of obesity in the United States,[5,6] the FDA has been considering changes to the food label to help consumers eat a more healthful diet and maintain a healthy weight. In 2003, FDA established an internal Obesity Working Group.[7] As a result of the ideas suggested by the group, FDA issued two Advance Notices of Proposed Rulemaking in 2005 requesting comments on format changes to the NF label. One Advance Notice of Proposed Rulemaking requested comments on whether and, if so, how to give greater emphasis to calories on the NF label, including by removing "calories from fat,"[8] and the other requested comments on whether and, if so, how to amend the agency's serving size regulations.[9]

Under current regulations,[1] there is some discretion for determining serving sizes for packaged foods that contain >1 serving but that are reasonably consumed in a single eating occasion. Examples of these types of products include a 20-oz soda and a "grab bag" of chips. The serving size amounts for these foods are based on reference amounts customarily con-

sumed (RACC) and are defined for a variety of food categories.[10] When the product contains between 100% and 200% of the RACC, it must be labeled as a single serving, but when it contains more than 200% of the RACC, the food may be labeled as 1 serving if it can be reasonably consumed in a single eating occasion. Products that have large RACCs (100 g or 100 mL or larger) and that contain between 150% and 200% of the RACC may be labeled as 1 or 2 servings. For example, the RACC for soda is 240 mL (8 fl oz). A soda container with >480 mL (16 fl oz) may be labeled as 1 serving if it can be reasonably consumed in a single eating occasion, but otherwise must be labeled as 2 or more servings.

Recent research has suggested that environmental factors, including the size of packages, may significantly influence how much consumers eat.[11] Consumers may not fully consider serving size information when using food labels and may, therefore, make inappropriate conclusions about the nutrient content of a packaged food.[12,13] Two labeling remedies have been suggested to make the actual nutrient content for these products more obvious to consumers: a dual-column approach that highlights that there is >1 serving per container by presenting nutrition information for 1 serving and for the entire container, and changing the labeling rules to require these products to declare nutrition information for the entire container (ie, define the entire container as a single serving). Dual-column labeling formats and labeling these types of products as a single serving were rated favorably in a focus group study.[14] Other research has also suggested that dual-column or single-serving labeling may help consumers make more informed choices.[12,15] However, no quantitative study has directly examined how these two remedies compare to alternative remedies. Our study presents the results of an online experiment evaluating the effect of format changes on products that have 1 or 2 servings per container but that are customarily consumed at a single eating occasion.

METHODS

Study Design and Procedures

The experiment used a 10 (label format)×2 (product category)×2 (nutritional profile per category—one fixed as more healthful than the other) between-subjects design. The 10 labeling formats shown in Figure 1 can be classified into three groups: listing 2 servings per container with a single column ("two servings, single-column"), listing 2 servings per container with a dual column ("two servings, dual-column"), and listing 1 serving per container (one serving, single-column). There were five formats in the two servings, single-column grouping: 1) current NF label "control"; 2) current label, but without "calories from fat"; 3) current label, without "calories from fat" and with the font for calories enlarged; 4) changed wording for serving size declaration to emphasize that there were two servings per container and removed calories from fat; and 5) dual listing for calories, in which the calories per serving and calories per container were declared, but the remaining nutrients were declared only per serving, and calories from fat was removed. The two servings, dual-column grouping consisted of three similar label formats: 6) all information (ie, calories, weight amounts, and percent daily values [%DVs]) for a single serving and for the full container appeared in separate columns; 7) same as the previous dual column but without "calories from fat"; and 8) a dual column in which only the calories and %DVs for a single serving and for the full container appeared in separate columns (without "calories from fat"). There were two label formats in the one serving, single-column grouping, both of which labeled the product as having a single, large serving: 9) like the control label, but without "calories from fat"; and 10) like the control label, but without "calories from fat" and with the font for calories enlarged. The two product categories were a frozen meal and a "grab bag"–sized bag of chips. Within each product category there were two products, one that was more healthful and one that was less healthful. The nutrient profiles of the products were based on frozen meal and chip products found on the market. The formats and nutrition profiles are shown in Figure 1 and Table 1, respectively.

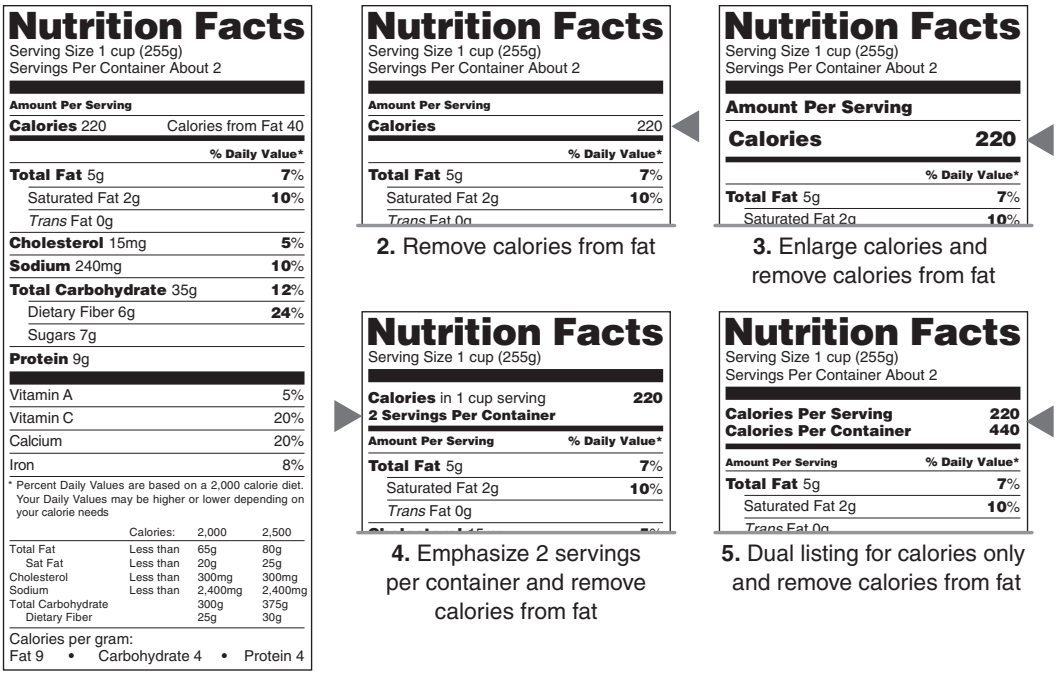
Participants were invited by e-mail to a website to complete the study online. After accessing the website, participants were randomly assigned to an experimental condition and were asked to complete two sets of tasks, which were followed by a set of questions about participants' use of food labels in general and demographics. For the first task set ("Single Product Task"), participants viewed one product NF label (randomly assigned from 40 possible combinations of product×nutrition profile×format) and answered a series of questions about the information shown on that NF label. For the second task set ("Choice Task"), participants were shown a pair of product NF labels (either for two frozen meals or for two bags of chips). One label showed the more healthful nutrition profile, and the other showed the less healthful profile. Depending on the experimental condition assigned, the label formats for both products could be the same or could be different. The purpose of the Choice Task was to explore how participants' ability to compare products might be affected by the NF label format modifications in two scenarios: when comparing labels of the same format, and when comparing labels with different formats. For the latter scenario, representative label formats (label numbers 2, 3, 7, 9, and 10 in Figure 1) were selected based on input provided from nutrition experts within FDA. The order of the Single Product Task and Choice Task was counterbalanced, as was the screen position (right or left) where the more healthful product appeared in the Choice Task. In addition, the product category viewed in the Single Product Task and Choice Task was counterbalanced: participants who saw a NF label for a frozen meal in the Single Product Task saw NF labels for chips in the Choice Task, and vice versa.

Before conducting the experiment, two sets of six in-person cognitive interviews and two sets of 50 online pretests were conducted to ensure that the study questionnaire and stimuli were understandable, that respondents could provide informative answers, and that the overall study time averaged about 15 minutes. Cognitive interview participants were selected from a list maintained by the interview facility, and pretest participants (who were not included in the final study) came from the ePanel described below.

Participants

Participants for this study were recruited from Synovate's Global Opinion Panels, Internet ePanel, a commercially available online research panel of 1 million households and 2 million individuals. This panel was chosen because it covers a wide range of US consumers and has been used before for

A. Two servings, single-column formats



1. Current label

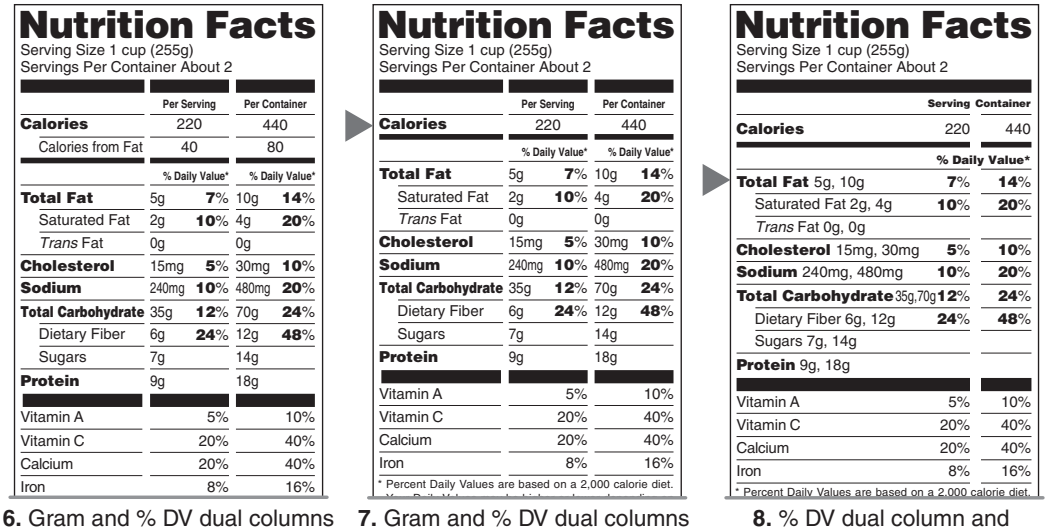
2. Remove calories from fat

3. Enlarge calories and remove calories from fat

4. Emphasize 2 servings per container and remove calories from fat

5. Dual listing for calories only and remove calories from fat

B. Two servings, dual-column formats



6. Gram and % DV dual columns

7. Gram and % DV dual columns and remove calories from fat

8. % DV dual column and remove calories from fat

C. One serving, single-column formats

9. Remove calories from fat

10. Enlarge calories and remove calories from fat

Figure 1. Label formats shown to participants in a study to examine whether modifications to the Nutrition Facts label can help consumers make more healthful choices. Full Nutrition Facts labels were shown to participants but have been truncated in this Figure below the gray line to save space. Arrows did not appear on the labels shown to participants, but have been added here to emphasize changes.

Table 1. Nutrition profiles of the four food products shown to participants in a study to examine whether modifications to the Nutrition Facts label can help consumers make more healthful choices

	Chips A		Chips B		Frozen Meal A		Frozen Meal B	
Nutrient	g or mg	%DV[a]	g or mg	%DV	g or mg	%DV	g or mg	%DV
Calories	140		180		220		300	
Calories from fat	60		80		40		80	
Total fat	8	10	10	15	5	7	9	13
Saturated fat	1	5	2	8	2	10	4.5	23
Trans fat	0		0		0		0	
Cholesterol (mg)	0	0	0	0	15	5	30	10
Sodium (mg)	120	5	240	10	240	10	600	25
Total carbohydrate	19	6	25	7	35	12	30	10
Dietary fiber	3	10	1	6	6	24	4	16
Sugars	2		3		7		8	
Protein	2		2		9		11	
Vitamin A		5		2		5		2
Vitamin C		0		0		20		4
Calcium		0		2		20		15
Iron		2		0		8		6

[a]%DV=percent daily value.

similar types of experimental studies.[16,17] Panel members are volunteers who are aged 18 years or older, mostly recruited though online marketing programs and referrals from existing members. Synovate maintains the panel on an ongoing basis by monitoring for and removing overused households, poor-returning households, and households from which surveys are returned as undeliverable. Panelist demographic and contact information are routinely updated throughout the year. Panel members typically participate in 12 to 14 studies per year. Although not paid for their participation in specific surveys, panel members are offered incentives in the form of sweepstakes entries (where winners can receive cash prizes between $10 and $500 in a 1-month period) and a redeemable points reward program (where 1,000 points=$1) for their participation.

The survey program incorporated multiple levels of data security. First, the website at which the survey could be accessed was secured and only allowed respondents with a valid ID and passcode to enter. Upon entering, participants were encouraged to complete the survey in a single session, but were permitted to exit before finishing and to re-enter the survey (again, only with their ID and passcode) at the point where they left off. However, once participants completed the questionnaire, the passcode could not be re-used, nor could the entered data be altered. The website was firewalled so that respondents could enter only the survey for which their ID and passcode were assigned.

Study invitations were sent out in cycles and were targeted to panelists to produce a sample that reflected the US population. By periodically examining the incoming sample for demographic criteria, additional e-mails could be broadcast in a staggered manner to increase the likelihood that the final sample matched the 2010 US census for sex, age, education, and race/ethnicity, region, income, and household size. Data collection was carried out during August 2011. A total of 32,897 study invitations were sent for a final sample of 9,493 completed interviews for a completion rate of 28.8%. The study protocol was approved under exempt review by the FDA Institutional Review Board.

Measures

There were four main outcome measures for the Single Product Task, all employed in or adapted from prior research.[2,18-20] The first measure was participants' overall rating of product healthfulness within the product category (chips or frozen meal) on a 5-point scale (1=not at all healthy, 5=very healthy) ("Assume you were going to eat a frozen meal [chips], how healthy of a choice would this frozen meal [chips] be?"). The second measure ("total correct") was the number of correct responses to eight questions about the nutrient content of the product (eg, "How many grams of total fat are in one serving of these chips?" and "How many grams of dietary fiber are in the whole container of these chips?"). An index was calculated by adding one point for each correctly answered question (range=0 to 8; Cronbach's α=.84). The third measure focused on a single item from the eight nutrient content questions, namely, whether participants correctly identified the number of total calories per container. We analyzed this item independently to determine how the label formats specifically affected participants' ability to determine the number of calories associated with consuming an entire container of food. The fourth measure was a five-item scale assessing participants' evaluation of the label format itself.

The items in this label perception index asked participants to rate (1=not at all, 5=very) how useful, trustworthy, helpful, and the like they considered the label format to be (Cronbach's α=.82).*

There were three main measures for the Choice Task. The first measure was based on participants' responses to the question, "Based on what you can see on the labels, if you wanted to buy the healthier product, which of these two products would you select?" If participants chose the product with fewer calories, less fat and sodium, and more positive nutrients, then the answer was considered correct; otherwise, the answer was considered incorrect. The second measure asked participants to identify which product in the pair had the fewest calories per container, and the third measure asked participants to select the product with fewer calories per serving.

Because previous research has shown that individual differences in general label use and demographics can influence label use in a specific situation[3,21] participants were asked how often they use the NF label when deciding to buy a food product (1=never, 4=often). Demographic variables included: age, sex, level of education, and race/ethnicity.

Statistical Analysis

Four analysis of covariance models (ANCOVAs) were estimated for the Single Product Task and three ANCOVAs for the Choice Task. Each dependent variable was modeled as a function of label format, product (chips or frozen meal), nutrition profile (more or less healthful for the Single Product Task), and covariates (ie, general label use, age, sex, level of education, and race/ethnicity). A Tukey-Kramer test set at the 0.05 level was used to compare the adjusted means for each label format. The analysis was conducted in SAS 9.2 (1999, SAS Institute, Inc).

RESULTS

Single Product Task

Table 2 shows the sample characteristics. More than 70% of participants report using the NF label either sometimes or often. This is similar to the results from the 2008 FDA Health and Diet Survey.[2]

The ANCOVA results for the four outcome measures are shown in Table 3. In the Single Product Task, the only label format modification that appeared to consistently affect healthfulness ratings was the modification that defined the entire container as a single serving (formats 9 and 10 in Figure 1): participants who saw products labeled as having 1 serving per container rated the product less healthful than participants who saw products labeled with any other format, including the current label control, that indicated the product had 2 servings per container ($P<0.05$). Among the label formats indicating 2 servings per container, there were not many statistically significant different mean scores on healthfulness. However, the two servings, dual-column label formats had slightly lower healthfulness scores than label formats that did not show the nutrition information for the entire package, although most of these differences were not statistically significant.

In contrast to the findings for healthfulness ratings, more than one format modification appeared to produce differences in the two measures of accuracy. The one serving, single-column formats and some of the two servings, dual-column formats performed the best. On the broad index of eight nutrient content questions, the one serving, single-column formats and the two serving, dual-column formats that had dual columns for both grams and for %DV (formats 6 and 7 in Figure 1) had the highest accuracy. The two servings, dual-column format that had dual columns only for %DV (format 8) and the format with the dual listing for calories only (format 5) had the next highest accuracy. Formats 1 through 4, which were all two servings, single column formats, had the lowest scores. Among these formats, the control label format (format 1) had the lowest accuracy.

The pattern is similar when looking at the narrower measure of the percentage that correctly identified the number of calories for the total package. The one serving, single-column

Table 2. Descriptive sample characteristics of subjects (N=9,493) in a study to examine whether modifications to the Nutrition Facts label can help consumers make more healthful choices

Characteristic	Response	
	Mean±*SD*[a]	
Age (y)	46±15.5	
Body mass index	28.5±7.1	
	n	**%**
Sex		
Female	4,651	49.1
Race/ethnicity		
White, non-Hispanic	6,239	65.7
Black/African American	1,124	11.8
Hispanic/Latino	1,317	13.9
Asian, American Indian, Pacific Islander	603	6.4
Other/no answer	210	2.2
Education		
Less than high school	279	3.0
Completed high school	3,756	39.8
Some college	2,558	27.1
Completed college	2,843	30.1
Label use frequency		
Never	821	8.7
Rarely	1,680	17.9
Sometimes	3,113	33.1
Often	3,788	40.3

[a]SD=standard deviation.

Participants could answer "Don't Know" to any of the five perception questions. Such responses were omitted in constructing the perception index; therefore, the number of questions answered could be less than five.

Table 3. Mean ratings of healthfulness, label perception, total correct index, and percent correct calories per container given by subjects in a study to examine whether modifications to the Nutrition Facts label can help consumers make more healthful choices

Label format	Healthfulness rating[a] (n=8,660)	Total correct index[b] (n=9,219)	Percent correct total calories[c] (n=9,219)	Label perception index[d] (n=9,098)
A. Two servings, single-column formats				
1. Current label	2.91^{w}	4.43^{z}	63^{y}	3.65^{y}
2. Remove calories from fat	2.85^{wx}	4.52^{z}	67^{xy}	3.63^{y}
3. Enlarge calories and remove calories from fat	2.91^{w}	4.59^{yz}	67^{xy}	3.62^{y}
4. Emphasize 2 servings per container and remove calories from fat	2.90^{w}	4.69^{yz}	71^{x}	3.66^{y}
5. Dual listing for calories only and remove calories from fat	2.83^{wx}	4.84^{xy}	84^{w}	3.77^{wx}
B. Two servings, dual-column formats				
6. Dual column—g and %DV[e] columns	2.75^{wx}	5.08^{wx}	83^{w}	3.85^{w}
7. Dual column—g and %DV columns and remove calories from fat	2.77^{wx}	5.07^{wx}	85^{w}	3.83^{w}
8. Dual column—%DV only and remove calories from fat	2.70^{x}	4.85^{xy}	85^{w}	3.81^{wx}
C. One serving, single-column formats				
9. Remove calories from fat	2.29^{y}	5.34^{w}	83^{w}	3.70^{xy}
10. Enlarge calories and remove calories from fat	2.28^{y}	5.37^{w}	82^{w}	3.79^{wx}

[a]Healthfulness rating ranges from 1 (not at all healthy) to 5 (very healthy).
[b]Total correct index is based on eight questions. For each question the respondent could get it correct or incorrect. The index is the sum of the correct answers and can range from 0 to 8.
[c]Percent correct for total calories is based on being able to correctly identify the number of calories per container.
[d]Label perception index is based on five questions each with a 5-point scale. The index is divided by the number of questions answered such that it ranges from 1 (low perception) to 5 (high perception).
[e]%DV=percent daily value.
[wxyz]For each column, means with the same superscript letter (w, x, y, z) are not significantly different from each other, and means with different letters are significantly different. A Tukey-Kramer test set at the 0.05 level was used. The following covariates were included in the models: product name and healthfulness profile, age, sex, race, education, and label use before purchase.

formats, the entire set of dual-column formats, and the dual listing for calories only (format 5) did equally well, and all performed better than the remaining two servings, single-column formats (formats 1-4). Among the two servings, single-column formats, the format that emphasized that there were 2 servings per container (format 4) scored significantly higher than the control label format ($P<0.05$).

On label perception ratings, dual-column formats, including the format with a dual listing for calories only (format 5), were rated more positively than the other two servings, single-column formats ($P<0.05$).

Choice Task

In addition to evaluating a single product, participants were asked to compare NF labels for a more and less healthful version of the same product (Choice Task). They could have seen either the same or different label formats for both product versions. When participants compared products labeled with the same format, label format did not have a significant effect on participants' ability to determine the more healthful of the two products ($F=1.76$, $P>0.05$), or which one had fewer calories per container ($F=1.19$, $P>0.05$). Across all experimental conditions, the vast majority of respondents correctly identified the more healthful product (88%) and the one with fewer calories per container (90%). On the other hand, label format did affect participants' accuracy in selecting the product with fewer calories per serving ($F=3.64$, $P<0.01$). Post hoc comparisons showed that participants who saw two servings, dual-column labels were slightly less accurate on average when reporting calories per serving (about 93% correct) than participants who saw more traditional single-column formats (about 96% correct).

When participants compared products labeled with different formats (ie, mixed-format comparisons), other differences were observed (results shown in Table 4). Because there were no significant differences between comparisons involv-

Table 4. The three outcome measures for the Choice Task involving the comparison of different label formats in a study to examine whether modifications to the Nutrition Facts label can help consumers make more healthful choices

Label format	Percent correct healthier (n=4,627)	Percent correct fewer calories per container (n=4,627)	Percent correct fewer calories per serving (n=4,627)
Easy comparisons[a]			
Two servings, single-column vs one serving, single-column	86[w]	86[w]	89[w]
Two servings, dual column vs one serving, single-column	81[w]	80[x]	87[w]
Two servings, dual-column vs two servings, single-column	81[w]	84[wx]	89[w]
Hard comparisons[b]			
Two servings, single-column vs one serving, single-column	44[z]	45[z]	74[y]
Two servings, dual-column vs one serving, single-column	51[y]	64[y]	75[y]
Two servings, dual-column vs two servings, single-column	75[x]	68[y]	81[x]

[a]The task was considered "easy" when looking at the calories line without considering the number of serving per container would lead to the correct answer; that is, the number of calories per serving for the healthier product was less than both the number of calories per serving and per container on the unhealthy version.
[b]The task was considered "hard" when looking at the calories line without considering the number of serving per container could lead to the wrong answer.
[wxyz]For each column, percentages with the same superscript letter (w, x, y, z) are not significantly different from each other, and percentages with different letters are significantly different. A Tukey-Kramer test set at the 0.05 level was used. The following covariates were included in the models: product name and healthfulness profile, age, sex, race, education, and label use before purchase.

ing formats 2 and 3 or between comparisons involving formats 9 and 10, their scores were combined for this analysis. For each of the three mixed-format comparisons (two servings, single-column vs one serving, single-column; two servings, dual-column vs one serving, single-column; and two servings, dual-column vs two servings, single-column), there was an "easy" and "hard" version of that comparison (see Figure 2). The task was considered "easy" when a participant could rely on the calorie declaration without considering the number of servings per container to derive the correct answer in all cases (ie, the number of calories per serving for the more healthful product was less than both the number of calories per serving and per container for the less healthful version). Conversely, the task was considered "hard" when looking at calories without considering the number of serving per container could lead to the wrong answer.

As shown in Table 4, for all three dependent measures, participants did significantly better on the "easy" comparisons than on the "hard" comparisons ($P<0.05$). There were very few differences between the label format comparisons for the "easy" comparisons. However, for the "hard" comparisons, the presence of a dual-column format in a mixed label format comparison increased the percentage of participants who could correctly identify the more healthful product or the one with fewer calories per container ($P<0.05$). For example, in the "hard" experimental conditions where both label formats were a single-column format and the more-healthful product was labeled as containing 1 serving per container, whereas the less-healthful product was labeled as containing 2 servings per container, only 44% of participants could correctly identify the more healthful product. This percentage increased to 51% ($P<0.05$) when a dual-column label was compared with the one serving, single-column format and to 75% ($P<0.05$) when a dual-column label was compared to a two servings, single-column label. Similarly, only 45% of participants could correctly identify the product with fewer calories per container when the two servings, single-column formats were compared with the one serving, single-column formats. This increased to 64% and 68%, respectively ($P<0.05$ for both), when the dual-column format was compared with the one serving, single-column formats and the two servings, single-column formats.

Among the "hard" comparisons, participants were better at choosing the product with fewer calories per serving than at identifying the product with fewer calories per container or the more healthful product. The former task may have been relatively easier than the other two tasks because all labels prominently displayed the number of calories per serving and multiplying the number of servings by 2 was not necessary to obtain the correct answer. When participants had to identify the product with fewer calories per serving, only the "hard" comparison involving the dual-column format vs the two servings, single-column format resulted in higher scores (81% correct compared with 74% and 75% correct). In other words, there was no difference in the percent that could correctly identify the product with fewer calories per serving between the "hard" comparisons involving the one serving, single-column format. This may be because for the "hard" comparisons with the one serving, single-column format, the label with the fewer calories per serving was always the "less-healthy" product and the product with more calories per the entire package. This contradiction between which product had fewer calories per serving and which had fewer calories per container may have confused some participants.

DISCUSSION

Using an online experimental design, this research evaluated participants' ability to use and their preference for nine modified nutrition labels and a current label control. Because the focus was on testing changes to serving size declarations and the effects of emphasizing calories on the label, all products

A. "Easy" example

This is an "easy" comparison since a participant could rely on the calorie declaration without considering the number of servings per container in order to derive the correct answer in all cases (i.e., the number of calories per serving for the more healthful product was less than both the number of calories per serving and per container for the less healthful version).

Nutrition Facts
Serving Size 1 cup (255g)
Servings Per Container About 2

Amount Per Serving	
Calories	220
	% Daily Value*
Total Fat 5g	**7%**
Saturated Fat 2g	**10%**
Trans Fat 0g	
Cholesterol 15mg	**5%**
Sodium 240mg	**10%**
Total Carbohydrate 35g	**12%**
Dietary Fiber 6g	**24%**
Sugars 7g	
Protein 9g	
Vitamin A	5%
Vitamin C	20%
Calcium	20%
Iron	8%

* Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Nutrition Facts
Serving Size 2 cups (510g)
Servings Per Container 1

Amount Per Serving	
Calories	600
	% Daily Value*
Total Fat 18g	**26%**
Saturated Fat 9g	**46%**
Trans Fat 0g	
Cholesterol 60mg	**20%**
Sodium 1200mg	**50%**
Total Carbohydrate 60g	**20%**
Dietary Fiber 8g	**32%**
Sugars 16g	
Protein 22g	
Vitamin A	4%
Vitamin C	8%
Calcium	30%
Iron	12%

* Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

B. "Hard" example

This comparison is considered "hard" since failure to notice the number of servings per container could result in thinking the product on the left has fewer calories per container, when in fact, the product on the right has fewer calories per container.

Nutrition Facts
Serving Size 1 cup (255g)
Servings Per Container About 2

Amount Per Serving	
Calories	300
	% Daily Value*
Total Fat 9g	**13%**
Saturated Fat 4.5g	**23%**
Trans Fat 0g	
Cholesterol 30mg	**10%**
Sodium 600mg	**25%**
Total Carbohydrate 30g	**10%**
Dietary Fiber 4g	**16%**
Sugars 8g	
Protein 11g	
Vitamin A	2%
Vitamin C	4%
Calcium	15%
Iron	6%

* Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Nutrition Facts
Serving Size 2 cups (510g)
Servings Per Container 1

Amount Per Serving	
Calories	440
	% Daily Value*
Total Fat 10g	**14%**
Saturated Fat 4g	**20%**
Trans Fat 0g	
Cholesterol 30mg	**10%**
Sodium 480mg	**20%**
Total Carbohydrate 70g	**24%**
Dietary Fiber 12g	**48%**
Sugars 14g	
Protein 18g	
Vitamin A	10%
Vitamin C	40%
Calcium	40%
Iron	16%

* Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Figure 2. Examples of "easy" and "hard" comparisons for the Product Choice task in a study to examine whether modifications to the Nutrition Facts label can help consumers make more healthful choices.

tested could contain 1 or 2 servings, but were generally considered types that can reasonably be consumed at a single eating occasion. The main findings are that for single product evaluations, single serving per container labeling and dual-column formats generally performed better and scored higher on the label perception index than two servings, single-column formats, including the control label. In tasks where nutrition information for two products is displayed in the same label format, participants were very accurate in determining the healthier product and the one with fewer calories per container, regardless of the label format. When nutrition information was displayed in different formats, no performance differences were found for the "easy" comparisons where participants could identify the lower-calorie product without considering the number of servings per container. However, the presence of a dual-column format improved scores for "hard," mixed-format comparisons. Another main finding is that enlarging the font size for calories and removing "calories from fat" did not independently affect label usability as measured in this study.

These findings about the beneficial effects of one serving, single-column and two servings, dual-column labeling complement those of other studies.[12,14,15] Lando and Labiner-Wolfe[14] found in focus group research that participants repeatedly expressed displeasure with labels that listed ≥2 servings per container for products that they thought they would eat in a single eating occasion. Regardless of their math skills, many stated that doing calculations on food labels was not an interest or priority.[14] Antonuk and Block[15] found in an experimental study that nondieting participants ate less of a multiple-serving snack food when the food was labeled with a dual-column vs a single-column format. They speculate that dual columns may act as a contextual cue to highlight the number of servings per container and the amount consumed if the entire package is eaten and, hence, reduce consumption. Similarly, in our study, dual-column labeling may have made serving size more evident, especially when participants compared products that used different serving sizes to declare products' nutrition information.

Similar to findings of Mohr and colleagues,[12] our study found that labeling a food as having 1 serving per container (instead of 2 servings) caused participants to rate the products as being less healthful, whereas dual-column labeling did not have this effect. Thus, if one of the goals of improving nutrition labeling is to emphasize the relative healthfulness of various foods and perhaps decrease the rate at which individuals exceed their daily calorie needs, then labeling foods customarily consumed in a single eating occasion as a single serving may be more effective than dual-column labeling.

There are a number of plausible reasons why enlarging the font in which calories is displayed or removing "calories from fat" from the label did not improve participants' comprehension of the label over the current label. These changes may not have been noticed.[14] Or, even if they were noticed, they may not have helped cue respondents to notice the number of servings per container, which was the key for getting many of the questions correct. Participants who saw format 4, which emphasized serving size by changing the words and using boldface type (format 4), did somewhat better than those in the control label format group in assessing the total calories per container but not on other tasks. Perhaps because the placement of the "2 Servings Per Container" was directly under "Calories in 1 cup serving," this format was helpful in cueing participants that calories would need to be doubled. Nevertheless, this label format still required participants to do the math to determine the calorie and nutrient content of a container-sized portion.

This research has a number of strengths and limitations. In addition to the randomized, controlled, experimental design, the study included a large sample size that permitted many label format modifications to be compared simultaneously and allowed for the detection of small differences between the label formats. Also, by using a national consumer panel, a diverse range of individuals was included. The study was limited by the nature of showing people NF labels on a computer screen as opposed to showing them actual food labels. The labels shown on the computer screen were probably larger and easier to read than NF labels on actual packaged foods. Therefore, changes such as enlarging calories may not have had the same effect as on smaller packages where poor visibility could adversely affect comprehension. Also, the NF labels were the only information provided to participants while they answered questions about these products. In more realistic shopping or eating occasions, consumers may rely on other information in addition to, or in lieu of, the NF label, so it is uncertain how these label modifications would affect actual purchase and eating behavior. Moreover, although we found dual-column labeling to be effective, this type of labeling could perform worse on smaller-sized packages due to increased clutter. Additional research would be needed to determine how the various label modifications might perform in a more realistic setting, such as when consumers are comparing multiple products in a grocery store. Finally, although reflective of US census data on most demographics, the study sample had slightly higher levels of education than the general public. Therefore, comprehension of these alternative label formats among lower-educated consumers, especially those with limited literacy and numeracy skills, may need further examination in future research.

CONCLUSIONS

We found that on products that contain 2 servings but are customarily consumed at a single eating occasion, using a single serving per container or a dual-column labeling approach may help consumers make healthier food choices.

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STATEMENT OF POTENTIAL CONFLICT OF INTEREST

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