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Correlates of Self-Reported and Functional Understanding of Nutrition Labels across 5 Countries in the 2018 International Food Policy Study

Jasmin Bhawra,[1] Sharon I Kirkpatrick,[1] Marissa G Hall,[2] Lana Vanderlee,[3] James F Thrasher,[4,5] and David Hammond[1]

[1]School of Public Health Sciences, University of Waterloo, Waterloo, Ontario, Canada; [2]Department of Health Behavior, Gillings School of Global Public Health, and Lineberger Comprehensive Cancer Center, University of North Carolina, Chapel Hill, NC, USA; [3]École de Nutrition, Centre Nutrition, santé et société (Centre NUTRISS), and Institut sur la nutrition et les aliments fonctionnels (INAF), Université Laval, Québec, Canada; [4]Department of Health Promotion, Education, and Behavior, Arnold School of Public Health, University of South Carolina, Columbia, SC, USA; and [5]Center for Population Health Research, National Institute of Public Health, Cuernavaca, Morelos, México

ABSTRACT

Background: Nutrition labels on prepackaged foods are an important source of nutrition information; however, differences in comprehension of varying label formats can limit their use and effectiveness.

Objectives: This study examined levels and correlates of consumers' self-reported understanding of Nutrition Facts tables (NFts) and front-of-package (FOP) labels, as well as functional NFt understanding.

Methods: Adults (≥18 y) in Australia (n = 3901), Canada (n = 4107), Mexico (n = 4012), the United Kingdom (n = 5121), and the United States (n = 4445) completed online surveys in November/December 2018. Descriptive statistics summarized sample profiles by country. Linear regression models examined the association between label understanding (self-reported NFt and FOP, functional NFt) and consumer dietary behaviors, functional nutrition knowledge, and sociodemographic characteristics. NFt understanding was measured in all countries, with FOP labeling assessed only in Mexico, Australia, and the United Kingdom.

Results: Self-reported and functional NFt understanding was significantly higher in the United States and Canada ($P < 0.0001$). In adjusted analyses, functional NFt understanding was significantly higher among women compared to men ($P < 0.0001$); respondents from the "majority" ethnic group in their respective countries compared with minority ethnic groups ($P < 0.0001$); those with higher education levels ($P < 0.0001$) and functional nutrition knowledge compared with their lower education and nutrition knowledge counterparts ($P < 0.0001$), respectively; and those making efforts to consume less sodium, sugar, or fat compared with those not reporting dietary efforts ($P < 0.0001$). Self-reported FOP label understanding was significantly higher for interpretive labeling systems in Australia (health star ratings) and the United Kingdom (traffic lights) compared with Mexico's Guideline Daily Amounts (GDAs) ($P < 0.0001$).

Conclusions: Nutrition labels requiring greater numeracy skills (i.e., NFts, GDAs) were more difficult for consumers to understand than interpretive FOP labels (i.e., traffic lights). Differences in NFt and FOP label understanding by income adequacy and education suggest potential disparities in labeling policy effects among vulnerable subgroups. *J Nutr* 2022;152:13S–24S.

Keywords: nutrition label, nutrition facts table, front-of-package label, food labeling policy, consumer understanding, international

Introduction

Nutrition labels on food packages provide nutrient content information at the point-of-purchase to support consumers in making informed choices (1). Nutrition Facts tables (NFts)—tables in a standard format found on the back or side of packaged foods listing calories per serving and percentage daily value for key nutrients—are one of the most commonly used sources of nutrition information, particularly among consumers trying to modify their dietary intake (2, 3). However, studies have found that consumers generally struggle with interpreting and applying NFt information (4–7).

Poor NFt understanding has been observed across countries, with studies using both self-reported and functional tests of consumer label understanding identifying issues with numeracy (6–10). Indeed, consumers with lower education, income, or

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literacy are less likely to understand and therefore use NFts (4, 6, 8). These disparities in NFt understanding are troubling given those with lower socioeconomic status are also more vulnerable to poor dietary patterns and nutrition-related chronic disease due to other barriers in accessing healthy foods (11, 12).

In response to concerns about NFts, front-of-package (FOP) labels have been proposed as a policy solution for providing simple and interpretive nutrition information in a noticeable location on food packages (1, 13, 14). Several FOP labeling systems are in use globally and range in presentation (i.e., nutrient-specific compared with summary-indicator labels), design (i.e., various symbols, colours, sizes), and nutrient focus (13, 14). For example, nutrient-specific FOP labels [e.g., Guideline Daily Amounts (GDAs)] display information on specific nutrients from the NFt, often highlighting nutrients of public health concern such as sodium, saturated fats, and sugars (13, 14). Summary-indicator systems [e.g., Health Star Ratings (HSRs), Nutri-Score] summarize nutrient content and product healthfulness using algorithms to provide an overall score for the product (13, 14).

Overall, studies suggest FOP labels are easier for consumers to understand than NFts alone (1, 4, 15, 16). Among consumers with lower self-reported nutrition knowledge, income, and education, the preference for simpler FOP label designs is consistent with better understanding of these labeling systems (4, 17, 18).

Although many studies use self-reported measures of label understanding, consumers tend to overestimate their ability to use and apply label information (6, 10, 19), thereby making functional tests a preferred measure. Functional measures of label understanding, which commonly ask participants to complete a rating task comparing foods based on nutritional profile, have found that FOP labels have higher comprehension, and therefore greater potential to promote healthy food choices compared with numerical label formats such as the NFt or GDA (16–18, 20).

Label understanding is influenced by a variety of factors ranging from individual-level characteristics such as consumer nutrition knowledge and dietary practices, to broader nutrition education policies and national health promotion efforts (2, 3, 21). To date, few cross-country studies have been conducted examining understanding of nutrition labels, including potential disparities among subgroups. Using cross-sectional data from the International Food Policy Study (IFPS), this study aimed to determine levels and correlates of self-reported and functional nutrition label understanding across countries. In particular, 4 research questions were examined: *1*) What are the levels of self-reported (NFt and FOP) label and functional NFt understanding across Australia, Canada, Mexico, the United Kingdom, and the United States? *2*) Does self-reported FOP label understanding vary by label type (i.e., HSR compared with GDA)? *3*) Is self-reported label understanding associated with functional label understanding and nutrition knowledge? and *4*) Does label understanding vary by consumers' dietary behaviors or sociodemographic characteristics?

Methods

Study design and participants

This study used cross-sectional data from the 2018 wave of the IFPS (22). Respondents aged ≥18 y were recruited through Nielsen Consumer Insights Global Panel and their partners' panels, and completed web-based surveys in November/December 2018. The Nielsen panel is recruited using both probability and nonprobability recruitment methods in each country. After applying age- and sex-based quotas to facilitate recruitment of a diverse sample approximating known proportions in each country, e-mail invitations were sent to a random sample of panelists; panelists known to be ineligible were not invited. Surveys were conducted in English in Australia and the United Kingdom; in Spanish in Mexico; in English or French in Canada; and in English or Spanish in the United States. The median time to complete the survey across all countries was 40 min.

Of the 22,824 respondents who completed the 2018 IFPS survey, a subsample of 21,586 respondents from Australia (n = 3901), Canada (n = 4107), Mexico (n = 4012), the United Kingdom (n = 5121), and the United States (n = 4445) were included in the current study. Those with missing data for self-reported NFt understanding (n = 160), self-reported FOP label understanding (n = 153), functional NFt understanding (n = 29), Food Processing Knowledge (FoodProK) score (n = 17), dietary efforts (n = 122), food shopping role (n = 29), education (n = 69), ethnicity (n = 296), and income adequacy (n = 182) were excluded from analyses. All respondents provided informed consent prior to completing the survey and received remuneration in accordance with the panel's usual incentive structure (e.g., points-based or monetary rewards, chances to win prizes). The study was reviewed by and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE# 21460). More details can be found in the 2018 IFPS Technical Report (22).

Measures

Self-reported understanding of food labels.

Participants were shown an image of the NFt that appears on packages in their country and asked, "Do you find this information … 'very hard to understand,' 'hard to understand,' 'neither hard or easy to understand,' 'easy to understand,' or 'very easy to understand?'" In addition, participants in Australia, Mexico, and the United Kingdom were then shown an image of an FOP label for their respective countries and asked to respond to the same measure of self-reported understanding (**Figure 1**). This measure was adapted from the 2014 Food and Drug Agency Health and Diet Survey (23).

Functional NFt understanding.

Participants completed an online version of the Newest Vital Sign, which consists of 6 questions that test functional ability to use NFts (**Supplemental Table 1**). The Newest Vital Sign assesses respondents' ability to make mathematical calculations (numeracy), read and apply label information (prose literacy), and understand the label information (document literacy) (24). It thus serves not only as a proxy measure of health and nutrition literacy (25), but also as a functional measure of consumer NFt understanding. We adapted the Newest Vital Sign tool to the NFt design and layout mandated in each country (**Supplemental**

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Supplemental Tables 1 and 2 are available from the "Supplementary data" link in the online posting of the article and from the same link in the online table of contents at https://academic.oup.com/jn/.

Address correspondence to DH (e-mail: dhammond@uwaterloo.ca).

Abbreviations used: FoodProK, Food Processing Knowledge; FOP, front-of-package; GDA, Guideline Daily Amount; HSR, Health Star Rating; IFPS, International Food Policy Study; NFt, Nutrition Facts table; Q, question; r_s, Spearman's rank correlation coefficient.

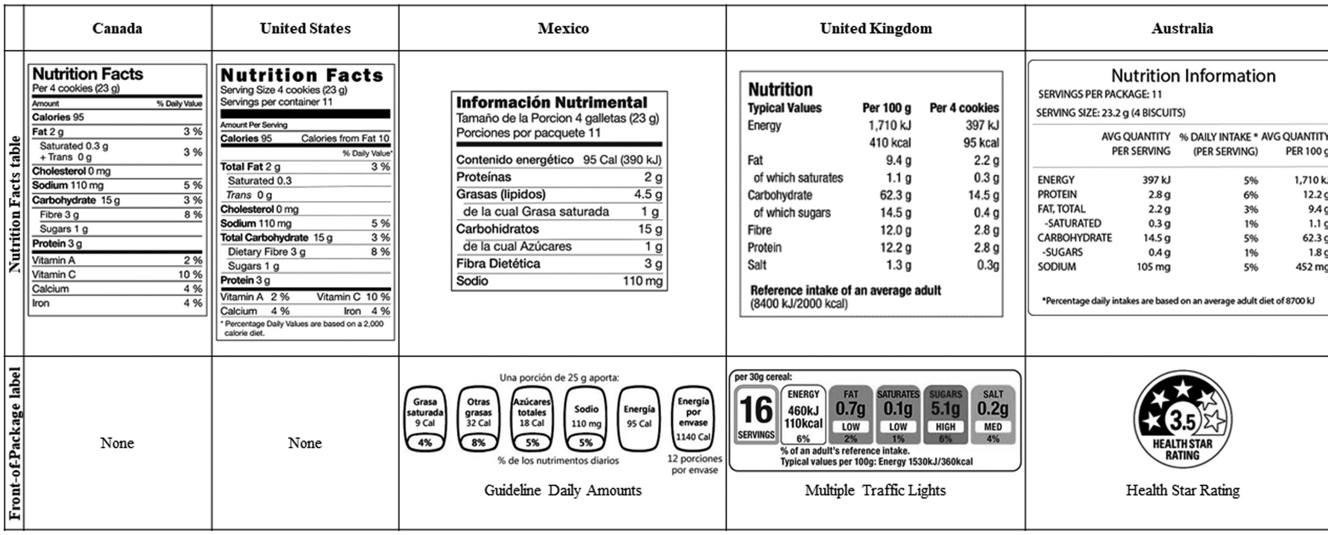

FIGURE 1 Food labels by country in the International Food Policy Study survey.

Table 2). A score between 0 and 6 was calculated based on the number of correct answers, with higher scores corresponding with a higher understanding of NFts.

Correlates of label understanding were selected based on evidence regarding associations between nutrition knowledge, dietary behaviors, and sociodemographic characteristics.

Functional nutrition knowledge.

Prior nutrition knowledge can influence consumers' understanding of nutrition labels (17, 21); hence, this survey assessed consumer nutrition knowledge using the FoodProK score, a functional test of nutrition knowledge based on level of food processing (26). Respondents viewed and rated images of 3 food products within each of 4 categories: fruits (apple, apple juice, apple sauce), meat (chicken breast, deli chicken slices, chicken nuggets), dairy (1% milk, cheese block, processed cheese slices), and grains (oats, cereal, cereal bar). Products in each category were selected based on availability in multiple international contexts, and to represent varied levels of processing according to the NOVA food classification system (27). The 12 product images and corresponding NFts and ingredients lists were displayed 1 at a time, in random order. For each product, respondents were asked, "Overall, how healthy is this food product?" and answered using a scale of 0 to 10, with 0 representing "not healthy at all" to 10 indicating "extremely healthy." Respondents' FoodProK scores (ranging from 0 to 8) were calculated based on whether they correctly ordered foods according to the NOVA classification for level of processing, with less-processed foods representing higher healthiness (26, 27).

Consumer dietary behaviors.

Dietary modification efforts, another possible predictor of label understanding, were measured by asking, "Have you made an effort to consume more or less of the following in the past year?" Respondents answered, "consume less," "consume more," or "no effort made," to a list of nutrients and food categories. This study focused on efforts in 5 categories that have received increasing attention in policies such as dietary guidelines within the 5 countries: "*trans* fats," "sugar/added sugars," "salt/sodium," "calories," and "processed foods" (18, 28–32). A value of −1 was assigned for any responses to "consume less," +1 for responses to "consume more," and 0 for "no effort made" in the 5 categories. Dietary modification efforts were recoded into a scale variable, with 5 points added to all responses to create a 0 to 10 scale where 0 represents "consume less" responses to all categories, 10 represents "consume more" responses to all categories, and the range between reflects all other response combinations.

Consumers with specific dietary practices, as well as those with a primary food shopping role in their households, are hypothesized to have greater interest in and exposure to labels. Respondents indicated whether they engaged in any of the following dietary practices: "vegetarian," "vegan," "pescatarian," "following a religious practice for eating (please specify)," or "none of the above." This variable was recoded as binary (no specific dietary practices = 0; ≥1 dietary practices = 1) (33). Food shopping role was captured using an adapted version of the USDA Eating and Health survey measure: "Do you do most of the food shopping in your household?" with response options "yes," "no," or "share equally with other(s)" (34).

Sociodemographic variables and BMI.

Nutrition label understanding has been shown to vary by sociodemographic and socioeconomic characteristics, which can contribute to greater disparities in nutrition outcomes (11, 35). Age, sex at birth (female or male), country (Australia, Canada, Mexico, United Kingdom, United States), and derived variables for education and minority race/ethnicity were included in analyses. Less than 1% ($n = 113$) of IFPS respondents reported a gender different than their biological sex, which was insufficient for providing robust estimates in modeling. Hence, sex at birth was used as a binary covariate. Education level was categorized in accordance with country-specific criteria, with respondents classified as having "low" (high school completion or lower), "medium" (some post–secondary school qualifications, including some university), or "high" (university degree or higher) levels of education (36–39). Ethnicity was assessed using country-specific race/ethnicity categories and analyzed as a derived variable (majority/minority/unstated) to accommodate different measures across countries. To enable cross-country comparisons, respondents were categorized as "majority" in Mexico if they identified themselves as "non-Indigenous," and "majority" in Australia, Canada, the United Kingdom, and the United States if they identified themselves as "white," predominantly English-speaking, or non-Indigenous based on country-specific ethnic identity questions (38–41). Income adequacy was assessed by asking, "Thinking about your total monthly income, how difficult or easy is it for you to make ends meet?" with Likert scale response options "very difficult," "difficult," "neither easy nor difficult," "easy," and "very easy" (42).

Categorization of BMI (kg/m^2) followed WHO criteria (43), with self-reported height and weight used to classify respondents based on BMI <18.5, 18.5–24.9, 25.0–29.9, and ≥30. Response options "don't know" and "refuse to answer" were provided for all survey questions and recoded as missing. Given the large number of cases with missing height and weight data—including those who selected "don't know" or "refuse to answer"—a separate category for "missing" was created and retained as a response category for analyses.

TABLE 1 Sample characteristics ($n = 21{,}586$), International Food Policy Study, 2018[1]

Characteristic	Australia ($n = 3901$), % (n)	Canada ($n = 4107$), % (n)	Mexico ($n = 4012$), % (n)	United Kingdom ($n = 5121$), % (n)	United States ($n = 4445$), % (n)
Age group					
18–29 y	21.3 (831)	18.9 (777)	29.8 (1194)	19.0 (974)	20.6 (914)
30–44 y	26.2 (1022)	24.7 (1014)	32.3 (1297)	24.8 (1270)	25.1 (1115)
45–59 y	24.7 (963)	25.8 (1059)	28.7 (1151)	25.9 (1327)	25.7 (1141)
≥60 y	27.8 (1085)	30.6 (1257)	9.2 (370)	30.3 (1550)	28.6 (1275)
Sex					
Male	48.7 (1898)	49.4 (2028)	47.6 (1911)	47.8 (2448)	48.2 (2141)
Female	51.3 (2003)	50.6 (2079)	52.4 (2101)	52.2 (2673)	51.8 (2304)
Ethnicity[2]					
Majority	76.1 (2969)	79.9 (3280)	78.7 (3156)	89.1 (4563)	76.1 (3382)
Minority	23.9 (932)	20.1 (827)	21.3 (856)	10.9 (558)	23.9 (1063)
Education level[3]					
Low	41.6 (1622)	41.0 (1683)	19.5 (782)	47.6 (2438)	58.2 (2585)
Medium	32.6 (1272)	34.1 (1400)	13.2 (531)	23.5 (1203)	10.0 (443)
High	25.8 (1007)	24.9 (1024)	67.3 (2699)	28.9 (1480)	31.8 (1417)
Income adequacy					
Very difficult to make ends meet	8.5 (331)	8.4 (345)	12.0 (482)	6.8 (349)	9.4 (416)
Difficult to make ends meet	19.2 (750)	19.6 (804)	31.7 (1273)	18.5 (949)	20.3 (902)
Neither easy nor difficult to make ends meet	37.8 (1473)	36.8 (1511)	38.9 (1559)	36.0 (1844)	33.7 (1497)
Easy to make ends meet	23.6 (921)	22.5 (927)	13.9 (557)	24.7 (1265)	21.8 (970)
Very easy to make ends meet	10.9 (426)	12.7 (520)	3.5 (141)	14.0 (714)	14.8 (660)
BMI, kg/m^2					
≤18.5	3.1 (122)	3.2 (133)	2.1 (85)	2.9 (150)	3.4 (153)
18.5–24.9	36.3 (1416)	33.5 (1376)	39.6 (1588)	34.8 (1780)	31.2 (1385)
25.0–29.9	26.6 (1039)	28.8 (1183)	30.1 (1208)	27.0 (1384)	27.6 (1226)
≥30.0	20.9 (815)	24.7 (1015)	15.5 (620)	17.0 (870)	27.4 (1218)
Missing	13.1 (509)	9.8 (400)	12.7 (511)	18.3 (937)	10.4 (463)
Food shopping role					
Primary shopper	71.6 (2792)	72.0 (2959)	74.9 (3005)	74.6 (3820)	73.2 (3255)
Not primary shopper	6.9 (268)	5.9 (242)	5.0 (201)	4.5 (230)	6.6 (293)
Shared equally with others	21.5 (841)	22.1 (906)	20.1 (806)	20.9 (1071)	20.2 (897)
Dietary practices					
No specific dietary practices	87.1 (3396)	90.4 (3714)	88.2 (3539)	86.8 (4446)	88.6 (3936)
≥1 dietary practices (i.e., vegetarian, vegan, pescatarian, religious practices)	12.9 (505)	9.6 (393)	11.8 (473)	13.2 (675)	11.4 (509)
Dietary efforts score[4,5]	2.7 (2.2)	2.6 (2.1)	2.5 (2.3)	3.0 (2.1)	2.9 (2.3)
FoodProK score[5,6]	5.0 (1.7)	5.1 (1.5)	4.8 (1.5)	4.9 (1.8)	4.6 (1.8)

[1] Data presented have been weighted. FoodProK, Food Processing Knowledge.
[2] "Majority" ethnicity refers to respondents who identified as "white," "predominantly English-speaking," or "non-Indigenous" based on country-specific ethnic identity questions.
[3] "Low" education refers to high school completion or lower, "medium" education refers to some post–secondary school qualifications including some university, and "high" refers to respondents who received a university degree or higher.
[4] The dietary efforts score reflects consumers' efforts to consume more or less of the following nutrient categories: *trans* fats, sugar/added sugars, salt/sodium, calories, and processed foods. On a scale of 0–10, 0 represents "consume less" responses to all categories, 10 represents "consume more" responses to all categories, and the range in between reflects all other response combinations.
[5] Mean and SD reported for dietary efforts and FoodProK score.
[6] The FoodProK score reflects consumers' functional nutrition knowledge based on level of food processing. On a scale of 0–8, scores reflect whether respondents correctly ordered foods according to the NOVA classification for level of processing, with higher scores reflecting higher functional nutrition knowledge.

Statistical analysis

Descriptive statistics were used to summarize the sample profile and labeling outcomes by country. Analyses were conducted only on respondents who had complete data from all variables, with the exception of BMI, as described above. Hypotheses and the analytic plan were specified before data collection based on current evidence.

Using pooled data from all the countries where the relevant question was asked, 3 multiple linear regression models were fitted to examine self-reported NFt understanding (all countries), FOP label understanding (Australia, United Kingdom, Mexico), and functional NFt understanding (all countries). All models were adjusted for sociodemographic characteristics (age, sex, country, income adequacy, education level, ethnicity), consumer dietary behaviors (food shopping role, dietary efforts and practices), BMI, and functional nutrition knowledge (FoodProK score). Multiple comparisons were conducted to assess all pairwise contrasts for categorical variables. The Benjamini–Hochberg procedure was applied to decrease the false detection rate following multiple exploratory tests (44). All statistically significant pairwise contrasts are reported after applying the Benjamini–Hochberg procedure, assuming a false discovery rate of 10%. Spearman rank correlation tested bivariate associations between self-reported NFt understanding, self-reported FOP understanding, and functional NFt understanding (Newest Vital Sign score).

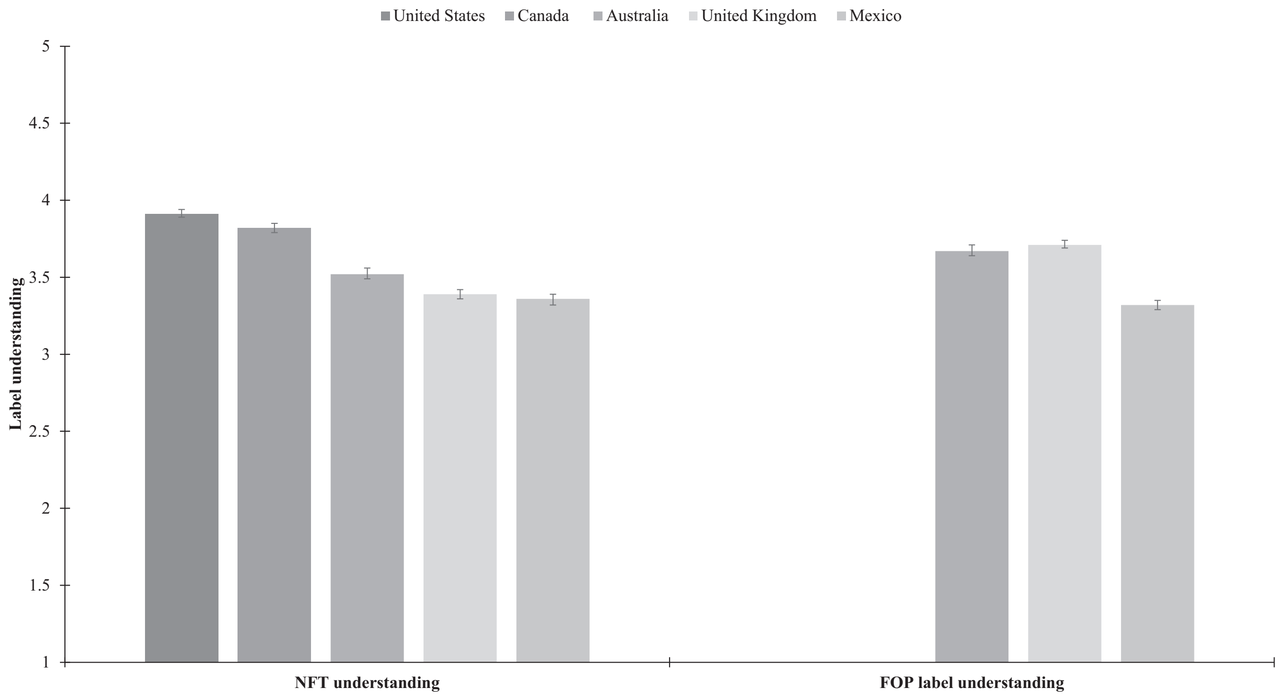

FIGURE 2 Self-reported understanding of Nutrition Facts tables (NFts) and front-of-package (FOP) labels, by country. Participants rated their level of label understanding, where 1 = very hard to understand, 2 = hard to understand, 3 = neither hard or easy to understand, 4 = easy to understand, and 5 = very easy to understand. Mean levels of self-reported understanding are shown with 95% CIs. For NFt understanding, all cross-country differences in means are statistically significant ($P < 0.001$) with the exception of the United Kingdom compared with Mexico. For FOP label understanding, all cross-country differences in means are statistically significant ($P < 0.001$).

Statistical analyses were conducted using SAS Studio (SAS Institute). Parameter estimates are reported with 95% CIs. Data were weighted with poststratification sample weights constructed using a raking algorithm with population estimates from respective country-based censuses based on age group, sex at birth, region, ethnicity (except in Canada), and education (except in Mexico) (22). All reported estimates are weighted.

Results

Sample characteristics are presented in Table 1.

Self-reported and functional label understanding across countries

Respondents from the United States self-reported significantly higher NFt understanding than respondents from Canada, Australia, the United Kingdom, and Mexico (Figure 2). All other cross-country differences in means were statistically significant ($P < 0.001$), with the exception of the United Kingdom compared with Mexico. For FOP labels, the mean level of understanding for traffic lights and HSR labels was higher than GDA labels ($P < 0.0001$), respectively. When comparing NFt with FOP labels, self-reported FOP label understanding was significantly higher than NFt understanding in Australia and the United Kingdom ($P < 0.0001$), whereas FOP label understanding was significantly higher than NFt label understanding in Mexico ($P < 0.0001$).

Table 2 shows functional NFt understanding in each of the 5 countries. Respondents in all countries had the highest proportions of correct answers for questions pertaining to nut allergies, and the lowest proportion of correct answers for the question regarding concentrations of saturated fats. A greater number of respondents received full scores for questions requiring minimal or no mathematical calculations [i.e., question (Q) 5 and Q6].

In general, self-reported NFt understanding was greater with higher Newest Vital Sign scores (i.e., functional NFt understanding), with a few exceptions in Mexico and the United States (Table 3). Self-reported FOP label understanding similarly was greater with higher Newest Vital Sign scores.

Functional NFt understanding was weakly correlated with self-reported understanding of NFt labels [Spearman's rank correlation coefficient (r_s) = 0.18, $P < 0.0001$] and self-reported understanding of FOP labels ($r_s = 0.16$, $P < 0.0001$). Self-reported NFt and FOP understanding were moderately correlated ($r_s = 0.51$, $P < 0.0001$).

Cross-country differences and correlates of NFt and FOP label understanding

As shown in Table 4, respondents from the United States, Canada, and Australia self-reported significantly higher NFt understanding than respondents from Mexico ($P < 0.0001$). Additional pairwise contrasts (data not shown) demonstrated that respondents from Australia reported significantly lower NFt understanding than respondents from Canada (β: −0.27; 95% CI: −0.33, −0.22; $P < 0.0001$) and the United States (β: −0.41; 95% CI: −0.45, −0.35; $P < 0.0001$), and higher NFt understanding than UK respondents (β: 0.15; 95% CI: 0.10, 0.20; $P < 0.0001$). Respondents from Canada and the United Kingdom reported lower NFt understanding than those from the United States (β: −0.13; 95% CI: −0.18, −0.01; $P < 0.0001$; and β: −0.56; 95% CI: −0.61, −0.51; $P < .0001$, respectively), and respondents in Canada reported higher NFt understanding than UK respondents (β: 0.43; 95%

TABLE 2 Functional understanding of Nutrition Facts tables, by country ($n = 21,586$)[1]

Country	Newest Vital Sign questions[2] Q1: calorie content, % (*n*)	Q2: carbohydrates, % (*n*)	Q3: saturated fats, % (*n*)	Q4: percentage daily value, % (*n*)	Q5: allergy safety, % (*n*)	Q6: allergy rationale, % (*n*)	Total score[3] (mean ± SD)
Mexico ($n = 4012$)	41.7 (1675)	41.5 (1667)	37.7 (1512)	44.9 (1803)	62.0 (2489)	56.2 (2253)	2.84 ± 1.99
United Kingdom ($n = 5121$)	55.8 (2856)	53.2 (2726)	44.0 (2253)	48.3 (2473)	61.7 (3161)	55.8 (2860)	3.19 ± 2.22
Australia (N = 3901)	52.6 (2053)	46.3 (1805)	41.2 (1618)	49.6 (1935)	66.3 (2585)	60.8 (2373)	3.23 ± 2.12
United States ($n = 4445$)	64.9 (2883)	55.0 (2444)	44.9 (1995)	53.0 (2357)	68.8 (3057)	63.1 (2807)	3.50 ± 2.12
Canada ($n = 4107$)	62.7 (2576)	61.5 (2525)	45.0 (1848)	61.0 (2505)	72.0 (2959)	67.2 (2762)	3.69 ± 1.97

[1]Data presented have been weighted.
[2]% refers to total percentage of respondents who answered the Newest Vital Sign question correctly in each country, and "*n*" refers to the total number in the sample.
[3]Scores range from 0 to 6, with higher scores representing greater understanding of Nutrition Facts tables.

CI: 0.38, 0.48; $P < 0.0001$). Respondents from Australia and the United Kingdom reported significantly higher FOP label understanding than respondents from Mexico (β: 0.41; 95% CI: 0.35, 0.47; $P < 0.0001$; and β: 0.38; 95% CI: 0.32, 0.44; $P < 0.0001$).

Respondents from Australia, Canada, the United Kingdom, and the United States scored significantly higher on the Newest Vital Sign measure than respondents in Mexico, indicative of higher functional NFt understanding (Table 5). Functional NFt understanding in respondents in Australia was significantly lower compared with Canadian and US respondents, adjusting for other covariates. Respondents from Canada received significantly higher scores for functional NFt understanding than those in the United Kingdom, and UK respondents received significantly lower scores than US respondents. The differences in functional NFt understanding scores between respondents in Australia and the United Kingdom, and Canada and the United States were not statistically significant.

Self-reported NFt and FOP label understanding was higher in respondents with higher FoodProK scores, primary food shoppers, those who engaged in specific dietary practices, as well as respondents reporting efforts to consume less sodium, sugars, *trans* fats, calories, or processed food. Similarly, respondents who scored higher on the FoodProK, those who reported efforts to consume less sodium, sugars, *trans* fats, calories, or processed food, and those with higher self-reported NFt understanding received significantly higher scores for functional NFt understanding. In contrast to self-reported label understanding, respondents who were primary food shoppers had lower functional NFt understanding than those who were not primary food shoppers or who shared the responsibility equally with others in their households. Also, respondents engaging in vegetarian or other dietary practices had lower functional NFt understanding scores than those with no specific practice.

With respect to sociodemographic characteristics, self-reported NFt and FOP label understanding was lower with higher age. Education was not significantly associated with self-reported NFt understanding; however, self-reported FOP label understanding was higher in respondents with "high" education compared with "low" education levels. Both self-reported NFt and FOP label understanding were higher with higher income adequacy. Sex and ethnicity were not significantly associated with self-reported label understanding. For functional NFt understanding, females, younger respondents, and those from "majority" ethnic groups in their respective countries scored higher than their male, older, or "minority" counterparts. Respondents with "high" education scored higher for functional NFt understanding compared with those with "medium" and "low" education levels.

Respondents with BMIs ≥ 30, between 25 and 29.9, <18.5, or "missing" self-reported lower NFt understanding compared with those with a BMI between 18.5 and 24.9. Moreover, respondents with missing BMI or BMI ≥ 30 self-reported lower NFt understanding compared with those with BMIs <18.5. Respondents with BMIs ≥ 30 also self-reported lower FOP label understanding compared with those with BMIs between 18.5 and 24.9. Similarly, respondents with missing BMI data scored significantly lower for functional NFt understanding compared with all other BMI categories

TABLE 3 Mean self-reported label understanding by Newest Vital Sign score across countries[1]

NVS score[2]	Self-reported NFt understanding (mean ± SD)[3,4] All countries	Canada	United States	Australia	United Kingdom	Mexico	Self-reported FOP label understanding (mean ± SD)[3,4] All countries	Australia	United Kingdom	Mexico
0	3.22 ± 1.15	3.33 ± 1.06	3.74 ± 1.07	3.13 ± 1.11	2.98 ± 1.14	3.13 ± 1.62	3.25 ± 1.11	3.46 ± 1.04	3.22 ± 1.19	3.11 ± 1.15
1	3.38 ± 1.11	3.55 ± 1.02	3.60 ± 1.08	3.29 ± 1.15	3.18 ± 1.13	3.33 ± 1.10	3.38 ± 1.07	3.49 ± 1.05	3.35 ± 1.04	3.32 ± 1.12
2	3.44 ± 1.12	3.64 ± 1.05	3.81 ± 1.02	3.34 ± 1.21	3.20 ± 1.17	3.36 ± 1.03	3.42 ± 1.07	3.57 ± 1.05	3.50 ± 1.05	3.26 ± 1.09
3	3.56 ± 1.08	3.77 ± 0.96	3.86 ± 1.01	3.45 ± 1.12	3.40 ± 1.14	3.34 ± 1.08	3.51 ± 1.05	3.60 ± 0.94	3.72 ± 1.04	3.25 ± 1.08
4	3.61 ± 1.04	3.82 ± 0.93	3.92 ± 0.92	3.51 ± 1.12	3.41 ± 1.07	3.35 ± 1.03	3.56 ± 1.02	3.64 ± 0.99	3.70 ± 0.97	3.29 ± 1.08
5	3.73 ± 1.00	3.91 ± 0.89	3.95 ± 0.86	3.73 ± 1.01	3.52 ± 1.09	3.46 ± 1.06	3.73 ± 0.98	3.76 ± 0.95	3.88 ± 0.90	3.44 ± 1.06
6	3.83 ± 0.96	4.03 ± 0.83	4.07 ± 0.76	3.79 ± 1.00	3.60 ± 1.09	3.49 ± 0.99	3.77 ± 0.96	3.63 ± 1.03	3.97 ± 0.85	3.48 ± 1.01

[1]Data presented have been weighted. FOP, front-of-package; NFt, Nutrition Facts table; NVS, Newest Vital Sign.
[2]Scores range from 0 to 6, with higher scores representing greater understanding of Nutrition Facts tables.
[3]The 5-country sample size for self-reported NFt understanding was $n = 21,586$; for self-reported FOP label understanding in 3 countries, $n = 12,360$.
[4]Self-reported NFt label understanding means reflect 5-country mean ($n = 21,586$); FOP label means reflect 3-country mean for Australia, Mexico, and the United Kingdom only.

TABLE 4 Sociodemographic and behavioral correlates of self-reported NFt and FOP label understanding[1]

	NFt understanding, mean ± SD	NFt understanding[2]			FOP label understanding, mean ± SD	FOP label understanding[2]		
		β	95% CI	P value[3]		β	95% CI	P value
Country								
Mexico	3.36 ± 1.07		Ref		3.31 ± 1.09		Ref	
United Kingdom	3.36 ± 1.12	0.01	−0.04, 0.07	0.6609	3.65 ± 1.01	0.38	0.32, 0.44	<0.0001*
Australia	3.53 ± 1.11	0.16	0.10, 0.21	<0.0001*	3.68 ± 0.97	0.41	0.35, 0.47	<0.0001*
Canada	3.81 ± 0.95	0.44	0.38, 0.49	<0.0001*	—	—	—	—
United States	3.90 ± 0.95	0.57	0.51, 0.62	<0.0001*	—	—	—	—
Age	—	− 0.005	−0.006, −0.004	<0.0001*	—	− 0.006	−0.008, −0.005	<0.0001*
Sex at birth								
Male	3.56 ± 1.08		Ref		3.55 ± 1.03		Ref	
Female	3.60 ± 1.06	0.00	−0.04, 0.03	0.8489	3.56 ± 1.05	− 0.04	−0.08, 0.00	0.0589
Ethnicity[4]								
Minority	3.67 ± 1.16		Ref		3.55 ± 1.24		Ref	
Majority	3.57 ± 1.05	− 0.03	−0.08, 0.01	0.1553	3.55 ± 1.01	0.02	−0.05, 0.08	0.5305
Education level[5]								
Low	3.56 ± 1.37		Ref		3.52 ± 1.27		Ref	
Medium	3.58 ± 0.97	0.02	−0.03, 0.06	0.4544	3.58 ± 0.99	0.02	−0.04, 0.08	0.5115
High	3.61 ± 0.91	0.04	0.00, 0.08	0.0588	3.57 ± 0.93	0.11	0.06, 0.16	<0.0001*
Income adequacy	—	0.12	0.11, 0.14	<0.0001*	—	0.10	0.08, 0.12	<0.0001*
BMI, kg/m^2								
18.5–24.99	3.65 ± 1.04		Ref		3.62 ± 0.99		Ref	
<18.5	3.70 ± 1.15	0.06	−0.05, 0.17	0.2790	3.56 ± 1.17	− 0.06	−0.21, 0.09	0.4146
25.0–29.99	3.58 ± 1.05	− 0.06	−0.10, −0.01	0.0076*	3.53 ± 1.03	− 0.05	−0.11, 0.00	0.0490
≥30.0	3.57 ± 1.09	− 0.08	−0.13, −0.03	0.0010*	3.49 ± 1.07	− 0.09	−0.15, −0.03	0.0066*
Missing	3.42 ± 1.14	− 0.11	−0.16, −0.05	0.0002*	3.50 ± 1.10	− 0.05	−0.12, 0.02	0.1619
Food shopping role								
Not primary shopper	3.46 ± 1.14		Ref		3.43 ± 1.13		Ref	
Share equally with others	3.54 ± 1.05	0.07	0.00, 0.16	0.0766	3.53 ± 1.13	0.08	−0.03, 0.19	0.1574
Primary shopper	3.61 ± 1.07	0.16	0.08, 0.23	<0.0001*	3.57 ± 1.04	0.14	0.03, 0.25	0.0078*
Dietary practices								
No specific dietary practices	3.57 ± 1.07		Ref		3.54 ± 1.04		Ref	
≥1 dietary practices (i.e., vegetarian, vegan, pescatarian, religious practices)	3.63 ± 1.10	0.09	0.04, 0.15	0.0010*	3.62 ± 1.04	0.08	0.01, 0.14	0.0161*

(*Continued*)

TABLE 4 *(Continued)*

	NFt understanding, mean ± SD	NFt understanding[2]			FOP label understanding, mean ± SD	FOP label understanding[2]		
		β	95% CI	*P* value[3]		β	95% CI	*P* value
Dietary efforts score[6]	—	− 0.05	−0.06, −0.04	<0.0001*	—	− 0.04	−0.05, −0.03	<0.0001*
FoodProK score[6,7]	—	0.06	0.05, 0.07	<0.0001*	—	0.08	0.06, 0.09	<0.0001*

[1]Data presented have been weighted. FoodProK, Food Processing Knowledge; FOP, front-of-package; NFt , Nutrition Facts table; Ref, reference category.
[2]Sample size is 21,586 for NFt understanding model, and 12,360 for the FOP label understanding model.
[3]Variables marked with an asterisk are significant ($P < 0.05$) after post hoc adjustment using the Benjamini–Hochberg procedure.
[4]"Majority" ethnicity refers to respondents who identified as "white," "predominantly English-speaking," or "non-Indigenous" based on country-specific ethnic identity questions.
[5]"Low" education refers to high school completion or lower, "medium" education refers to some post–secondary school qualifications including some university, and "high" refers to respondents who received a university degree or higher.
[6]The dietary efforts score reflects consumers' efforts to consume more or less of the following nutrient categories: *trans* fats, sugar/added sugars, salt/sodium, calories, and processed foods. On a scale of 0–10, 0 represents "consume less" responses to all categories, 10 represents "consume more" responses to all categories, and the range in between reflects all other response combinations.
[7]The FoodProK score reflects consumers' functional nutrition knowledge based on level of food processing. On a scale of 0–8, scores reflect whether respondents correctly ordered foods according to the NOVA classification for level of processing, with higher scores reflecting higher functional nutrition knowledge.

($P < 0.0001$ for all); however, those with BMIs ≥30 scored higher compared with respondents with BMIs between 18.5 and 24.9.

Discussion

Several studies have assessed consumer understanding of front- and back-of-package nutrition labeling systems across multiple countries (15–18); however, to our knowledge, this is the only population-based, multicountry analysis to report on levels of understanding for different label types and various consumer characteristics. The results therefore provide several unique insights.

Respondents in the United States self-reported the highest level of NFt understanding, and also scored highest on the functional test of NFt understanding, followed by Canada, Australia, the United Kingdom, and Mexico. Given that NFts are mandatory and similarly formatted in all countries, these differences can be explained by parallel healthy eating policies or food labeling campaigns in each country. For example, the United States and Canada released fact sheets, websites, and updates to school curricula alongside changes to food labeling policy to increase exposure to and education about food labels (31, 45). Other countries have developed similar campaigns; however, it is possible that more aggressive NFt label promotion in Canada and the United States resulted in relatively higher self-reported NFt understanding. It is also possible that the findings reflect differences in levels of numeracy across countries (6, 10).

The functional test of NFt understanding (Newest Vital Sign) showed that respondents performed poorly on questions requiring mathematical calculations or numeracy skills. These findings suggest that poor NFt understanding can reflect problems with numeracy and low health literacy. Although formal education is a factor in literacy and numeracy skills (46), inadequate nutrition education and promotional strategies can contribute to consumers being ill-equipped to interpret NFt information. For instance, although most countries have created guides for nutrition label use, consumers must actively seek out these resources because they are seldom promoted in publicly accessible domains (i.e., television advertising) or outside of educational settings.

Another potential explanation for cross-country differences lies in the prominence of processed, packaged foods: countries with a greater reliance on packaged food consumption could have greater exposure to—and therefore understanding of—NFts. Americans obtain ≤60% of their total energy intake from ultraprocessed foods—potentially the highest of all the countries in this study (27, 47).

As expected, mean self-reported NFt understanding was higher with higher functional NFt understanding in all countries, but with a weak correlation between these measures ($r = 0.18$). Moreover, many respondents in this study self-reported high NFt understanding while performing poorly on the functional measure. These findings are consistent with research indicating that consumers tend to overestimate their nutrition knowledge (6, 10, 19). In particular, studies have shown that consumers perform poorly on functional tasks, in part due to low awareness about what percentage daily value means, and in some cases, confusion about terminology (i.e., calories compared with kilojoules) (5, 6, 10).

Self-reported FOP label understanding was highest in Australia, followed by the United Kingdom and Mexico. Although self-reported understanding of FOP labels was

TABLE 5 Sociodemographic and behavioral correlates of functional NFt understanding ($n = 21{,}586$)[1]

	β	95% CI	P value[2]
Country			
Australia vs. Canada	− 0.31	−0.40, −0.21	<0.0001*
Australia vs. Mexico	0.46	0.36, 0.57	<0.0001*
Australia vs. United Kingdom	− 0.06	−0.15, 0.03	0.1957
Australia vs. United States	− 0.38	−0.48, −0.29	<0.0001*
Canada vs. Mexico	0.77	0.67, 0.87	<0.0001*
Canada vs. United Kingdom	0.25	0.15, 0.34	<0.0001*
Canada vs. United States	− 0.08	−0.17, 0.02	0.1134
United Kingdom vs. Mexico	0.52	0.43, 0.62	<0.0001*
United Kingdom vs. United States	− 0.32	−0.42, −0.23	<0.0001*
United States vs. Mexico	0.84	0.75, 0.95	<0.0001*
Age	− 0.004	−0.006, −0.002	<0.0001*
Sex at birth			
Female vs. male	0.23	0.17, 0.29	<0.0001*
Ethnicity[3]			
Majority vs. minority	0.63	0.55, 0.72	<0.0001*
Education level[4]			
Medium vs. low	0.36	0.28, 0.43	<0.0001*
High vs. low	0.52	0.44, 0.58	<0.0001*
High vs. medium	0.16	0.80, 0.23	<0.0001*
Income adequacy	0.00	−0.02, 0.03	0.8572
BMI			
Missing vs. <18.5	− 0.72	−0.92, −0.53	<0.0001*
Missing vs. 18.5–24.9	− 0.69	−0.79, −0.59	<0.0001*
Missing vs. 25–29.9	− 0.70	−0.80, −0.60	<0.0001*
Missing vs. ≥30	− 0.80	−0.90, −0.69	<0.0001*
≥30 vs. <18.5	0.07	−0.11, 0.26	0.4494
≥30 vs. 18.5–24.9	0.10	0.02, 0.19	0.0148*
≥30 vs. 25–29.9	0.09	0.01, 0.18	0.0297*
25–29.9 vs. 18.5–24.9	0.01	−0.07, 0.08	0.8023
25–29.9 vs. <18.5	− 0.02	−0.21, 0.16	0.8186
<18.5 vs. 18.5–24.9	0.03	−0.15, 0.21	0.7349
Food shopping role			
Primary shopper vs. not primary shopper	− 0.34	−0.48, −0.21	<0.0001*
Primary shopper vs. share equally with others	− 0.24	−0.31, −0.17	<0.0001*
Not primary shopper vs. share equally with others	− 0.10	−0.25, 0.04	0.1725
Dietary practices			
≥1 dietary practices (i.e., vegetarian, vegan, pescatarian, religious practices) vs. no specific dietary practices	− 0.45	−0.54, −0.36	<0.0001*
Dietary efforts score[5]	− 0.10	−0.11, −0.09	<0.0001*
FoodProK score[5,6]	0.38	0.36, 0.40	<0.0001*
Self-reported NFt understanding	0.19	0.16, 0.22	<0.0001*

[1] Data presented have been weighted. FoodProK, Food Processing Knowledge; NFt, Nutrition Facts table.
[2] Variables marked with an asterisk are significant ($P < 0.05$) after post hoc adjustment using Benjamini–Hochberg procedure.
[3] "Majority" ethnicity refers to respondents who identified as "white," "predominantly English-speaking," or "non-Indigenous" based on country-specific ethnic identity questions.
[4] "Low" education refers to high school completion or lower, "medium" education refers to some post–secondary school qualifications including some university, and "high" refers to respondents who received a university degree or higher.
[5] The dietary efforts score reflects consumers' efforts to consume more or less of the following nutrient categories: *trans* fats, sugar/added sugars, salt/sodium, calories, and processed foods. On a scale of 0–10, 0 represents "consume less" responses to all categories, 10 represents "consume more" responses to all categories, and the range in between reflects all other response combinations.
[6] The FoodProK score reflects consumers' functional nutrition knowledge based on level of food processing. On a scale of 0–8, scores reflect whether respondents correctly ordered foods according to the NOVA classification for level of processing, with higher scores reflecting higher functional nutrition knowledge.

higher than for NFts in Australia and the United Kingdom, the differences were more modest than some experimental studies might suggest. This could reflect that FOP labels are voluntary in both countries and appear on a minority of products (13, 14, 48). Mexico was the only country in which self-reported understanding of GDA labels was lower than that for the NFts, despite having a mandatory FOP labeling policy. This finding likely reflects the shortcomings of the design and type of information included on the Mexican FOP label. HSR and traffic light labels in Australia and the United Kingdom use symbols and provide interpretive information, whereas Mexico's industry-based GDA system provides reductive nutrient information similar to the NFt—simply replicating this information from the back to FOP.

Previous research has demonstrated that consumers have poor understanding of the numeric information on GDA labels, which is consistent with the current findings (14, 49). This is likely compounded by lower levels of literacy and numeracy in Mexican respondents, which could limit their ability to use nutrition labels (50). This finding highlights the importance of simple, interpretive information, particularly in countries that have lower levels of numeracy. Accordingly, Mexico recently approved a new regulation to replace the GDA with FOP "high-in" labels similar to those used in Chile (51).

Food processing knowledge was associated with greater label understanding, particularly for functional NFt understanding. Packaged foods are predominantly highly processed; thus, it is expected that consumers with an increased interest in or knowledge of nutrition would have a better understanding of levels of food processing and how to interpret the information on NFts. Given the repercussions for noncommunicable disease risk (35), consumers with a greater understanding of the relative healthiness of food products based on processing would be better equipped to navigate the increasingly processed food landscape (27).

Respondents with a primary food shopping role had higher self-reported NFt and FOP label understanding, but lower functional NFt understanding than those who were not primary shoppers. This finding is surprising given that primary shoppers likely have greater exposure to labels. Those engaging in vegetarian or other dietary practices also reported higher NFt and FOP understanding, but scored lower on the functional test of NFt understanding. These findings point to discrepancies in self-report compared with functional measures. Although self-reported measures can still be informative in labeling policy research, they might not accurately reflect consumers' ability to read and interpret NFts—particularly for labels involving numeracy skills.

With respect to sociodemographic characteristics, self-reported label understanding decreased with age, which might reflect lower awareness of labels or lower numeracy skills in older age groups (9, 52, 53). Consistent with existing literature (54, 55), this study found higher functional NFt understanding in females, "majority" ethnic groups, and respondents with higher income adequacy and education levels compared with their respective counterparts. These differences might be explained by disparities in label comprehension, because consumers with lower education, in particular, could have lower numeracy skills than those with higher educational attainment (8, 9). FOP labels were designed to be accessible to consumers with lower education or literacy levels; however, differences in understanding were observed in this study based on income adequacy and education. Research has shown that respondents with lower incomes demonstrate poorer understanding and responsiveness to FOP labels than those with higher incomes (14), although some evidence points to FOP "high-in" labels, in particular, having similar benefits across sociodemographic subgroups compared with other labeling systems (20, 56). More research is needed to explore whether disparities persist for FOP label understanding across various label types; however, this evidence is important to consider because lower label comprehension can be compounded by competing priorities in food selection. Consumers identifying as ethnic minorities in their respective countries and those with low incomes might prioritize cultural preferences or affordability in food purchasing and consumption, which could impact attention to NFts and resultant comprehension or use (55, 57, 58).

Respondents with BMIs between 18.5 and 24.9 self-reported higher NFt understanding than all other BMI categories. Similarly, self-reported FOP label understanding was higher for respondents in this BMI range compared with those with BMIs $\geq$30. In contrast, those with BMIs $\geq$30 scored higher for functional NFt understanding compared with respondents with BMIs of 18.5–24.9 and 25–29.9. The literature demonstrates mixed findings regarding label understanding and BMI (59). The use of self-reported measures of label comprehension suggests a possible role of weight-based goals in shaping NFt use; however, more research is needed to unpack patterns and differences in functional NFt understanding based on weight status, either objectively measured or perceived.

There were several limitations of the current analysis. The sample was recruited using nonprobability sampling, which does not enable nationally representative population estimates. For example, although data were weighted by age, sex, and region, the Mexico sample had higher levels of education than the Mexican population based on census estimates, whereas mean BMI was lower than national estimates in each of the 5 countries (22). The primary outcomes, NFt and FOP label understanding, as well as BMI, are subject to social desirability bias given the use of self-reported measures. There are also limitations of the functional NFt understanding measure, because the Newest Vital Sign has been tested across a variety of age and ethnic groups in different countries, but has not yet been validated as a self-administered measure (60). Moreover, despite being tested in Hispanic American populations (61), the Newest Vital Sign has not been tested in Mexico. The FoodProK score is also limited in its ability to assess overall nutrition knowledge, because only 1 component (knowledge of level of food processing based on nutritional recommendations) is assessed. Other important factors associated with diet quality (i.e., frequency of consumption of processed foods) are not captured by the FoodProK score. This study was also limited to understanding of labels and did not examine the implications of label understanding for food choices and dietary quality.

Overall, the between-country differences in self-reported and functional label understanding across countries reflect the extent to which mandatory compared with voluntary nutrition labeling policies are implemented and effective, as well as the uptake of parallel healthy eating policies or food labeling campaigns in each country. The differences found in label understanding by consumer characteristics such as sex, ethnicity, income adequacy, and education suggest that current nutrition labeling policies are contributing to existing disparities in nutrition-related health behaviors and outcomes, because nutrition labels are less accessible to certain groups. Given the relative ease of understanding of simple, interpretative FOP labels, future research should examine the extent to which FOP labeling policies affect consumers' functional label understanding, as well as implications for dietary patterns across different sociodemographic groups.

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