American Journal of Health Promotion
2026, Vol. 0(0) 1-12

DOI: 10.1177/08901171261458529
journals.sagepub.com/home/ahp
Mary Ann Liebert
A Part of Sage

Awareness and Self-Reported Effects of the Innovative Mexican Front-of-Package Nutrition Labeling Policy Among Mexican Americans Across Different US Regions, Health Literacy Levels, and Educational Attainment, 2021-2023

James F. Thrasher, PhD[1,2], Dai Fang, PhD[3], Muskaan Makkar, BA[1], Victor Eduardo Villalobos-Daniel, PhD[4], Christine M. White, MS[5], Alejandra Contreras-Manzano, DSc[4], Alejandra Jáuregui, DSc[4], Lana Vanderlee, PhD[6], David Hammond, PhD[5], and Rachel E. Davis, PhD[1]

Abstract

Purpose: Evaluate trends and correlates of self-reported awareness of and responses to front-of-package warning labels (FoPWLs) on packaged Mexican foods among Mexican Americans (MAs) in the United States (US).
Design: International Food Policy Study annual cross-sectional surveys (2021, 2022, 2023).
Setting: Online survey.
Sample: MA adults in the US (n = 9662).
Measures: Self-reported past-month frequency of buying food at Mexican-oriented stores (recoded: often/very often vs less often), awareness of Mexican FoPWLs (recoded: often/very often vs less often), and self-reported reductions in purchasing less healthy foods (yes vs no for eight foods) due to FoPWLs.
Analysis: Adjusted logistic models regressed binary outcomes (above) on sociodemographics and survey year.
Results: Most participants bought food in Mexican-oriented stores (87.2%). Of those who noticed Mexican FoPWLs (67.6%), many reported that FoPWLs influenced them to reduce purchasing less healthy foods (range = 31.1% [snacks like chips] to 43.9% [cola]). In adjusted models, noticing FoPWLs often/very often (vs less often) increased over time ($AOR_{2022\ vs\ 2021}$ = 1.30; $AOR_{2023\ vs\ 2021}$ = 1.21), as did self-reported reductions in purchasing sweetened fruit drinks ($AOR_{2022\ vs\ 2021}$ = 1.27), and desserts ($AOR_{2022\ vs\ 2021}$ = 1.32). People with limited vs adequate health literacy reported higher awareness of FoPWLs (AOR = 1.21).
Conclusion: MAs' awareness and reported effects of Mexican FoPWLs were high and stable or increased over time, with greater awareness among those with limited health literacy.

Keywords

nutrition policy, nutrition labeling, front-of-package warning labels, health communication, Mexican Americans, disparities

[1]Department of Health Promotion, Education & Behavior, Arnold School of Public Health, University of South Carolina, Columbia, SC, USA
[2]Center for Population Health Research, National Institute of Public Health, Cuernavaca, Mexico
[3]Department of Epidemiology & Biostatistics, Arnold School of Public Health, University of South Carolina, Columbia, SC, USA
[4]Center for Nutrition and Health Research, National Institute of Public Health, Cuernavaca, Mexico
[5]School of Public Health Sciences, University of Waterloo, Waterloo, ON, Canada
[6]School of Nutrition, Faculté des sciences de l'agriculture et de l'alimentation (FSAA), Centre NUTRISS (Nutrition, Santé et Société), Université Laval, Québec, QC, Canada

Corresponding Author:
James F. Thrasher, PhD, Department of Health Promotion, Education & Behavior, Arnold School of Public Health, University of South Carolina, 915 Greene Street, Discovery I, Columbia, SC 29208, USA.
Email: thrasher@mailbox.sc.edu

Introduction

As of May 2021, all prepackaged food and beverage products in Mexico are required to display front-of-package warning labels (FoPWLs) if they contain high levels of nutrients[1] that are linked to a range of diet-related non-communicable diseases (e.g., heart disease, diabetes). The FoPWLs use octagonal "stop sign" icons (see Supplement Figure 1) to warn consumers about foods that are high in calories and critical ingredients: sugar, sodium, trans fats, and saturated fats,[1] using thresholds from the Pan American Health Organization's nutrient profile models.[2] Depending on the level of these nutrients, product packaging can display up to 5 warnings. In addition, products with caffeine or artificial sweeteners must also display front-of-package legends that warn against consumption by children. The simplified nutrition information and symbolic nature of FoPWLs, combined with their prominence on the front of packaging, aims to minimize the cognitive load of identifying healthier food alternatives and, thereby, may reduce consumption of less healthy foods.

Among both Mexicans and Latinos in the United States (US), FoPWLs have been found to be more noticeable and more easily understood than industry's voluntary front-of-package labeling systems, as well as mandatory Nutrition Facts labels.[3,4] Consumers, especially those with lower education and literacy levels, struggle to understand and apply quantitative information in Nutrition Facts labels,[5-9] and these disparities are found among US Latinos.[10] Many US and Mexican consumers cannot correctly calculate calorie intake,[11,12] highlighting difficulties with mathematical tasks required for Nutrition Facts label interpretation,[13,14] such as whether nutrient amounts are low or high relative to daily recommendations.[15,16] The US Food and Drug Administration has proposed simplified, front-of-package labels to overcome some of these challenges, promote consumption of healthier foods, and, thereby, help address diet-related diseases like cardiovascular disease – the leading cause of death in the US[17] – and diabetes, which is high (11.1%) among MAs in the US.[18]

After the implementation of FoPWLs in Mexico, adults' awareness, use, and understanding of front-of-package labeling increased more in Mexico than in countries not using FoPWLs.[19,20] In Mexico, almost half of adults reported that they reduced purchases of less healthy foods, especially sugar-sweetened beverages, due to the FoPWLs.[21] US consumers can also be exposed to the Mexican FoPWLs through stores that sell Mexican food products, as these imported products may display FoPWLs while simultaneously complying with US labeling regulations by placing stickers with required US Nutrition Facts labels and ingredient disclosures on packages (Supplement Figure 1). A 2021 survey indicated that 88% of Mexican American (MA) adults in the US had purchased foods in Mexican stores in the prior month.[22] Most of these respondents (64%) reported having seen FoPWLs on packaged foods, among whom many reported that the FoPWLs influenced them to reduce purchasing less healthy products (range = 32% for snacks – 44% for colas).[22] Reported reductions in purchasing less healthy products due to FoPWLs mostly did not differ by income adequacy or education, consistent with the Mexican FoPWL policy intent: to be understood and used equally across sociodemographic groups.[4,20,23] Furthermore, after FoPWLs were implemented in Mexico, Mexican adults with lower education were less likely to report reducing purchases of less healthy products due to the FoPWLs,[21] suggesting the policy may help offset education-related disparities in nutrition.

Health literacy – an individual's ability to comprehend health-related information to make informed decisions[24] – is associated with education but it is more specific to skills that are relevant to interpreting nutrition information. Indeed, people with lower health literacy tend to have lower understanding and use of Nutrition Facts labels than their higher health literacy counterparts,[25-29] though findings are mixed across studies.[30] While relationships between health literacy and front-of-package label use and effects are less well studied, one study evaluated this association after pooling adults from 5 countries with different front-of-package labeling systems (e.g., Guiding Stars, Traffic Light), none of which had implemented FoPWLs: adults with lower health literacy were more likely to report using front-of-package labels.[29]

A more complete understanding of potential exposures to the Mexican FoPWLs in the US should consider where MAs reside. MAs are more concentrated in US states along the border and with longer histories of Mexican migration.[31] In 2020, MAs were the largest ethnic minority group in California and Texas, and MAs in these states comprised 58.4% of all MAs in the US. The states with the next largest number of MAs are Illinois (5.8%) and Arizona (4.6%), with no other state being home to more than 3.0% of MAs.[32] Distribution networks and retailers of Mexican-made packaged foods likely parallel where MAs live. However, it is unknown whether Mexican manufacturers–to avoid displaying the FoPWLs required for sales in Mexico–changed the packaging of food products for the US market. Attention toward and effects of FoPWLs may also diminish over time, as found for tobacco labeling.[33-36] These factors likely result in different opportunities for FoPWL exposure across time and geographic location.

The current study investigated whether the potential reach, awareness, and self-reported influence of Mexican FoPWLs on MA's purchases of less healthy foods differs over time, from the period of its initial implementation in 2021 to 2022 and 2023. The focus on FoPWL awareness is because of it is a meaningful indicator of communication campaign exposure,[37] which can produce changes in attitudes and behaviors like food purchases.[38] Awareness and self-reported impact of FoPWLs was hypothesized to decline over time, as MAs habituated to the labels and any new purchasing

behaviors became established. Differences in these trends by region of residence in the US were also evaluated, given expectations that regions with larger MA populations could provide more opportunities for FoPWL exposures and, thereby, be less likely to diminish over time. Finally, differences in trends by health literacy level and education were explored, though mixed findings in prior research precluded hypotheses.

Methods

Sample

Data were obtained from the 2021, 2022, and 2023 US Mexican American oversample of the International Food Policy Study (IFPS), an online, repeat cross-sectional survey conducted between November and December each year. The IFPS Mexican American oversample was recruited from consumer panels that Qualtrics and its partners manage, with targeted recruitment focused on and eligibility limited to adults aged 18 to 100 who lived in the US and self-identified as having Mexican descent. Email and panelist dashboard application invitations included unique links to a screening survey to assess eligibility, as well as age, sex, and education (i.e., <=high school; >high school). These screener data were used to reach soft quotas for sociodemographic subgroups that approximated those in the general population of MAs based on 2020 census data. Before starting the main survey, participants gave their consent. Participants received remuneration in accordance with their usual incentive structure (e.g. points-based, monetary rewards). Participants could choose to complete the survey in English or Spanish. Professional translations of the questionnaires into Spanish were reviewed by Mexican research team members who were native, bilingual Spanish speakers. The study was reviewed and received ethics clearance through a University of Waterloo Research Ethics Board (REB #30829) and the University of South Carolina's Institutional Review Board (Pro00110489).

Measurement

Primary Outcomes. Participants were asked "In the last month, how often did you buy food at Mexican stores or markets?" (responses: Never, Rarely, Sometimes, Often, All the Time). Next, participants were asked a "cued recall" question[37] adapted from previous studies,[39] to assess awareness of FoPWLs. Specifically, they were shown an image of a Mexican FoPWL indicating "excess calories" (such as the black octagon in Supplemental Figure 1) and asked "In the last month, how often have you seen this type of food label on Mexican food packages?" (responses: Never, Rarely, Sometimes, Often, All the Time). This question was limited to those who reported having shopped at Mexican stores in the 2021 survey, though it was asked of everyone in 2022 and 2023 (as high levels of awareness in 2021 became clear).

Participants who reported any awareness of FoPWLs during the prior month were asked, "Have the warning labels (black octagons) changed whether you buy the following packaged products for you or your family?" They were shown a checklist of the following foods and beverage categories: cola (Coca-Cola, Pepsi, etc.); soft drinks (Sprite, Orange Crush, etc.); diet soda or soda (Coca-Cola Zero, Diet Pepsi, etc.); sweetened fruit drinks (lemonade, iced tea, SunnyD, fruit punch/cocktail, etc.); chocolate or candy bars; snacks such as potato chips; desserts such as cakes, cookies, and ice cream; and sugary cereals. While cola was queried in all three survey years, the other products were only queried in 2021 and 2022 (due to survey space constraints). For each food category, original responses (Buy Less, Buy More, No Change, Don't Know) were dichotomized to identify less frequent purchases (Buy Less vs Other Options, with "Don't Know" = missing).

Primary Independent Variables. Participants reported the state where they resided. California and Texas were maintained as separate categories due to the large numbers of participants residing in these states. Due to relatively lower sample sizes, participants from other states were grouped into geographic regions (i.e., West, Midwest/Plains, Northeast, Southeast) based on USDA categories.[40] Health literacy was assessed using an adapted measure,[41] which involved showing and asking 6 questions about an Nutrition Facts label for a container of ice cream. As the questions involved mathematical calculations (numeracy), understanding (document literacy), and applying (prose literacy) information from a Nutrition Facts label, the measure also reflected functional understanding of these labels. The number of correct answers was summed (range = 0-6) and categorized as: high likelihood of limited literacy (i.e., "Limited" score = 0-1); possibility of limited literacy (i.e., "Possibly Limited" score = 2-3); and high likelihood of adequate literacy ("Adequate" score = 4-6).

Covariates. Sociodemographic information included age (recoded as: 18 to 29; 30 to 44; 45 to 59; 60 years or older), sex assigned at birth (Male or Female), and education (recoded as: Low = high school or lower; Medium = associate's degree or technical/vocational certificate; High = Bachelor's degree or higher). Perceived income adequacy was assessed by asking "Thinking about your total monthly income, how difficult or easy is it for you to make ends meet?" (Very difficult, Difficult, Neither difficult nor easy, Easy, Very easy).[42] Language use was assessed using an 8-item scale (e.g., "In general, what languages do you read and speak?") with responses averaged (range: 1 = Only English to 5 = Only Spanish).[43]

Participants reported the number of their children under age 18 who lived in their household (recoded: None, One, Two or more) and how often they shopped for household foods (recoded to: Most, Shared equally, and Less or None of the shopping). Finally, participants reported whether or not

(Yes = 1/No = 0) a healthcare professional had told them that they had any of the following chronic diseases: hypertension or high blood pressure; a heart attack (myocardial infarction); angina or coronary disease; diabetes or high blood sugar; or high cholesterol.[44] "Yes" responses were summed and, given the skewed distribution, recoded as none, one, or two or more diet-related chronic diseases.

Analysis. For each survey year, post-stratification sample weights were developed based on the 2021 American Community Survey, Public Microdata Sample distributions of MAs by combinations of sex, age, educational level, and region. Weights reflected the 2021 population size estimates for MAs in each subgroup defined by the combination of these characteristics, with values rescaled to sum to the actual study sample size (weight range = 0.147-3.655). Weighted and unweighted descriptive statistics are reported for outcomes and covariates, and all models were weight-adjusted.

Bivariate and adjusted logistic regression models were estimated for each primary outcome. Since ordinal regression models violated proportional odds assumptions for the two frequency variables (shopping in Mexican stores, FoPWL awareness), we derived a binary variable for each of these outcomes to indicate frequent (i.e., "Often" or "All the time") vs lower frequencies (other responses = reference). For reported reductions in purchasing less healthy foods due to FoPWLs ("Buy less" vs other responses = reference), separate models were estimated for each product type. Adjusted models included all covariates (see Measurement). For the outcomes of FoPWL awareness and reported reductions in purchasing less healthy foods, additional adjusted models were estimated after including interactions between year (2021 = reference) and region (California = reference), education (Low = reference), and health literacy (Adequate = reference). Each of these interactions with year was assessed in a separate model, using a global F-test to evaluate variability in time trends across subgroups (e.g., region, education, literacy). When the test was statistically significant, specific contrasts between sociodemographic subgroups were estimated along with their model-implied adjusted means for each year. As sensitivity analyses, models for awareness and buying less were re-estimated after deleting from the analytic sample those who indicated that they did not shop in Mexican stores in the 2022 and 2023 surveys. In 2021, those outcomes were only asked of people who shopped in Mexican stores (see Supplement Tables 3-5). All variables queried included "Don't Know" and "Refused" options; respondents selecting these responses were excluded from analyses (Missingness: Mexican stores n = 303 = 3.1%; FoPWL Awareness n = 369 = 4.4%; Buy less range n = 192-270 = 4.7%-6.9%). We re-estimated all models using multiple imputation with chained equations (i.e., fully conditional specification)[45] and 20 imputations[46] to estimate missing values (See Supplement Tables 6-9). The valence, statistical significance, and interpretation of results from these sensitivity analyses were consistent with the main results we report here and, therefore, are not described in detail. All analyses were conducted using SAS software version 9.4.

Results

Study participation rates (sample/total eligible invitations) were 10.1% in 2021, 30.0% in 2022, and 18.5% in 2023. The cooperation rates (sample/eligible invitations that accessed the survey link) were 65.3% in 2021, 68.1% in 2022, and 64.5% in 2023. The final combined sample included 9662 MA adults who completed the survey and passed data quality checks. The characteristics of each analytic sample are shown in Table 1. For the prior month, most participants reported having purchased food from Mexican stores (87.2%), and two-thirds (67.6%) reported noticing Mexican FoPWLs.

Frequency of Shopping in Mexican Stores

Approximately one third of participants (33.9%) reported buying food "Often" or "All the time" in Mexican stores. In adjusted logistic regression models (Table 2), frequent shopping in Mexican stores was less likely among those who were older or lived in Texas, the West, or Southeast compared to California. Frequent shopping in Mexican stores was more likely for people who: reported greater perceived income adequacy (AOR = 1.12; 95% CI = 1.06-1.19), had children living at home ($AOR = 1.33_{\text{one v none}}$, 95%CI = 1.14-1.55; $AOR_{\geq 2 \text{ vs none}} = 1.41$, 95%CI = 1.22-1.62), had two or more chronic diseases ($AOR_{\geq 2 \text{ vs none}} = 1.18$, 95%CI = 1.00-1.39), used Spanish more often (AOR = 1.80; 95%CI = 1.69-1.91); and had more limited health literacy ($AOR_{\text{possibly limited vs adequate}} = 1.39$, 95%CI = 1.20-1.61; $AOR_{\text{limited vs adequate}} = 1.30$, 95%CI = 1.13-1.49). No differences were found across survey years.

Awareness of FoPWLs

More than one-fifth (22.3%) of participants reported frequent awareness (i.e., noticing Mexican FoPWLs "Often" or "All the time"). Adjusted regression models (Table 3) indicated that older age was associated with reduced likelihood of frequent awareness, whereas other factors were positively associated with frequent awareness: higher education ($AOR_{\text{medium v low}} = 1.18$, 95%CI = 1.02-1.37; $AOR_{\text{high v low}} = 1.50$, 95%CI = 1.31-1.72); greater perceived income adequacy (AOR = 1.26, 95%CI = 1.18-1.34); having children at home ($AOR = 1.25_{\text{one v none}}$, 95%CI = 1.04-1.51; $AOR_{\geq 2 \text{ vs none}} = 1.46$, 95%CI = 1.24-1.72); having two or more chronic diseases ($AOR_{\geq 2 \text{ vs none}} = 1.27$, 95%CI = 1.05-1.53); using Spanish more often (AOR = 1.95; 95%CI = 1.81-2.09); doing most of the household shopping ($AOR_{\text{most v none/some}} = 1.30$; 95%CI = 1.00-1.43); and having limited health literacy ($AOR_{\text{limited vs adequate}} = 1.27$, 95%CI = 1.03-1.43). Compared to 2021, frequent awareness was higher in 2022 (AOR = 1.30, 95%CI = 1.11-1.53) and 2023 (AOR = 1.21, 95%CI = 1.02-1.44). In the adjusted models

Table 1. Analytic Samples of Mexican American Adults in the United States, 2021-2023

		Entire sample (n = 9662)		Subsample: Noticed FoPWLs in last month,[a] 2021-2023 (n = 5799)		Subsample: Noticed FoPWLs in last month,[a] 2021-2022 (n = 3965)	
Sample characteristics		Unweighted %	Weighted %	Unweighted %	Weighted %	Unweighted %	Weighted %
Sex	Male	43.6	49.9	47.8	53.3	49.2	53.5
	Female	56.4	50.1	52.2	46.7	50.8	46.5
Age	18-29 years old	31.6	34.4	38.3	41.5	39.0	41.2
	30-44 years old	35.5	28.9	38.6	31.4	38.7	31.4
	45-59 years old	25.2	28.4	19.3	23	18.7	23.7
	60+ years old	7.8	8.3	3.8	4.0	3.6	3.7
Education	Low (≤high school)	49.2	76.3	46.3	73.7	46.6	73.4
	Medium	22.9	7.4	21.9	7.5	22.5	7.6
	High (≥Bachelor's)	27.9	16.3	31.8	18.8	31.0	19.0
Income adequacy[b] (mean)	2.8	2.8	2.9	2.8	2.9	2.9	
Health literacy	Adequate	38.5	35.9	32.1	29.9	32.9	30.9
	Possibly limited	24.4	24.9	23.5	23.6	23.5	23.1
	Limited	37.2	39.2	44.4	46.5	43.6	46
Children in household	None	55.4	60.1	50.1	55.3	49.9	54.4
	One	19.6	18.1	21.4	19.9	21.7	20.4
	Two or more	25.0	21.8	28.5	24.9	28.4	25.2
Diet-related chronic diseases	None	59.9	60.5	62.5	63.5	63.0	63.4
	One	20.7	20.4	19.4	18.8	19.8	19.3
	Two or more	19.4	19.2	18.1	17.8	17.2	17.3
Shopping role for household	None to some	10.8	13.3	10.9	13.4	11.2	13.7
	Equal to other(s)	23.6	24.8	24.9	26.0	24.6	25.4
	Most	65.6	61.9	64.3	60.6	64.2	60.9
Spanish language use[c] (mean)	2.3	2.3	2.6	2.6	2.6	2.6	
State/region of residence[d]	California	27.2	32.8	26.4	32.4	26.7	32.1
	Texas	26.5	24.5	25	23.6	25.1	24.3
	West	16.6	20.2	15.5	19.1	15.9	18.9
	Midwest	12.5	9.2	12.7	9.0	12.8	9.5
	Southeast	11.9	10.0	13.5	11.5	12.9	10.9
	Northeast	5.2	3.3	6.9	4.4	6.6	4.2
Frequency of shopping in Mexican food stores, last month	Never	12.7	12.8	1.8	1.7	1.3	1.2
	Rarely	16.9	16.6	12.5	12.0	12.9	12.5
	Sometimes	35.5	36.1	40.7	41.4	40.4	41.3
	Often	25.6	25.3	32.8	32.8	33.1	32.6
	All the time	9.3	9.2	12.2	12.0	12.3	12.4
Frequency of noticing FoPWLs, last month	Never	35.6	37.3	N/A	N/A	N/A	N/A
	Rarely	17.7	18.0	27.5	28.6	27.9	28.3
	Sometimes	24.5	24.2	38.0	38.5	37.4	38.5
	Often	14.1	12.9	21.9	20.6	21.6	20.5
	All the time	8.1	7.7	12.6	12.2	13.1	12.7
Survey year	2021	34.8	34.8	33.1	32.4	48.3	47.9
	2022	34.5	34.5	35.3	35.2	51.7	52.1
	2023	30.8	30.8	31.6	32.4	N/A	N/A

[a]FoPWL = Front-of-package warning label; for analyses of reducing purchases of less healthy products, only one product (cola) was querried in all three surveys; the other seven products were queried in 2021-2022, but not 2023.
[b]Range = 1. Very difficult – 5. Very easy for adequacy of household monthly income for making ends meet.
[c]Range = 1. English only – 5. Spanish only (average of 8 items) for frequency of language use.
[d]West = Alaska, Arizona, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming; Midwest = Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin; Southast = Alabama, Arkansas, Florida, Georgia, Kentucky, Lousiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Virginia, West Virginia; Northeast = Connecticut, Delaware, District of Columbia, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island.

Table 2. Prevalence and Correlates of Mexican American Adults Who Frequently Purchased Food[a] in Mexican-Oriented Stores in the Prior Month, 2021-2023

		Bivariate models		Adjusted model	
Characteristics	% Purchased "often"/"all the time"	OR	[95% CI]	AOR	[95% CI]
Sex (ref = Male)	35.3	Ref		Ref	
Female	33.7	0.92	[0.84, 1.02]	0.93	[0.83, 1.04]
Age (ref = 18-29 years old)	41.2	Ref		Ref	
30-44 years old	37.7	0.87*	[0.77, 0.98]	0.75***	[0.65, 0.86]
45-59 years old	29.3	0.60***	[0.52, 0.69]	0.62***	[0.53, 0.74]
60+ years old	14.1	0.23***	[0.18, 0.31]	0.30***	[0.22, 0.41]
Education (ref = Low)	34.1	Ref		Ref	
Medium	34.4	1.01	[0.90, 1.13]	1.05	[0.93, 1.19]
High	36.6	1.11	[1.00, 1.23]	0.97	[0.86, 1.09]
Income adequacy[b]		1.11***	[1.05, 1.16]	1.12***	[1.06, 1.19]
Children at home (ref = None)	29.8	Ref		Ref	
One	39.6	1.56***	[1.36, 1.79]	1.33***	[1.14, 1.55]
Two or more	43.0	1.80***	[1.59, 2.04]	1.41***	[1.22, 1.62]
Chronic diseases (ref = none)	35.6	Ref		Ref	
One	33.1	0.90	[0.79, 1.03]	1.07	[0.92, 1.23]
Two or more	32.4	0.88	[0.76, 1.01]	1.18*	[1.00, 1.39]
Shop role (ref = None/Some)	34.4	Ref		Ref	
Share equally with other(s)	32.1	0.94	[0.77, 1.13]	0.92	[0.75, 1.13]
Most	35.4	1.09	[0.92, 1.29]	1.13	[0.94, 1.37]
Spanish vs English use[c]		1.94***	[1.83, 2.05]	1.80***	[1.69, 1.91]
Health literacy (ref = Adequate)	26.1	Ref		Ref	
Possibly limited	36.0	1.59***	[1.38, 1.83]	1.39***	[1.20, 1.61]
Limited	41.5	2.00***	[1.77, 2.26]	1.30***	[1.13, 1.49]
State/Region (ref = California)	40.7	Ref		Ref	
Texas	28.3	0.58***	[0.50, 0.67]	0.57***	[0.49, 0.67]
West	29.7	0.62***	[0.53, 0.73]	0.66***	[0.56, 0.78]
Midwest	35.2	0.80*	[0.67, 0.95]	0.84	[0.69, 1.00]
Northeast	42.5	1.07	[0.84, 1.36]	0.79	[0.60, 1.04]
Southeast	35.8	0.83*	[0.69, 0.98]	0.66***	[0.55, 0.80]
Survey year (ref = 2021)	35.4	Ref		Ref	
2022	33.8	0.92	[0.82, 1.05]	0.99	[0.86, 1.13]
2023	34.2	0.95	[0.83, 1.08]	1.01	[0.88, 1.17]

[a]"often" or "all the time" vs less often = 34.5%; original distribution shown in Table 1; entire sample (n = 9662).
[b]Range = 1. Very difficult – 5. Very easy for adequacy of household monthly income for making ends meet.
[c]Range = 1. English only – 5. Spanish only (average of 8 items) for frequency of language use.
OR = odds ratio, AOR = adjusted odds ratio, BMI = Body Mass Index, CI = confidence interval. *pvalue<0.05, **pvalue<0.01, ***pvalue<0.001.

predicting frequent awareness and that included interactions with year, health literacy was marginally significant (F-test = 2.31, P = 0.06), but the other interactions were not (region F-test = 1.30, P = 0.22; education F-test = 1.25, P = 0.29): from 2021 to 2023, the relative increase in frequent awareness was greater for those with adequate vs limited literacy (B = 0.51, SE = 0.20, P = 0.010; see Supplement Figure 2).

Reported Reductions in Purchasing Less Healthy Foods due to FoPWLs

Among those who were aware of FoPWLs, the proportion who reported that they bought less of specific products due to the FoPWLs ranged from 31.1% for snacks like chips in 2021 to 43.9% for cola in 2022 and 2023 (see Figure 1). In adjusted models (Supplement Tables 1-2), reduced purchasing of two less healthy food categories due to the FoPWLs was more likely in 2022 than 2021: sweetened fruit drinks (AOR = 1.27, 95%CI = 1.07-1.50), and desserts (AOR = 1.32, 95%CI = 1.11-1.55); reported decreases in purchasing other food categories did not change over time. Associations with health literacy were mixed: those with limited health literacy were more likely than those with adequate literacy to purchase fewer colas ($AOR_{possibly\ limited\ vs\ adequate}$ = 1.37, 95% CI = 1.13-1.65; $AOR_{limited\ vs\ adequate}$ = 1.23, 95%CI = 1.05-1.44), sodas ($AOR_{possibly\ limited\ vs\ adequate}$ = 1.48, 95%CI = 1.18-1.85)

Table 3. Prevalence and Correlates of Mexican American Adults Who Frequently Noticed Front-Of-Package Warning Labels[a] in the Last Month, 2021-2023

Characteristics	% Who notice "often"/"all the time"	Bivariate model		Adjusted model	
		OR	[95% CI]	AOR	[95% CI]
Sex (ref = Male)	21.0	Ref		Ref	
Female	20.2	0.96	[0.85, 1.09]	0.97	[0.84, 1.11]
Age (ref = 18-29 years old)	27.4	Ref		Ref	
30-44 years old	23.9	0.81***	[0.71, 0.93]	0.63***	[0.54, 0.73]
45-59 years old	13.2	0.40***	[0.33, 0.48]	0.38***	[0.30, 0.46]
60+ years old	4.3	0.11***	[0.07, 0.19]	0.13***	[0.08, 0.23]
Education (ref = Low)	18.8	Ref		Ref	
Medium	20.7	1.11	[0.97, 1.28]	1.18*	[1.02, 1.37]
High	28.6	1.71***	[1.51, 1.93]	1.50***	[1.31, 1.72]
Income adequacy[b]		1.25***	[1.18, 1.33]	1.26***	[1.18, 1.34]
Children at home (ref = None)	16.8	Ref		Ref	
One	23.5	1.54***	[1.31, 1.81]	1.25*	[1.04, 1.51]
Two or more	28.1	1.94***	[1.69, 2.23]	1.46***	[1.24, 1.72]
Chronic diseases (ref = none)	21.5	Ref		Ref	
One	18.8	0.85*	[0.72, 1.00]	1.06	[0.89, 1.27]
Two or more	19.5	0.88	[0.75, 1.04]	1.27*	[1.05, 1.53]
Shop role (ref = None/Some)	18.1	Ref		Ref	
Share equally with other(s)	19.6	1.09	[0.86, 1.38]	1.07	[0.83, 1.39]
Most	21.4	1.21*	[0.98, 1.50]	1.30*	[1.02, 1.66]
Spanish vs English use[c]		2.03***	[1.91, 2.16]	1.95***	[1.81, 2.09]
Health literacy (ref = Adequate)	15.1	Ref		Ref	
Possibly limited	19.7	1.39***	[1.17, 1.64]	1.20	[1.00, 1.43]
Limited	26.1	2.01***	[1.74, 2.32]	1.21**	[1.03, 1.43]
State/Region (ref = California)	20.8	Ref		Ref	
Texas	18.8	0.88	[0.74, 1.04]	0.95	[0.79, 1.15]
West	19.1	0.90	[0.75, 1.09]	1.00	[0.81, 1.23]
Midwest	20.3	0.96	[0.78, 1.18]	1.00	[0.80, 1.24]
Northeast	27.1	1.41*	[1.08, 1.84]	0.97	[0.73, 1.29]
Southeast	24.9	1.27*	[1.04, 1.56]	0.96	[0.76, 1.20]
Survey year (ref = 2021)	20.2	Ref		Ref	
2022	21.4	1.05	[0.91, 1.22]	1.30**	[1.11, 1.53]
2023	20.1	0.99	[0.85, 1.15]	1.21*	[1.02, 1.44]

[a]"often" or "all the time" vs less often (20.6%); original distribution shown in Table 1; analytic sample (n = 9258).
[b]Range = 1. Very difficult – 5. Very easy for adequacy of household monthly income for making ends meet.
[c]Range = 1. English only – 5. Spanish only (average of 8 items) for frequency of language use.
OR = odds ratio, AOR = adjusted odds ratio, BMI = Body Mass Index, CI = confidence interval. *pvalue<0.05, **pvalue<0.01, ***pvalue<0.001.

and diet sodas ($AOR_{possibly\ limited\ vs\ adequate}$ = 1.30, 95%CI = 1.04-1.64; $AOR_{limited\ vs\ adequate}$ = 1.26, 95%CI = 1.03-1.54), but less likely to purchase fewer desserts (AOR = 0.79, 95%CI = 0.65-0.96) and sugary cereals (AOR = 0.79, 95%CI = 0.65-0.96) due to the FoPWLs. Compared to California, region of residence was unassociated with purchasing less of any product except one: the likelihood of purchasing less sweetened fruit drinks was lower in the Midwest than in California (AOR = 0.74, 95%CI = 0.55-0.99). Covariates that were consistently associated with self-reported buying less due to the FoPWLs included being female (vs male) and using Spanish more often (vs English); otherwise, the covariates were mostly unassociated with reported reductions in buying less healthy foods. Interactions between year and region (F-test range = 0.10-1.05; *P*-value range = 0.39-0.99), year and education (F-test range = 0.05-0.92; *P*-value range = 0.45-0.95), and year and health literacy (F-test range = 0.05-1.45; *P*-value range = 0.23-0.95) were not statistically significant for any food category.

Discussion

This study found that 68% of MA adults in a US sample were aware of Mexican FoPWLs between 2021 to 2023. After 2021, frequent awareness of FoPWLs and self-reported reductions in purchasing some less healthy foods due to FoPWLs increased, with no evidence of declines in

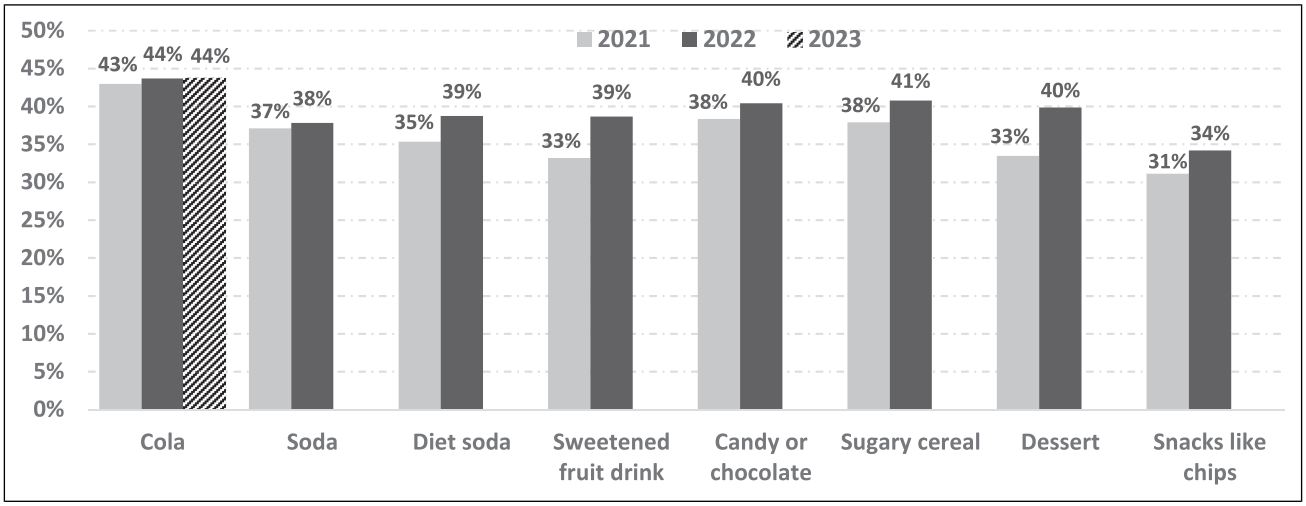

Figure 1. Percentage of Mexican Americans who reported reducing purchases of different less healthy foods because of FoPWLs, 2021 - 2022/3. *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$ for higher percentage in 2022 vs 2021 in fully adjusted models. 1. Analytic sample for 2021 (n = 1917), 2022 (n = 1990) and, for cola only, in 2023 (n = 1775)

self-reported effects. Overall, the Mexican FoPWL policy's reach and self-reported influence among MAs appear to have been maintained or strengthened over the three years since implementation, similar to trends in Mexico during initial FoPWL policy implementation.[21] This stability contrasts with declines in awareness of and responses to health warning labels on cigarette packages,[33-36] although a variety of factors may explain divergences in trends (e.g., different exposure frequency, message content). MAs in California were more likely to shop in Mexican stores than MAs in most other US regions, probably because California–the state with the largest MA population–is likely to have more of these stores. However, no regional differences were found in frequent awareness of Mexican FoPWLs, suggesting relatively uniform opportunities for exposure to packaged foods from Mexico – perhaps through venues beyond Mexican stores – among MAs across the US. Given that awareness and self-reported effects of FoPWLs did not decline, Mexican manufacturers may have maintained product packaging with FoPWLs even when destined for the US market; further research with sales data and/or store audits should aim to characterize the extent and types of Mexican products that display FoPWLs.

MAs who used Spanish more frequently or had limited (vs adequate) health literacy were more likely to report frequent awareness of Mexican FoPWLs. Differences by health literacy levels diminished over time, similar to converging trends in tobacco labeling effects across SES-groups,[47] possibly due to faster declines in attention to health information. Nevertheless, in 2023, awareness among those with adequate health literacy was comparable to those with limited health literacy, perhaps because pictorial heuristics like FoPWL "stop signs" facilitate engagement. This suggests the Mexican FoPWL system reached subgroups who are less likely to use and understand mandated Nutrition Facts labels in the US.[40,48,49] Furthermore, MAs with lower health literacy were more likely than to report that the FoPWLs caused them to buy less cola and soda–key sugar-sweetened beverages for which modeling studies suggest that Mexican-style FoPWLs could meaningfully reduce obesity.[50,51] For other products, lower health literacy was associated with lower reductions (i.e., desserts, sugary cereals) or no differences (i.e., candy, snacks like chips, sweetened fruit drinks) in self-reported reductions in purchasing due to FoPWLs. Qualitative research could aim to clarify these inconsistent patterns for which there is no clear interpretation. Future research should also evaluate potential psychosocial mechanisms for how FoPWLs influence behavior, as these pathways may also help explain why associations differ across product types. Future research may also illuminate whether FoPWLs on Mexican-packaged products prompt substitution toward equally or less healthy products that do not display FoPWLs because they were not packaged for Mexico.

No evidence was found for differential changes over time in reported effects of FoPWLs on reducing purchases of less healthy foods by health literacy or education levels, suggesting stable reported effects of FoPWLs. Greater FoPWL awareness and mostly null or positive reported effects of FoPWLs on purchasing behaviors among those with lower health literacy should be contextualized alongside other results. Health literacy is positively correlated with education across IFPS samples,[28] yet frequent awareness of FoPWLs was higher among MAs with higher education and with higher perceived income adequacy, suggesting that FoPWLs might contribute to SES-related disparities among MAs. Amongst the two-thirds of the study sample who were aware of FoPWLs, higher education had mixed associations with self-reported reductions in buying less healthy products due to

FoPWLs (i.e., null for four food categories, positive for three, negative for one), with higher income adequacy either unassociated (5 categories) or inversely associated (3 categories). Hence, consistent with a systematic review,[52] this study found mixed evidence around whether FoPWLs may offset SES-related health disparities, with the most consistent evidence found when considering health literacy. Interpretation is limited by the inability to verify which foods displayed FoPWLs in the contexts where participants encountered them. Nevertheless, the pattern of self-reported buying less of different food types because of FoPWLs among MAs is similar to, though somewhat lower than in Mexico,[21] likely reflecting greater exposure to FoPWLs. Future research should evaluate whether exposure to Mexican-made packaged foods with FoPWLs in the US promotes healthier diets over time.

These study results may have limited generalizability due to sample recruitment from an online panel provider, which resulted in over-representation of MAs with high education in spite of US Latinos having high internet use (95%).[53] Education, however, was mostly unassociated with study outcomes, suggesting that this was not a serious limitation. Importantly, participants resided in US regions in proportions that were similar to 2021 US Census estimates. While analyses integrated weights to address imbalances in the demographic composition of our sample, this approach may not have fully addressed potential selection biases. The relatively low participation rate may have compounded selection bias issues, although other online surveys have similarly low rates. Furthermore, self-reported outcomes may suffer from recall and social desirability biases that led to overestimates of policy exposure and effects. Providing participants with compensation could have compounded these biases, though participants were recruited from market research panels where compensation is expected and data quality controls are in place. It is unclear, however, if measurement biases affected the associations explored; nevertheless, the same self-report measures were used across surveys and biases were unlikely to have varied systematically over the study period, adding confidence to the assessment of trends. More detailed research is needed to clarify policy effects on purchasing of different types of food products, as has been done with store receipts and household purchases after Chile implemented FoPWLs.[54] We queried general awareness of FoPWLs, not FoPWL awareness for each food category, and category-specific factors (e.g., pricing and availability of alternatives within each category) may influence label effects on dietary behavior.

In January 2025, the US Food and Drug Administration proposed a mandatory front-of-package labeling system with the percent daily value of saturated fat, sodium, and added sugars, each with an indication of these amounts as "High," "Medium," or "Low." Alongside emerging evidence around FoPWLs,[3,4,19,20] this study suggests the US should consider a simpler FoPWL system - indicating only if nutrients of concern are "High" - although evidence is still needed on which front-of-package system will best promote healthy eating.[52]

So What?

What Is Already Known on This Topic?

Front-of-package warning labels (FoPWLs) on packaged food with less healthy nutritional content have been adopted in Mexico and across Latin America, where evidence for their effectiveness is growing. Mexican-made packaged foods with FoPWLs are sold in the US, and a prior survey found that many Mexican Americans (MAs) report seeing and being influenced by these FoPWLs.

What Does This Article Add?

This study investigated whether the potential reach and self-reported influence of Mexican FoPWLs on MA's purchases of less healthy foods has changed from its initial implementation in 2021 through 2022 and 2023. Differences in self-reported responses to FoPWLs both overall and across time were assessed by region of US residence, health literacy level, and education.

What Are the Implications for Health Promotion Practice or Research?

Our results suggest that FoPWLs capture attention and promote healthy dietary behaviors among US consumers; hence, the US Food and Drug Administration's pending rule on front-of-package labeling should consider this type of system.

ORCID iDs

James F. Thrasher https://orcid.org/0000-0001-6418-4863
Victor Eduardo Villalobos-Daniel https://orcid.org/0000-0003-1112-8643
Christine M. White https://orcid.org/0000-0003-3319-7391
Alejandra Contreras-Manzano https://orcid.org/0000-0003-1576-5922
Alejandra Jáuregui https://orcid.org/0000-0001-9158-2007

Ethical Considerations

The study was reviewed and received ethics clearance through a University of Waterloo Research Ethics Board and the University of South Carolina's Institutional Review Board.

Consent to Participate

Participants provided consent online, before initiating the online survey.

Author Contributions

JFT conceptualized the study, wrote the manuscript and secured funding; DF managed data, conducted the analyses and led the writing of the methods and results sections; MM, VV, and ACM critically reviewed and edited the manuscript; CMW managed the project and critically reviewed and edited the manuscript; AJ, LV, DH and RED helped conceptualize the study, critically reviewed the manuscript, and secured funding.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Funding for this project was provided by the National Institute of Diabetes and Digestive and Kidney Disorders (R01 DK128967), with additional project support from the Canadian Institutes of Health Research (CIHR) (PJT-162167) and the National Institute for Health Research (NIHR13059). The content is the sole responsibility of the authors and does not necessarily represent the official opinions of the National Institutes of Health, the Canadian Institutes of Health Research, or other sources of funding.

Declaration of Conflicting Interests

The authors declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: David Hammond has provided paid expert testimony on behalf of public health authorities in response to challenges from the food and beverage industry.

Data Availability Statement

Disclosure of data online is not covered under the project ethics approvals; however, de-identified participant data from this study will be made available to interested parties upon reasonable request. Interested parties should submit a proposal to the project PI (David Hammond) that he and other key personnel will review for scientific merit. Once a proposal is approved, a data access agreement will need to be signed before the data and relevant protocol information are shared. De-identified survey data will be shared, along with technical reports that include survey protocols, questionnaires, and other relevant details (e.g., post-stratification weight development, follow-up rates).

Supplemental Material

Supplemental material for this article is available online.

References

1. Diario Oficial de la Federacion. MODIFICACIÓN a la Norma Oficial Mexicana NOM-051-SCFI/SSA1-2010, Especificaciones generales de etiquetado para alimentos y bebidas no alcohólicas preenvasados-Información comercial y sanitaria, 2020 [MODIFICATION to the Mexican Official Standard NOM-051-SCFI/SSA1- 2010, General labeling specifications for prepackaged foods and non- alcoholic beverages—Commercial and health information, 2020.] [cited March 22, 2026]. Available from: https://www.dof.gob.mx/normasOficiales/8150/seeco11_C/seeco11_C.html.
2. Pan American Health Organization. *Pan American Health Organization Nutrient Profile Model*. PAHO; 2016.
3. Vargas-Meza J, Jáuregui A, Pacheco-Miranda S, Contreras-Manzano A, Barquera S. Front-of-pack nutritional labels: understanding by low- and middle-income Mexican consumers. *PLoS One*. 2019;14(11):e0225268. doi:10.1371/journal.pone.0225268
4. Nieto C, Jáuregui A, Contreras-Manzano A, et al. Understanding and use of food labeling systems among whites and Latinos in the United States and among Mexicans: results from the international food policy study, 2017. *Int J Behav Nutr Phys Activ*. 2019;16(1):87. doi:10.1186/s12966-019-0842-1.
5. Campos S, Doxey J, Hammond D. Nutrition labels on pre-packaged foods: a systematic review. *Public Health Nutr*. 2011; 14(08):1496-1506.
6. Canadian Council of Food and Nutrition. *Tracking Nutrition Trends VI: An Initiative of the Canadian Council of Food and Nutritio*, Canadian Council of Food and Nutrition. 2006.
7. James DC. Impact of health literacy on the use of the nutrition facts panel among African- American women. *J Am Diet Assoc*. 2011;111(9):A92.
8. González-Vallejo C, Lavins BD, Carter KA. Analysis of nutrition judgments using the nutrition facts panel. *Appetite*. 2016; 105:71-84.
9. Soederberg MLM, Cassady DL. The effects of nutrition knowledge on food label use: a review of the literature. *Appetite*. 2015;92:207-216.
10. Wilson MD, Ramírez AS, Arsenault JE, Miller LMS. Nutrition label use and its association with dietary quality among latinos: the roles of poverty and acculturation. *J Nutr Educ Behav*. 2018; 50(9):876-887. doi:10.1016/j.jneb.2018.05.019
11. De la Cruz-Góngora V, Villalpando S, Rodríguez-Oliveros G, Castillo-García M, Mundo-Rosas V, Meneses-Navarro S. Use and understanding of the nutrition information panel of prepackaged foods in a sample of Mexican consumers. *Salud Publica Mex*. 2012;54(2):158-166. doi:10.1590/s0036-36342012000200012.
12. Persoskie A, Hennessy E, Nelson WL. US consumers' understanding of nutrition labels in 2013: the importance of health literacy. *Prev Chronic Dis*. 2017;14:E86.
13. Hobin E, Shen-Tu G, Sacco J, et al. Comprehension and use of nutrition facts tables among adolescents and young adults in Canada. *Can J Diet Pract Res*. 2016;77(2):59-65.
14. Dukeshire S, Nicks E. Benchmarks and blinders: how Canadian women utilize the nutrition facts table. *Can J Diet Pract Res*. 2017;78(2):53-58.
15. Hobin E, Sacco J, Vanderlee L, et al. A randomized trial testing the efficacy of modifications to the nutrition facts table on comprehension and use of nutrition information by adolescents

and young adults in Canada. *Health Promotion, Chronic Disease Prevention in Canada: Research, Policy and Practice*. 2015;35(10):173-183.
16. Vanderlee L, White CM, Bordes I, Hobin EP, Hammond D. The efficacy of sugar labeling formats: implications for labeling policy. *Obesity*. 2015;23(12):2406-2413.
17. National Center for Health Statistics. *Multiple Cause of Death 2018–2023: CDC WONDER Database: NCHS*. Centers for Disease Control and Prevention, 2025. https://wonder.cdc.gov/mcd.html. (Accessed February 1 2025).
18. Center for Disease Control and Prevention. *National Diabetes Statistics Report*. CDC; 2025. https://www.cdc.gov/diabetes/php/data-research/index.html (Accessed October 22 2025).
19. Hammond DAR, Rynard VL, White CM, et al. Awareness, use and understanding of nutrition labels among children and youth from six countries: findings from the 2019 – 2020 international food policy study. *Int J Behav Nutr Phys Activ*. 2023;20(1):55.
20. Acton RBRV, Adams J, Bhawra J, et al. Awareness, use and understanding of nutrition labels among adults from five countries: findings from the 2018 – 2020 international food policy study. *Appetite*. 2023;180:e106311.
21. Contreras-Manzano A, White CM, Nieto C, et al. Self-reported decreases in the purchases of selected unhealthy foods resulting from the implementation of warning labels in Mexican youth and adult population. *Int J Behav Nutr Phys Activ*. 2024;21(64):1-14.
22. Thrasher JF, Villalobos-Daniel VE, Fang D, et al. Assessing transnational spillover effects of Mexico's front-of-package nutritional labeling system among Mexican Americans in the US. *Prev Med*. 2024;179:107855.
23. Vargas-Meza J, Jáuregui A, Contreras-Manzano A, Nieto C, Barquera S. Acceptability and understanding of front-of-pack nutritional labels: an experimental study in Mexican consumers. *BMC Public Health*. 2019;19(1):1751. doi:10.1186/s12889-019-8108-z
24. Mansfield E, Wahba R, De Grandpré E. Integrating a health literacy lens into nutrition labelling policy in Canada. *Int J Environ Res Publ Health*. 2020;17(11):4130. doi:10.3390/ijerph17114130
25. Rothman RL, Housam R, Weiss H, et al. Patient understanding of food labels: the role of literacy and numeracy. *Am J Prev Med*. 2006;31(5):391-398.
26. Cha ES, Kim KH, Lerner HM, et al. Health literacy, self-efficacy, food label use, and diet in young adults. *Am J Health Behav*. 2014;38(3):331-339. doi:10.5993/AJHB.38.3.2
27. Viswanathan M, Hastak M, Gau R. Understanding and facilitating the usage of nutritional labels by low-literate consumers. *J Publ Pol Market*. 2009;28(2):135-145.
28. Bhawra J, Kirkpatrick SI, Hall MG, Vanderlee L, Thrasher JF, Hammond D. Correlates of self-reported and functional understanding of nutrition labels across 5 countries in the 2018 international food policy study. *J Nutr*. 2022;52:3S-24S.
29. Bhawra J, Kirkpatrick S, Hall M, et al. A five-country study of front- and back-of-package nutrition label awareness and use: patterns and correlates from the 2018 international food policy study. *Public Health Nutr*. 2023;26(1):275-286.
30. Malloy-Weir L, Cooper M. Health literacy, literacy, numeracy and nutrition label understanding and use: a scoping review of the literature. *Public Health Nutr*. 2017;30(3):309-325.
31. Durand J, Massey DS, Charvet F. The changing geography of Mexican immigration to the United States: 1910-1996. *Soc Sci Q*. 2000;81(1):1-15.
32. United States Census Bureau. *Racial and Ethnic Diversity in the United States: 2010 Census and 2020 Census*; 2021. https://www.census.gov/library/visualizations/interactive/racial-and-ethnic-diversity-in-the-united-states-2010-and-2020-census.html (Accessed March 2 2025).
33. Anshari D, Yong HH, Borland R, Hammond D, Swayampakala K, Thrasher J. Which type of tobacco product warning imagery is more effective and sustainable over time? A longitudinal assessment of smokers in Canada, Australia and Mexico. *BMJ Open*. 2018;8(7):e021983. doi:10.1136/bmjopen-2018-021983
34. Li L, Borland R, Yong H, et al. Longer term impact of cigarette package warnings in Australia compared with the United Kingdom and Canada. *Health Educ Res*. 2015;30(1):67-80. doi:10.1093/her/cyu074
35. Borland R, Wilson N, Fong GT, et al. Impact of graphic and text warnings on cigarette packs: findings from four countries over five years. *Tob Control*. 2009;18(5):358-364. doi:10.1136/tc.2008.028043
36. Hitchman SC, Driezen P, Logel C, Hammond D, Fong GT. Changes in effectiveness of cigarette health warnings over time in Canada and the United States, 2002-2011. *Nicotine Tob Res*. 2014;16(5):536-543. doi:10.1093/ntr/ntt196
37. Niederdeppe J. Conceptual, empirical, and practical issues in developing valid measures of media campaign exposure. *Commun Methods Meas*. 2014;8(2):138-161.
38. Fishbein M, Cappella J. The role of theory in developing effective health communications. *J Commun*. 2006;56:S1-S17.
39. Center for Food Safety and Applied Nutrition. *2014 Food and Drug Association Health and Diet Survey*. United States Food and Drug Administration. 2016.
40. United States Department of Agriculture (USDA) Research Services. *National Household Food Acquisition and Purchase Survey (FoodAPS)*. USDA; 2016.
41. Weiss BD, Mays MZ, Martz W, et al. Quick assessment of literacy in primary care: the newest vital sign. *Ann Fam Med*. 2005;3(6):514-522.
42. Litwin H, Sapir EV. Perceived income adequacy among older adults in 12 countries: findings from the survey of health, ageing, and retirement in Europe. *Gerontol*. 2009;49(3):397-406. doi:10.1093/geront/gnp036
43. Marín GSF, Marín BV, Otero-Sabogal R, Perez-Stable EJ. Development of a short acculturation scale for hispanics. *Hisp J Behav Sci*. 1987;9:183-205.
44. Centers for Disease Control and Prevention. *Behavioral Risk Factor Surveillance System Questionnaire (BRFSSQ) 2016*, 2017. [BRFSS item CVDINFR4]. https://wwwn.cdc.gov/nchs/data/nhanes/2015-2016/questionnaires/WHQ_I.pdf (Accessed August 7 2020).

45. Van Buuren S. Multiple imputation of discrete and continuous data by fully conditional specification. *Stat Methods Med Res*. 2007;16(3):219-242.
46. Graham JW, Olchowski AE, Gilreath TD. How many imputations are really needed? Some practical clarifications of multiple imputation theory. *Prev Sci*. 2007;8:206-213.
47. Swayampakala K, Thrasher JF, Yong HH, et al. Over-time impacts of pictorial health warning labels and their differences across smoker subgroups: results from adult smokers in Canada and Australia. *Nicotine Tob Res*. 2018;20(7):888-896. doi:10.1093/ntr/ntx134
48. Ollberding NJ, Wolf RL, Contento I. Food label use and its relation to dietary intake among US adults. *J Am Diet Assoc*. 2011;111(5):S47-S51.
49. Todd JE, Variyam JN. The decline in consumer use of food nutrition labels, 1995-2006, Economic research report No. 63, Economic Research Service, U.S. Dept. of Agriculture. August 2008.
50. Grummon AH, Smith NR, Golden SD, Frerichs L, Taillie LS, Brewer NT. Health warnings on sugar-sweetened beverages: simulation of impacts on diet and obesity among U.S. adults. *Am J Prev Med*. 2019;57(6):765-774. https://doi.org/10.1016/j.amepre.2019.06.022
51. Basto-Abreu A, Torres-Alvarez R, Reyes-Sánchez F, et al. Predicting obesity reduction after implementing warning labels in Mexico: a modeling study. *PLoS Med*. 2020;17(7):e1003221. doi:10.1371/journal.pmed.1003221
52. Shrestha A, Cullerton K, White KM, Mays J, Sendall M. Impact of front-of-pack nutrition labelling in consumer understanding and use across socio-economic status: a systematic review. *Appetite*. 2023;187:106587.
53. Pew Research Center. Internet/Broadband fact sheet: who uses the internet 2021. https://www.pewresearch.org/internet/fact-sheet/internet-broadband/?tabId=tab-d5edf003-5858-4269-89c5-f2889ecf7951 (Accessed August 24 2023).
54. Taillie L, Reyes M, Colchero M, Popkin B, Corvalán C. An evaluation of Chile's law of food labeling and advertising on sugar-sweetened beverage purchases from 2015 to 2017: a before-and-after study. *PLoS Med*. 2020;17(2):e1003015.