frontiers in Nutrition

TYPE Original Research
PUBLISHED 02 November 2026
DOI 10.3389/fnut.2026.1973978

Check for updates

OPEN ACCESS

EDITED BY
Igor Pravst,
Institute of Nutrition, Slovenia

REVIEWED BY
Patricio Pérez-Armijo,
Universidad Isabel I de Castilla, Spain
Sibel Özdemir,
Bülent Ecevit University, Türkiye

*CORRESPONDENCE
Natalia Rebolledo
✉ natalia.rebolledo@inta.uchile.cl
Aline D'Angelo Campos
✉ adangelo-campos@unc.edu

RECEIVED 20 August 2026
REVISED 29 September 2026
ACCEPTED 29 September 2026
PUBLISHED 02 November 2026

CITATION
D'Angelo Campos A, Smith Taillie L, Hall MG, Ng SW and Rebolledo N (2026) Front-of-package ultraprocessed warning labels: a randomized controlled trial with Chilean parents.
Front. Nutr. 13:1973978.
doi: 10.3389/fnut.2026.1973978

COPYRIGHT
© 2026 D'Angelo Campos, Smith Taillie, Hall, Ng and Rebolledo. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

Front-of-package ultraprocessed warning labels: a randomized controlled trial with Chilean parents

Aline D'Angelo Campos[1]*, Lindsey Smith Taillie[1,2], Marissa G. Hall[1,3,4], Shu Wen Ng[1,2] and Natalia Rebolledo[5]*

[1]Carolina Population Center, University of North Carolina at Chapel Hill, Chapel Hill, NC, United States, [2]Department of Nutrition, Gillings School of Global Public Health, University of North Carolina at Chapel Hill, Chapel Hill, NC, United States, [3]Department of Health Behavior, Gillings School of Global Public Health, University of North Carolina at Chapel Hill, Chapel Hill, NC, United States, [4]Lineberger Comprehensive Cancer Center, University of North Carolina at Chapel Hill, Chapel Hill, NC, United States, [5]Center for Research in Food Environments and Prevention of Nutrition-Related Chronic Diseases (CIAPEC), Institute of Nutrition and Food Technology (INTA), University of Chile, Santiago, Chile

Background: Interest in ultraprocessed food (UPF) front-of-package labels (FOPLs) has been gaining momentum, but questions remain about their added value in the context of established nutrient-based FOPL systems. This study examined the impact of adding a UPF label to Chile's existing nutrient FOPLs on Chilean parents' product perceptions and behavioral intentions.
Methods: In 2025, Chilean parents (analytical sample $n = 3{,}519$) were randomly assigned to either a control condition (nutrient labels only) or a UPF label condition (nutrient labels plus UPF label). Participants viewed three similar products (all potato chips with the same flavor, all UPFs, one not high in any nutrients of concern, one high in one nutrient, and one high in two nutrients), indicated whether they believed each product to be ultraprocessed, and rated their product purchase intentions and perceived product healthfulness. Average differential effects (ADEs) are reported in percentage points (pp) or 1–5 scales.
Results: Compared to control, the addition of the UPF label improved participants' ability to correctly identify products as ultraprocessed, but effect sizes decreased as the number of nutrient labels increased (ADE = 12pp for product not high in nutrients of concern, ADE = 4pp for product high in one nutrient, both $p < 0.001$; $p > 0.05$ for product high in two nutrients). The addition of the UPF label also led to lower purchase intentions and perceived healthfulness for all three products, but effect sizes again decreased as the number of nutrient labels increased (purchase intentions: ADE = 0.32 for product not high in nutrients of concern, ADE = 0.23 for product high in one nutrient, ADE = 0.20 for product high in two nutrients; perceived healthfulness: ADE = 0.33 for product not high in nutrients of concern, ADE = 0.17 for product high in one nutrient, ADE = 0.11 for product high in two nutrients; all $p < 0.001$).
Conclusions: Overall, the addition of UPF labels to existing FOPL systems may help consumers more easily identify products as ultraprocessed and lower consumers' perceived healthfulness and purchase intentions of UPFs. UPF labels could have the largest effects when applied to UPFs that carry no or few nutrient labels.
Registration: https://clinicaltrials.gov/study/NCT06842680.

KEYWORDS
food labeling, food labels, front-of-pack labeling, front-of-package labeling, ultraprocessed foods, warning labels

Introduction

Front-of-package labels (FOPLs) on packaged foods and beverages provide nutritional information through interpretive design, making it easier for consumers to evaluate products' nutritional quality without extensive cognitive processing or in-depth nutritional knowledge (1, 2). Interpretive FOPLs are mandated in 14 countries, most of which only employ FOPLs that communicate about products' nutrient content (e.g., sugar, sodium, saturated fat), and a few additionally communicate the presence of non-nutritive sweeteners (NNS) (3). However, a growing body of evidence suggests that food processing may have negative impacts on health independently of nutrient content (4). As such, interest in adding labels communicating that products are ultraprocessed to FOPL systems has been growing: as of July 2026, ultraprocessed food (UPF) labels have been included in the Pan-American Health Organization's latest publication on principles to guide the development of FOPL systems (5), formally proposed by Colombia's Ministry of Health (6), and are currently under discussion in Chile's Senate (7).

UPFs are industrial products manufactured using intense physical, chemical, and biological processes, containing little to no whole-food ingredients, and often including cosmetic additives (4). While UPFs are commonly nutritionally unbalanced, nutrient content is not part of the UPF definition, and many UPFs do not qualify as high in nutrients of public health concern (8–11). Importantly, UPFs' relationship with adverse health outcomes seems to persist even after accounting for nutrient content (4, 12, 13), which may be explained by nutrient-independent mechanisms of harm for which evidence is growing – including hyperpalatability, rapid digestion, harms to the microbiome, and presence of processing and packaging contaminants (14–20). Additionally, manufacturers can reformulate products to meet nutrient criteria without addressing or even introducing other attributes that make them UPFs, such as cosmetic additives – as seen in Chile, where the implementation of "high in sugar" FOPLs was followed by decreases in the percentage of products that qualify as such, but also by increases in the use of NNS [which are UPF markers (21)] in packaged products (22, 23). The scientific and policy rationale for communicating products' ultraprocessed status to consumers separately from their nutrient content is therefore clear. However, it is less clear whether UPF labels might have additional influence on consumers' perceptions and behaviors in the context of existing nutrient-based FOPL systems.

Previous studies have shown that, when assessed in isolation (in comparison to no-label controls), UPF labels can not only improve consumers' ability to identify UPFs, but also reduce intentions to select or consume them (24–27). However, UPF labels may not be implemented in isolation, as many countries have already implemented and set a strong precedent for nutrient-based FOPL systems. To our knowledge, only one study so far has examined the incremental effects of adding a UPF label to existing nutrient labels, and found that while it improved consumers' ability to identify products as UPFs, it did not further influence product healthfulness or label effectiveness perceptions (28). However, the generalizability of that study was limited by not including any UPFs that did not carry nutrient labels (which may represent a meaningful portion of the food supply in many contexts) and by using a UPF label that matched Brazil's weaker FOPL system's visual identity (i.e., rectangular shape) (29). Octagonal UPF labels, which may be more effective, have never been examined in the context of existing nutrient labels.

Chile was the country to pioneer not only the octagonal FOPL design now used in several Latin American countries, but also mandatory interpretive FOPL policies overall (30). Implemented in 2016, Chile's package of nutrition policies, which includes nutrient-based FOPLs, has had beneficial effects on the amount of nutrients of concern purchased by Chilean households (31), but no evidence is available on whether these policies have similarly impacted UPF consumption in Chile, which remains high (32). As policymakers in Chile and other countries with existing nutrient-based FOPL systems consider whether to incorporate UPF labels into these policies, evidence on how such labels perform alongside existing nutrient warning labels is needed. Thus, to strengthen the evidence on the effects of UPF labels in the context of existing nutrient-based FOPL systems and inform policy discussions in Chile and globally, this study examined the impact of a UPF label on Chilean parents' product perceptions and behavioral intentions.

Methods

Participants

In July and August 2025, we recruited an online convenience sample of Chilean parents through the panel company Netquest. This study was conducted following an unrelated parent study on non-nutritive sweetener labels (33), and participants were re-randomized into this study's arms. Re-randomization ensured that any influence of the parent study on participants' responses to the present study was evenly distributed across the present study's arms and thus did not affect results.

Participants were eligible if they were at least 18 years old, resided in Chile, and had a child between 2–14 years old who had never been diagnosed with diabetes, prediabetes, or insulin resistance. Participants' parental status and children's diagnosis criteria were specified due to the topic of the parent study – however, parents were also a particularly relevant population for this study, as UPF consumption is especially high among children in Chile (32). To ensure diverse representation across educational levels, we established a quota requiring 50% of participants to have a high school education or less.

The University of North Carolina at Chapel Hill Institutional Review Board approved this study (#24-2896). The University of Chile Ethics Committee determined that separate local review was not required. All participants provided electronic informed consent. This study's design, measures, hypotheses,

Abbreviations: ADE, average differential effect; FOPL, front of package label/labeling; NNS, non-nutritive sweeteners; UPF, ultraprocessed food.

and analytic plan were registered before data collection on ClinicalTrials.gov (NCT06842680).

Stimuli

The study stimuli consisted of three fictitious packages of potato chips. We used fictitious products to avoid the influence of existing brand preferences. We also intentionally used savory products in this study to further mitigate any possibility of influence from the parent study, which only used sweet products.

All three products used in this study qualified as UPFs. The three packages of potato chips had the same flavor (i.e., sour cream and onion) to avoid confounding by product type or flavor when comparing the effects of the UPF label between products while still presenting plausibly distinct products. Our research question required products to be distinct enough to plausibly carry different nutrient warning labels (i.e., one product with zero nutrient warnings, one with only a "high in sodium" warning, and one with "high in sodium" and "high in saturated fat" warnings), but not so distinct that differences in the effect of the UPF label between products could be attributed to other key product characteristics (i.e., product type or flavor). Thus, we designed fictitious products that, outside of nutrients warnings, only differed in minor package design elements, such as background color, product name (although all names chosen were generic), and imagery shown (although all images depicted sour cream and onions; Figure 1).

Procedures

Participants completed an online experiment programmed in Qualtrics software. Using the randomizer function in Qualtrics, participants were randomly assigned to one of two labeling conditions using a 1:1 allocation ratio: control or UPF warning label. In the control condition, products carried only nutrient warning labels, reflecting Chile's current policy scenario (i.e., black octagonal labels stating when the product is high in sodium and/or saturated fat). In the UPF warning label condition, products carried both nutrient warning labels (identical to those seen in the control condition) and an additional warning label stating "ULTRAPROCESSED." We used a white octagon for the UPF label to differentiate it from Chile's existing nutrient labels, as in a previous study (24). After randomization, participants were shown the three products described above in random order.

Before the experiment, we informed participants that the term "ultraprocessed," which they might encounter during the study, refers to products "made using various industrial techniques and containing ingredients not commonly used in culinary preparations to enhance their flavor and extend their shelf life, such as flavorings, colorings, and preservatives, among others." This information was provided to emulate a policy



FIGURE 1
Stimuli used in experiment, by labeling condition.

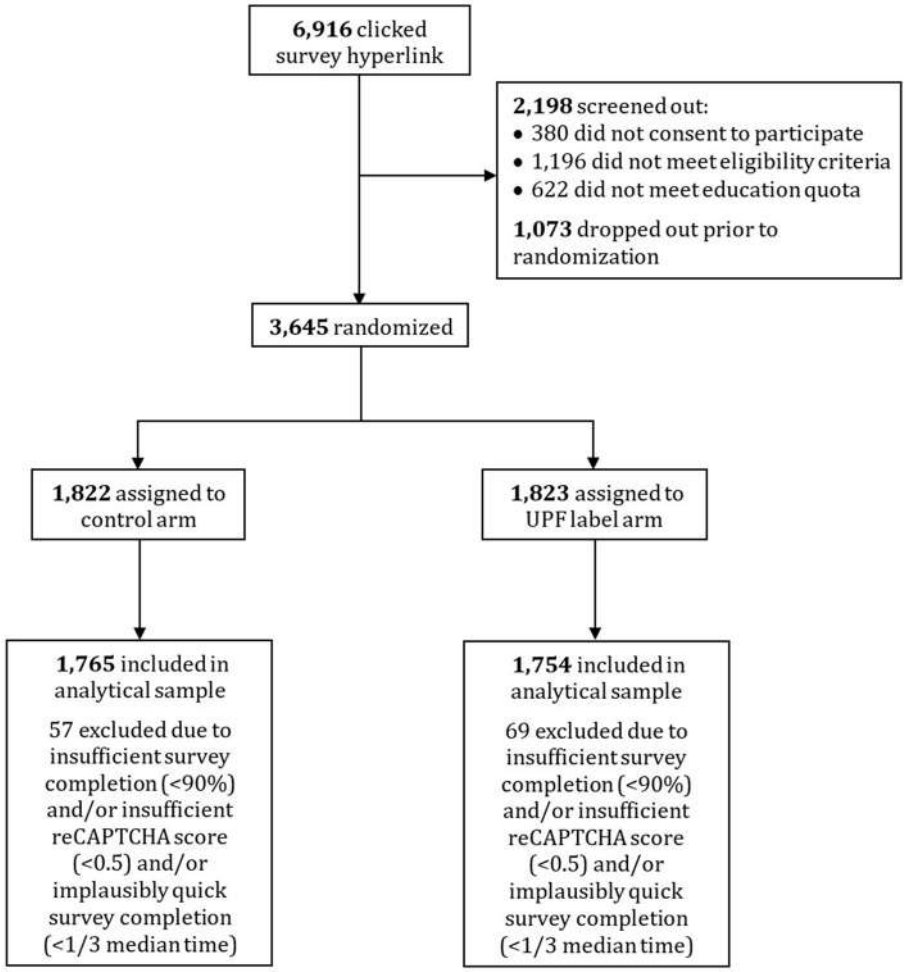


FIGURE 2
Participant flow diagram.

implementation scenario in which the government informs consumers about the meaning of the information communicated by a new label.

Measures

Using previously established measures, participants rated their product purchase intentions (28, 34) ("How likely would you be to buy this product in the next week, if it were available in a store?", co-primary outcome), identified whether the product was ultraprocessed (28) ("Do you think this product is ultraprocessed?", co-primary outcome), and rated their perceived product healthfulness (28, 35) ("How good or bad for your health would it be to consume this product every day?", secondary outcome) for each product seen. Response options for purchase intentions and perceived healthfulness were on a 5-point Likert-style scale ranging from the lowest to the highest value, while response options for UPF identification were dichotomous (i.e., "yes" or "no"). The survey also collected information on demographic characteristics.

Analyses

Given a sample size of around 3,300 (which was pre-determined based on the parent study), 80% power, and a critical alpha of 0.05, two groups, three repeated measures, and a correlation among repeated measures of 0.5, we calculated that we would be able to detect a minimum effect size of $d = 0.08$ for the primary outcomes (i.e., UPF identification and purchase intentions). We therefore determined that the sample size would be sufficient, given that, on a previous study of UPF labels, we found an effect size of $d = 0.15$ on UPF identification (28).

Participants who completed the survey implausibly fast (i.e., in less than 1/3 of the median completion time), who completed less than 90% of the survey, or who had reCAPTCHA scores below 0.5 were excluded from analysis, as in prior studies (total of 126 excluded, Figure 2) (36). Otherwise, the analytical sample included all participants according to the trial arm to which they were randomized. We used complete case analysis to handle missing data, resulting in the exclusion of only one participant from the analysis of the UPF identification outcome.

To examine whether correct identification of products as UPF differed between labeling conditions, we used a logistic

10.3389/fnut.2026.1973978

regression model with cluster-robust standard errors to account for the repeated measures within participants. The model included indicator variables for experimental arm, product, and their interactions. After model estimation, we examined the joint statistical significance of the interaction terms using a Wald test. This test yielded significant results, so we retained the interactions and report average differential effects (ADEs) of the UPF labeling condition (i.e., differences in predicted probabilities between labeling conditions) for each separate product and their comparisons. Alternatively, to examine whether purchase intentions and perceived healthfulness differed between labeling conditions, we used linear mixed-effects regression models with random intercepts to account for repeated measures within participants. Wald tests indicated that the interaction terms were also jointly significant for these models, so we retained them in both cases and report ADEs of the UPF labeling condition (i.e., differences in predicted means between labeling conditions) for each separate product and their comparisons.

Lastly, to examine whether the effect of the UPF labeling condition varied based on participants' education level or gender, we conducted exploratory moderation analyses for the co-primary outcomes (i.e., UPF identification and purchase intentions). Due to significant interactions between labeling condition and product in the main model, we fit separate models for each product. Models included indicator variables for labeling condition, the moderator (one per model) and their interaction. We considered moderation to be supported if the interaction term was statistically significant.

We made the following changes from the registered analytic plan: (1) we did not register our plan to exclude participants with reCAPTCHA scores below 0.5, but decided to exclude such participants *post-hoc* per advice from the Qualtrics platform, as they indicate a high likelihood that the response originated from a bot; (2) we registered that we would use mixed-effects models with random intercepts to account for repeated measures when examining effects on all outcomes, but had to instead use logistic regression with cluster-robust standard errors to examine effects on UPF identification since the mixed-effects specification would not converge for this outcome (likely due to low variability); (3) we did not register our plan to conduct moderation analyses, but decided to conduct such exploratory analyses *post-hoc* given that education and gender are two critical characteristics that may influence how consumers respond to labels; and (4) we re-estimated the minimum detectable effect size *post-hoc* to account for repeated measures, which were not accounted for at the time of registration.

Analyses were conducted using G*Power 3.1.9.4 and Stata/MP version 19.5 with a two-sided critical alpha of 0.05.

Results

The final analytic sample included 3,519 participants (Figure 2). Participants' mean age was 39.6 years (SD = 7.8) and 70% identified as women. Around 44% had an educational level of high school or less, 11% identified as Indigenous, and 59% considered themselves overweight or very overweight (Table 1).

TABLE 1 Participant characteristics ($N = 3,519$).

Characteristics	*n*	%
Gender		
Man	1,048	30%
Woman	2,468	70%
Other	3	<1%
Education level ($n = 3,509$)		
Basic education or less	107	3%
High school	1,435	41%
Higher-level technician (1–3 years)	836	24%
Professional (4 years or more)	919	26%
Post-graduate	212	6%
Indigenous ethnicity ($n = 3,506$)		
Indigenous	374	11%
Not indigenous	3,132	89%
Region ($n = 3,496$)		
Santiago and surroundings	1,774	51%
Valparaíso	391	11%
Biobío	246	7%
North (Antofagasta, Atacama, Arica y Parinacota, Coquimbo, Tarapacá)	271	8%
Central-West (O'Higgins, Ñuble, Maule)	365	10%
South (Aysén, La Araucanía, Los Lagos, Los Ríos, Magallanes)	449	13%
Perceived weight ($n = 3,500$)		
Very underweight	14	<1%
Underweight	70	2%
About the right weight	1,335	38%
Overweight	1,833	52%
Very overweight	248	7%
Ever diagnosed with† ($n = 3,506$)		
Diabetes	575	16%
Hypertension	545	16%
High cholesterol	675	19%
Cardiovascular disease	60	2%
None	2,114	60%
Frequency of FOPL use ($n = 3,432$)		
Never	203	6%
Rarely	487	14%
Sometimes	1,075	31%
Often	1,169	34%
All the time	498	15%
Perceived income adequacy˘ ($n = 3,433$)		
Somewhat or very difficult	2,454	71%
Neither difficult nor easy	725	21%

(Continued)

TABLE 1 (Continued)

Characteristics	*n*	%
Somewhat or very easy	254	7%
	Mean	SD
Age	39.6	7.8
Household size	4.1	1.4

Sample size is provided for specific variables when data was not available for the entire analytic sample for that variable.
†Non-exclusive options.
˜Measured as perceived difficulty of making ends meet without going into debt.

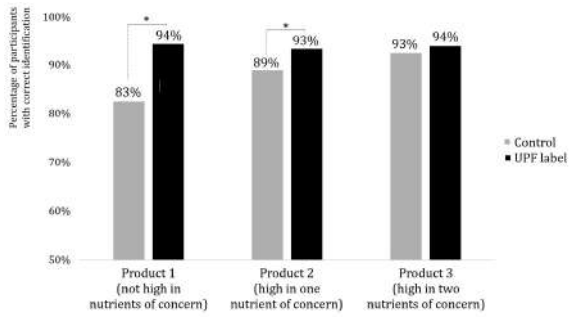


FIGURE 3
Predicted probability of correct UPF identification by labeling condition (n = 3,518)

UPF identification

Compared to participants in the control condition, those in the UPF label condition were more likely to identify the product as UPF for the product that was not high in any nutrients of concern (ADE = 12pp) and for the product that was high in one nutrient (ADE = 4pp, both $p < 0.001$), but not for the product that was high in two nutrients ($p > 0.05$; Figure 3, Table 2). The effect of the UPF label differed across products (Wald test $p < 0.0001$; ADE for product high in one nutrient vs. ADE for product not high in any nutrients = −7pp, $p < 0.001$; ADE for product high in two nutrients vs. ADE for product not high in any nutrients = −10pp, $p < 0.001$; ADE for product high in two nutrients vs. ADE for product high in one nutrient = −3pp, $p < 0.001$; Table 3).

Product purchase intentions

Compared to participants in the control condition, those in the UPF label condition exhibited lower intentions to purchase all three products (ADE = −0.32 for the product not high in nutrients of concern, ADE = −0.23 for the product high in one nutrient, and ADE = −0.20 for the product high in two nutrients, all $p <$ 0.001; Figure 4, Table 2). Notably, the effect of the UPF label on this outcome was larger for the product not high in any nutrients than for the product high in one nutrient (ADE comparison = 0.10, $p =$ 0.02) and for the product high in two nutrients (ADE comparison = 0.12, $p = 0.002$), but did not differ between the product high in one nutrient and the product high in two nutrients (ADE comparison $p > 0.05$; Wald test $p = 0.005$; Table 3)

TABLE 2 Average differential effects of the UPF labeling condition (compared to control) on participants' UPF identification, product purchase intentions, and perceived product healthfulness, by product.

Product	ADE	SE	95% CI	*p*-value
UPF Identification˜ (n = 3,518)				
Product 1 (not high in nutrients)	0.12*	0.01	0.10, 0.14	<0.001
Product 2 (high in one nutrient)	0.04*	0.01	0.03, 0.06	<0.001
Product 3 (high in two nutrients)	0.01	0.01	−0.003, 0.03	0.10
Purchase intentions† (n = 3,519)				
Product 1 (not high in nutrients)	−0.32*	0.04	−0.41, −0.23	<0.001
Product 2 (high in one nutrient)	−0.23*	0.04	−0.31, −0.14	<0.001
Product 3 (high in two nutrients)	−0.20*	0.04	−0.29, −0.11	<0.001
Perceived healthfulness† (n = 3,519)				
Product 1 (not high in nutrients)	−0.33*	0.03	−0.39, −0.28	<0.001
Product 2 (high in one nutrient)	−0.17*	0.03	−0.23, −0.11	<0.001
Product 3 (high in two nutrients)	−0.11*	0.03	−0.16, −0.05	<0.001

˜ADEs represent differences between labeling conditions in participants' predicted probability of identifying the product as ultraprocessed.
†ADEs represent differences between labeling conditions in participants' predicted mean score on a 1–5 scale.
*Statistically significant at the 95% confidence level.

Perceived product healthfulness

Compared to participants in the control condition, those in the UPF label condition perceived all three products as less healthful (ADE = −0.33 for the product not high in nutrients of concern, ADE = −0.17 for the product high in one nutrient, and ADE = −0.11 for the product high in two nutrients, all $p < 0.001$; Figure 5, Table 2). The effect of the UPF label differed across products (Wald test $p < 0.0001$; ADE for product high in one nutrient vs. ADE for product not high in any nutrients = 0.16, $p < 0.001$; ADE for product high in two nutrients vs. ADE for product not high in any nutrients = 0.23, $p < 0.001$; ADE for product high in two nutrients vs. ADE for product high in one nutrient = 0.06, $p =$ 0.004; Table 3).

Exploratory moderation analyses

Gender did not moderate the effects of the UPF label on UPF identification or product purchase intentions (all $p > 0.05$ for the interaction terms). Education level also did not moderate the effects of the UPF label on product purchase intentions or on UPF identification for the product not high in any nutrients of concern and for the product high in one nutrient (both $p >$

10.3389/fnut.2026.1973978

TABLE 3 Comparisons between average differential effects of the UPF labeling condition (compared to control) for each product on participants' UPF identification, product purchase intentions, and perceived product healthfulness.

Product	ADE contrast	SE	95% CI	*p*-value
UPF identification				
Product 2 (high in one nutrient) vs. Product 1 (not high in nutrients)	−0.07*	0.01	−0.09, −0.06	<0.001
Product 3 (high in two nutrients) vs. Product 1 (not high in nutrients)	−0.10*	0.01	−0.12, −0.09	<0.001
Product 3 (high in two nutrients) vs. Product 2 (high in one nutrient)	−0.03*	0.01	−0.05, −0.01	<0.001
Purchase intentions				
Product 2 (high in one nutrient) vs. Product 1 (not high in nutrients)	0.10*	0.04	0.02, 0.17	0.02
Product 3 (high in two nutrients) vs. Product 1 (not high in nutrients)	0.12*	0.04	0.04, 0.20	0.002
Product 3 (high in two nutrients) vs. Product 2 (high in one nutrient)	0.03	0.04	−0.05, 0.10	0.51
Perceived healthfulness				
Product 2 (high in one nutrient) vs. Product 1 (not high in nutrients)	0.16*	0.02	0.12, 0.21	<0.001
Product 3 (high in two nutrients) vs. Product 1 (not high in nutrients)	0.23*	0.02	0.18, 0.27	<0.001
Product 3 (high in two nutrients) vs. Product 2 (high in one nutrient)	0.06*	0.02	0.02, 0.11	0.004

ADE, average differential effect.
*Statistically significant at the 95% confidence level.

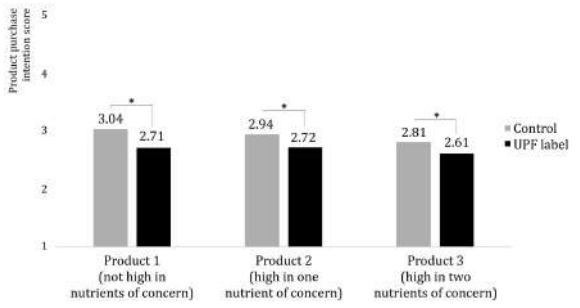


FIGURE 4
Mean predicted product purchase intentions (1–5 scale) by labeling condition (n = 3,519)

0.05 for the interaction terms). However, for the product high in two nutrients, education level did moderate the effect of the UPF label on UPF identification, such that, compared to control, UPF labels led to higher identification of the product as UPF among consumers with higher education, but among those a high school education or less there was no effect (interaction $p = 0.04$; Supplementary Tables 1, 2).

Discussion

In this online randomized controlled trial with Chilean parents, the addition of a UPF label to Chile's existing nutrient labels improved participants' ability to identify products as UPFs when the product carried zero or one nutrient label, but not when the product carried two nutrient labels. It also led to reductions in purchase intentions and perceived healthfulness for all products, but effect sizes decreased as the number of nutrient labels on products increased. These findings suggest that, in the context of existing FOPL systems, UPF labels could have the largest impact on parents' perceptions and behavior when applied to UPFs that carry no or few nutrient labels. Considering that more than 40% of UPFs in Chile do not carry any nutrient labels, impacts could be substantial in this context (Rebolledo, unpublished data). Additionally, UPF labels could be the only front-of-package label applied to many products reformulated by manufacturers to avoid nutrient warning labels, thereby helping shape perceptions of products that remain harmful to health despite reformulation.

The observed attenuation of the UPF label's effects as the number of nutrient labels increased may reflect a ceiling effect in which, because products with multiple nutrient labels are already perceived as highly unhealthful, the opportunity for an additional UPF label to further influence healthfulness perceptions and purchase intentions is limited. However, interestingly, we observed the same pattern even on participants' ability to identify products as UPFs, which is conceptually related only to the information presented by the UPF label and we might thus have expected to be independent from nutrient labels. This finding suggests that participants may have been influenced less by the conceptually distinct information presented by the UPF label and more by the simple presence of an additional label. This interpretation aligns with previous qualitative research with mothers of young children in Chile, where many reported simply counting the number of FOPLs on products to compare their level of unhealthfulness (37). Thus, as long as UPFs are associated with unhealthfulness — which previous evidence from several other countries suggests is common (28, 38–45) — the overall number of labels on a product may still serve as the dominant heuristic cue at play.

Compared to a study previously conducted in Brazil, the UPF label in this study similarly improved participants' ability to identify products as UPFs (28). However, differently from that study, the UPF label in this study did influence product healthfulness perceptions and purchase intentions in the presence of nutrient

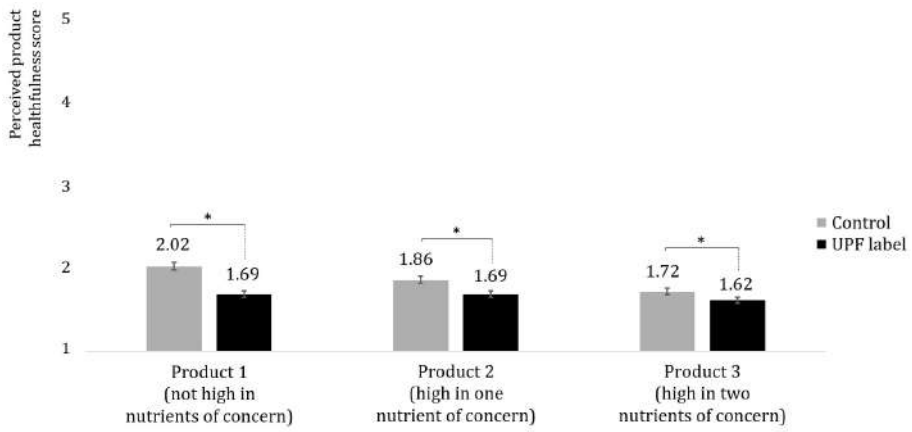


FIGURE 5
Mean predicted perceived product healthfulness (1–5 scale) by labeling condition (n = 3,519)

labels (despite effect attenuation). These discrepancies may be simply due to differences between the two studies' countries, samples, or products used. However, it may also be that the rectangular UPF label used in the Brazil study (to match that country's FOPL system's visual identity) may not have drawn enough attention or signaled clearly enough that products' UPF status represents a distinct indicator of unhealthfulness. Future studies should thus examine how different UPF label designs might impact the effectiveness of UPF labels, especially considering that the different types of nutrient labels with which UPF labels may be paired might require UPF label designs different from the one used in this study (26).

Participants' education level moderated the effect of the UPF label on identification of the product as UPF for the product high in two nutrients (but not for other products with fewer nutrient labels), such that there was a positive effect among participants with higher education but no effect among those with a high school education or less. This finding raises the possibility that the effects of the UPF label for products with zero or few nutrient labels might be similar across parents with different education levels, which would be encouraging since our main analyses suggest that these are the scenarios in which UPF labels may have the largest effects. Simultaneously, this possibility would suggest that, for products with multiple nutrient labels, the UPF label may only have an effect among parents with higher education levels, perhaps due to these individuals engaging more with the distinct content of the UPF label or to being less sensitive to possible ceiling effects. However, considering that our exploratory moderation analyses involved multiple interaction tests and only one reached statistical significance, further investigation would be important to confirm these findings.

Considering that the effect of the UPF label in this study was found to be largest when this was the only label present on products, an important question for future studies is how consumers might interpret stand-alone UPF labels relative to stand-alone nutrient labels. A qualitative study in Chile previously revealed that one of the ways that mothers responded to FOPLs was by developing a preference for "natural" foods, despite this not being the focus of the country's current FOPL system (46). This raises the question of whether consumers might, for example, prefer a product high in "natural" sugars that is not ultraprocessed over a product with NNS (and thus ultraprocessed), which would not lead to a nutritionally positive shift. More broadly, anticipating and examining possible unintended effects of signaling UPF status will be important as countries consider this modification to an already well-established and well-evaluated labeling approach based on nutrient content.

This study's strengths include the use of an experimental design allowing for causal inference, of policy-relevant FOPLs, and of a diverse sample with large representation of low-education parents. However, this study also has limitations. As an online study, we cannot determine whether results would generalize to real-world conditions, a question that should be examined in future studies. Due to survey space constraints, we used only one type of product, and thus cannot determine how results would generalize to a wider range of products — a question that should also be examined in future studies. Additionally, we used a convenience sample including only Chilean parents, and thus cannot determine how findings would generalize to the Chilean population or to people who do not have children. However, previous evidence suggests that online convenience samples tend to produce experimental results similar in direction to nationally representative samples (47, 48). Moreover, differences in the magnitude of the effect of the UPF label between products may be attributed to any of the elements that differed between products, which included not only the number and type of nutrient warnings, but also minor package design elements (i.e., color, product name, and imagery). However, as previously detailed, these design elements were intentionally selected so that their influence was likely very low, making differences in the outcomes more likely to be attributed to differences in the nutrient warnings present on products. Lasty, informing participants about the meaning of the term "ultraprocessed" prior to experiment may have influenced the magnitude of the effects observed; however, our goal was to emulate a scenario where the government rolls out an education campaign alongside new UPF labels, which previous evidence suggests could improve policy effectiveness (49).

Conclusions

This study provides new evidence that, overall, the addition of UPF labels to existing FOPL systems could help consumers identify products as ultraprocessed more easily, as well as lower UPFs' perceived healthfulness and purchase intentions. More specifically, findings suggest that UPF labels could have the largest effects when applied to UPFs that carry no or few nutrient labels, and more modest effects when applied to UPFs that carry a large number of nutrient labels.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors upon request, without undue reservation.

Ethics statement

The studies involving humans were approved by University of North Carolina at Chapel Hill Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

ADC: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. LST: Funding acquisition, Supervision, Writing – review & editing. MGH: Conceptualization, Methodology, Supervision, Writing – review & editing. SWN: Conceptualization, Supervision, Writing – review & editing. NR: Funding acquisition, Investigation, Methodology, Project administration, Supervision, Writing – review & editing.

Funding

The author(s) declared that financial support was received for this work and/or its publication. This research was funded by Bloomberg Philanthropies (grant #2019-71181). General support to this study was provided by the NIH grant to the Carolina Population Center [grant P2C #HD050924 and T32 #HD007168]. NR is supported by the ANID/Subvención a la Instalación en la Academia Grant #85240064. The content is solely the responsibility of the authors and does not necessarily represent the official views of the funders. The funders had no role in the design, execution, interpretation, or writing of the study.

Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declared that Generative AI was not used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fnut.2026.1973978/full#supplementary-material

References

1. Roberto CA, Ng SW, Ganderats-Fuentes M, Hammond D, Barquera S, Jauregui A, et al. The influence of front-of-package nutrition labeling on consumer behavior and product reformulation. *Annu Rev Nutr.* (2021) 41:1. doi: 10.1146/annurev-nutr-111120-094932

2. Taillie LS, Hall MG, Popkin BM, Ng SW, Murukutla N. Experimental studies of front-of-package nutrient warning labels on sugar-sweetened beverages and ultra-processed foods: a scoping review. *Nutrients.* (2020) 12:2. doi: 10.3390/nu12020569

3. Global Food Research Program UNC. *Front-of-Package Labeling Map*. 2026. Available online at: https://www.globalfoodresearchprogram.org/wp-content/uploads/2026/07/GFRP-UNC_FOPL_maps_2026-Jan-REV.pdf (Accessed September 8, 2026).

4. Monteiro CA, Louzada ML, Steele-Martinez E, Cannon G, Andrade GC, Baker P, et al. Ultra-processed foods and human health: the main thesis and the evidence. *Lancet.* (2025) 406:2667–84. doi: 10.1016/S0140-6736(25)01565-X

5. *The Design of Effective Front-of-Package Warning Labels to Protect Public Health from Unhealthy Food Products*. Pan American Health Organization; 2026. Available online at: https://iris.paho.org/server/api/core/bitstreams/d1d575b0-0807-4b0f-8fd0-0df83b07d0c0/content (Accessed July 1, 2026).

6. Ministerio de Salud y Protección Social de Colombia. *Proyecto Etiquetado Nutricional y Frontal*. Available online at: https://www.minsalud.gov.co/Normatividad_Nuevo/PR%20Etiquetado%20Frontal.pdf (Accessed June 18, 2026).

7. Senado República de. Chile. Comisión de Salud - Sesión 23 junio. (2026).

8. Romero Ferreiro C, Lora Pablos D, Gómez de. la Cámara A. Two dimensions of nutritional value: nutri-score and NOVA. *Nutrients*. (2021) 13:8. doi: 10.3390/nu13082783

9. Popkin BM, Miles DR, Taillie LS, Dunford EK. A policy approach to identifying food and beverage products that are ultra-processed and high in added salt, sugar and saturated fat in the United States: a cross-sectional analysis of packaged foods. *Lancet Reg Health Am*. (2024) 32. doi: 10.1016/j.lana.2024.100713

10. Canella DS, Martins APB, Ribeiro M, Andrade GC, Montera V. dos SP, Mais LA. Brazilian front-of-package nutrition labelling and food additives: an approach to identify ultra-processed food products. *Br J Nutr*. (2025) 133:1466–72. doi: 10.1017/S000711452500090X

11. Vatavuk-Serrati G, Meyer KA, Miles DR, Taillie LS. Prevalence of ultra-processed foods and beverages in newly launched products across the Americas: a comparison between the United States and Latin American countries from 2018 to 2023. *Front Public Health*. (2025) 13:1659915. doi: 10.3389/fpubh.2025.1659915

12. Hatta-Langedyk J, Wang L, Fan B, Shi P, Mozaffarian D. Ultraprocessed Food Versus Diet Quality in Relation to Cardiometabolic Health and All-Cause Mortality: NHANES 1999–2018. *Am J Public Health*. (2026) 116:1015–24.

13. Dicken SJ, Batterham RL. The role of diet quality in mediating the association between ultra-processed food intake, obesity and health-related outcomes: a review of prospective cohort studies. *Nutrients*. (2022) 14:1. doi: 10.3390/nu14010023

14. Hall KD, Ayuketah A, Brychta R, Cai H, Cassimatis T, Chen KY, et al. Ultra-processed diets cause excess calorie intake and weight gain: an inpatient randomized controlled trial of Ad Libitum food intake. *Cell Metab*. (2019) 30:1. doi: 10.1016/j.cmet.2019.05.020

15. Hamano S, Sawada M, Aihara M, Sakurai Y, Sekine R, Usami S, et al. Ultra-processed foods cause weight gain and increased energy intake associated with reduced chewing frequency: a randomized, open-label, crossover study. *Diabetes Obes Metab*. (2024) 26:5431–43. doi: 10.1111/dom.15922

16. Martínez Steele E, Buckley JP, Monteiro CA. Ultra-processed food consumption and exposure to acrylamide in a nationally representative sample of the US population aged 6 years and older. *Prev Med*. (2023) 174:107598. doi: 10.1016/j.ypmed.2023.107598

17. Martínez Steele E, Monteiro CA. Association between dietary share of ultra-processed foods and urinary concentrations of phytoestrogens in the US. *Nutrients*. (2017) 9:209. doi: 10.3390/nu9030209

18. Brichacek AL, Florkowski M, Abiona E, Frank KM. Ultra-processed foods: a narrative review of the impact on the human gut microbiome and variations in classification methods. *Nutrients*. (2024) 16:1738. doi: 10.3390/nu16111738

19. Fardet A. Minimally processed foods are more satiating and less hyperglycemic than ultra-processed foods: a preliminary study with 98 ready-to-eat foods. *Food Funct*. (2016) 7:5. doi: 10.1039/C6FO00107F

20. Fardet A, Méjean C, Labouré H, Andreeva VA, Feron G. The degree of processing of foods which are most widely consumed by the French elderly population is associated with satiety and glycemic potentials and nutrient profiles. *Food Funct*. (2017) 8:2. doi: 10.1039/C6FO01495J

21. Martinez Steele E, Khandpur N, Batis C, Bes-Rastrollo M, Bonaccio M, Cediel G G, et al. Best practices for applying the Nova food classification system. *Nat Food*. (2023) 2, 445–8. doi: 10.1038/s43016-023-00779-w

22. Reyes M, Taillie LS, Popkin B, Kanter R, Vandevijvere S, Corvalán C. Changes in the amount of nutrient of packaged foods and beverages after the initial implementation of the Chilean law of food labelling and advertising: a nonexperimental prospective study. *PLoS Med*. (2020) 17:7. doi: 10.1371/journal.pmed.1003220

23. Zancheta Ricardo C, Corvalán C, Smith Taillie L, Quitral V, Reyes M. Changes in the use of non-nutritive sweeteners in the chilean food and beverage supply after the implementation of the food labeling and advertising law. *Front Nutr*. (2021). doi: 10.3389/fnut.2021.773450

24. D'Angelo Campos A, Ng SW, McNeel K, Hall MG. How promising are "ultraprocessed" front-of-package labels? A formative study with us adults. *Nutrients*. (2024) 16:7. doi: 10.3390/nu16071072

25. Gomez P. The role of processing-related labels in consumer identification and choice of ultra-processed foods. *J Consum Policy*. (2025) 48:421–44. doi: 10.1007/s10603-025-09595-0

26. Srour B, Hercberg S, Galan P, Monteiro CA, Edelenyi FS de, Bourhis L, et al. Effect of a new graphically modified Nutri-Score on the objective understanding of foods' nutrient profile and ultraprocessing: a randomised controlled trial. *BMJ Nutr Prev Health*. (2023) 6. doi: 10.1101/2022.11.18.22282494

27. Taillie LS, Noe V, Sehgal M, Campos AD, Grummon A, Falbe J, et al. Impacts of warning labels on ultra-processed foods among Latino adults: a randomized trial. medRxiv. (2026) doi: 10.64898/2026.03.18.26348497

28. D'Angelo Campos A, Ng SW, Duran AC, Khandpur N, Taillie LS, Christon FO, et al. "Warning: ultra-processed": an online experiment examining the impact of ultra-processed warning labels on consumers' product perceptions and behavioral intentions. *Int J Behav Nutr Phys Act*. (2024) 21:1. doi: 10.1186/s12966-024-01664-w

29. Khandpur N, Mais LA, de Morais Sato P, Martins APB, Spinillo CG, Rojas CFU, et al. Choosing a front-of-package warning label for Brazil: a randomized, controlled comparison of three different label designs. *Food Res Int*. (2019) 121:854–61. doi: 10.1016/j.foodres.2019.01.008

30. Corvalán C, Reyes M, Garmendia ML, Uauy R. Structural responses to the obesity and non-communicable diseases epidemic: the Chilean law of food labeling and advertising. *Obes Rev*. (2013) 14:79–87. doi: 10.1111/obr.12099

31. Taillie LS, Bercholz M, Popkin B, Rebolledo N, Reyes M, Corvalán C. Decreases in purchases of energy, sodium, sugar, and saturated fat 3 years after implementation of the Chilean food labeling and marketing law: an interrupted time series analysis. *PLoS Med*. (2024) 21:e1004463. doi: 10.1371/journal.pmed.1004463

32. Zancheta C, Rebolledo N, Smith Taillie L, Reyes M, Corvalán C. The consumption of ultra-processed foods was associated with adiposity, but not with metabolic indicators in a prospective cohort study of Chilean preschool children. *BMC Med*. (2024) 22:340. doi: 10.1186/s12916-024-03556-z

33. D'Angelo Campos A, Smith Taillie L, Sylvetsky AC, Rebolledo N. Warning labels for nonnutritive sweeteners: a randomized controlled trial with chilean parents. *Curr Dev Nutr*. (2026) 10:109463. doi: 10.1016/j.cdnut.2026.109463

34. Moran AJ, Roberto CA. Health warning labels correct parents' misperceptions about sugary drink options. *Am J Prev Med*. (2018) 55:2. doi: 10.1016/j.amepre.2018.04.018

35. Bollard T, Maubach N, Walker N, Ni Mhurchu C. Effects of plain packaging, warning labels, and taxes on young people's predicted sugar-sweetened beverage preferences: an experimental study. *Int J Behav Nutr Phys Act*. (2016) 13:1. doi: 10.1186/s12966-016-0421-7

36. Fraud Detection. *Qualtrics XM*. Available online at: https://www.qualtrics.com/support/survey-platform/survey-module/survey-checker/fraud-detection/ (Accessed January 26, 2026).

37. Correa T, Fierro C, Reyes M, Dillman Carpentier FR, Taillie LS. Corvalan C. Responses to the Chilean law of food labeling and advertising: exploring knowledge, perceptions and behaviors of mothers of young children. *Int J Behav Nutr Phys Act*. (2019) 16:21. doi: 10.1186/s12966-019-0781-x

38. Aguirre A, Borneo MT, El Khori S, Borneo R. Exploring the understanding of the term "ultra-processed foods" by young consumers. *Food Res Int*. (2019) 115:535–40. doi: 10.1016/j.foodres.2018.09.059

39. Ares G, Vidal L, Allegue G, Giménez A, Bandeira E, Moratorio X, et al. Consumers' conceptualization of ultra-processed foods. *Appetite*. (2016) 105:611–7. doi: 10.1016/j.appet.2016.06.028

40. Bolhuis D, Mosca AC, Pellegrini N. Consumer awareness of the degree of industrial food processing and the association with healthiness—a pilot study. *Nutrients*. (2022) 14:4438. doi: 10.3390/nu14204438

41. Gonzales Santos M, Rosenthal A, Beatriz Araujo Martins I, de Alcantara M, Almeida Lima M, de Assis Carvalho R, et al. Exploring the role of the general interest in health on the perceptions of healthy, industrialized, and ultra-processed foods among Brazilians. *Food Res Int*. (2024) 181:113992. doi: 10.1016/j.foodres.2024.113992

42. Hässig A, Hartmann C, Sanchez-Siles L, Siegrist M. Perceived degree of food processing as a cue for perceived healthiness: the NOVA system mirrors consumers' perceptions. *Food Qual Prefer*. (2023) 110:104944. doi: 10.1016/j.foodqual.2023.104944

43. Robinson E, Cummings JR, Gough T, Jones A, Evans R. Consumer awareness, perceptions and avoidance of ultra-processed foods: a study of UK adults in 2024. *Foods*. (2024) 13:2317. doi: 10.3390/foods13152317

44. Sapio S, Caso G, Annunziata A, Vecchio R. Low-income consumers' perceptions of ultra-processed foods. *Food Qual Prefer*. (2025) 127:105457. doi: 10.1016/j.foodqual.2025.105457

45. Niederdeppe J, Barry CL, Gollust SE, Porticella N, Brownell KD, Gearhardt AN. Public awareness and support for governmental intervention to address harms associated with consumption of ultraprocessed foods: a national survey, United States, June 2025. *Am J Public Health*. (2026) 116:960–70.

46. Correa T, Fierro C, Reyes M, Taillie LS, Carpentier FRD, Corvalán C. Why don't you [government] help us make healthier foods more affordable instead of bombarding us with labels? Maternal knowledge, perceptions, and practices after full implementation of the chilean food labelling law. *Int J Environ Res Public Health*. (2022) 19:8. doi: 10.3390/ijerph19084547

47. Coppock A, Leeper TJ, Mullinix KJ. Generalizability of heterogeneous treatment effect estimates across samples. *Proc Natl Acad Sci.* (2018) 115:12441–6. doi: 10.1073/pnas.1808083115

48. Jeong M, Zhang D, Morgan JC, Ross JC, Osman A, Boynton MH, et al. Similarities and differences in tobacco control research findings from convenience and probability samples. *Ann Behav Med.* (2019) 53:476–85. doi: 10.1093/abm/kay059

49. Wolf EC, Hall MG, Schillinger D, Krieger J, Baidal JAW, Solar S, et al. Online RCT of added-sugar warning labels and spanish–english label education. *Am J Prev Med.* (2025) 69:107966. doi: 10.1016/j.amepre.2025.107966