

Perceived importance of warning labels among Mexican adults with non-communicable diseases

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Sagaceta-Mejía J, Cruz-Casarrubias C, Munguía A, Durán R, Tolentino-Mayo L, Barquera S. Importancia percibida del etiquetado de advertencia en adultos mexicanos con enfermedades no transmisibles. *Salud Publica Mex.* 2026;68:245-254.

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Abstract

Objective. Identify the perceived importance of front-of-package warning labels in purchase decisions of industrialized food products among Mexican adults with self-reported non-communicable diseases (NCDs). **Materials and methods.** Data from the 2021 Mexican National Health and Nutrition Survey labeling and health questionnaires were analyzed. Logistic regression models adjusted for confounding variables and health data were used to estimate the mean predicted probability of considering each warning label (WL) as the most important. **Results.** Overall, 80.9% considered at least one WL important. The adjusted mean probabilities of considering each WL as the most important were 35.4% for “Excess sugar” and 9.0% for “Excess trans fat”. Among participants with diabetes mellitus 2 (DM2), probabilities were 12.1 percentage points higher for “Excess sugar” and 3.1 percentage points lower for “Excess trans fat” than those without DM2. **Conclusion.** WLs are widely considered in purchasing decisions of industrialized food products in Mexico, with perceived importance varying by nutrient and health condition, particularly among adults with DM2. These findings highlight the relevance of WLs as a policy tool to support informed decision-making, promote healthier food environments and comprehensive NCDs prevention and control strategies.

Keywords: food labeling; non-communicable diseases; diabetes mellitus type 2; nutrition policy; health policy; consumer behavior

Resumen

Objetivo. Identificar la importancia percibida del etiquetado frontal de advertencia (EFA) en la decisión de compra en adultos mexicanos con autorreporte de enfermedades no transmisibles (ENT). **Material y métodos.** Se analizaron los cuestionarios de etiquetado y salud de la Encuesta Nacional de Salud y Nutrición 2021. Se emplearon modelos de regresión logística ajustados por variables de confusión y condición de salud para estimar la probabilidad media predicha de considerar cada uno de los cinco octágonos del EFA como el más importante. **Resultados.** El 80.9% de los participantes consideró muy importante algún octágono. La probabilidad media ajustada de considerar “Exceso de azúcares” como el octágono más importante fue de 35.4% y de 9.0% para “Exceso de grasas trans”. En participantes con diabetes mellitus 2 (DM2) autorreportada, las probabilidades fueron 12.1 puntos porcentuales mayores para “Exceso de azúcares” y 3.1 puntos porcentuales menores para “Exceso de grasas trans”, en comparación con participantes sin diagnóstico previo de DM2. **Conclusión.** Los octágonos del EFA son considerados en las decisiones de compra en México, con variaciones en su importancia percibida según el nutriente y la condición de salud, particularmente entre adultos con DM2. Estos hallazgos destacan el papel del EFA como una herramienta de política pública relevante para mejorar los entornos alimentarios y contribuir, en el marco de estrategias integrales, a la prevención y control de las ENT.

Palabras clave: etiquetado de alimentos; enfermedades no transmisibles; diabetes mellitus tipo 2; política nutricional; política de salud; comportamiento del consumidor

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In response to the global epidemic of obesity and non-communicable diseases (NCDs), the World Health Organization (WHO) has recommended that governments implement policies to promote healthy diets.¹ One of these recommendations is the implementation of front-of-pack labeling to identify products with excess calories and nutrients of concern (sugars, sodium, and fats).^{1,2} In line with this, Mexico implemented a front-of-pack warning labeling (FOPWL) system in October 2020. This system uses five warning labels (WLs) to highlight prepackaged food and beverages containing excessive amounts of calories and nutrients of concern: "Excess calories", "Excess sugars", "Excess saturated fats", "Excess trans fats" and "Excess sodium".³ Whether a product will carry a warning label (WL) is based on the WHO/Pan American Health Organization (PAHO) nutrient profile model.⁴

To contribute to the reduction of the prevalence and complications of obesity and NCDs, the FOPWL system must be accepted, understood, and used by the population to promote healthier purchasing decisions and, consequently, healthier food consumption, improving the quality of the population's diets.⁵ Several studies have assessed which front-of-pack labeling system is most suitable for the Mexican population, finding that the FOPWL is widely accepted and understood across different socioeconomic levels, scholarship, and ages compared to other systems,^{6,7} and consequently, it promotes healthier food choices by reducing critical nutrients intake.^{6,8,9}

Regarding NCDs, FOPWL use increases the likelihood that self-reported NCDs population identifies unhealthy products.¹⁰ Additionally, Mexican adults and youth reported buying fewer sugar-sweetened beverages (SSBs); these changes were associated with a higher likelihood of drinking plain water and consuming fewer SSBs.¹¹ Moreover, FOPWL could contribute to long-term reductions in obesity.¹² After the modification of the food labeling regulation in Mexico, the FOPWL has become the most utilized system among the general population, aiding in the identification of healthier foods.^{13,14} However, the priority of FOPWL in purchasing decisions, as well as the importance of each WL, remains unclear. Therefore, this study aims to identify the importance of WLs in the purchase decision of the Mexican population with self-reported NCDs.

Materials and methods

Study design and sample selection

For this study, we used data from participants aged 20 years and older, obtained from the National Health and Nutrition Survey (Ensanut, for its Spanish acronym)

2021, which had a cross-sectional, probabilistic, multistage, and stratified design. Data was taken from the labeling of packaged foods and beverages and health questionnaire. The first was designed to monitor the use, understanding, and awareness of labeling, and includes other components such as the importance of food labeling in Mexican adults. The methodology, including the description of the sample and the logistic design, has been previously described.¹⁵ The Ensanut survey procedures were approved by the Research Ethics, Biosafety, and Research Committee of the National Institute of Public Health. Participants signed an informed consent form before the interview.

Sociodemographic information

Data on sex, age, educational level, locality, region, and well-being index (WBI) were obtained for all participants. Age was categorized into decades (20-29, 30-39, 40-49, 50-59, ≥ 60), and educational level was classified as elementary school or less, middle school, high school, technical/university or more. The locality was categorized according to the number of inhabitants into rural ($< 2\,500$ inhabitants) and urban ($> 2\,500$ inhabitants) localities. Region corresponds to the division of the country with similar population sizes: North Pacific, Frontier, Central Pacific, North Central, Center, Mexico City, State of Mexico, South Pacific, and Peninsula. The WBI was estimated using principal component analysis based on housing characteristics, household attributes, and services available.¹⁵ It was classified into terciles according to the final distribution of the score obtained as cut-off points: low, medium, and high.

Self-reported non-communicable diseases

The surveyed participants were asked about their previous diagnosis of obesity, arterial hypertension, diabetes mellitus type 2 (DM2), and dyslipidemia, which includes hypertriglyceridemia and/or hypercholesterolemia. This data was obtained from the Ensanut 2021 health questionnaire. Self-report was considered positive when the participants confirmed any of the above-mentioned NCDs. Data is reported by presence or absence of NCDs and NCD groups (DM2, dyslipidemia, hypertension, and obesity).

Warning labels perceived importance

It was obtained from the question, "Which of these WLs do you give the most importance in the purchase decision of the products? *Rank from 1 to 5 (where 1 is the most important and 5 the least important)". To

respond, participants were shown an image displaying WL (figure 1). Response options also included “All”, “None” and “Don’t know/No response”; participants who selected any of these options were unable to rank the importance of the WLs. Participants who responded “Don’t know/No response” ($n = 547$) were excluded from the analysis as they did not provide interpretable information regarding the perceived importance of each WL.

The variable *Any* was created to identify participants who ranked the WLs from 1 to 5.

Statistical analysis

All variables included in the study were categorical; therefore, frequencies, proportions, and 95% confidence intervals (95%CI) are reported. Chi-square tests were used to examine differences in sociodemographic characteristics and in the perceived importance of WLs across groups.

Mean predicted probabilities of considering each WL as the most important was estimated using logistic regression models. For each model, selecting a given WL as “very important” was coded as 1 and all other responses coded as 0. Separate models were estimated for each nutrient in the WL. Three sets of models were constructed and adjusted for sociodemographic characteristics (sex, age, educational level, locality, region, and WBI). Model 1 included self-reported NCDs, Model 2 included each NCD group separately, and Model 3 simultaneously included all NCD groups.

To assess potential multicollinearity among covariates, variance inflation factors were calculated, with all values below 5, indicating no relevant multicollinearity. Model fit was evaluated using the Akaike Information Criterion (AIC), with lower values indicating a better balance between goodness of fit and parsimony. Across WLs, the lowest AIC values were observed in models adjusted for diabetes, except for sodium, for which the

hypertension-adjusted model showed the best fit. The second lowest AIC values corresponded to Model 3, suggesting that the inclusion of multiple health conditions provided a modest improvement in model fit for most outcomes. Because Stata does not compute VIF or AIC statistics after survey-adjusted (*svy*) estimations, these diagnostics were obtained from non-survey-adjusted logistic models and were used exclusively for comparative and diagnostic purposes rather than for statistical inference. Final model interpretation and statistical inference were based on survey-adjusted estimates and design-adjusted Wald tests.

Finally, percentage point differences in the predicted probabilities between participants with and without self-reported NCDs were estimated, using participants with NCDs or NCD group as the reference category. All analyses accounted for the complex survey design using the *svy* module in Stata 14,^{*} and statistical significance was set at $p < 0.05$.

Results

The analytic sample was derived from the labeling questionnaire, which comprised 8 811 observations. Participants with missing data of self-reported disease ($n = 960$) were excluded, resulting in 7 851 eligible individuals. Among these, 547 participants who responded “don’t know/no response” were further excluded. The final analytic sample, therefore, comprised 7 304 adults aged 20 years and older, representing 68 365 144 Mexicans when applying the expansion factors.

As shown in table I, 56.5% of participants were women, 24.1% were aged between 20-29 years, 29.6% had completed middle school, 79.8% lived in urban localities and 37.7% were in the high WBI category.

* Stata Corp. Stata Statistical Software Release 14. College Station, TX: Stata Corp LLC;2015



Participants were asked: “Which of these warning labels do you give the most importance in the purchase decision of the products? Order from 1 to 5 (where 1 is the most important and 5 the least important)”

FIGURE 1. WARNING LABELS SHOWN TO PARTICIPANTS TO RANK ACCORDING TO THEIR IMPORTANCE IN PURCHASE DECISIONS. ENSANUT 2021, MEXICO

Regarding health status, 40.3% self-reported NCDs: including dyslipidemia (18.7%), hypertension (16.8%), obesity (17.4%), and DM2 (11.0%).

Differences in sociodemographic and self-reported health characteristics between included and excluded participants in the analytic sample can be found in supplementary table I.¹⁶

As shown in table II, 80.9% of participants reported considering any of the WLs as important in their purchasing decisions, 4.7% all WLs, and 14.4% none. Differences across sociodemographic characteristics and NCDs were statistically significant ($p < 0.001$), except for sex, overall self-reported NCDs and dyslipidemia.

Among those who considered any WL important, higher proportions were observed among participants aged 20 to 29 years (85.4%), with a highschool education (87.3%), living in urban localities (82.4%), residing in Mexico City (92.4%) and in the highest WBI category (84.1%). Regarding specific NCDs, the proportion was higher among participants with obesity (83.4%) compared with participants without obesity, whereas lower proportions were found among participants with hypertension (76.2%) and DM2 (75.3%) compared with their counterparts without these conditions.

As shown in figure 2, "Excess sugar" (panel A) was the most frequently selected WL as the most important for purchasing decisions (35.4%), with higher proportions among participants with obesity and DM2 compared with those without these conditions. The "Excess calories" and "Excess saturated fat" (panel B and C) WLs were selected by similar proportions of participants (14.6% and 14.8%, respectively) with comparable values across most NCD groups. In contrast, "Excess trans fat" (9.0%) (panel E) and "Excess sodium" (7.1%) (panel D). WLs were least frequently prioritized with modest variation across NCD groups.

As shown in table III, the estimated mean probability of considering each WL as the most important in purchasing decisions showed that "Excess sugar" had the highest adjusted probability (35.4%; 95%CI: 33.9,36.8), with similar values across most self-reported NCDs. However, participants with DM2 had a significantly higher probability (46.2%; 95%CI: 41.5,51.0), corresponding to a 12.1 percentage point difference compared with those without DM2 ($p < 0.001$).

The adjusted mean probability for selecting "Excess calories" WL was 14.6% (95%CI: 13.6,15.6), with similar values across self-reported NCDs. Likewise, "Excess saturated fat" WL showed a mean probability of 14.8% (95%CI: 13.4,16.1), with no statistically significant differences by NCDs.

The "Excess trans fat" WL, had an adjusted mean probability of 9.0%. Lower probabilities were observed

Table I
SOCIODEMOGRAPHIC AND SELF-REPORTED HEALTH CHARACTERISTICS OF PARTICIPANTS. MEXICO, ENSANUT 2021

		%	95%CI
Sex	Men	43.5	41.9,45.3
	Women	56.5	54.7,58.2
Age	20-29	24.1	22.6,25.6
	30-39	22.5	21.2,23.9
	40-49	20.1	19.3,21.8
	50-59	14.8	13.6,16.1
	≥60	18.1	16.9,19.4
Educational level	Elementary school or less	26.0	24.3,27.8
	Middle school	29.6	27.9,31.3
	Highschool	19.5	18.1,20.9
	Technical/University or more	24.9	22.9,27.0
Locality	Rural	20.2	18.5,21.9
	Urban	79.8	78.1,81.5
Region	North Pacific	9.8	8.5,11.3
	Frontier	13.3	11.9,14.9
	Central Pacific	11.1	10.3,12.0
	North Central	13.2	12.3,14.1
	Center	9.6	8.6,10.7
	Mexico City	8.1	7.6,8.7
	State of Mexico	13.7	12.9,14.5
	South Pacific	11.9	10.6,13.4
	Peninsula	9.2	8.1,10.6
	Low	29.0	26.8,31.3
Well-being index	Middle	33.3	31.3,35.4
	High	37.7	35.4,40.1
Self-reported NCDs	No	59.7	58.1,61.3
	Yes	40.3	38.7,41.9
Diabetes mellitus type 2	No	89.0	88.0,89.9
	Yes	11.0	10.1,12.0
Dyslipidemia	No	81.3	80.0,82.6
	Yes	18.7	17.4,20.0
Obesity	No	82.6	81.3,83.8
	Yes	17.4	16.2,18.7
Hypertension	No	83.2	82.1,84.4
	Yes	16.8	15.6,17.9

n= 7 304. N= 68 365 144.

NCDs: non-communicable diseases.

Ensanut: Encuesta Nacional de Salud y Nutrición.

Table II
PERCEIVED IMPORTANCE OF WARNINGS LABELS IN THE PURCHASE DECISION ACCORDING TO SOCIODEMOGRAPHIC AND SELF-REPORTED HEALTH CHARACTERISTICS. MEXICO, ENSANUT 2021

		Any % (95%IC)	All % (95%IC)	None % (95%IC)	P value
Total		80.9 (79.3,82.4)	4.7 (4.1,5.4)	14.4 (13.0,15.8)	
Sex	Men	81.0 (78.2,83.5)	4.4 (3.3,5.7)	14.6 (12.3,17.4)	0.743
	Women	80.9 (78.9,82.7)	5.0 (4.3,5.8)	14.2 (12.6,15.9)	
Age	20-29	85.4 (82.5,87.9)	3.4 (2.3,5.1)	11.2 (8.9,14.0)	<0.001
	30-39	85.2 (82.1,87.8)	4.1 (2.9,5.7)	10.7 (8.5,13.4)	
	40-49	83.7 (80.5,86.6)	3.6 (2.5,5.2)	12.6 (10.1,15.7)	
	50-59	80.1 (76.4,83.2)	4.9 (3.6,6.7)	15.1 (12.2,18.5)	
	≥60	67.1 (63.4,70.6)	8.4 (6.5,10.7)	24.6 (21.4,28.0)	
Educational level	Elementary school or less	70.0 (66.5,73.2)	6.3 (4.9,8.1)	23.7 (20.7,27.0)	<0.001
	Middle school	82.0 (79.2,84.4)	5.0 (3.9,6.4)	13.1 (11.0,15.5)	
	Highschool	87.3 (84.4,89.8)	3.6 (2.4,5.3)	9.1 (7.1,11.6)	
	Technical/University or more	86.1 (83.1,88.5)	3.6 (2.6,5.2)	10.3 (8.0,13.2)	
Locality	Rural	75.1 (70.9,78.8)	4.9 (3.5,6.7)	20.1 (16.6,24.0)	<0.001
	Urban	82.4 (80.7,83.9)	4.7 (4.0,5.5)	12.9 (11.5,14.5)	
Region	North Pacific	88.9 (85.8,91.3)	5.3 (3.6,7.7)	5.9 (4.4,7.8)	<0.001
	Frontier	75.3 (70.0,79.9)	2.7 (1.4,5.3)	22.1 (17.6,27.3)	
	Central Pacific	78.1 (72.5,82.3)	6.1 (4.4,8.4)	15.9 (11.7,21.3)	
	North Central	81.7 (77.4,85.4)	3.4 (2.3,5.1)	14.8 (11.3,19.2)	
	Center	72.2 (65.2,78.3)	7.2 (4.9,10.6)	20.6 (15.7,26.5)	
	Mexico City	92.4 (89.5,94.5)	2.4 (1.6,3.6)	5.3 (3.3,8.2)	
	State of Mexico	89.3 (84.3,92.9)	2.3 (1.3,4.1)	8.4 (5.1,13.5)	
	South Pacific	89.9 (86.9,92.3)	4.4 (2.7,6.9)	5.7 (4.2,7.7)	
	Peninsula	57.9 (53.1,62.5)	10.8 (8.2,14.0)	31.4 (26.6,36.6)	
Well-being index	Low	77.0 (74.0,79.8)	4.8 (3.7,6.3)	18.2 (15.7,20.9)	<0.001
	Middle	80.7 (78.4,82.8)	5.4 (4.3,6.9)	13.9 (11.9,16.3)	
	High	84.1 (81.6,86.4)	4.0 (3.0,5.3)	11.9 (10.0,14.0)	
Self-reported NCDs	No	81.3 (79.3,83.1)	4.3 (3.5,5.3)	14.4 (12.7,16.3)	0.406
	Yes	80.4 (78.3,82.4)	5.3 (4.3,6.5)	14.3 (12.7,16.1)	
Diabetes mellitus type 2	No	81.6 (80.0,83.1)	4.4 (3.8,5.2)	14.0 (12.6,15.4)	0.002
	Yes	75.3 (70.9,79.2)	7.2 (5.2,9.8)	17.5 (14.1,21.6)	
Dyslipidemia	No	81.1 (79.4,82.6)	4.3 (3.7,5.1)	13.4 (12.1,14.8)	0.804
	Yes	80.4 (72.9,79.2)	4.9 (3.7,6.6)	13.7 (11.4,16.3)	
Obesity	No	79.9 (78.2,81.6)	4.9 (4.1,5.7)	15.2 (13.7,16.8)	0.003
	Yes	83.4 (80.3,86.0)	4.1 (2.8,5.7)	10.4 (8.3,13.0)	
Hypertension	No	81.9 (80.2, 83.4)	4.4 (3.7, 5.2)	13.8 (12.3, 15.4)	0.002
	Yes	76.2 (73.1, 79.1)	6.4 (4.8, 8.5)	17.4 (14.9, 20.1)	

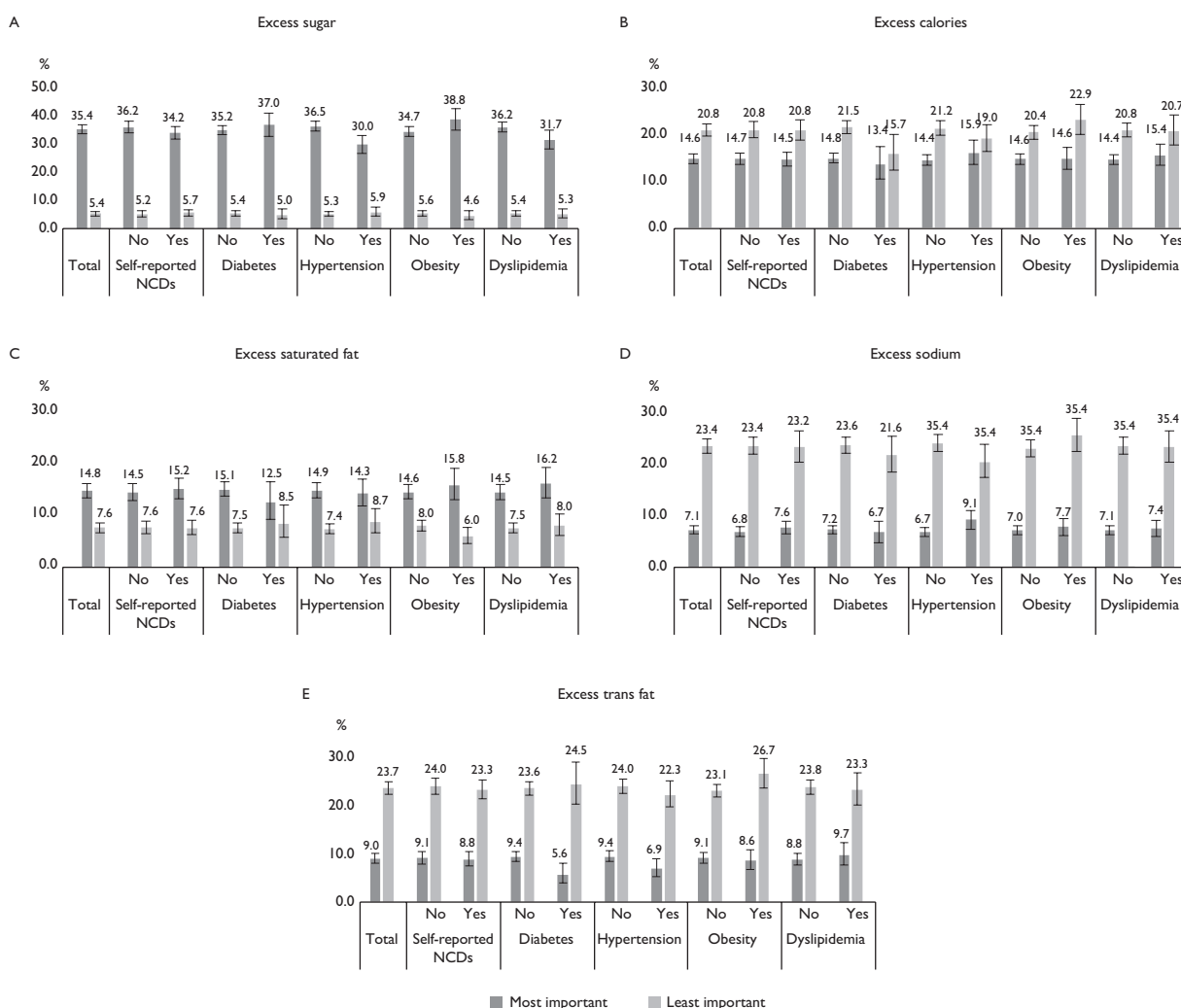
Participants were asked: "To which of these warning labels do you give the most importance in the purchase decision of the products? Order from 1 to 5 (where 1 is the most important and 5 the least important)". "Any" corresponds to participants who ranked the warning labels from 1 to 5. $n=7\,304$; $N=68\,365\,144$; NCDs: Non-communicable diseases; p value corresponds to the χ^2 test used to evaluate the association between the perceived importance of the warning labels and each of the sociodemographic variables; Ensanut: *Encuesta Nacional de Salud y Nutrición*.

among participants with DM2 and hypertension; corresponding to absolute differences of -3.1 percentage points (95%CI: -5.4,-0.8) and -2.2 percentage points (95%CI: -3.1,-0.4), respectively, compared with those without NCDs; both differences were statistically significant ($p < 0.05$).

Finally, the adjusted mean predicted probability of selecting "Excess sodium" WL was 7.1% (95%CI: 6.3,7.9). Although probabilities were slightly higher among participants with hypertension (absolute difference of 2.2 percentage points compared with those without), this difference was not statistically significant.

Discussion

This study provides evidence that WL plays a relevant role in industrialized food products purchasing decisions among Mexican adults. Approximately eight in ten adults reported considering at least one WL when making purchasing decisions, confirming the broad reach of the FOPWL system in the population. Among all WLs, "Excess sugar" consistently emerged as the most prioritized, and its perceived importance was significantly higher among participants with DM2, underscoring a closer alignment between nutrient warn-



Perceived importance of warning labels A: "Excess sugar", B: "Excess calories", C: "Excess saturated fat", D: "Excess sodium" and E: "Excess trans fats". NCDs: non-communicable diseases.

Ensanut: Encuesta Nacional de Salud y Nutrición.

FIGURE 2. PERCEIVED IMPORTANCE OF WARNING LABELS IN PURCHASE DECISIONS BY SELF-REPORTED HEALTH CHARACTERISTICS. MEXICO, ENSAUT 2021

Table III
PREDICTED MEAN PROBABILITY OF CONSIDERING WARNING LABELS AS VERY IMPORTANT AT THE TIME OF PURCHASE ACCORDING TO SELF-REPORTED HEALTH CHARACTERISTICS. MEXICO, ENSANUT 2021

	Calories		Sugar		Sodium		Saturated fat		Trans fat	
	Model 1 Mean (95%CI)	Model 2 Mean (95%CI)	Model 1 Mean (95%CI)	Model 2 Mean (95%CI)	Model 1 Mean (95%CI)	Model 2 Mean (95%CI)	Model 1 Mean (95%CI)	Model 2 Mean (95%CI)	Model 1 Mean (95%CI)	Model 2 Mean (95%CI)
Total	14.6 (13.6,15.6)		35.4 (33.9,36.8)		7.1 (6.3,7.9)		14.8 (13.4,16.1)		9.0 (8.0,10.0)	
Self-reported NCDs										
No	14.8 (13.4,16.1)		34.4 (32.5,36.3)		7.0 (5.9,8.1)		14.4 (12.8,16.0)		9.4 (8.1,10.7)	
Yes	14.4 (12.8,16.0)		36.9 (34.5,39.3)		7.3 (6.0,8.6)		15.3 (13.2,17.4)		8.5 (7.1,10.0)	
Difference	-0.4 (-2.4,1.7)		2.5 (-0.6,5.6)		0.3 (-1.5,2.0)		0.9 (-1.6,3.4)		-0.8 (-2.3,1.0)	
Diabetes mellitus type 2										
No	14.9 (13.9,16.0)		34.2 (32.6,35.8)		7.3 (6.4,8.1)		15.0 (13.6,16.4)		9.4 (8.3,10.5)	
Yes	12.3 (8.9,15.7)		45.8 (41.3,50.3)		6.2 (3.8,8.5)		12.9 (9.1,16.6)		6.0 (3.8,8.1)	
Difference	-2.6 (-6.1,0.9)		11.5 [§] (6.6,16.5)		-1.1 (-3.5,1.4)		-2.1 (-5.9,1.7)		-3.4 [‡] (-5.7,-1.1)	
Obesity										
No	14.5 (13.4,15.6)		34.8 (33.1,36.4)		7.0 (6.1,7.9)		14.7 (13.3,16.1)		9.4 (8.2,10.6)	
Yes	15.3 (12.8,17.8)		38.2 (34.6,41.9)		7.6 (5.7,9.4)		15.2 (12.2,18.2)		7.5 (5.7,9.2)	
Difference	0.8 (-1.9,3.5)		3.5 (-0.6,7.5)		0.6 (-1.5,2.6)		0.5 (-2.5,3.5)		-1.9 (-4.0,0.1)	
Hypertension										
No	14.5 (13.3,15.6)		35.3 (33.7,36.9)		6.8 (5.9,7.7)		14.8 (13.3,16.3)		9.4 (8.3,10.5)	
Yes	15.4 (12.7,18.0)		35.7 (32.2,39.3)		8.7 (6.5,10.9)		14.5 (11.7,17.4)		6.7 (5.1,8.7)	
Difference	0.9 (-2.0,3.8)		0.4 (-3.4,4.2)		1.9 (-0.4,4.3)		-0.3 (-3.4,2.9)		-2.6 [‡] (-4.5,-0.6)	
Dyslipidemia										
No	14.5 (13.4,15.6)		35.6 (34.0,37.3)		7.2 (6.3,8.1)		14.4 (13.0,15.9)		8.9 (7.8,10.0)	
Yes	15.1 (12.7,17.6)		34.2 (30.7,37.7)		6.9 (5.2,16.6)		16.3 (13.3,19.2)		9.7 (7.4,12.0)	
Difference	0.6 (-2.0,3.3)		-1.5 (-5.3,2.4)		-0.3 (-2.3,1.7)		0.2 (-1.3,5.0)		0.8 (-1.6,3.2)	

Predicted probability was estimated from logistic regression models for each warning label adjusted for sex, age, educational level, locality, region, well-being index and: Model 1: self-reported NCDs; Model 2: Each type of NCDs: DM2 or obesity or hypertension or dyslipidemia; Model 3: All types of NCDs: DM2, obesity, hypertension and dyslipidemia. Difference reflects the comparison between those who self-identified as having the disease (Yes) and those who denied it (No). n= 7 304; N= 68 365 144; NCDs: Non-communicable diseases; * p value <0.05; † p value <0.01; ‡ p value <0.001; § p value <0.001; Encuesta Nacional de Salud y Nutrición.

ings and disease-specific risk awareness. In contrast, the lower importance of “Excess trans fat” among those with DM2 and hypertension highlights persistent gaps in the recognition of certain nutrient-health relationships, even among populations at elevated cardiometabolic risk.

A considerable proportion of Mexican adults reported considering WLs in their purchasing decisions, particularly those with obesity, whereas lower proportions were observed among participants with hypertension and DM2. This pattern contrasts with previous evidence from the Guidelines Daily Amount (GDA) system, in which 59% of participants reported not using labels when making purchasing decisions.¹⁷ Under the GDA system, participants with obesity were less likely to use labels,¹⁷ whereas the FOPWL system appears to be more effective in supporting food product evaluations among this group. These findings reinforce previous evidence showing that WLs facilitate the identification of unhealthy products, particularly among participants affected by obesity,¹⁰ highlighting their potential utility for addressing diet-related NCDs.

Across analyses, “Excess sugar” was identified as the most important WL, while “Excess sodium” was the least prioritized. These findings are consistent with previous studies in Mexico and Chile. Batis and colleagues,¹⁸ reported sugar-related warnings as the most salient among parents from middle- and high-income households, as well as with evidence from Chile, where “Excess sugar” WL was also prioritized in purchasing decisions.^{19,20} Despite differences in study populations, the consistent prominence of sugar-related warnings suggests strong cognitive salience among consumers. Nevertheless, the overall influence of WLs observed in our sample was lower than that reported in Chilean or Batis et al. studies, which may reflect differences in socioeconomic context.^{18,20}

Similarly, Contreras and colleagues found that “Excess sugars” was perceived as the most useful WL among adults and youth, whereas “Excess sodium” and “Excess trans fat” were rated as least useful.¹¹ The authors suggested that limited exposure to certain WLs could partially explain these perceptions. In the Mexican food supply, only around 1% of products display the “Excess trans fat” WL¹⁴ which may restrict consumer familiarity with this WL. Limited exposure, combined with lower awareness of trans fats and their health implications, may contribute to the consistently low prioritization of this WL, even among individuals with DM2 and hypertension.

Differences in WL relevance among participants with NCDs are expected given the direct nutrient-disease relationships. For example, the “Excess sugar” is particularly meaningful in DM2 due to its link with

glycemic control, while “Excess sodium” should hold greater relevance in hypertension due to sodium’s role in elevated blood pressure. Our findings partially support this expectation, as participants with DM2 showed a significantly higher probability of prioritizing “Excess sugar”. However, no statistically significant differences were observed for “Excess sodium” among participants with hypertension. This may be influenced by limited awareness of the distinction between sodium and salt, as previously documented in the Mexican population.²¹ Such gaps may hinder the self-management of NCDs and reduce the effectiveness of nutrient-specific warnings among high-risk populations.²²⁻²⁴

Overall, most Mexican adults perceive WLs as a relevant tool for guiding purchase decisions, particularly those related to sugar content. This pattern is consistent with previous evidence indicating increasing awareness of the role of added sugars and other critical nutrients in the development of NCDs.^{25,26} In Mexico, prior studies have documented self-reported reductions in the purchase of unhealthy products following the implementation of the FOPWL system, particularly regular and diet sodas.¹¹ Evidence from other research indicates that reductions in sugar and calorie intake are associated with improvements in weight control,²⁷ and long-term cardiovascular risk,²⁸ and that high consumption of SSBs remains a major contributor to mortality among Mexican adults.²⁹ Within this broader evidence base, the high perceived importance of sugar-related WLs observed in this study underscores their public health relevance, although further research is needed to determine whether such perceptions translate into sustained behavioral changes over time.

Although no statistically significant differences were found in the perceived importance of most WLs between participants with self-reported and non-self-reported NCDs, some descriptive patterns emerged. For instance, a higher proportion of participants with hypertension selected the “Excess sodium” WL as the most important compared to those without this condition. This may reflect greater awareness of post-diagnosis or attention to nutritional guidance provided by healthcare professionals. Evidence suggests that individuals with diagnosed NCDs are more likely to use nutrition labels compared to their healthy counterparts,³⁰ further emphasizing the potential of WL as a supportive tool for NCD management.

This study has limitations. First, the perceived importance of WLs may not correspond directly to actual purchasing behavior. Additionally, participants excluded due to “don’t know / no response” answers differed from those included in several sociodemographic characteristics and some NCD groups. Given that this

group represented approximately 6% of the initial sample, their exclusion may limit the generalizability of the findings, particularly among older adults with lower educational levels living in rural localities. These differences suggest that the results may underrepresent populations who face greater structural barriers to interpreting nutritional information. This highlights the need for further studies specifically designed to assess the understanding, relevance, and use of WLs among vulnerable populations.

Despite limitations, a major strength of the study is the use of a national survey designed to collect information for monitoring the implementation of FOPWL in Mexico. This allows for a population-level assessment of the perceived relevance of WLs among Mexican adults who participated in and were able to complete the ranking task in the labeling module.

In conclusion, this study provides evidence that WL are widely considered in industrialized food purchasing decisions among Mexican adults, with “Excess sugar” consistently perceived as the most relevant WL, particularly among individuals with DM2. The perceived importance of specific WLs varied by nutrient and NCD groups, suggesting differential salience of nutrient-related health risks across population subgroups. Lower prioritization of WLs, even among participants with related NCDs, suggests persistent gaps in nutrient–disease risk perception. Overall, these findings highlight the importance of continuing to strengthen complementary strategies that enhance awareness and understanding of critical nutrients to maximize the public health impact of FOPWL system.

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References

1. World Health Organization, Best buys' and other recommended interventions for the prevention and control of noncommunicable diseases TACKLING NCDs. Geneva:WHO, 2022 [cited June 13, 2024]. Available

- from: <https://apps.who.int/iris/bitstream/handle/10665/259232/WHO-NMH-NVI-17.9-eng.pdf>
2. Organización Panamericana de la Salud. El etiquetado frontal como instrumento de política para prevenir enfermedades no transmisibles en la Región de las Américas. Washington DC: OPS, 2020 [cited September 26, 2023]. Available from: <https://iris.paho.org/handle/10665.2/53013>
3. Secretaría de Economía. 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 [Internet]. Ciudad de México: Diario Oficial de la Federación, 2020 [cited May 27, 2020]. Available from: http://dof.gob.mx/2020/SEECO/NOM_051.pdf
4. Organización Panamericana de la Salud. Modelo de Perfil de Nutrientes de la Organización Panamericana de la Salud [Internet]. Washington DC: OPS, 2016 [cited August 13, 2024]. Available from: https://iris.paho.org/bitstream/handle/10665.2/18622/9789275318737_spa.pdf
5. Crockett RA, King SE, Marteau TM, Prevost AT, Bignardi G, Roberts NW, et al. Nutritional labelling for healthier food or non-alcoholic drink purchasing and consumption. *Cochrane Database Syst Rev*. 2018;2021(6). <https://doi.org/10.1002/14651858.CD009315.pub2>
6. 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. <https://doi.org/10.1186/s12889-019-8108-z>
7. Rincon-Gallardo Patino S, Carriedo Á, Tolentino-Mayo L, Araneda J, Allemandi L, Murillo A, et al. Front-of-pack warning labels are preferred by parents with low education level in four Latin American countries. *World Nutrition*. 2019;10(4):11-26. <https://doi.org/10.26596/wn.201910411-26>
8. Jáuregui A, Vargas-Meza J, Nieto C, Contreras-Manzano A, Alejandro NZ, Tolentino-Mayo L, et al. Impact of front-of-pack nutrition labels on consumer purchasing intentions: a randomized experiment in low- and middle-income Mexican adults. *BMC Public Health*. 2020;20(1):463. <https://doi.org/10.1186/s12889-020-08549-0>
9. Mendoza R, Tolentino-Mayo L, Hernández-Barrera L, Nieto C, Monterrubio-Flores E, Barquera S. Modifications in the consumption of energy, sugar, and saturated fat among the Mexican adult population: simulation of the effect when replacing processed foods that comply with a front of package labeling system. *Nutrients*. 2018;10(1):101. <https://doi.org/10.3390/nu10010101>
10. Sagaceta-Mejía J, Tolentino-Mayo L, Cruz-Casarrubias C, Nieto C, Barquera S. Understanding of front of package nutrition labels: Guideline daily amount and warning labels in Mexicans with non-communicable diseases. Chávez-González ML, editor. *PLoS One*. 2022;17(6):e0269892. <https://doi.org/10.1371/journal.pone.0269892>
11. Contreras-Manzano A, White CM, Nieto C, Quevedo KL, Vargas-Meza J, Hammond D, 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. *medRxiv*. 2023;2023.11.22.23298843. <https://doi.org/10.1101/2023.11.22.23298843>
12. Basto-Abreu A, Torres-Alvarez R, Reyes-Sánchez F, González-Morales R, Canto-Orsorio F, Colchero MA, et al. Predicting obesity reduction after implementing warning labels in Mexico: A modeling study. *PLoS Med*. 2020;17(7):e1003221. <https://doi.org/10.1371/journal.pmed.1003221>
13. Shamah-Levy T, Romero-Martínez M, Barrientos-Gutiérrez T, Cuevas-Nasu L, Bautista-Arredondo S, Colchero MA, et al. Encuesta Nacional de Salud y Nutrición 2021 sobre Covid-19. Resultados Nacionales. Cuernavaca: INSP, 2022 [cited June 11, 2022]. Available from: https://ensanut.insp.mx/encuestas/ensanutcontinua2021/doctos/informes/220804_Ensa21_digital_4ago.pdf
14. Contreras-Manzano A, Cruz-Casarrubias C, Munguía A, Jáuregui A, Vargas-Meza J, Nieto C, et al. Evaluation of the Mexican warning label nutrient profile on food products marketed in Mexico in 2016 and 2017: A cross-sectional analysis. *PLoS Med*. 2022;19(4):e1003968. <https://doi.org/10.1371/journal.pmed.1003968>

15. Romero-Martínez M, Barrientos-Gutiérrez T, Cuevas-Nasu L, Bautista-Arredondo S, Colchero MA, Gaona-Pineda EB, et al. Metodología de la Encuesta Nacional de Salud y Nutrición 2021. *Salud Publica Mex.* 2021;63(6):813-8. <https://doi.org/10.21149/13348>
16. Sagaceta-Mejía J, Cruz-Casarrubias C, Munguía A, Durán R, Tolentino-Mayo L, Barquera S. Supplementary Table 1. Sociodemographic and self-reported health characteristics of included and excluded participants in the analytic sample. Ensanut 2021, Mexico. Figshare, 2026. <https://doi.org/10.6084/m9.figshare.31366930.v1>
17. Nieto C, Tolentino-Mayo L, Monterrubio-Flores E, Medina C, Patiño SRG, Aguirre-Hernández R, et al. Nutrition label use is related to chronic conditions among Mexicans: data from the Mexican National Health and Nutrition Survey 2016. *J Acad Nutr Diet.* 2020;120(5):804-14. <https://doi.org/10.1016/j.jand.2019.07.016>
18. Batis C, Aburto TC, Pedraza LS, Angulo E, Hernández Z, Jáuregui A, et al. Self-reported reactions to the front-of-package warning labelling in Mexico among parents of school-aged children. *medRxiv.* 2023;2023. <https://doi.org/10.1101/2023.07.26.23293213>
19. Valdebenito-Verdugo M, Labrín-Elgueta JM, León-Porath V, Fierro-Kalbhenn S. Informe de resultados: Descripción de las percepciones y actitudes de los/as consumidores respecto a las medidas estatales en el marco de la implementación del Decreto 13/15. 2017. Universidad de Chile [cited November 20 2023]. Available from: <https://www.minsal.cl/wp-content/uploads/2017/01/Informe-Percepci%C3%B3n-Consumidores-ICEI.pdf>
20. Quintiliano-Scarpelli-Dourado D, Gomes-Ramires T, Aráneda-Flores JA, Pinheiro-Fernandes AC, Dourado DQS, Ramires TG, et al. Impact of front-of-pack labeling on food purchase pattern in Chile. *Nutr Hosp.* 2021;38(2):358-65 [cited May 8, 2024]. <https://doi.org/10.20960/nh.03311>
21. Vargas-Meza J, Pedroza-Tobías A, Campos-Nonato I, Nilson E, Jáuregui A, Barquera S. Retos del etiquetado frontal de alimentos para lograr la reducción del consumo de sodio (sal). *Salud Publica Mex.* 2019;61(5):555. <https://doi.org/10.21149/10593>
22. Barquera S, Hernández-Alcaraz C, Jáuregui A, Medina C, Mendoza-Herrera K, Pedroza-Tobías A, et al. Diabetes awareness, treatment, and control among Mexico City residents. *Diabetology.* 2021;2(1):16-30. <https://doi.org/10.3390/diabetology2010002>
23. Vargas-Meza J, Nilson EAF, Nieto C, Khandpur N, Denova-Gutiérrez E, Valero-Morales I, et al. Modelling the impact of sodium intake on cardiovascular disease mortality in Mexico. *BMC Public Health.* 2023;23(1):983. <https://doi.org/10.1186/s12889-023-15827-0>
24. Morales-Villegas EC, Yarleque C, Almeida ML. Manejo de la hipertensión y dislipidemia en México: evidencia, brechas y aproximaciones. *Arch Cardiol Mex.* 2023;93(1):77-87. <https://doi.org/10.24875/ACM.21000330>
25. Ma X, Nan F, Liang H, Shu P, Fan X, Song X, et al. Excessive intake of sugar: An accomplice of inflammation. *Front Immunol.* 2022;13:988481. <https://doi.org/10.3389/fimmu.2022.988481>
26. Prada M, Saraiva M, Garrido MV, Sérgio A, Teixeira A, Lopes D, et al. Perceived associations between excessive sugar intake and health conditions. *Nutrients.* 2022;14(3):640. <https://doi.org/10.3390/nu14030640>
27. Campos-Nonato I, Galván-Valencia O, Hernández-Barrera L, Oviedo-Solís C, Barquera S. Prevalencia de obesidad y factores de riesgo asociados en adultos mexicanos: resultados de la Ensanut 2022. *Salud Publica Mex.* 2023;65:s238-47. <https://doi.org/10.21149/14809>
28. Pietrantoni D, Mayrovitz HN. The Impacts of Sugar-sweetened beverages (SSB) on cardiovascular health. *Cureus.* 2022;14(7):e26908. <https://doi.org/10.7759/cureus.26908>
29. Braverman-Bronstein A, Camacho-García-Formentí D, Zepeda-Tello R, Cudhea F, Singh GM, Mozaffarian D, et al. Mortality attributable to sugar sweetened beverages consumption in Mexico: an update. *Int J Obes.* 2020;44(6):1341-9. <https://doi.org/10.1038/s41366-019-0506-x>
30. Lewis JE, Arheart KL, LeBlanc WG, Fleming LE, Lee DJ, Davila EP, et al. Food label use and awareness of nutritional information and recommendations among persons with chronic disease. *Am J Clin Nutr.* 2009;90(5):1351-7. <https://doi.org/10.3945/ajcn.2009.27684>