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Effects of front-of-package nutrition labelling systems on objective understanding and purchase intention in Panama: results from a multi-arm parallel-group randomised controlled trial

Fabio S Gomes[1,*], Israel Ríos-Castillo[2], Leon Ramon Leal Correa[3], Bethy Cruzado[3], Carlos Felipe Urquizar Rojas[4,5], Gastón Ares Devincenzi[6,7], Elka González-Madden[8] and Jorge Victoria[8]

[1]Pan-American Health Organization (PAHO), Washington DC, USA: [2]Food and Agriculture Organization for the United Nations, Subregional Office for Mesoamerica, Panama City, Panama: [3]Fundación Movimiento de Alimentación Saludable, Panama City, Panama: [4]Department of Design, University of Joinville Region, Joinville, Brazil: [5]Laboratory of Information Design Systems (LabDSI), Federal University of Paraná, Curitiba, Brazil: [6]Instituto Polo Tecnológico de Pando, Facultad de Química, Universidad de la República, Pando, Uruguay: [7]Centro de Investigación Básica en Psicología (CIBPsi), Facultad de Psicología, Universidad de la República, Montevideo, Uruguay: [8]Pan-American Health Organization (PAHO), Panama City, Panama

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Abstract

Objective: To assess the effect of different front-of-package labelling (FOPL) schemes on the objective understanding of the nutritional content and intention to purchase products, in Panama.

Design: Single-blinded multi-arm parallel-group randomised controlled trial.

Setting: Supermarkets across Panama. Participants were exposed to two-dimensional images of fifteen mock-up products presented at random and balanced orders. Participants assigned to the intervention groups were exposed to mock-ups featuring one FOPL scheme: black octagonal warning labels (OWL), traffic-light labelling (TFL) or guideline daily amounts (GDA). The control group was not exposed to any FOPL scheme.

Participants: Adult supermarket shoppers (*n* 1200). Participants were blinded to group assignment.

Results: A similar number of participants were randomised and analysed in each group: OWL (*n* 300), TFL (*n* 300), GDA (*n* 300) and control (*n* 300). The odds of choosing to purchase the least harmful or none of the options more often was the highest in the OWL group. Compared with the control group, these odds were two times higher in the OWL group (OR 2·13, 95 % CI 1·60, 2·84) and 57 % higher in the TFL (1·57, 1·40–2·56), with no changes in the GDA (0·97, 0·73–1·29). OWL also resulted in the highest odds for correctly identifying the least harmful option and for correctly identifying a product with excessive amounts of sugars, sodium and/or saturated fats.

Conclusions: OWL performed best in helping shoppers to correctly identify when a product contained excessive amounts of nutrients of concern, to correctly identify the least harmful option and to decide to purchase the least harmful or none of the options, more often.

Keywords
Food labelling
Nutrition labelling
Nutrition policies
Food policies
Public health

Panama faces a serious public health problem due to the high prevalence of overweight, obesity and chronic non-communicable diseases (NCD)[1,2]. According to the latest nationally representative survey, the prevalence of overweight and obesity was 71·7 % among adults, 36·6 % in schoolchildren and 13 % in pre-schoolers[3]. Like in other countries worldwide, NCD are the main leading cause of death in Panama[4–6], including CVD, neoplasia, diabetes and hypertension[7].

Unhealthy eating has been identified as one of the main modifiable causes of overweight and obesity, and NCD [8]. The expansion of unhealthy diets has been largely driven by

*Corresponding author: Email gomesfabio@paho.org

the consumption of ultra-processed products and processed products that are energy-dense and contain excessive amounts of nutrients associated with NCD (i.e. sugars, sodium, total fat, saturated fats, and trans fats)[9,10].

For these reasons, public policies are needed to promote food environments that facilitate healthier diets[9–11]. The provision of information that can effectively encourage healthier food decisions is essential for this purpose[12,13]. Quantitative nutrient declaration tables are difficult to find and understand for consumers, and therefore, they are seldom used for making food purchase decisions[14]. Considering that people spend little time and cognitive effort when making their food purchase decisions[15–20], simplified nutrition information schemes have been recommended as a measure to improve their ability to find and understand nutrition information, encouraging healthier food choices[11,21]. For these reasons, the adoption of front-of-package labelling (FOPL) has been identified as a priority globally[22,23].

Several FOPL schemes have been developed worldwide. They differ in purpose and performance[11]. Considering that almost half of deaths are caused by high blood fasting glucose, hypertension, and overweight and obesity[24], one of the main purposes sought to be met with FOPL is to allow consumers to easily and correctly identify products that are excessive in critical nutrients associated with those risk factors, including sugars, total fat, saturated fats, trans fats and sodium, and to discourage their consumption[25].

Panama, like other Central American countries, has put forward a proposal of a FOPL system, which has been tabled in the parliament[26,27]. Likewise, the Council of the Ministers of Health of Central America and Dominican Republic (COMISCA) has also tabled a proposal for a FOPL system for adoption by the Central American Integration System[28]. The production of local evidence could help in informing the development and adoption of both these national and sub-regional regulatory initiatives.

This study was designed to add another piece to the existing body of evidence to help informing policy decisions in Panama, in Central America and worldwide. Considering that evidence on the effectiveness of different FOPL schemes is still emerging worldwide, the study makes a relevant contribution to the literature. It compares the octagonal warning labels (OWL) included in the proposal put forward by COMISCA[28], which was also tabled in Panamanian domestic parliament, and the guideline daily amounts (GDA) and the traffic-light labelling (TFL), which have been proposed by food industry sectors as alternatives.

This was the first study of its kind to be completed in Panama. The trial aimed at assessing the effect of these FOPL schemes on the objective understanding of the nutritional content (correctly selecting the least harmful option and correctly identifying sugars, sodium and/or saturated fats found to be in excess) and choosing to purchase the least harmful option (purchase intention) of a series of products, in Panama.

Methods

Design

A single-blinded multi-arm parallel-group randomised controlled trial was conducted among adult shoppers at supermarkets in Panama. Participants were randomly allocated at an equal rate (1/4) to the four study groups (three experimental and the control group). Participants in each group were exposed to either one of the experimental conditions or allocated to the control group.

Participants

Adult supermarket shoppers in Panama (n 1200) of 18 years old or older were included in the study, except for those visually impaired or unable to read or to give informed consent. Participants were recruited and interviewed at popular supermarkets serving customers of varying socioeconomic status, in April and May 2022.

A total of thirty-one supermarkets were included in the study, which were located in different provinces across Panama (Chiriquí, Coclé, Colón, Herrera, Los Santos, Panamá and Veraguas). Field research procedures to recruit and interview shoppers were similar to those adopted and described elsewhere[29].

Interventions

The preparation and presentation of the two-dimensional images of mock-up products shown to participants followed similar procedures used by White-Barrow *et al.*[29]. Figure 1 illustrates one of the pages of a booklet of images shown to participants of one of the experimental groups.

The mock-ups resembled characteristics of real commercial products available in the Panamanian market in terms of package and graphic design, and nutritional composition. Five sets of mock-ups were designed. Each set included three products from each of the five product categories of ultra-processed products commonly consumed ($3 \times 5 = 15$ mock-up products). The product categories were breakfast cereal extrudates, chocolate flavoured milks, filled cookies, white breads and yogurts.

The same fifteen mock-up products were used in each group; the only difference across groups was the FOPL scheme they were featuring. Participants were randomly allocated to one of four experimental groups: OWL, TFL, GDA or no FOP label (control group). Mock-ups shown to participants featured solely the scheme they were allocated to.

The application of TFL followed the specifications developed by the UK Department of Health, the Food Standards Agency and devolved administrations in Scotland, Northern Ireland and Wales in collaboration with the British Retail Consortium[30]. For the GDA, the specifications proposed by the industry for adoption in the Central American Integration System were used[28]. The serving sizes featured on TFL and GDA labels resembled

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Fig. 1 Example of a set of images of one category of products shown to participants with one of the FOPL schemes tested (TFL, traffic-light labelling scheme)

the ones found in real products (see online supplementary material, Table S1). The specifications used for the application of black OWL followed the standard proposed by COMISCA[28]. For consistency, thresholds used to define the 'high/excess' content of sugars, total fat, saturated fats or sodium were the same for all FOPL systems, when such category applied (i.e. OWL and TFL), and the Pan American Health Organization criteria included in the COMISCA proposed standard were the one used[31]. See the nutritional composition of products in the supplementary material (see online supplementary material, Table S1). All sets of mock-up products were identical except for the FOPL icons featured. Figure 2 illustrates one of the mock-up products with the FOPL schemes applied.

The order of the questions asked aimed at reducing potential response bias and followed the procedures used and described in greater detail elsewhere[29]. In summary, first, participants were asked to indicate which product they would buy in each category and, in a second task, which product was the least harmful to health. For the last task, they were asked whether products had an amount of sugars, sodium, total fat, saturated fat, trans fat or none of these nutrients, which was higher than the recommended for a healthy diet.

Outcomes

The contribution of the different FOPL schemes to improving the decision of participants to buy the least harmful option more often, the selection of the least harmful option more often and the correct identification of sugars, sodium, total fat, trans fats and/or saturated fats found to be in excess in the products more often are the primary outcomes of this study.

The metrics used to assess the outcomes have been described in greater detail elsewhere[29]. These included the frequency with which participants responded they would buy the least harmful option or none of the options, the frequency with which participants made a correct identification of the least harmful option, and the number of correct answers and the proportion of participants with zero, one, two, three, four or five correct answers when responding whether the products contained amounts of sugars, sodium, total fat, trans fats and/or saturated fats found to be higher than the recommended for a healthy diet.

Sample size

The sample size was estimated based on calculations to detect a difference between two proportions. The most conservative criterion was used, assuming that the proportion of participants who correctly identify products with nutrient above nutritional recommendations for the control condition would be 50 %. The number of participants needed to detect an absolute increase of 12 % (which is smaller than what has been previously reported[32,33]) with a confidence level of 95 % and a power level of 80 % was estimated in 265 participants in each of the experimental groups (comparisons and control) ($n = 265 \times 4 = 1060$). The total resulting sample size used was of 1200 participants.

Randomisation

Shoppers were selected using quota sampling to meet a composition of age, gender and educational level within each group that resembles the one found for the population of Panama. A similar number of participants were randomly allocated to one of the three intervention groups or the control group: OWL (n 300), TFL (n 300), GDA (n 300) and the control group which was not exposed to any FOPL scheme (n 300). The randomisation of the experimental conditions and groups and single-blinding procedures were similar to those used and described in greater detail elsewhere[29].

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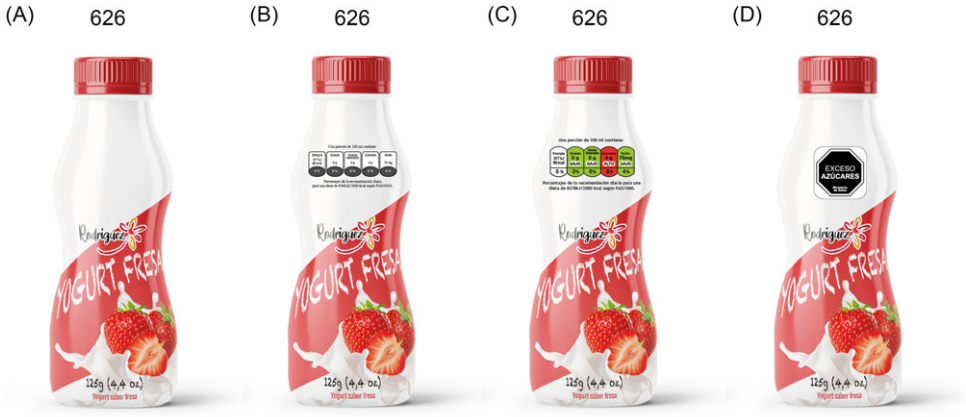

Fig. 2 Example of a product with the different front-of-package labelling (FOPL) schemes applied. (A) No FOPL (control condition), (B) guideline daily amounts (GDA), (C) traffic-light labelling scheme (TFL), (D) octagonal warning label (OWL)

Statistical analyses

Descriptive statistics on the sample included proportions (for categorical variables), means (for numeric variables) and their respective 95 % CI. Ordered logistic regression models were used to estimate the OR of FOPL schemes improving, more often, the frequency with which consumers would choose to purchase the least harmful products or none of the products, the correct identification of the least harmful options of products and the number of times participants correctly identified when products contained excessive amounts of sugars, total fat, saturated fats, trans fats and/or sodium.

Models were adjusted for age, gender, education level, and reported NCD and related risk factors. Subset analyses for each single category of products were also conducted using logistic regression with logit link function.

All tests were two-sided, and we considered $P \leq 0{\cdot}05$ to be statistically significant. The analyses were conducted in R language and environment for statistical computing version 4.0.1[34].

Results

As shown in Table 1, most of the respondents were under 50 years of age, women and who reached the secondary level of education or lower. In addition, the most commonly reported NCD condition and risk factor was hypertension, followed by high cholesterol, overweight and obesity, diabetes and heart disease.

When compared with the control, the chances of participants choosing to purchase the least harmful option or none of them more often doubled when they were exposed to the OWL (OR 2·13, 95 % CI 1·60, 2·84). The TFL (OR 1·57, 95 % CI 1·17, 2·10) performed significantly better than the control and the GDA and significantly worse than the OWL, and the GDA (0·97, 95 % CI 0·73, 1·29) was inefficacious in improving such odds compared with the control condition (Table 2).

The OWL also practically doubled the odds of participants choosing to purchase the least harmful option more often compared with the control (OR 1·94, 95 % CI 1·31, 2·88). As shown in Table 2, all the other systems were inefficacious in improving such odds (GDA, 1·05, 95 % CI 0·71, 1·54; TFL, 1·43, 95 % CI 0·97, 2·10).

The effects exerted by the OWL on the intention to purchase the least harmful option or none of the options were similar for almost all product categories when they were analysed separately. The TFL was only able to improve the intention to purchase the least harmful or none of the options for two categories (yogurts and breakfast cereals), whereas the GDA was inefficacious for all categories. As a matter of fact, the GDA performed worse than the control in terms of encouraging consumers to choose to buy the least harmful or none of the options (Table 2).

The odds of participants correctly identifying the least harmful option more often was the highest and increased by more than sevenfold compared with the control when they were exposed to the OWL (OR 7·51, 95 % CI 5·52, 10·27). It was 2·7 times higher for participants in the TFL group (2·74, 95 % CI 2·03, 3·71), whereas the GDA (0·81, 95 % CI 0·61, 1·08) was inefficacious in improving such odds, compared with the control (Table 2).

When analysing the results separately by product category, the OWL again performed best in improving the capacity of participants to identify the least harmful option for all product categories. The TFL performed significantly worse than the OWL and significantly better than the GDA for all product categories. The GDA was not able to help participants completing this task correctly when applied to flavoured milks and to white breads. In addition, it worsened the capacity of participants correctly completing this task in yogurts and filled cookies (Table 2).

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Table 1 Sociodemographic characteristics and reported non-communicable disease conditions and related risk factors of the sample

	Total (*n* 1200)		Control (*n* 300)		GDA (*n* 300)		TFL (*n* 300)		OWL (*n* 300)	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
Age brackets (years)										
18–29	428	35·7 %	81	27 %	139	46·3 %	120	40 %	88	29·3 %
30–49	515	42·9 %	127	42·3 %	111	37 %	131	43·7 %	146	48·7 %
50–69	240	20 %	82	27·3 %	47	15·7 %	47	15·7 %	64	21·3 %
70+	17	1·4 %	10	3·3 %	3	1 %	2	0·7 %	2	0·7 %
Women	749	62·4 %	189	63 %	172	57·3 %	214	71·3 %	174	58 %
Men	428	35·7 %	106	35·3 %	123	41 %	83	27·7 %	116	38·7 %
Other gender	23	1·9 %	5	1·7 %	5	1·7 %	3	1 %	10	3·3 %
Educational levels										
Primary	141	11·7 %	54	18 %	28	9·3 %	19	6·3 %	40	13·3 %
Secondary	704	58·7 %	166	55·3 %	151	50·3 %	222	74 %	165	55 %
Tertiary	355	29·6 %	80	26·7 %	121	40·4 %	59	19·7 %	95	31·7 %
Participants who have been informed by a health professional that they have…										
Diabetes or raised blood sugar	405	33·8 %	70	23·3 %	110	36·7 %	136	45·3 %	89	29·7 %
Hypertension or high blood pressure	677	56·4 %	130	43·3 %	153	51 %	199	66·3 %	195	65 %
Heart disease	181	15·1 %	24	8 %	56	18·7 %	66	22 %	35	11·7 %
High cholesterol	521	43·4 %	88	29·3 %	114	38 %	171	57 %	148	49·3 %
Overweight or obesity	424	35·3 %	71	23·7 %	102	34 %	182	60·7 %	69	23 %

GDA: guideline daily amounts; TFL: traffic-light system; OWL: octagonal warning labels.

Table 2 Effect of different FOPL schemes on the objective understanding of the nutritional content, harmfulness perception and intention to purchase products, in Panama, compared with the control condition.‡ Values are odds ratios (95 % CI)

		Front-of-package labelling (FOPL) experimental groups					
		GDA (*n* 300)		**TFL (*n* 300)**		**OWL (*n* 300)**	
Outcomes	Products	OR	95 % CI	OR	95 % CI	OR	95 % CI
Intention to purchase the least harmful option or none of the options	All categories of products	0·97[a]	0·73, 1·29	**1·57**[*,b]	**1·17, 2·10**	**2·13**[*,c]	**1·60, 2·84**
	Breakfast cereals	1·17[a]	0·83, 1·66	**2·04**[*,b]	**1·45, 2·88**	**2·05**[*,b]	**1·47, 2·87**
	Yogurts	**0·64**[*,a]	**0·45, 0·91**	**1·71**[*,b]	**1·23, 2·39**	**1·77**[*,b]	**1·27, 2·46**
	Flavoured milks	**0·61**[*,a]	**0·43, 0·86**	0·96[b]	0·68, 1·35	**1·61**[*,c]	**1·13, 2·31**
	Filled cookies	1·11[a]	0·79, 1·55	1·33[*,a]	0·96, 1·86	**2·08**[*,b]	**1·50, 2·89**
	White breads	1·15	0·82, 1·61	1·30	0·93, 1·82	1·35	0·97, 1·88
Intention to purchase the least harmful option	All categories of products	1·05[a]	0·71, 1·54	1·43[a,b]	0·97, 2·10	**1·94**[*,b]	**1·31, 2·88**
	Breakfast cereals	1·15[a]	0·79, 1·67	**2·11**[*,b]	**1·48, 3·02**	**2·30**[*,b]	**1·62, 3·26**
	Yogurts	0·76[a]	0·51, 1·14	1·17[b]	0·80, 1·72	**3·07**[*,c]	**2·14, 4·44**
	Flavoured milks	0·80[a]	0·54, 1·19	1·29[b]	0·87, 1·92	**2·28**[*,c]	**1·53, 3·43**
	Filled cookies	1·14[a]	0·76, 1·71	**1·52**[*,a,b]	**1·03, 2·25**	**1·87**[*,b]	**1·26, 2·80**
	White breads	1·23	0·85, 1·79	**1·64**[*]	**1·16, 2·35**	**1·64**[*]	**1·16, 2·35**
Correct identification of the least harmful option	All categories of products	0·81[a]	0·61, 1·08	**2·74**[*,b]	**2·03, 3·71**	**7·51**[*,c]	**5·52, 10·27**
	Breakfast cereals	**1·49**[*,a]	**1·06, 2·11**	**3·74**[*,b]	**2·65, 5·32**	**6·16**[*,c]	**4·31, 8·90**
	Yogurts	**0·69**[*,a]	**0·50, 0·97**	**1·56**[*,b]	**1·11, 2·20**	**4·96**[*,c]	**3·35, 7·46**
	Flavoured milks	1·05[a]	0·75, 1·46	**1·81**[*,b]	**1·29, 2·53**	**4·57**[*,c]	**3·14, 6·72**
	Filled cookies	**0·63**[*,a]	**0·45, 0·88**	**1·78**[*,b]	**1·27, 2·48**	**3·58**[*,c]	**2·52, 5·12**
	White breads	0·85[a]	0·60, 1·19	**1·90**[*,b]	**1·36, 2·66**	**3·75**[*,c]	**2·65, 5·34**
Correct understanding of the nutritional content of products	All categories of products	1·08[a]	0·78, 1·48	**3·71**[*,b]	**2·72, 5·06**	**16·32**[*,c]	**11·70, 22·89**
	Breakfast cereals	**1·72**[*,a]	**1·09, 2·75**	**3·61**[*,b]	**2·37, 5·61**	**16·16**[*,c]	**10·65, 25·10**
	Yogurts	0·85[a]	0·53, 1·35	**4·33**[*,b]	**2·92, 6·52**	**6·54**[*,c]	**4·44, 9·79**
	Flavoured milks	**0·40**[*,a]	**0·23, 0·66**	0·98[*,b]	0·65, 1·49	**7·99**[*,c]	**5·48, 11·79**
	Filled cookies	1·65[a]	0·91, 3·04	**3·52**[*,b]	**2·07, 6·21**	**14·69**[*,c]	**8·98, 25·19**
	White breads	1·31[a]	0·84, 2·06	**2·46**[*,b]	**1·62, 3·78**	**6·02**[*,c]	**4·06, 9·07**

GDA: guideline daily amounts; TFL: traffic-light system; OWL: octagonal warning labels.
[a,b,c]Different superscript letters within a row in the comparison between columns indicate significant differences between the effects of FOPL schemes ($P \leq 0.05$).
‡Estimates for sets of products were obtained using ordered logistic regression models and estimates for single categories of products were obtained using logistic regression models with link function binomial logit. All estimates were adjusted for adjusted for age, gender and education level.
*Significantly different from the control condition. Also highlighted in bold ($P \leq 0.05$).

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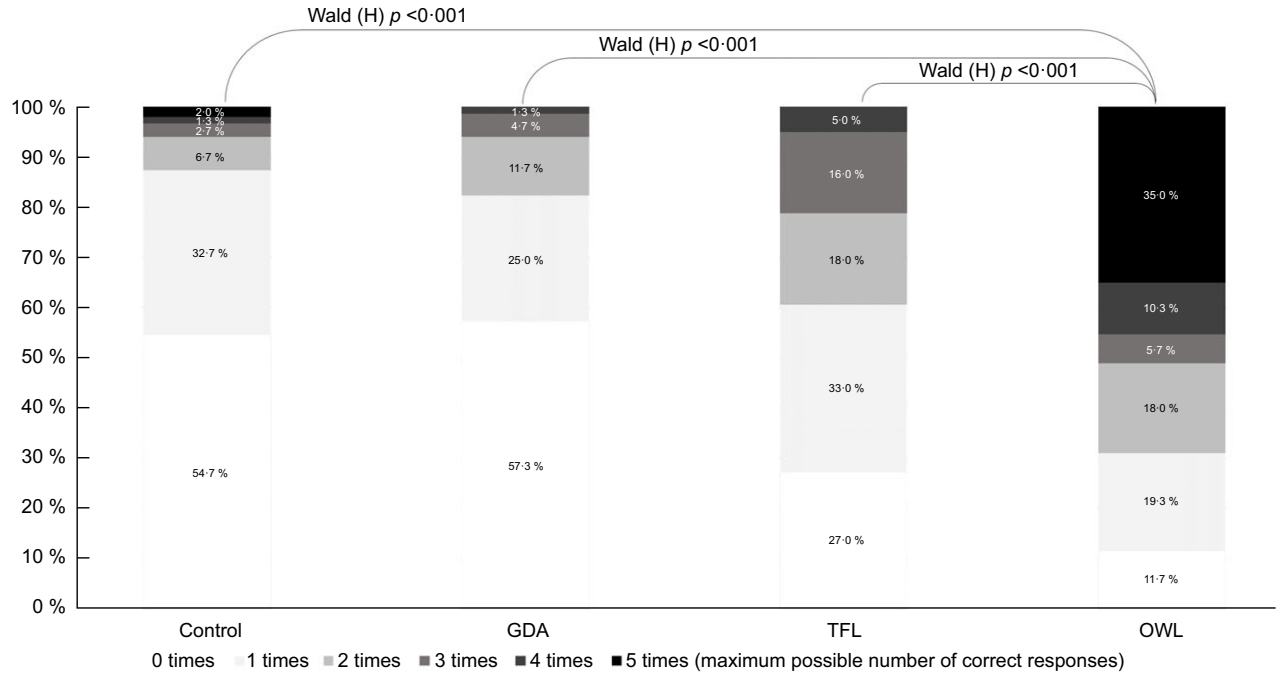

Fig. 3 Proportional distribution of the number of times participants correctly identified the presence of critical nutrients in excess in products, by experimental groups. Wald (H): Wald statistics for homogeneity indicating proportional distributions differ significantly. GDA: guideline daily amounts; TFL: traffic-light labelling scheme; OWL: octagonal warning label

The chances of participants correctly identifying when a product contained excessive amounts of critical nutrients (sodium, sugars and saturated fats) more often were also the highest when they were exposed to the OWL (16·32, 95 % CI 11·70, 22·89), followed by the TFL (3·71, 95 % CI 2·72, 5·06), whereas the GDA (1·08, 95 % CI 0·78, 1·48) was inefficacious (Table 2). The Wald statistics for homogeneity also confirms the superiority of OWL in improving the capacity of participants to correctly identify products with excessive amounts of critical nutrients (Fig. 3). When analysing these results separately by product category, the OWL again performed best for all product categories. Again, the TFL performed significantly worse than the OWL and significantly better than the GDA for all product categories. The GDA was not able to help participants completing this task correctly when applied to yogurts, filled cookies and white breads. In addition, it worsened the capacity of participants correctly completing this task for flavoured milks (Table 2).

Discussion

The study found that the OWL outperformed the GDA and TFL in helping consumers correctly identifying the least harmful option and the presence in products of critical nutrients in excess and choosing to purchase the least harmful option or none of the options in Panama, regardless of the populations' age, gender and education.

Similarly, to what this study has found, previous studies have also reported that warning labels perform better than GDA and TFL in helping consumers make healthier decisions. Some of the reasons include the fact that OWL are easier and quicker to find on the labels and to understand due to their simplicity and higher salience from the usual colourful background of processed and ultra-processed packaged products[29,32,33,35–37]. The TFL classifies the content of target nutrient content into low/medium/high, and this information is expected to require more time and cognitive effort to interpret compared with the OWL, as reported in previous studies[32,35]. The use of green colour found in systems such as the TFL may drive consumers to misperceive a product as healthier and undesirably raise their appetite for such products, which may explain their lower effect on improving understanding of nutritional information and reducing purchase intention for products high in nutrients associated with NCD [35,38–43]. In addition, the use of red colour, also found in such systems, although intended to communicate a higher harmfulness level, may trigger an opposite effect in some products. Lemos *et al.* (2020) have shown, using objective measures of brain activities, that the red colour triggers a positive emotional motivation towards sweet ultra-processed products[44].

Two studies differed from some of our results[45,46]. One study using a virtual supermarket simulator found the nutritional composition of the simulated shopping carts was similar to the OWL and TFL groups[45]. In another study, Bandeira *et al.* (2021) reported that the OWL performed better than the TFL in improving the understanding about nutritional content of products, but differences regarding the intention to purchase products were not significant[46].

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Reviews and meta-analyses have documented that warning labels are more consistently successful and perform best in reducing purchase intention of unhealthy products[47,48]. In this sense, a real-life interrupted time series study conducted in Chile has shown warning labels contributed to reductions in the purchase of products high in calories, sodium, saturated fats and sugars[49].

One of the major strengths of this study is the robust multi-arm parallel-group randomised controlled design which allows the results to be attributed to FOPL schemes and avoids differential carry-over effects that are more likely to happen in within-subject studies. The exposure of participants to two-dimensional mock-up products with different FOPL schemes was standardised to match real products' label sizes and sizes and proportions of FOPL, approaching real-life conditions, also strengthened its external validity. However, it should be noted that the study was conducted using fictitious brands, products were not associated with price information and participants did not purchase the products, which has strengthened the attribution of the effects to the FOPL schemes but, conversely, limited the analysis of the relative importance of these other factors.

The findings of this study indicate that among the FOPL options under discussion and consideration in Panama and Central America, the OWL included in the COMISCA proposal[28] to be adopted by Member States of the Central American Integration System and in bills to be adopted by the Panamanian parliament is the most effective option in meeting the regulatory objective of helping the population to correctly identify the least harmful option and the presence of excessive amounts of critical nutrients and to choose to purchase the least harmful product more often. Once the system is implemented in Central American countries, future research to evaluate the impact on actual purchases of products and on dietary changes will be needed to keep track of the changes expected to be exerted by OWL in the short- and mid-terms. Efforts to safeguard the policy space from ultra-processed food industry's known attempts to shape food and nutrition policies in their favour and jeopardising public health are also paramount.

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Conflict of interest

None.

Authorship

All authors provided substantial contributions to the conception and design of the study. LRLC and BC led the data acquisition. FSG performed the statistical analyses and provided a preliminary interpretation of the findings. FSG and IRC drafted the first version of the paper, and all authors revised it critically for important intellectual content. All authors approved the final version to be published. All authors agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. FSG is a staff member of the Pan American Health Organization. Authors hold sole responsibility for the views expressed in the manuscript, which may not necessarily reflect the opinion or policy of the Pan American Health Organization.

Ethics of human subject participation

This study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving research study participants were approved by the Institutional Ethics Committee of the Institute of Nutrition of Central America and Panama, by the Bioethics Committee of the University of Panama and by the Pan American Health Organization Ethics Review Committee. Written informed consent was obtained from all subjects.

Supplementary material

For supplementary material accompanying this paper, visit https://doi.org/10.1017/S1368980024001009.

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