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Effects of front-of-package nutrition labelling systems on understanding and purchase intention in Jamaica: results from a multiarm randomised controlled trial

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ABSTRACT

Objective To assess the effects of three different front-of-package labelling (FOPL) schemes on objective understanding and intention to purchase of products, in Jamaica.

Setting Supermarkets in Jamaica.

Participants Adult supermarket shoppers in Jamaica (n=1206) aged 18 years old or older were included in the study, except for those visually impaired, or unable to give informed consent.

Design Multiarm parallel-group randomised trial.

Interventions Participants were randomly allocated to one of the three intervention groups or the control group. They were exposed to two-dimensional images of 12 mock-up products presented in random and balanced order. Participants assigned to the intervention groups were exposed to one FOPL scheme: black octagonal warning labels (OWL), magnifying glass high-in single icon (MGG) or traffic-light labelling (TFL). The control group was exposed to the nutrition facts up front.

Outcome measures OR for correctly understanding nutritional information (correctly selecting the least harmful option, correctly identifying sugars, sodium and/or saturated fats found to be in excess) and choosing to purchase the least harmful option (purchase intention), more often.

Results Compared with the control group, the odds for correctly selecting the least harmful option more often were 107% higher in the OWL group (OR 2.07, 95% CI 1.54 to 2.78; p<0.001), whereas the MGG (1.18, 95% CI 0.89 to 1.57; p=0.24) and the TFL (1.13, 95% CI 0.85 to 1.51; p=0.39) were inefficacious in improving such odds. OWL also resulted in the highest odds for correctly identifying a product with excessive amounts of sugars, sodium and/or saturated fats and for deciding to purchase the least harmful option or none of the options.

Conclusions Octagonal warning labels performed best at improving the ability of adult shoppers in Jamaica to understand the nutrition information and at encouraging them to purchase the least harmful option more often.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study used a between-subject design which allows the results to be attributed to front-of-package labelling (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, resembling real-life conditions.

⇒ The study was conducted using fictious 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.

BACKGROUND

The prevalence of overweight, obesity and non-communicable diseases (NCDs) continues to increase in the Americas among all age groups.[1] This region has the highest prevalence of overweight and obesity in the world: the global prevalence of overweight and obesity in adults is 39%, whereas in the Americas it is 64.1% among men and 60.9% among women. NCDs are the major cause of disability and premature death, and in 2016, they were responsible for 80.7% of all deaths in the region.[2] Thirty-four per cent of these NCD-related deaths occurred prematurely in people between the ages of 30 and 69 years, when people have the most economically productive time of their life.[3] In particular, Jamaica is among the countries with the highest rates of overweight and obesity and NCDs in the Americas. In 2016–2017, the latest estimate available, the prevalence of overweight and obesity in male and female adults was 38.8% and

67.6%, respectively.[4] In 2016, 80% of deaths in Jamaica were caused by NCDs.[2]

Unhealthy eating has been identified as one of the main modifiable causes of this situation,[5] and the expansion of unhealthy diets has been largely driven by the consumption of ultra-processed products and processed products that are energy-dense and contain excessive amounts of nutrients associated with NCDs (ie, sugars, sodium, fats, saturated fats and trans fats).[6–11] For these reasons, the development and adoption of policies that create supportive food environments that enable the population to improve their diets are paramount.[5] Provision of information about the content of products is usually regarded as a core policy for encouraging healthier food decisions.[12] Although nutrient declarations have been compulsorily implemented in several countries worldwide, a large body of literature has shown that people find it difficult to detect and understand this type of information and that they seldom use it for making their food purchases.[13–18]

Considering that people spend little time and cognitive effort when taking their food purchase decisions, the inclusion of simplified nutrition information schemes can improve their ability to find and understand nutrition information, encouraging informed food choices.[17–20] For this reason, the adoption of front-of-package (FOP) nutrition labelling has been identified as a priority globally.[21] FOP nutrition labelling intends to increase attention to nutrition information at the point of purchase and to subsequently improve consumer ability to understand it.[22] Increased attention and understanding are expected to encourage consumers to take the nutritional composition of products into account for their food purchase decisions, acting like a nudge towards healthier choices.[22 23] In particular, FOP nutrition labelling is expected to discourage purchase and consumption of products excessive in nutrients associated with NCDs, which would lead to changes in nutrient intake in the middle term.[16 24 25] This sequence of steps is expected to contribute to reducing the prevalence of obesity and NCDs in the long term, as shown by several modelling studies.[26–28]

Several FOP nutrition labelling schemes have been developed worldwide, but they differ in purpose and performance.[29] Non-interpretive schemes (eg, guidelines daily amounts, facts up front) only intend to provide numerical information about the content of nutrients, whereas interpretive schemes aim at facilitating the interpretation of nutrition information by including graphical or textual information.[30] Among interpretive schemes, two main types can be identified: nutrient-specific schemes (eg, traffic-light system or warning labels) that provide simplified information about specific nutrients of concern and summary indicators of overall nutritional quality (eg, Health Star Rating and Nutri-Score).[30]

In the Americas, the Caribbean and in Jamaica, where almost half of deaths are caused by high fasting blood glucose, hypertension and overweight and obesity, the main objective sought to be met with FOP labelling is to allow consumers to easily and correctly identify products that are excessive in critical nutrients associated with those risk factors, including sugars, fats, saturated fats, trans fats and sodium. In addition, FOP labelling is expected to encourage consumers to make more informed and healthier food choices, leading to a reduction in the consumption of fats, sodium and/or sugars.

Jamaica's existing Standard Act and Regulation[31] form the legislative framework for labelling, and the country is still to incorporate provisions on the application of FOP labelling to fulfil its commitments to national, subregional and regional mandates. As part of the country's NCD response, a National Task Force was assembled under the auspices of the Minister of Health with the aim of achieving improvements in the food environment, including the adoption of FOP labelling for prepackaged food products to provide adequate and understandable product and nutrition information to consumers. In addition, Jamaica is also taking part in a subregional standard development process that the Caribbean Community (CARICOM) Regional Organisation for Standards and Quality (CROSQ) has been leading, since 2018, to incorporate FOP labelling specifications into a revision of CARICOM Regional Standard for Specification for labelling of prepackaged foods (CRS 5:2010).[32] This has involved extensive consultations at country level through National Mirror Committees established by the National Bureaus of Standards with representation of government, industry, commerce and civil society organisations. During this process, the FOP octagonal warning labelling system was proposed as the best fit for purpose based on the evidence, and other proposals were put forward by representatives of industry during consultations.

This research, which is the first study of its kind in the Caribbean, was designed to add another piece to the existing body of evidence to help inform policy decisions. The study compared the octagonal warning labels (OWL) included in the CROSQ proposal for adoption by the CARICOM, the 'high in' single icon FOP labelling system known as the magnifying glass (MGG) and the traffic-light labelling (TFL), using nutrition facts up front as a control. These other FOP labelling schemes were included in the study since they were suggested by industry representatives along the regulatory process as alternatives to OWL. The comparisons aimed at assessing the effect of these FOP labelling schemes on objective understanding (correct identification of the least harmful product and correct identification of excessive nutrient content), and intention to purchase of a series of products, in Jamaica. Results are also expected to contribute to the evaluation of the effect of graphical design on the effectiveness of warning labels, a topic that has been increasingly receiving more attention in the literature more recently.[33–39] The hypotheses tested in the study include: (1) OWL, MGG and TFL improve consumers' ability to correctly identify the least harmful product more often; (2) these FOP labelling schemes improve

consumers' ability to correctly identify the presence of excessive nutrient content in products more often; (3) and these FOP labelling schemes increase consumers' intention to purchase the least harmful option or none of the options of a series of products, more often. These hypotheses have been tested both against the control condition, and between the FOP labelling schemes, to verify whether there is a scheme that performs differently from the others for each hypothesis.

METHODS

Design

A multiarm parallel-group randomised trial was conducted among adult shoppers at supermarkets across Jamaica. Participants were randomly allocated at 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 Jamaica (n=1206) aged 18 years old or older were included in the study, except for those visually impaired, or unable to give informed consent. Participants were recruited and interviewed at popular supermarkets serving customers of varying socioeconomic status, between December 2020 and February 2021. The 24 supermarkets included in the study were located in different parishes across Jamaica (Clarendon n=2, Hanover n=2, Kingston and St Andrew n=4, St Ann n=2, St Catherine n=5, St Elizabeth n=2, St James n=3, St Mary n=2 and St Thomas n=2). Shoppers were individually invited by interviewers to participate in a survey about food packages while they were entering the supermarket. They were informed that the study aimed to find out how people in Jamaica perceive food packages, and that they would be presented with a series of pictures of food packages and asked to answer simple questions that would take about 15 min to respond in total. An information sheet providing more detailed information about the study was also read by the interviewer, if additional information was required by the recruit. Participants were interviewed consecutively by trained field researchers after providing their signed informed consent, and the interviews took place before they entered the supermarket, during the supermarket opening hours, on weekdays.

Interventions

Participants in the experimental groups were shown two-dimensional (2D) images of 12 different mock-up products presented in random and balanced order between and within categories of products. The images were printed in A3 size booklets. Figure 1 illustrates one of the pages of a booklet of images shown to participants of one of the experimental groups.

The mock-up products did not correspond to real commercial products available in the Jamaican market but had similar characteristics in terms of graphical design and nutritional composition. Four sets of mock-ups were designed. Each set included three (3) products from each of four (4) product categories of ultra-processed products commonly consumed (3×4=12 mock-up products). The product categories were breakfast cereal extrudates, chocolate milk, cream crackers and yoghurt.

The same 12 mock-up products were used in each group;f the only difference across groups was the FOP

Figure 1 Example of images of one category of products shown to participants assigned to one of the front-of-package labelling groups (traffic-light labelling). Images developed by coauthors, Carlos Felipe Urquizar Rojas and Carla Galvão Spinillo, and designed by Carlos Felipe Urquizar Rojas and Carla Galvão Spinillo.

labelling scheme they were featuring. Mock-ups shown to participants featured solely one of the following front-of-package labelling (FOPL) schemes, according to the group they were allocated to: black octagonal warning labels (OWL group), magnifying glass high-in single icon (MGG group), traffic-light labelling (TFL group) or the nutrition facts up front (control group).

The application of TFL and the nutrition facts up front (control condition) followed the specifications developed by the UK Department of Health (DH), the Food Standards Agency (FSA), and devolved administrations in Scotland, Northern Ireland and Wales in collaboration with the British Retail Consortium.[40] The nutrition symbol that features an MGG proposed in the public consultation launched by Health Canada was used to depict the high-in single icon FOP label.[41] The specifications used for the application of black OWL followed the CROSQ proposed standard.[32] For consistency, thresholds used to define the 'high' content of sugars, fats, saturated fats or sodium, was the same for all FOPL systems, and the Pan American Health Organization (PAHO) nutrient profile model criteria included in the CROSQ proposed standard was the one used.[42] The thresholds for low and medium levels of nutrients used in the TFL were those established by the UK/DH/FSA, and devolved administrations in Scotland, Northern Ireland and Wales in collaboration with the British Retail Consortium.[40] See the nutritional composition of products in the supplemental material (online supplemental 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 aimed at reducing potential response bias. Participants were first shown the three products from each of the four product categories and asked to indicate which product they would buy in each category. Participants could also indicate that they would not buy any of the options within each category. The four product categories were shown one by one. Both the categories and the products within the categories were presented in random and balanced order.

Participants were then shown the same products in different order of categories, and different order within categories. For each set of three products within a category they were asked to indicate which of those was the least harmful for health.

For the last task, participants were shown one product of each category, in a random and balanced order, and asked to indicate if the product had an amount of sugars, sodium, fat, saturated fat and/or trans fat, that was higher than the recommended for a healthy diet.

Finally, participants answered questions about their socio-demographic and health statuses.

Outcomes

The primary outcomes of the study included 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 and/or saturated fats found to be in excess in the products more often.

For the first task participants had four opportunities to indicate which product, out of a set of three, they would buy, or whether they would not buy any of the products, which served the estimation of the frequency with which participants intended to buy the least harmful option or none of the options. The second task also provided four opportunities for participants to identify the least harmful product, out of a set of three, and this data served the estimation of the frequency with which participants made a correct identification. The third task allowed participants

Figure 2 Example of a product from each of the FOPL groups. (A) Nutrition facts up front (control condition); (B) single icon high in FOPL with magnifying glass; (C) traffic-light labelling scheme; (D) octagonal warning label. Images developed by coauthors, Carlos Felipe Urquizar Rojas and Carla Galvão Spinillo, and designed by Carlos Felipe Urquizar Rojas and Carla Galvão Spinillo. FOPL, front-of-package labelling.

Table 1 Outcomes, survey questions and responses

Outcome	Survey question	Response
Intention to purchase the least harmful option or none of the options	Please imagine that you are in the supermarket purchasing food. You want to purchase several products. You will see sets of packages and you will be asked to indicate the one you would purchase. You can also indicate that you would not select any of the available products. (*The respondents were shown four sets of three products, and for each set they were asked the following question*) ► Which product would you buy?	Number of times the respondent chose the least harmful option or none of the options (zero to four times).
Correct identification of the least harmful option	Please imagine that you are still in the supermarket purchasing food. This time you want to select the least harmful product in different categories. You will see sets of packages and you will be asked to indicate the product least harmful to health. (*The respondents were shown four sets of three products, and for each set they were asked the following question*) ► Which is the product least harmful to health?	Number of times the respondent selected the least harmful option correctly (zero to four times).
Correct understanding about the nutritional content of products	Please imagine that you are still in the supermarket purchasing food. You have selected a product and you want to decide whether the content of any nutrient is higher than recommended for a healthy diet. You will see a series of packages and you will be asked to indicate whether the content of any of the listed nutrients is higher than recommended for a healthy diet. (*The respondents were shown four products from different categories, one by one and for each product they were asked the following question*). Is the content of any of the following nutrients in this product higher than recommended for a healthy diet? You can select all the options that apply. I will read the options to you. ► Sugar is higher than recommended for a healthy diet. ► Sodium is higher than recommended for a healthy diet. ► Total fat/fat is higher than recommended for a healthy diet. ► Saturated fat is higher than recommended for a healthy diet. ► Trans fat is higher than recommended for a healthy diet. ► None of the nutrients is higher than recommended for a healthy diet.	Number of times the respondent answered correctly about the nutritional content of products (zero to four times).

to verify four products, one at a time, and to indicate whether they contained amounts of sugars, sodium and/or saturated fats found to be higher than the recommended for a healthy diet. With this data the number of correct answers and the proportion of participants with zero, one, two, three or four correct answers for the total of four products was estimated.

The estimated frequencies with which participants chose to buy the least harmful product or none of the products, with which participants correctly identified the least harmful product and the frequencies with which they correctly identified the nutrients in excess in the four products, were compared between the experimental and control groups to assess how systems performed according to the primary outcomes described above.

Table 1 summarises the outcomes, the questions asked to gather the data on each outcome in the order they were asked and the responses.

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[43 44]) 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). The total resulting sample size was of 1200 (300×4) 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 Jamaica.[45] A similar number of participants were randomly allocated to one of the three intervention groups or the control group: black OWL (n=303); MGG (n=301); TFL (n=301); and the control group which was exposed to the nutrition facts up front (n=301). The randomisation of the experimental conditions and groups was completed adopting a Williams design[46] to ensure the order of categories of products and the order of products within categories was random and balanced for all groups. This randomisation produced four random and balanced sequences of categories of products and products within categories used for each of the four groups, resulting in 16 possible combinations of groups and sequences (4×4), equally balanced and order within each group.

For the allocation of participants into each of the groups and each of the four sequences within the group,

a simple randomisation technique was adopted using a Pareto randomisation procedure. Random numbers falling between 0 and 1 were generated for each of the 16 combinations of groups and sequences, then these combinations were sorted by the random numbers and used to sequentially randomise participants' allocation to 1 of these 16 combinations of groups (experimental or control) and random sequences of categories of products and of products within categories.

The study was single-blinded, since participants were not aware they had been assigned to an intervention or control group. Although field researchers had no prior knowledge of which intervention would be assigned to a participant, once, and only once, the exposure of the participant to an intervention or the control was initiated, researchers could tell which intervention or control participants were assigned to.

Statistical analyses

Descriptive statistics on the sample included proportions (for categorical variables), means (for numeric variables) and their respective CIs. To examine the contribution of FOPL schemes to improving the frequency with which consumers would correctly identify the least harmful options of products, ordered logistic regression models were used to estimate the OR of correctly identifying the least harmful products more often. The number of times participants correctly identified the least harmful option was used as the ordinal dependent variable, and FOPL schemes the independent covariates. Following a similar procedure, the number of times participants correctly identified when products contained excessive amounts of sugars, fats, saturated fats, trans fats and/or sodium was analysed as the ordinal dependent variables to verify the contribution of FOPL schemes in helping consumers to correctly identify those more often. To analyse the contribution of FOPL schemes to improving the frequency with which consumers would choose to buy the least harmful options of products, a similar model was adjusted. The number of times participants indicated they would purchase the least harmful option was the ordinal dependent variable, in this case. The ORs respective 95% CIs were also calculated, and Wald test was used to verify the significance of the contribution of FOPL schemes against the control condition and between schemes for the three outcomes listed above.

Models were also adjusted for age, gender, education and reported NCD and related risk factors. A similar set of models were also adjusted using logistic regression with logit link function for each single category of products as subset analyses.

All tests were two-sided and we considered p<0.05 to be statistically significant. The analyses were conducted in R language and environment for statistical computing V.4.0.1.[47]

Patient and public involvement

No patient involved.

RESULTS

Table 2 provides a description of the socio-demographic characteristics of participants as well as reported NCDs conditions and related risk factors. Similar to the estimates made by the United Nations for the Jamaican population in 2021,[48] the majority of the respondents were under 50 years of age, with the proportion of women and men around half, and most of them with an education level of up to secondary/vocational to Grade 11–13. In addition, one-fourth indicated they had been informed by a health professional to have overweight or obesity and the most common reported NCD condition and risk factor was hypertension, followed by diabetes, high cholesterol and heart disease. Table 2 also confirms the random allocation resulted in an even and proportional distribution of participants in the different groups.

Identification of the least harmful option

The odds of participants correctly identifying the least harmful option more often more than doubled when they were exposed to the OWL (OR 2.07, 95% CI 1.54 to 2.78; p<0.001), whereas the MGG (1.18, 95% CI 0.89 to 1.57; p=0.24) and TFL (1.13, 95% CI 0.85 to 1.51; p=0.39) were inefficacious in improving such odds, compared with the control (table 3).

When analysing the results separately by product category, the OWL significantly improved the capacity of participants to identify the least harmful option for all product categories, except for flavoured milks. The MGG was only able to significantly help participants to correctly complete this task when applied to breakfast cereal extrudates, being inefficacious in all the other products, whereas the TFL was inefficacious in all products (table 3).

Understanding about the nutritional content

The chances of participants correctly identifying when a product contained excessive amounts of critical nutrients (sodium, sugars and saturated fats) more often were significantly the highest when they were exposed to the OWL (4.57, 95% CI 3.41 to 6.15; p<0.001), followed by MGG (2.69, 95% CI 2.01 to 3.62; p<0.001) and the TFL (2.09, 95% CI 1.57 to 2.79; p<0.001), which did not differ from each other. Similar results were found for the analysis of each product category separately (table 3). OWL outperformed the other two systems, except for the flavoured milk category, where it did not significantly differ from MGG (table 3).

Intention to purchase

When compared with the control, the chances of participants choosing to purchase the least harmful option or none of the options more often also doubled when they were exposed to the OWL (OR 2.03, 95% CI 1.51 to 2.72; p<0.001), and the odds for MGG (1.58, 95% CI 1.18 to 2.11; p=0.002) were lower than but not significantly different from OWL's, whereas TFL (1.25, 95% CI 0.93 to 1.67; p=0.13) was inefficacious in improving such odds

Table 2 Socio-demographic characteristics and reported non-communicable diseases conditions and related risk factors of the sample

	Total (n=1206)	Control (n=301)	TFL (n=301)	MGG (n=301)	OWL (n=303)
Age brackets					
18–29	410 (34%)	103 (34.2%)	95 (31.6%)	94 (31.2%)	118 (38.9%)
30–49	454 (37.7%)	120 (39.9%)	115 (38.2%)	113 (37.5%)	106 (35%)
50–69	298 (24.7%)	63 (20.9%)	81 (26.9%)	79 (26.3%)	75 (24.8%)
70+	44 (3.6%)	15 (5%)	10 (3.3%)	15 (5%)	4 (1.3%)
Female	678 (56.2%)	193 (64.1%)	174 (57.8%)	161 (53.5%)	150 (49.5%)
Male	525 (43.5%)	107 (35.5%)	127 (42.2%)	140 (46.5%)	151 (49.8%)
Educational level					
Primary	60 (5%)	16 (5.3%)	11 (3.7%)	18 (6%)	15 (5%)
Secondary/vocational to Grade 9	139 (11.5%)	40 (13.3%)	35 (11.6%)	28 (9.3%)	36 (11.9%)
Secondary/vocational to Grades 11–13	524 (43.4%)	132 (43.9%)	133 (44.2%)	128 (42.5%)	131 (43.2%)
Tertiary/graduate/postgraduate	480 (39.8%)	113 (37.5%)	121 (40.2%)	126 (41.9%)	120 (39.6%)
Participants who have been informed by a health professional that they have…					
Diabetes or raised blood sugar	352 (29.2%)	88 (29.2%)	92 (30.6%)	84 (27.9%)	88 (29%)
Hypertension or high blood pressure	519 (43%)	129 (42.9%)	133 (44.2%)	122 (40.5%)	135 (44.6%)
Heart disease	85 (7%)	19 (6.3%)	23 (7.6%)	17 (5.6%)	26 (8.6%)
High cholesterol	233 (19.3%)	63 (20.9%)	52 (17.3%)	47 (15.6%)	71 (23.4%)
Overweight or obesity	290 (24%)	83 (27.6%)	65 (21.6%)	77 (25.6%)	65 (21.5%)

MGG, magnifying glass high-in single icon; TFL, traffic-light system; WRN, octagonal warning labels.

and did not differ significantly from the MGG. Similar results were found for the intention to purchase the least harmful options, whereas for the intention to not purchase any of the options, the OWL was the only one significantly increasing the odds for such decision (1.77, 95% CI 1.27 to 2.47; p<0.001) (table 3).

The effects exerted by OWL were similar for almost all product categories when they were analysed separately, except for yoghurts. In only two instances schemes different from the OWL improved the intention to purchase the least harmful or none of the options: MGG in breakfast cereal extrudates and the TFL in crackers (table 3). For yoghurts and flavoured milks both MGG and TFL were inefficacious in increasing the intention to purchase the least harmful product or none of the products.

DISCUSSION

The present study contributes to the growing body of evidence suggesting that FOP nutrition labelling improves consumer understanding of the nutritional composition of packaged foods.[22 23] The three schemes including interpretational aids (OWL, MGG and TFL) increased participants' ability to correctly identify products with high content of sugars, fat and sodium. However, results showed that the OWL significantly outperformed the MGG and the TFL in helping consumers to (a) correctly identify the least harmful option and (b) correctly identify when products contained excessive amounts of critical nutrients and (c) choose to purchase the least harmful option or none of the options in Jamaica, regardless of the populations' age, gender, education and reported NCD and related risk factors. In addition, TFL was inefficacious in helping consumers to correctly identify the least harmful option and to choose to purchase the least harmful option or none of the options (except for crackers), and the MGG was inefficacious in helping consumers to correctly identify the least harmful option (except for breakfast cereals).

These findings contribute to the growing body of evidence showing that warning labels outperform the TFL in improving understanding and encouraging consumers to make healthier food choices. Some of the reasons include the fact that warning labels are easier and quicker to find on the labels and to understand than TFL due to their simplicity and higher salience from the background.[33 34 43 44 49 50] The TFL classifies the content of target nutrient content into low/medium/high. This information is expected to require more time and cognitive effort to interpret compared with the OWL or MGG, as reported in previous studies based on response times.[43 49] Previous studies have also shown that the use of green colour found in systems such as the TFL and Nutri-Score may drive consumers to misperceive a product as healthier and undesirably raise their appetite for such products, which may explain their lower effect on

Table 3 Effect of different FOPL schemes on correct identification of the least harmful option, understanding of the nutritional content and intention to purchase products, in Jamaica, compared with the control condition.* Values are ORs (95% CIs)

Outcomes	Products	Front-of-package labelling experimental groups		
		TFL (n=301)	MGG (n=301)	OWL (n=303)
Correct identification of the least harmful option	All categories of products	1.13 (0.85 to 1.51)[a]	1.18 (0.89 to 1.57)[a]	**2.07 (1.54 to 2.78)†[b]**
	Breakfast cereals	1.16 (0.83 to 1.61)[a]	**1.83 (1.30 to 2.60)†[b]**	**1.97 (1.39 to 2.82)†[b]**
	Crackers	1.02 (0.74 to 1.41)[a]	1.18 (0.85 to 1.63)[a]	**1.75 (1.26 to 2.44)†[b]**
	Yoghurts	1.20 (0.86 to 1.68)[a]	0.69 (0.50 to 0.96)[b]	**1.42 (1.01 to 2.00)†[a]**
	Flavoured milks	0.99 (0.71 to 1.38)[a]	1.11 (0.80 to 1.55)[a,b]	1.41 (1.00 to 1.98)[b]
Correct understanding about the nutritional content of products	All categories of products	**2.09 (1.57 to 2.79)†[a]**	**2.69 (2.01 to 3.62)†[a]**	**4.57 (3.41 to 6.15)†[b]**
	Breakfast cereals	**1.91 (1.33 to 2.76)†[a]**	**2.49 (1.74 to 3.58)†[a]**	**4.14 (2.90 to 5.96)†[b]**
	Crackers	**1.81 (1.27 to 2.58)†[a]**	**2.38 (1.68 to 3.38)†[a]**	**3.68 (2.60 to 5.25)†[b]**
	Yoghurts	**2.01 (1.43 to 2.83)†[a]**	**2.15 (1.53 to 3.04)†[a]**	**3.41 (2.43 to 4.83)†[b]**
	Flavoured milks	**5.52 (3.44 to 9.15)†[a]**	**7.99 (5.02 to 13.20)†[a,b]**	**9.04 (5.69 to 14.91)†[b]**
Intention to purchase the least harmful option or none of the options	All categories of products	1.25 (0.93 to 1.67)[a]	**1.58 (1.18 to 2.11)†[a,b]**	**2.03 (1.51 to 2.72)†[b]**
	Breakfast cereals	1.14 (0.82 to 1.59)[a]	**1.61 (1.15 to 2.26)†[b]**	**1.61 (1.15 to 2.26)†[b]**
	Crackers	**1.44 (1.03 to 2.04)†[a,b]**	1.28 (0.91 to 1.80)[a]	**1.79 (1.27 to 2.52)†[b]**
	Yoghurts	0.99 (0.72 to 1.37)	1.18 (0.85 to 1.63)	1.33 (0.96 to 1.85)
	Flavoured milks	1.06 (0.77 to 1.47)[a]	1.36 (0.98 to 1.88)[a,b]	**1.62 (1.17 to 2.25)†[b]**
Intention to purchase the least harmful option	All categories of products	1.16 (0.81 to 1.66)[a]	**1.50 (1.04 to 2.16)†[a,b]**	**1.80 (1.24 to 2.63)†[b]**
	Breakfast cereals	1.18 (0.84 to 1.66)	**1.65 (1.16 to 2.34)†**	**1.54 (1.09 to 2.19)†**
	Crackers	**1.47 (1.02 to 2.11)†**	1.16 (0.80 to 1.69)	**1.56 (1.08 to 2.25)†**
	Yoghurts	0.99 (0.69 to 1.41)	1.19 (0.83 to 1.70)	1.26 (0.88 to 1.81)
	Flavoured milks	1.08 (0.72 to 1.62)	1.23 (0.82 to 1.87)	1.36 (0.90 to 2.05)
Intention to not purchase any of the options	All categories of products	1.07 (0.76 to 1.49)[a]	1.23 (0.88 to 1.73)[a]	**1.77 (1.27 to 2.47)†[b]**
	Breakfast cereals	0.94 (0.51 to 1.71)[a]	1.09 (0.61 to 1.96)[a,b]	**1.84 (1.07 to 3.23)†[b]**
	Crackers	1.18 (0.57 to 2.46)[a]	1.77 (0.92 to 3.54)[a,b]	**2.78 (1.49 to 5.44)†[b]**
	Yoghurts	0.98 (0.62 to 1.56)	1.09 (0.70 to 1.72)	1.34 (0.86 to 2.09)
	Flavoured milks	1.02 (0.69 to 1.52)[a]	1.37 (0.94 to 2.00)[a,b]	**1.75 (1.20 to 2.56)†[b]**

Different superscript letters within a row in the comparison between columns indicate significant differences between the effects of FOPL schemes (p≤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 age, gender, education and reported non-communicable disease and related risk factors.
†Significantly different from control condition. Also highlighted in bold (p≤0.05).
FOPL, front-of-package labelling ; MGG, magnifying glass high-in single icon; OWL, octagonal warning labels; TFL, traffic-light labelling.

understanding of nutritional information and purchase intention.[49 51–61] 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* have shown, using objective measures of brain activities, that the red colour triggers in consumers a positive emotional motivation towards sweet ultra-processed products.[62] Reviews and meta-analysis have also documented that warning labels are more consistently successful and perform best in reducing purchase intention of products,[23 63] and a unique real-life interrupted time series study conducted in Chile has shown that warnings contributed to actual reductions in the purchase of products high in calories, sodium, saturated fats and sugars.[64]

The research also compared two warning labels with different graphical design: octagonal warnings and magnifier glass. Results showed that octagonal warnings were more effective at improving understanding of nutritional information and at encouraging healthier food choices, in agreement with results reported by Deliza *et al* and Goodman *et al*.[33 34] The difference can be attributed to the learnt association between octagons and danger in the context of traffic signs.[65] In addition, the literature on warnings for other unhealthy products have demonstrated that there is a dose-response between the proportion of the package surface occupied by warnings and the response of consumers, that is, the higher is the proportion of the warnings labels on the label the better is the response of consumers to avoid the product.[66]

OWL provides an implicit dose-response, as the surface occupied by this FOP labelling scheme increases as the number of nutrients in excess increase. Conversely, single icon schemes, such as the MGG, do not count with such mechanism since they occupy the same proportion of the label surface area regardless of the number of nutrients in excess found in the product. Prates *et al* have tested such hypothesis and found that in products with one single nutrient in excess, OWL and MGG performed similarly, however when products had two nutrients in excess, the OWL outperformed the MGG in reducing the healthfulness perceptions (all categories of products) and the purchase intention (cereal bars and cookies) of these products.[39] The superiority of octagonal signs supports the graphical design of warning labels implemented in most countries in the Americas, and can help informing policymaking in the Caribbean, as OWL outperformed other systems suggested by industry representatives along the regulatory process, such as the MGG and TFL.

This is the first study of its kind to be completed in the Caribbean region and one of the few that have compared different warning labelling schemes (multiple-icon vs single-icon scheme), thus helping to fill the local, regional and global knowledge gaps on the matter. One of its major strengths is the robust between-subject 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 2D 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. Additional studies should be conducted to assess the effect of octagonal warnings on actual purchases under real-life conditions.

Conclusions and policy implications

The findings of this study indicate that the OWL included in the CROSQ proposal[32] to be adopted by CARICOM Member States is the most effective option in meeting the regulatory objective of helping the population in Jamaica to correctly identify the least harmful option and the presence of excessive amounts of critical nutrients, and to choose to purchase the least harmful more often, regardless of the populations' age, gender, education and reported NCD and related risk factors. Once the system is implemented in Caribbean 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-terms and mid-terms.

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