Are nutritional warnings more efficient than claims in shaping consumers' healthfulness perception?

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A B S T R A C T

Nutritional warnings highlighting high content of nutrients associated with non-communicable diseases have been recently proposed as a tool to facilitate the identification of unhealthful products. However, several different cues raising positive healthful associations are usually included on food packages, which can reduce the effectiveness of nutritional warnings. This study aimed to evaluate the effect of nutritional warnings and claims on the perceived healthfulness of four product categories, frequently consumed in Brazil: yogurt, juice, bread and crackers. For each category, eight packages were designed following a full-factorial experimental design with three two-level factors: two types of claims (present vs. absent) and nutritional warnings highlighting high content of saturated fat, sugar and/or sodium (present vs. absent). A total of 820 adults participated in an online survey. They were randomly divided into four groups, each of which evaluated the packages of one product category. For each package, participants were asked to rate their perceived healthfulness using a 7-point scale (1: *not healthy at all*; 7: *very healthy*). Data were analyzed using ANOVA considering main effects and interactions. Results showed that although claims had a significant and positive effect on the perceived healthfulness of all categories, nutritional warnings had the largest relative importance and significantly decreased perceived healthfulness. Participants who were more willing to compromise pleasure for health tended to give more relative importance to the warnings. Results suggest that nutritional warning could facilitate the identification of products with unfavorable nutrient profile and can contribute to override the positive healthful associations generated by claims.

1. Introduction

Obesity and non-communicable diseases (NCDs) have become one of the most important public health problems worldwide (WHO, 2014). The high availability and affordability of processed foods with high sugar, fat and sodium contents has been identified as one of the main drivers of this situation (Swinburn et al., 2011; Monteiro, Cannon, Levy, Claro, & Moubarac, 2012; Pan American Health Organization, 2015). Several public policies have been proposed to reduce the consumption of these products, which include advertising restrictions, market regulations, tax differentiations and actions to encourage consumers to make healthier food choices via information provision, and social marketing initiatives (Caballero, 2007; Capacci et al., 2012; Scrinis & Parker, 2016).

In this context, nutritional warnings have been recently proposed as

a front-of-package nutrition labeling scheme that can facilitate the identification of foods containing high content of nutrients associated to obesity and NCDs and, consequently, to discourage their consumption (Kanter, Vanderlee, & Vandevijvere, 2018; Corvalán, Reyes, Garmendia, & Uauy, 2019). Chile was the first country to implement a mandatory warning system evidencing 'high' levels of calories, sugar, saturated fat and sodium (Ministério de Salud, 2015). According to Chilean regulations, separate black octagonal warning signs should be included on food products' packages for each of the nutrients (calories, sugars, saturated fat and sodium) that exceed the criteria established by the Ministry of Health(Ministério de Salud, 2015). Warnings have been shown to be efficient at discouraging the choice foods with high content of nutrients associated with non-communicable diseases (Arrúa, Curutchet, et al., 2017; Arrúa, Machín, et al., 2017; Correa et al., 2019; David et al., 2017; Khandpur et al., 2018, 2019), which has motivated

other governments to consider the implementation of this scheme (Government of Canada, 2017; Ministerio de Industria, & Energía y Minería, 2017; de Salud, 2018; Ministry of Health of Israel, 2017, ANVISA, 2018). However, research is still lacking to get an in-depth understanding of how this public policy can modify consumers' perception and choice of products with high content of nutrients associated with NCDs.

Nutritional warnings are not the only information that is included on food labels to communicate the healthfulness of a product. In particular, nutrition claims may compete with nutritional warnings and could decrease their efficacy for conveying the idea that products are unhealthful and, therefore, for discouraging their consumption. Nutrition claim can be defined as "*any representation which states, suggests or implies that a food has a particular nutritional property including but not limited to the energy value and to the content of protein, fat and carbohydrates, as well as the content of vitamins and minerals*" (WHO, 2004). The use of nutrition claims on food and non-alcoholic beverage is regulated in most countries (Hieke et al., 2016).

Apart from nutrition claims, the food industry uses several other claims in food package, as for example production related claims (e.g., organic, halal) and claims related to the presence of specific ingredients (e.g., ancestral grains, fruit content). Alike nutrition claims, those claims are fully voluntary. All these forms of voluntary nutrition information on food labels may be collectively named "nutrition marketing" claims; and they are of particular relevance because they are used on food packages at the food manufacturer's discretion (Schermel, Emrich, Arcand, Wong, & L'Abbé, 2013).

Several studies have identified products that include nutrition claims as having an unfavorable nutrition profile, being high in sugar, fat and/or sodium (Colby, Johnson, Scheett, & Hoverson, 2010; Sims, Mikkelsen, Gibson, & Warming, 2011; Gimenez, de Saldamando, Curutchet, & Ares, 2016) suggesting that healthfulness perception of food can be biased by claims. This poses a problem as other studies have reported that products with claims are perceived as healthier than their non-claimed equivalents, although this effect is generally relatively small or moderate (Lyly, Roininen, Honkapää, Poutanen, & Lähteenmäki, 2007; Van Trijp & Van Der Lans, 2007; Saba et al., 2010).

Nutrition claims can create a health halo effect, which can make consumers think the product is healthful and override the influence of other product information, such as nutritional warnings (Andrews, Netemeyer, & Burton, 1998; Hoch, 2002; Carels, Konrad, & Harper, 2007; Chandon & Wansink, 2007). Claims such as "low fat" (Roe, Levy, Brenda, & Derby, 1999; Chandon & Wansink, 2007), "organic" (Prada, Garrido, & Rodrigues, 2017) or "high in fiber" (Roe et al., 1999) have been reported to generate a favorable biased attitude, which could result in the underestimation of calories. Others studies suggest that the perceived healthfulness of a specific ingredient can influence the perceived healthiness of the product itself. For example, describing the ingredient sugar as "fruit sugar" has been reported to increase the healthfulness perception of a cereal (Sütterlin & Siegrist, 2015). Similarly, consumers exposed to "no cholesterol" claim perceived margarine as significantly lower in fat and significantly healthier than the same product without claim (Andrews et al., 1998).

All of the evidence described above emphasize the importance of better understanding how nutrition claims and warnings are perceived by consumers in order to develop regulations that ensure that nutrition-related information on food packages convey an accurate message to consumers about the nutritional profile of the products. In this context, the aim of the present work was to: (a) evaluate the effect of claims and nutritional warnings on the perceived healthfulness of food product categories frequently consumed in Brazil: yogurt, juice, bread and crackers, (b) to identify groups of consumers who give different relative importance to nutritional warnings and claims for making their healthfulness judgments. Results from the present work can provide relevant information to policymakers to facilitate informed decisions related to the implementation of warnings and regulations on the use of

Table 1
Socio-demographic characteristics of the participants.

Characteristics	Percentage of participants (%)
Gender	
Female	51.8%
Male	48.2%
Age	
18 to 25	30.0%
26 to 35	31.5%
36 to 45	19.3%
46to 55	12.9%
56 to 65	5.1%
66 or more	1.2%
Educational level	
Primary school	3.9%
Secondary school	51.0%
University	35.5%
Post-graduate	9.6%
Income*	
A and B	20.9%
C, D and E	79.1%
Consumption frequency of	**Bread**
Everyday	18.8%
2 or 3 times/week	23.4%
once a week	20.3%
2 or 3 times/month	17.3%
Never	20.1%
Consumption frequency of	**Cracker**
Everyday	11.1%
2 or 3 times/week	28.9%
once a week	27.4%
2 or 3 times/month	23.4%
Never	9.2%
Consumption frequency of	**Yogurt**
Everyday	15.0%
2 or 3 times/week	28.6%
once a week	20.5%
2 or 3 times/month	26.0%
Never	9.9%
Consumption frequency of	**Juice**
Everyday	48.1%
2 or 3 times/week	28.9%
once a week	9.8%
2 or 3 times/month	9.5%
Never	3.7%

* Income was defined considering self-reported household income: A (above 15 minimum wages), B (14.99 to 5 minimum wages), C (4.99 to 3 minimum wages), D (2.99 to 1 minimum wages) and E (less than 1 minimum wage). Minimum wage in Brazil in 2018 was 954 BRL (Governo do Brasil, 2019), equivalent to approximately 260 US dollars (IPEA, 2018).

claims on foods with an unfavorable nutrient profile.

2. Materials and methods

2.1. Participants

The study was conducted with 820 adults, recruited by a Brazilian marketing agency specialized in consumer testing. The respondents were 52% females, 48% males and were diverse in terms of age, income and education level. The description of the participants in terms of their socio-demographic characteristics is shown in Table 1. Given that the study was conducted online, the sample was not representative of the Brazilian population as over-represented consumers with high income (over 5 minimum wages, approximately USD 1.300) and with high education level (university and post-graduation). Most of the participants (91%) were in charge of grocery shopping for their household. The study was approved by the ethics committee of the Federal University of Rio de Janeiro (#3.180.253).

2.2. Experimental design

The product categories and claims included in the study were selected based on a preliminary survey conducted in the website of a large Brazilian supermarket chain. All available products in six categories frequently consumed in Brazil were analyzed: dairy (yogurt, chocolate milk), beverages (juice, iced tea, powder preparations, vegetal-based milks), bakery (industrialized breads), cereals (breakfast cereals, granolas, cereal bars), crackers and meat products. From the 883 products identified in the survey, 76% contained at least one claim. Claims were most frequently included in Cereals (94%) and Beverages (90%), followed by Bakery (77%), Crackers (71%) and Dairy (61%) categories. The meat products category showed the smallest percentage of products containing claims: 47%.

Based on the results of the survey, four product categories were included in the study taking into account the nutrition-related claims and their frequent consumption in Brazil (Monteiro, Levy, Claro, De Castro, & Cannon, 2011; Martins, Levy, Claro, Moubarac, & Monteiro, 2014; Louzada, Baraldi, et al., 2015; Louzada, Martins, et al., 2015; Abimabi, 2019): crackers, loaf bread, grape juice and strawberry yogurt. The category *cereals,* although contained numerous claims, was not included in the study once it was not possible to estimate its sugar content accurately (the nutrition facts table only informs total carbohydrates content).

A conjoint task was designed considering three categorical factors for each of the four product categories: two different types of claim (present vs. absent) and nutritional warnings highlighting high content of saturated fat, sugar and/or sodium (present vs. absent). Table 2 summarizes the factor levels used in this study. The claims for each category were also selected based on the results of the preliminary survey. The nutritional composition of commercial products available in the Brazilian marketplace was considered to determine which nutritional warnings should be included. The criteria of PAHO Nutrient Profile Model (Pan American Health Organization, 2016) was used to classify nutrient content as high for inclusion of nutritional warnings on the packages.

The three factors were varied independently from each other, following a full factorial design, which resulted in 8 (2*2*2) combinations of attributes, per category of product. For each combination, package images were specifically designed for the study. The packages did not correspond to commercial products available in the Brazilian marketplace to minimize the influence of participants' previous knowledge and experiences. Fig. 1 shows examples of the images included in the study.

2.3. Experimental procedure

Participants were randomly divided into four groups, each of which evaluated the eight packages of one product category. There were no significant differences in the socio-demographic characteristics of the four groups of participants who evaluated different product categories (gender $p = 0.737$; age $p = 0.765$; income $p = 0.429$; education level $p = 0.853$). No significant differences were found regarding food purchasing responsibility ($p = 0.494$) and consumption frequency of the four products: cracker ($p = 0.157$), bread ($p = 0.193$), yogurt

Fig. 1. Examples of the packages included in the conjoint study.

($p = 0.446$) and juice ($p = 0.392$).

At the beginning of the questionnaire, participants provided some basic socio-demographic information. Then, they were presented with the eight packages images, one by one, following a Williams' Latin Square design. They were asked to rate their perceived healthfulness using a 7-point scale (1: *not healthy at all* to 7: *very healthy*). Finally, participants filled out the *General Health Interest questionnaire*, a subscale of the *Health and Taste Attitude Scale*, developed by Roininen, Lähteenmäki, and Tuorila (1999), translated and validated into Portuguese by Soares, Deliza, and Gonçalves (2006).

2.4. Data analysis

All statistical analyses were performed using R language (R Core Team, 2017).

2.4.1. Conjoint analysis

For each product category, analysis of variance (ANOVA) was used to evaluate the influence of the conjoint variables on perceived healthiness scores. The factors of the experimental design and all their interactions were considered as fixed sources of variation in the model. Consumer was considered as random effect. A 5% significance level was considered. The individual utility and relative importance of the factors were calculated. The analysis was performed using the package lmerTest (Kutznetsova, Brockhoff, & Christensen, 2019).

2.4.2. Factor analysis of the General Health Interest questionnaire

Data from the *General Health Interest* questionnaire were analyzed using Exploratory Factor Analysis (EFA). EFA is a statistical multivariate technique used to reduce the complexity of a large number of variables to a relatively simple structure, consisting of a smaller number

Table 2

Attributes and levels included in the experimental design of the conjoint analysis for each of the four product categories.

Factor	Cracker	Bread	Yogurt	Juice
Claim 1 (C1)	Source of fiber	Source of fiber	Rich in Zinc, with vitamins A & D	Rich in Zinc, with vitamins C & B
	Absent	Absent	Absent	Absent
Claim 2 (C2)	7 whole grains	7 whole grains	With fruit pieces	Here you have one bunch of grapes
	Absent	Absent	Absent	Absent
Warning (W)	High in saturated fat High in sodium	High in sodium	High in sugar	High in sugar
	Absent	Absent	Absent	Absent

of factors (Henson & Roberts, 2006; Iantovics, Rotar, & Morar, 2019). The maximum likelihood estimation method and varimax were considered. The items with an absolute factor loading of 0.4 or higher were interpreted as having the meaningful part on the whole domain. The reliability of the factors was estimated using Cronbach's alpha coefficient.

2.4.3. Cluster analysis

For each product category, a cluster analysis was carried out in order to identify groups of consumers who gave different relative importance to the factors of the conjoint design. Individual utilities for the factors were calculated using the `conjoint` package in R software (Bak and Bartlomowicz, 2012). A hierarchical cluster analysis was performed on the individual utilities considering Euclidean distances and Ward's aggregation method. The number of clusters was visually determined based on the dendrograms. The ANOVA model described in the previous section was used separately for each cluster. Differences in the socio-demographic characteristics of consumers in the clusters were evaluated using chi-square test. In addition, differences between the clusters in their total scores of the *General Health Interest* questionnaire were evaluated using *t*-test or ANOVA, depending on the number of clusters.

3. Results

3.1. Analysis at the aggregate level

As shown in Table 3, claims (C1 and C2) and nutritional warnings (W) had a significant ($p < 0.05$) effect on the perceived healthfulness of all product categories, with the exception of the claim " Here you have one bunch of grapes" (C2) in grape juice. Interaction effects between claims and warnings were in most cases not significant, showing that the effects of these variables were independent from each other. The only exception was the interaction between the claim "Rich in Zinc, with vitamins A & D" (C1) and the warning "High in sugar" for yogurt. In this case, C1 increased perceived healthfulness when the warning was absent (4.5 vs. 5.3), whereas it showed a not significant effect when the warning was present (3.5 vs. 3.6).

As shown in Table 4, most claims had a significant ($p < 0.05$) and positive effect on the perceived healthfulness of all products, whereas nutritional warnings had a significant and negative effect. However, nutritional warnings had the highest relative importance compared to claims, in all four products: 53% for crackers, 60% for breads, 78% for yogurt and 58% for juice.

3.2. Exploratory Factor analysis of the General Health Interest questionnaire

Exploratory Factor Analysis of *General Health Interest Questionnaire* scores indicated that the 8 items could be divided into two distinct

factors: *Factor 1* composed of four items (items 5, 6, 7 e 8) related to the willingness to sacrifice pleasure for health, and *Factor 2* was composed by items 1, 2, 3 and 4, all related to the interest in following a healthy diet. Values for Cronbach's Alpha test for internal reliability for *Factor 1* and *Factor 2* was 0.92 and 0.90, respectively.

3.3. Cluster analysis

In the following sections, results from the cluster analysis performed on each product category are presented.

3.3.1. Cluster analysis – Cracker

Two groups of consumers were identified: Cluster 1 composed of 96 participants and Cluster 2, composed 106 consumers. All the factors had a significant effect on the perceived healthfulness of consumers in both clusters. However, the utilities for participants in Cluster 1 were markedly higher than those for participants in Cluster 2 (Table 5). In addition, the relative importance of warnings was higher for participants in Cluster 1 than for those in Cluster 2 (61% vs. 25%). Consumers in Cluster 1 perceived the crackers as significantly less healthful than for those in Cluster 2 (3.7 vs. 5.2).

Another difference between the clusters was the significance of the interactions. For participants in Cluster 2 none of the interactions were significant, whereas in the case of participants in Cluster 1 the interactions C1:C2 and C1:W were significant. As shown in Fig. 2a, the presence of Warning "neutralized" the effect of Claim 1 (C1). When the warnings were absent, C1 increased perceived healthfulness, whereas when the warnings were present changes in perceived healthfulness were not significant. As per Fig. 2b, the effect of C1 was higher when C2 was not included on the packages.

No significant differences between the clusters were found in their gender, age, educational level, income, and consumption frequency of cracker distributions. However, they significantly differed ($p < 0.05$) in their total scores of the two factors identified in the General Health Questionnaire (Table 6). Participants in Cluster 2 showed significantly higher scores for the factor related to "interest in healthy eating' than participants in Cluster 1 (21.6 vs 19.5), whereas they showed significantly lower scores for the factor related to willingness to give up pleasure for health (12.6 vs 14.7).

3.3.2. Cluster analysis – Loaf bread

Two groups of consumers were identified: Cluster 1 with 161 participants, and Cluster 2, composed of 51 consumers. Most factors had a significant effect on the perceived healthfulness of consumers in both clusters, except by *Warning* in Cluster 1. None of the interactions between factors were significant. The utilities for participants in Cluster 2 were markedly higher than those for participants in Cluster 1 (Table 5). In addition, the relative importance of warnings was considerably high for participants in Cluster 2 (81%), and not significant for those in Cluster 1. Consumers in Cluster 2 perceived the loaf breads as less healthful than for those in Cluster 1 (4.1 vs. 5.5).

No significant differences between clusters were found in relation to gender, age, educational level, income, and consumption frequency of bread. Clusters significantly differed ($p < 0.05$) in the scores of the factor "willingness to give up pleasure for health" identified in the General Health Questionnaire (Table 6). Participants in Cluster 1 showed significantly lower scores for this factor than participants in Cluster 2 (13.0 vs. 15.7).

3.3.3. Cluster analysis – Yogurt

Three groups of consumers were identified: Cluster 1, Cluster 2 and Cluster 3, composed of 85, 57 and 63 participants, respectively. For consumers in Cluster 3, all factors had a significant effect in the perceived healthfulness. In Cluster 2, only *C2* and *W* were significant; whereas in Cluster 1, the only significant factor was *W*. The *W* utility for participants in Cluster 1, although significant, was quite low (-0.07),

Table 3

p-values of fixed effects and interactions of the ANOVA models used for analyzing the influence of warnings and claims on consumers' perceived healthfulness of four product categories.

Factor	Cracker	Bread	Yogurt	Juice
C1	p < 0.001 *	0.006 *	p < 0.001 *	0.002 *
C2	p < 0.001 *	0.003 *	0.012 *	0.070
W	p < 0.001 *	p < 0.001 *	p < 0.001 *	p < 0.001 *
C1:C2	0.224	0.884	0.172	0.952
C1:W	0.205	0.770	0.047 *	1.000
C2:W	0.612	0.726	0.571	0.789
C1:C2:W	0.830	0.364	0.870	0.933

Factors with * had a significant effect ($p < 0.05$) according to ANOVA.
C1 = Claim 1; C2 = Claim 2; W = Warning.

Table 4
Individual utility and relative importance of factors calculated for analyzing the effect and importance of warnings and claims on consumers' perceived healthfulness of four product categories.

Product (average healthfulness)	Factors	Description	Individual Utility		Relative importance
Cracker (4,51)	C1	Source of fiber	0.18	*	18%
	C2	7 whole grains	0.27	*	28%
	W	High in saturated fat & High in sodium	−0.51	*	53%
Bread (5,20)	C1	Source of fiber	0.14	*	21%
	C2	7 whole grains	0.12	*	19%
	W	High in sodium	−0.38	*	60%
Yogurt (4,31)	C1	Rich in Zinc, with vitamins A & D	0.14	*	14%
	C2	With fruit pieces	0.08	*	8%
	W	High in sugar	−0.80	*	78%
Juice (3,95)	C1	Rich in Zinc, with vitamins C & B	0.18	*	27%
	C2	Here you have one bunch of grapes	0.10	ns	14%
	W	High in sugar	−0.39	*	58%

Individual utility for each factor and product with * are significantly different according to Tukey's test (p < 0.05), whereas utilities highlighted with *ns* are not significant.
C1 = Claim 1; C2 = Claim 2; W = Warning

compared to consumers in clusters 2 and 3, which were considerably higher (−1.90 and −0.79, respectively). In addition, the relative importance of warnings was higher than for claims for participants in all Clusters (96%, 91% and 57%, for Clusters 1, 2 and 3, respectively). Yogurt was perceived as less healthful for consumers in Cluster 2, followed by those in Cluster 3 (3.8 vs. 4.0). The highest score for perceived healthfulness was found for consumers in Cluster 1 (4.9).

Another difference between the clusters was the significance of the interactions. For participants in Cluster 3 none of the interactions were significant, whereas in the case of participants in Cluster 1 the interaction C1:W was significant, and for consumers in Cluster 2, the interactions C1:C2 and C1:C2:W were significant. As shown in Fig. 3a, for participants in Cluster 1 the presence of warning "minimized" the positive effect of C1. When the warnings were absent, C1 increased perceived healthfulness, whereas when the warnings were present changes in perceived healthfulness were not significant. As per Fig. 3b, for participants in Cluster 2, the effect of C2 was higher when C1 was not included on the packages. As shown in Fig. 3c and 3d (interactions C1:C2:W), the presence of warning "minimized" the positive effect of both C1 and C2, reducing the perceived healthfulness. No significant differences between the clusters were found in their gender, age, educational level, income, and consumption frequency of cracker. However, they significantly differed (p < 0.05) in their average scores of one of factors identified in the General Health Questionnaire: "willingness to give up pleasure for health" (Table 6). Participants in Cluster 2 showed significantly higher score (15.6) than Cluster 1 (12.4). The score for consumers in cluster 3 (13.4) did not significantly differ from the average scores of both clusters.

3.3.4. Cluster analysis – Grape juice

Three groups of consumers were identified: Cluster 1, Cluster 2 and Cluster 3, composed of 43, 88 and 70 participants, respectively. In both Cluster 1 and Cluster 3, all factors had a significant effect on the perceived healthfulness of consumers, whereas in Cluster 2 only the *Warning* was significant. None of the interactions between factors was significant. The utilities for participants in Cluster 1 were markedly higher than those for participants in Clusters 2 and 3 (Table 5). Warning had the higher relative importance for participants in all three Clusters (66%, 53% and 50%, in Clusters 1, 2 and 3, respectively). Grape juice was perceived as less healthful for consumers in both Cluster 1 and 3 (3.6), followed by those in Cluster 2 (4.2). No significant differences between the clusters were found in their gender, age, educational level, income, and consumption frequency of grape juice. They did not significantly differ in the average score of both factors of the General Health Questionnaire (Table 6).

4. Discussion

Front-of-package nutrition labeling is one of the strategies that has been proposed to discourage consumption of foods with excessive content of nutrients associated with NCDs (Khandpur et al., 2018). Results from the present work sum up to the increasing body of literature that shows the potential of this public policy in shaping consumers' perception. For the four product categories included in the study (strawberry yogurt, grape juice, crackers and loaf bread), the presence of nutritional warnings significantly decreased the perceived healthfulness of the products. Similar results have been reported by Arrúa, Machín, et al. (2017) and Lima, Ares, & Deliza, 2018. Similarly, Khandpur et al. (2019) reported that the use of warning labels improved participants' ability to interpret nutrition information and their ability to correctly identify products with excessive content of nutrients associated with NCDs. One year after the implementation of this public policy in Chile, consumers report that the warnings allowed them to realize that products that used to be advertised as healthy had an unfavorable nutrient profile (Correa et al., 2019). Considering that warnings are not the only information included on food labels to communicate product healthfulness, the present work analyzed the relative importance of nutritional warnings and different types of claims on consumers' healthfulness perception of four product categories.

Nutrition-related claims had a significant and positive effect on the perceived healthfulness of all product categories. Products featuring nutrition-related claims were perceived as more healthful than those without claims. This effect was observed for nutrient claims ("Source of fiber", "Rich in zinc, with vitamins A & D"), as well as for other marketing claims related to nutrition (7 whole grains, with fruit pieces), with the exception of the claim "Here you have a bunch of grapes" in the case of grape juice. This result is in agreement with those reported in several studies (Ares, Giménez, & Gámbaro, 2009; Provencher, Polivy, & Herman, 2009; Carrillo, Varela, & Fiszman, 2012; Gravel, Doucet, Herman, & Provencher, 2012; Sütterlin & Siegrist, 2015; Arrúa, Curutchet, et al., 2017; Tórtora & Ares, 2018), where the use of claims such as "source of fiber", "with cereals", "fruit sugar" or "healthy ingredients" increased the perceived healthfulness. Previous studies have shown that the effect of claims on consumers' perception depends on the perceived healthfulness of the base product, as well as its familiarity (Roe et al., 1999; Bech-Larsen & Grunert, 2003). In the present work, the relative importance of claims that were applied to different product categories was similar, which may be explained by the fact that the categories did not largely differ in their perceived healthfulness (c.f. Table 4).

Claims try to address consumers' interest in health by providing

Table 5
Utilities and relative importance of the variables of the experimental design of the conjoint analysis for each of the clusters identified in each of the four product categories.

Product	Factors	Description	Cluster 1			Cluster 2			Cluster 3		
			Healthfulness average	Individual Utility	Relative importance	Healthfulness average	Individual Utility	Relative importance	Healthfulness average	Individual Utility	Relative importance
Cracker	C1	Source of fiber	3.7	0.27 *	14%	5.2	0.09 *	40%	not applicable		
−4.51	C2	7 whole grains		0.47 *	25%		0.08 *	35%			
	W	High in saturated fat & High in sodium		−1.13 *	61%		0.06 *	25%			
Bread	C1	Source of fiber	5.5	0.12 *	53%	4.1	0.21 *	10%			
−5.20	C2	7 whole grains		0.1 *	47%		0.18 *	9%			
	W	High in sodium		0.00 ns	0%		−1.60 *	81%			
	C1	Rich in Zinc, with vitamins A & D		0.00 ns	2%		−0.02 ns	1%		0.47 *	34%
Yogurt	C2	With fruit pieces	4.9	0.00 ns	2%	3.8	0.16 *	8%	4.0	0.12 *	9%
−4.31	W	High in sugar		−0.07 *	96%		−1.90 *	91%		−0.79 *	57%
	C1	Rich in Zinc, with vitamins C & B		0.49 *	25%		−0.01 ns	15%		0.24 *	33%
Juice	C2	Here you have one bunch of grapes	3.6	0.18 *	9%	4.2	0.03 ns	32%	3.6	0.12 *	17%
−3.95	W	High in sugar		−1.33 *	66%		0.05 *	53%		−0.36 *	50%

Individual utility for each factor and product with * are significantly different according to Tukey's test ($p < 0.05$), whereas utilities highlighted with *ns* are are not significant.

C1 = Claim 1; C2 = Claim 2; W = Warning.

Clusters' size for Cracker: cluster 1 (n = 161), cluster 2 (n = 96), cluster 3 (n = 106); for Bread: cluster 1 (n = 85), cluster 2 (n = 51), cluster 3 (n = 63); for Yogurt: cluster 1 (n = 57), cluster 2 (n = 43), cluster 3 (n = 63); for Juice: cluster 1 (n = 43), cluster 2 (n = 88), cluster 3 (n = 70).
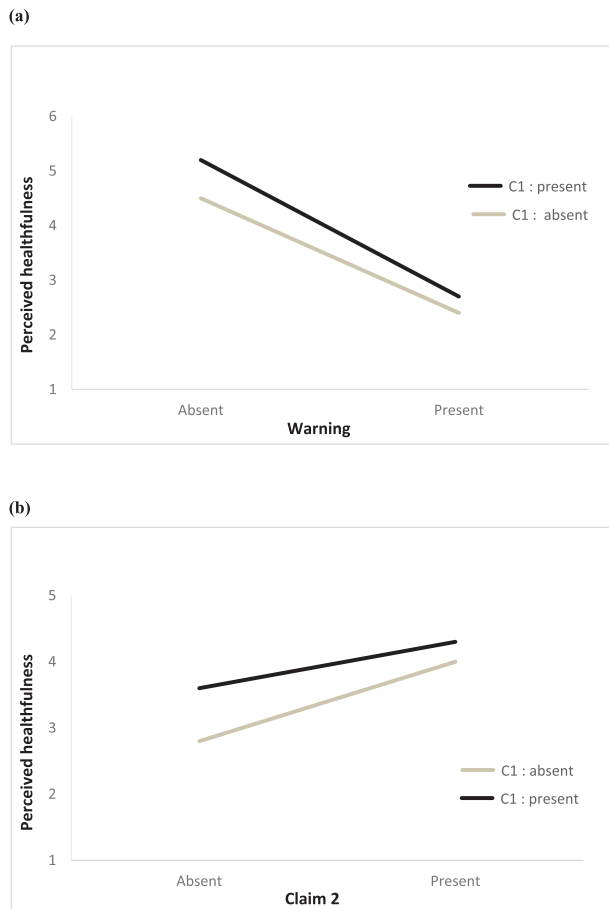
(a)

(b)

Fig. 2. Interactions' effects on the perceived healthfulness of crackers for Cluster 1 (n = 96): (a) interaction between claim 1 and warnings (C1: W), (b) claim 1 and claim 2 (C1: C2).

information about health-related benefits (Lähteenmäki, 2013). However, they should be used in a responsible way, i.e. only in products with a favorable nutrient profile, in order to avoid misleading consumers. In this sense, Australia and New Zealand have regulated the use of nutrient claims based on the nutritional composition of products (Food Standards Australia and New Zealand, 2016). However, it is important to consider that marketing nutrition-related claims are not usually regulated and can have a similar effect to that of nutrient claims.

Interestingly, in the present work, the relative importance of claims on perceived healthfulness was lower than that of nutritional warnings. This suggests that warnings override the positive healthful associations

generated by claims. Similar results have been reported by Centurión, Machín, and Ares (2019). According to these authors, warnings about excessive content of sugar and saturated fat were more important than nutrient claims and fruit images in shaping participants healthfulness perception of cereal bars. In addition, the interaction effects between claims and warning were not significant in most cases and did not suggest that claims could create a health halo that undermine the effect of warnings. Therefore, warnings can be an effective tool to minimize the effect of claims on consumers' healthfulness perception of products with excessive content of nutrients associated with NCDs. However, Acton et al. (2018) showed that voluntary nutrient claims can influence consumers' interpretation of "high in" warnings when they focus on the same nutrient. According to these authors, the use of voluntary 'reduced' nutrient claims decreases consumers' ability to identify products featuring warnings for the same nutrient as 'high' in that nutrient. Further research on this type of claims is warranted.

The effect of warnings and claims on perceived healthfulness cannot be expected to be homogeneous. In the present work, heterogeneity in consumers' healthfulness perception was observed. For all product categories, two to three consumer segments were identified. These segments did not significantly differ in their gender, age, educational level, socio-economic level and consumption frequency of the target product. This suggests that socio-demographic characteristics did not moderate the effect of claims and warnings on healthfulness perception. Instead, the clusters differed in their health interest. In the four product categories consumers segments that reported a higher intention to sacrifice pleasure for health perceived the products as less healthful and gave more importance to nutritional warnings (c.f. Table 5). On the contrary, consumers with lower health interest tended to perceive all products as relatively healthier, regardless of the inclusion of claims and warnings. In the specific case of crackers and bread, this consumer segment gave higher relative importance to claims compared to warnings. Previous studies have also identified health interest as the main determinant of consumers' use of claims and nutrition information for making their food choices (Carrillo et al., 2012; Cavaliere, De Marchi, & Banterle, 2017; Grunert et al., 2012; Visschers, Hartmann, Leins-Hess, Dohle, & Siegrist, 2013). In addition, previous studies have suggested that consumers with higher interest in healthful eating tend to use label information for making healthful food choices (Colby et al., 2010; Hoppert et al., 2014). These results suggest that communication campaigns aimed at increasing interest in health can contribute to maximize the efficacy of nutritional warnings in influencing consumers' food choices.

The present study only focused on consumers' perceived healthfulness. Future research should study the relative influence of warnings and claims on consumers' purchase intention. In this sense, previous studies have shown that although the inclusion of nutritional warnings on food labels discourage consumers' choice (Arrúa, Curutchet, et al., 2017; Tórtora & Ares, 2018), the relative importance of warnings

Table 6
Average scores of the two factors of the General Health Interest Questionnaire identified in the Exploratory Factor Analysis (*Interest in healthy eating* and *Willingness to sacrifice pleasure for health*) for consumers in each of the clusters identified for each product category.

	Factor 1: Willingness to sacrifice pleasure for health						Factor 2: Interest in healthy eating					
Product	Cluster 1		Cluster 2		Cluster 3		Cluster 1		Cluster 2		Cluster 3	
Cracker	14.7	b	12.6	a	n.a.		19.5	a	21.6	b	n.a.	
Bread	13.0	a	15.7	b	n.a.		20.2	ns	20.5	ns	n.a.	
Yogurt	12.4	a	15.6	b	13.4	ab	20.7	ns	21.1	ns	19.7	ns
Juice	14.5	ns	13.3	ns	14.3	ns	20.6	ns	20.2	ns	19.9	ns

Willingness and Interest factors with different letters within the same product category are significantly different (p < 0.05) according to *t*-test or ANOVA followed by LSD *t* test (depending on the number of clusters). Whereas Willingness and Interest highlighted with *ns* were not significantly different.
n.a. = not applicable.
Clusters' size for Cracker: cluster 1 (n = 96), cluster 2 (n = 106); for Bread: cluster 1 (n = 161), cluster 2 (n = 51); for Yogurt: cluster 1 (n = 85), cluster 2 (n = 57), cluster 3 (n = 63); for Juice: cluster 1 (n = 43), cluster 2 (n = 88), cluster 3 (n = 70).
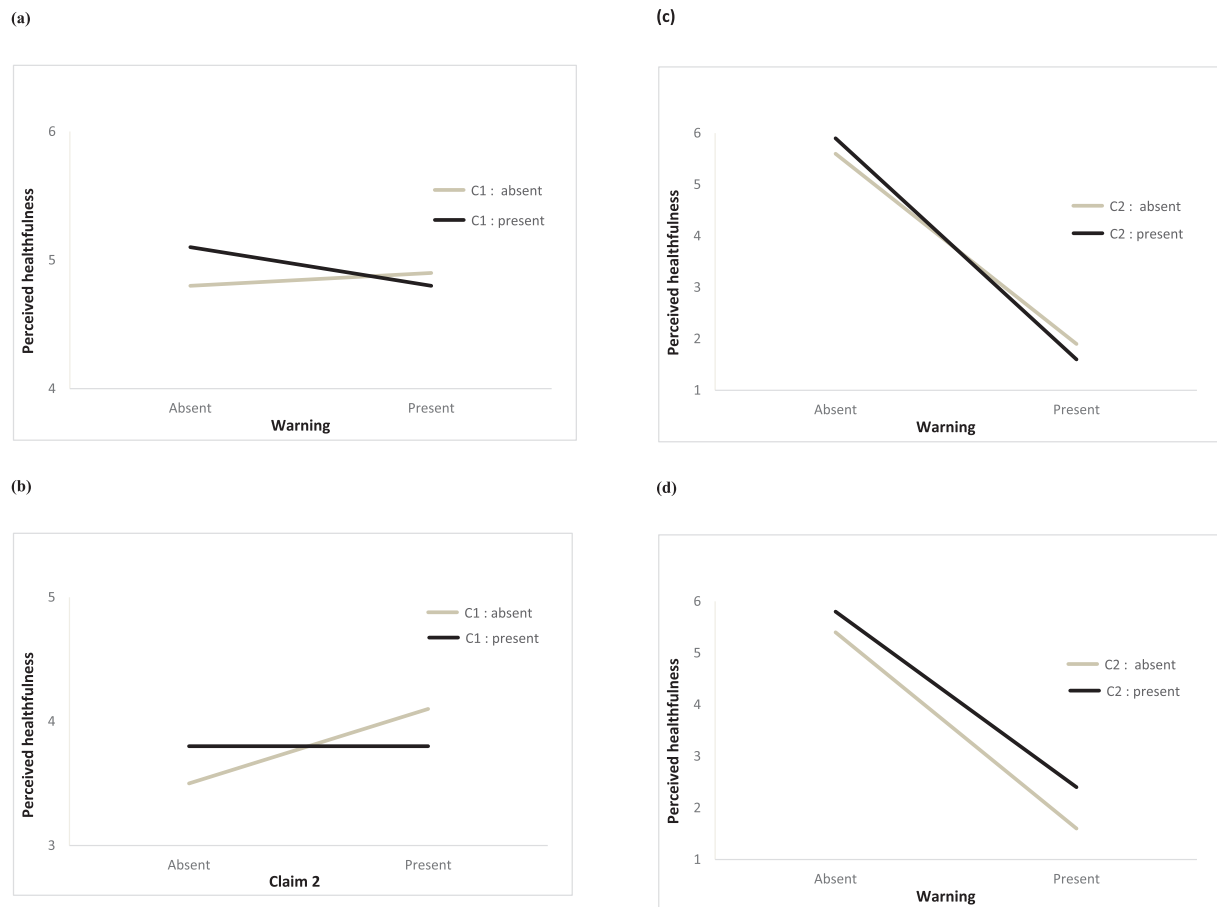
(a)

(c)

(b)

(d)

Fig. 3. Interactions' effects on the perceived healthfulness of yogurt: (a) between claim 1 and warnings (C1: W) for Cluster 1 (n = 85), (b) claim 1 and claim 2 (C1: C2) on the perceived healthfulness of yogurt for Cluster 2 (n = 57), (c) claim 2 and warning (C2:W), when claim 1 is present for Cluster 2 (n = 57), (d) claim 2 and warning (C2:W), when claim 1 is absent for Cluster 2 (n = 57).

compared with claims depends on the product category.

5. Conclusions

Results from the present work add additional evidence about the potential of nutritional warnings to reduce healthfulness perception of products with excessive content of nutrients associated with non-communicable diseases. Warnings were more important than claims in shaping perceived healthfulness, which suggests that they could contribute to override the positive healthful associations generated by claims, especially for health-orientated consumers. Results from the present work also add additional evidence about the effect of nutrition-related claims on perceived healthfulness, which suggests the need to regulate their use in order to avoid the generation of positive health associations with products with unfavorable nutrient profile. Findings from this study suggest that the implementation of warnings and the regulation of claims should be consider in public policies fighting obesity and NCDs. Additional research is needed to verify the validity of the findings using a bigger variety of products and to assess the impact of claims and nutritional warnings on real purchasing and consumption-related scenarios.

Acknowledgements

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.foodqual.2019.103749.

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