

Effects of nutritional profile system and front labeling in food selection during purchases: a systematic review

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Abstract: Effects of nutritional profile system and front labeling in food selection during purchases: a systematic review. Introduction. Nutritional profiling systems (NPS) are mainly used in front-end labeling policies in order to make the purchase and consumption choice conscious and healthy. **Objective.** This study systematically reviewed evidence from interventions on the effect of NPS in the front-of-package on food purchases. **Materials and methods.** A bibliographic search was carried out in electronic sources from Medline, Elsevier, Scielo and Lilacs, of experimental studies and intervention between 2012 and 2022. A total of 14 articles were included in the review. They were analyzed according to the intervention modality used: 4 studies analyzed the effect of NPS in a real purchase situation and 10 evaluated purchase perception/intention. **Results.** According to the modality of intervention, the 6 studies that analyzed the NPS-warning system, all recorded healthier purchases compared to the control groups. While for the NPS-NutriScore, Health Star Rating and Multiple Traffic Lights were effective in the decision to purchase healthier foods, in 5 of 7 studies for the first NPS, in 4 of 7 for the second and in 4 of 8 for the third, compared with control groups. **Conclusions.** Findings of this study suggest that NPSs may be effective for healthy purchase choices, even so it is necessary to strengthen the system and policies with nutritional food education campaigns. **Arch Latinoam Nutr 2023; 73(2): 144-153.**

Keywords: Nutritional profiling systems, frontal label, food purchase, experimental studies, systematic review.

Resumen: Efecto de los sistemas de perfilado nutricional y etiquetado frontal en la selección de alimentos durante la compra: una revisión sistemática. Introducción. Los sistemas de perfilado nutricional (SPN) son utilizados principalmente en políticas de etiquetado frontal con la finalidad de que la elección de compra y consumo sea consciente y saludable. **Objetivo.** Este estudio revisó sistemáticamente la evidencia de las intervenciones sobre el efecto de SPN en el frente del paquete en las compras de alimentos. **Materiales y métodos.** Se realizó una búsqueda bibliográfica en fuentes electrónicas de Medline, Elsevier, Scielo y Lilacs, de estudios experimentales e intervenciones entre 2012 y 2022. Se incluyeron un total de 14 artículos en la revisión. Fueron analizados según la modalidad de intervención utilizada: 4 estudios analizaron el efecto de los SPN en una situación de compra real y 10 evaluaron percepción/intención de compra. **Resultados.** Según la modalidad de intervención, los 6 estudios que analizaron el SPN-sistema de advertencia, todos registraron compras más saludables en comparación con grupo controles. Mientras que para los SPN-NutriScore, Estrellas de Salud y Semáforo Tricolor Múltiple fueron efectivas en la decisión de compra de alimentos más saludables, en 5 de 7 estudios para el primer SPN, en 4 de 7 para el segundo y en 4 de 8 para el tercero, comparados con grupo controles. **Conclusiones.** Los hallazgos de este estudio sugieren que los SPN pueden ser efectivos para elecciones de compras saludables, aun así, es necesario reforzar el sistema y las políticas con campañas de educación alimentaria nutricional. **Arch Latinoam Nutr 2023; 73(2): 144-153.**

Palabras clave: sistemas de perfilado nutricional, etiquetado frontal, compra de alimentos, estudios experimentales, revisión sistemática.

Introduction

Due to the nutritional transition, eating patterns have undergone substantial changes during the last 30-40 years. Calorie availability has been increasing in recent decades worldwide by approximately 450 kcal per capita per day (1). A substantial part of this caloric rebound can be attributed to the increased consumption of ultra-processed foods and beverages (2), as a response to advances in industrialization, urbanization,

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economic development and the globalization of markets (3).

Accompanying this trend of unhealthy diets, obesity, overweight, and associated chronic noncommunicable diseases (NCDs) have progressively increased in all age groups and have become the leading cause of death and disability in the Region of the Americas (55% of all causes in 2012, according to world health estimates from the World Health Organization (WHO)(4). In Argentina, according to data from the Second Nutrition and Health Survey, excess weight is the form of most severe malnutrition in all age groups, with a prevalence of 13.6% in children under 5 years of age, 41.1% in children and adolescents between 5 and 17 years of age, and 67.9% in people of 18 years or older (5).

Recognizing this public health problem, the WHO proposes, among other measures, the efficient implementation of nutritional labeling on the front of the package (FOP) (6), the objective of which is to reduce cognitive efforts and the time to process the information on the labels, facilitating the choice of healthier foods at the time of purchase (7). For the design and implementation of an FOP nutrition label, a nutritional profiling system (NPS) is required, defined by the WHO as tools to classify foods according to the attributes of their nutritional composition, applied with the aim of preventing diseases and promoting health (8).

There are dozens of NPSs in the world, which is a sign of their importance. A main difference between these is the nature of the information they offer. The NPSs currently used around the world can be organized into two main categories: specific nutrient indicators and, on the other hand, summary indicators (9). The methodology used for the specific nutrient is based on thresholds, evaluating the content of each nutrient, considered critical, independently, contrasting it with the proposed nutritional parameters. While summary indicators use a scoring method that, through algorithms, weights both families of nutrients (critical and positive) (10). In the category of specific nutrients, there are two main formats:

numerical, such as the reference intake (RI) format initially known as guideline daily amount (GDA), developed in 2006 and applied internationally by the food industry (11) and codified by colors such as the multiple tricolor traffic light format (Multiple Traffic Lights, MTL) or simple traffic light, introduced in the United Kingdom in 2005 and in Ecuador in 2014, respectively (12-13). Finally, a novel format developed in South America corresponds to warning symbols, which are placed on foods according to their levels of certain nutrients (as in the Chilean system) (14).

Systems that implement summary indicators provide a global evaluation of the food product. Among these, we find those that use a scale of graduated scores (15) such as the NutriScore (also called 5C) implemented in France in 2017 and in Belgium and Spain in 2018 (16) and the Health Star Rating system (HSR), introduced in Australia and New Zealand in 2014 (17). And systems that use labeling with seals of approval such as Choices, implemented by the Netherlands in 2006 (18) and the Green Keyhole symbol or the lock system adopted by Sweden, Denmark, and Norway since 2009 (19) (Figure 1).

In Latin America, the FOP is mandatory in Peru, Chile, Mexico, Uruguay and recently in Argentina. The vast majority use the warning systems, these NPS are more often associated with “danger” due to the use of symbols, octagons (stopping sign) of colour black and white. Ecuador and Bolivia have implemented the simple traffic light, which is presented with green lights, indicative of the concept of “health,” and red as warning high in calories, saturated fat, free sugars, and sodium (20).

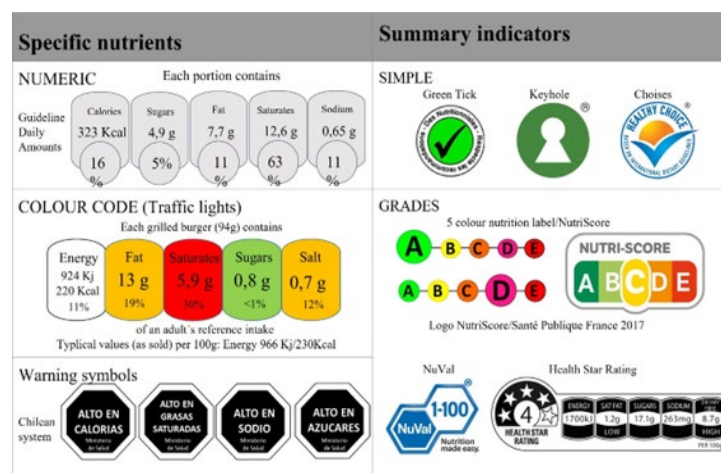


Figure 1: Types of NPS in use worldwide.

Most of the studies that have been carried out have focused on evaluating the role of NPS in helping consumers understand the nutrient compositions and general healthiness of food products, improving their knowledge about proper nutrition and healthy diet (21,22). However, the effect of NPS in persuading consumers to purchase healthier foods has been less studied.

Food shopping is the result of complex behavior that is influenced by multiple sociodemographic factors (eg, gender, race/ethnicity, age, and income level) (23) and contextual factors (eg, knowledge about nutrition, perceived health, taste preference, shopping environment, price, food product alternative, food environment, industry marketing, and political factors) (24,25). A change in the perception of the nutritional value of a food from the reading of the NPS does not necessarily translate into a modification of the purchase. Considering that food quality will ultimately be determined by the purchase and the combined consumption of food, this systematic review aimed to determine the effect of NPS on food purchase.

Materials and methods

Search strategy. A systematic search of the scientific literature was carried out, including data from June 2012 to June 2022, using the following electronic databases: Medline, Elsevier, Scielo, and Lilacs. The search algorithm included all possible combinations of keywords relating the exposure (nutrient profiling OR nutrient profiling system OR nutrient profiling model) and the outcome of interest (food purchases). The results of the study were reported according to the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) model (26).

Selection criteria. Original experimental articles and intervention studies such as controlled clinical trials (CCTs), published in English, and studying adults over 18 years of both sexes, were included. Articles published in formal academic journals were selected. In addition, studies that analyzed perception or purchase intention were admitted.

To reduce the risk of bias, we excluded observational studies such as case-control, retrospective and prospective cohort studies, animal studies, non-original studies (meta-analyses, reviews, and comments), and intervention studies without a control group.

Selection of studies, data collection and synthesis of results. A search of the aforementioned databases was performed independently by two reviewers. The reading of the title or abstract of the articles was considered following the eligibility criteria described above. The full-text versions of all potentially eligible articles were then independently assessed by two reviewers with the aim of selecting articles for definitive entry into this study. Discrepancies were resolved through consensus. Extracted data included study authors, country, year of publication, study design (intervention), type of NPS studied, site and mode of intervention, number of participants, duration, and main outcomes.

Results

From the aforementioned search strategy mentioned, 362 Pubmed articles, 569 Science Direct articles, 29 Virtual Health Library articles, and 12 Scielo articles were identified. Considering the initial selection based on the title and abstract and after removing duplicates, 26 articles remained for evaluation of the full text and 16 of these publications were excluded for various reasons. After applying all the eligibility parameters, 14 articles were found to be suitable and were therefore included for the systematic review (Figure 2).

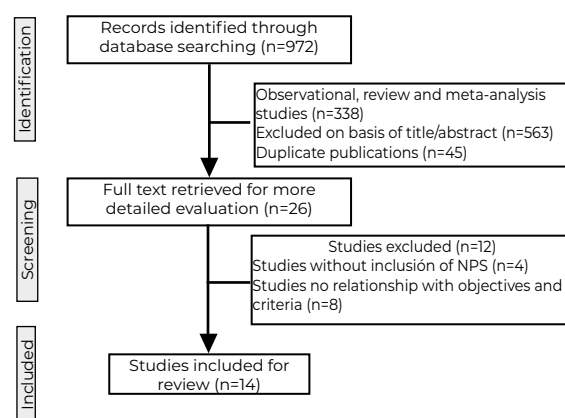


Figure 2. Flow diagram of literature search and selection of studie.

Regarding the basic characteristics of the 14 studies, all were published between 2016 and 2022. They were conducted in France (n=4), Australia (n=3), Canada (n=3), Netherlands (n=2), Mexico (n=1) and the United States (n=1). Study design included randomized controlled trials (RCT) (n=7), experimental (n=5), non-randomized controlled trial (n=1), and open-label, parallel trial (n=1). 13 studies incorporated a control group into their intervention, mostly (n=11) the methodology used was not to place the NPS on the food label and others (n=2) used the nutritional information table.

The studies were analyzed according to the intervention modality, as detailed below, actual/objective purchase and intention/perception of purchase. The descriptive data of the included studies are summarized in Tables 1 and 2.

Actual or objective purchase

Using the indicated selection criteria, 4 articles were included that analyzed the effect of NPSs in a real purchase situation (6823 subjects participated in total) (Table 1). These studies looked at a variety of NPSs, including health star rating (HSR) (n=4), multiple tricolor traffic light (MTL) (n=2), warning system (n=2), single traffic light (n=1), guideline daily amount (GDA) (n=1) and NutriScore or five colors (5C) (n=1). The interventions were carried out in a minimum of 4 weeks and a maximum of 12 weeks. These studies were conducted in naturalistic settings where people typically shop for food, such as supermarkets (27,28) and packaged goods outlets (29). In addition, a study carried out in Canada (30) was included within this category with the experimental supermarket modality, which tries to replicate the purchase behavior as faithfully as possible. To achieve this objective, the participants of said study received an amount of money to make your purchase. Of the studies that

Table 1. General characteristics of actual or objective purchase

Author, Year	Country	Type of study	Type of SPN studied	Site and mode of intervention	N° Particip.	Duration (weeks)	Main results and conclusions
Mhurchu, et al., 2017	Australia	RCT	i) STL; ii) HSR; iii) Control (NI table)	Supermarkets, using a smartphone application (NI scan)	n=1357	4	NPS-STL and HSR did not have a significant effect on food purchases. However, those shoppers who used the app the most had healthier purchases compared to the control group (p<0.05).
Neal, et al., 2017	Australia	RCT double-blind	i) HSR; ii) MTL; iii) GDA; iv) Warning system; v) Control (NI table)	Points of sale of packaged food, using a smartphone application (NI scan)	n=1578	4	There was no difference in the mean wholesomeness of the purchases for the NPS-HSR, MTL, or GDA (all p > 0.07), compared to the control. NPS-Warning resulted in healthier packaged food purchases (p=0.04).
Acton, et al., 2019	Canada	Experimental marketplace study	i) Warning system; ii) MTL; iii) HSR; iv) 5C; v) Control (without NI)	Experimental supermarket (participants select an image of the product among snack and beverage categories)	n=3584	≤12	The participants who saw the NPS of warnings, bought less sugar, SFA and calories in the purchase of drinks and less sodium and calories in snacks, in relation to the control group (p<0.05).
Cameron, et al., 2022	Australia	Non-RCT	i) HSR, divided into supermarkets with the intervention and supermarkets without intervention (control)	Supermarkets with the NPS-HSR posters on shelves	n=304	8	After the intervention with NPS-HSR posters, sales of high-quality products increased (4.5-5 stars) (p=0.03). In addition, there was a significant reduction (p=0.03) in the sales of total sugar, energy, SFA, TFA, CHO, sodium and protein.

RCT, Randomized controlled trial; STL, Simple traffic light; HSR, Health Star Rating; NI, Nutritional information; NL, nutrition label; NPS, Nutritional profiling systems; Non-RCT, Non-randomized controlled trial; MTL, Multiple tricolor traffic light; GDA, Guideline daily amounts; 5C, five colors; SFA, saturated fatty acids; TFA, Total fatty acids; CHO, carbs.

Table 2. General characteristics of perception/purchase intention

Author, Year	Country	Type of study	Type of SPN studied	Site and mode of intervention	N° Particip.	Duration (weeks)	Main results and conclusions
Julia, et al., 2016	France	RCT	i) 5C; ii) 5C plus consumer information; iii) Control (without front NL);	Shopper laboratory	n=901	≤16	The NPS-5C plus the information that explains its use was associated with a higher nutritional quality of the purchases of sweet cookies with respect to the control (p=0.02).
Ducrot, et al., 2016	France	RCT	i) GDA; ii) MTL; iii) 5C; iv) Green Tick; v) Control (without NL)	Online supermarket	n=11981	14	The NPS-5C led significantly (p<0.0001) to the highest nutritional quality with respect to the control. This NPS was the only one to lead to a lower content of TFA, SFA and sodium (all p<0.05) in the shopping cart.
Egnell, et al., 2019	France	RCT	i) 5C; ii) RI; iii) Control (without NL)	Experimental online supermarket	n=1866	≤28	The NPS-5C improves the general nutritional quality of purchases in Relation to RI (p=0.002). NutriScore reduced shopping cart content in terms of calories, SFA, sodium, fiber, and protein and increased fruit and vegetable content (all p<0.01).
Franco-Arellano, et al., 2020	Canada	RCT	i) Warning system; ii) HSR; iii) MTL; iv) Control (without NL)	Smartphone application and online survey to select "healthier" and "less healthy" drink	n= 1997	3	In less healthy drinks, all NPSs reduced (all p<0.01) purchase intentions compared to control. The NPS-HSR drove the most negative perception, followed by the warning label and the MTL, versus the control (p≤0.001)
Jáuregui, et al., 2020	México	Experimental	i) GDA; ii) MTL; iii) Warning system	Online supermarket	n=2194	≤12	The NPS-MTL and warnings are more effective in guiding healthier food choices with respect to GDA (all p<0.05).
Blitstein, et al., 2020	United States	Experimental	i) HSR; ii) MTL; iii) Hybrid (HSR plus NI); iv) Control (without NL)	Online supermarket	n=1452	≤8	All 3 NPS used as NL achieved significantly higher healthy purchase index (p<0.001) than the control group.
Vanderlee, et al., 2021	Canada	Parallel, open-label trial	i) Warning system; ii) HSR; iii) MTL; iv) Control (without NL)	Smartphone application and online survey	n= 1997	≤4	Purchasing intentions were more greatly suppressed when NPS-MTL carried at least two red lights, two or fewer stars in the HSR, and two warning symbols.
Folkvord, et al., 2021	Netherlands	Experimental	i) 5C; ii) Without NL 5C	Survey Platform	n=192	NE	No results were found for the use of the NPS-5C in purchase intentions (p=0.41).
Egnell, et al., 2021	France	RCT	i) 5C; ii) Controles: a) RI; b) Without NL	Experimental online supermarket	n=336	≤40	The NPS-5C identified the highest overall nutritional quality (p=0.02), also resulting in significantly (p<0.05) lower calorie and SFA content compared to the RI control group.
van den Akker, et al., 2022	Netherlands	Lab-in-field experiment	i)5C; ii) MTL; iii) Control (Without NL)	Supermarket choice experiment	n=299	≤4	The NPS-5C but not the MTL helped to identify the healthier option with respect to the control (p=0.001)

NE, non-specific; RI, Reference intakes

recorded purchases in a natural environment, in two of them the participants had to scan the barcodes of the products with an application on their smartphone and photographed the payment receipts (27,29). In the third, posters were placed on supermarket

shelves for those packaged products that had 4.5 or 5 stars using the NPS-HSR (28) and supermarkets reported sales within a specific time window to assess purchasing behavior.

Of the studies that analyzed the NPS-HSR, three reported no effect on purchases (27,29,30); however, Mhurchu *et al* (30) showed that those shoppers who used the application the most had healthier purchases compared to the control group. On the other hand, the study by Cameron *et al* (28) showed a significant reduction ($p=0.03$) in the sales of total sugar, energy, total fatty acids (TFA), saturated fatty acids (SFA), carbohydrates (CHO), sodium and protein, and increased sales of high-quality products (4.5 stars) in intervention stores compared to control stores.

Among the interventions that evaluated warning systems in food purchases (29,30), one of them evidenced the purchase of healthier packaged foods (29) and Acton *et al* (30) reported that those participants who viewed this NPS purchased less sugar, SFA and calories in the purchase of beverages and less sodium and calories in snacks, in relation to the control group.

Figure 3 summarizes the main results of the actual or objective purchase.

Perception/purchase intention

We identified 10 interventions (22945 subjects in total) that assessed purchase perception/intention (Table 2). In relation to the study variable, the NPSs analyzed were 5C (n=6), MTL (n=6), warnings system (n=3), HSR (n=3), GDA (n=2), reference intakes (RI) (n=2), seal of approval (n=1) and hybrid (n=1). The interventions lasted between 4 and 40 weeks. 5 of these studies were conducted in a controlled intervention environment using an online supermarket methodology (32,33,35,36,39). Another 3 used online surveys, two of them through a smartphone application (34,37) and the remaining one used a survey platform (38). Finally, two studies carried out their intervention from a shopping laboratory, where the participants' choices were filmed (31,40), the particularity was that one carried out its experiment in the field, that is, in a supermarket (40).

In relation to the 6 (31-33,38-40) studies that evaluated the effects of NPS-5C or NutriScore,



Figure 3. Main results of the actual or objective purchase according to types of NPS

5 reported that the use of this NPS allowed to identify significantly ($p<0.05$) the highest nutritional quality of the purchase (31-33,39,40), compared to the control group. In addition, these investigations showed that the use of NutriScore on the front of the package led to a lower content of TFA (32), SFA (32,33,39), sodium (32,33), calories (33,39), fiber and protein and an increase in the amount of fruits and vegetables (33) (all $p<0.05$) in the shopping cart compared to NPS-GDA, seal of approval, no nutrition label, MTL (32) and reference intakes(33,39). Julia *et al* (31) reported that the use of NPS-5C plus a brochure explaining its use led to a better-quality purchase for sweet cookies compared to the control group.

Regarding the 4 interventions that used NPS-HSR, MTL and warning system, all studies showed positive results with one of these NPS. Jauregui *et al* (35) showed that the NPS-MTL and warnings are more effective in guiding healthy food choices with respect to GDA. Similarly, Blitstein *et al* (36) reported that the healthy shopping index had a higher score with the MTL and HSR, with respect to the non-incorporation of an NPS on the food label. In addition, Franco-Arellano (34) showed regarding the purchase of less healthy beverages, that the use of the NPS-MTL, HSR and warning system on the front of the package decreased their purchase intentions and that HSR promoted the perception more negative, followed by the warning system and the MTL, compared to the control ($p\leq 0.001$). Finally, Vanderlee *et al* (37) found that purchase intentions were greatly suppressed when the NPS-MTL had at least two red lights, the HSR two or fewer stars, and two warning symbols.

Figure 4 summarizes the main results of the perception/purchase intention.

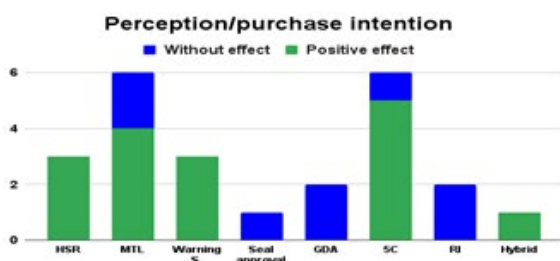


Figure 4. Main results of the perception/purchase intention according to types of NPS.

Discussion

This study, a systematic review on the effect of NPSs on the front of the package in food selection during purchases, provides convincing results of the beneficial influence of the use of NPSs, as it would guide the consumer to healthier food choices at the time of purchase.

We identified 14 relevant and adequate studies published from 2016 to 2022. These studies provided evidence from 29838 people from various countries. A variety of NPSs were evaluated, including stoplights, NutriScore, health star ratings, guideline daily amount, warning system, and seal of approval.

When studying the experimental interventions according to the response variable, it is observed that when the actual purchase and the perception of purchase were analyzed, the warning system led to healthier purchases. This may be because the graphic used is often associated with "danger" due to the use of symbols (eg, octagon, stop sign), color (black and white), and warning texts, this NPS attracts attention to consumers efficiently, and therefore requires less time to process the information (41-43). On the other hand, the warning system presents as a novel characteristic that it uses the absence of warning stamps to indicate the healthiness of a product (37). In this way, they could avoid misperceptions of consumers towards some products described as "healthy" by manufacturers, reducing the possible "halo effect" (34).

This review showed positive effects of the NPS-HSR on food purchase when perception of purchase was assessed, while the effects were mixed when purchase was actual. The HSR system is useful for comparing the nutrient profile of products within a single food category, but not between them (37,44). There is

empirical evidence on the effectiveness of the HSR for the identification of products of higher nutritional quality (45,46), it would be that this type of NPS corresponds to the category of interpretative ones that use summary indicators (17). The HSR has also been shown to elicit more accurate perceptions of unhealthy food items, thus avoiding positivity bias (47). Evidence indicates that interpretive NPSs have relatively small effects on consumer food choices at the population level. The use of these NPSs on the front of the package could achieve greater effects if implemented in the real world for a longer time and accompanied by educational campaigns on their use (27).

NutriScore or the 5C logo and the MTL did not show effects in the actual purchase situation, but they did show positive changes when purchasing perception was studied. These two NPSs share the characteristic of using a color code or scale, the green and red colors, corresponding to the recognized signals, may be easier to understand and interpret, the green being associated with safety and a "go" signal and red associated with danger and the "stop" sign (48,49). Nevertheless, we must differentiate that the MTL qualifies the level of each objective nutrient, while NutriScore summarizes the general level of the nutritional quality considering all the preferable and detrimental nutrients (50). NutriScore stands out for being easily understood by consumers, even among those of low socioeconomic status (9,51). However, critics of the NPS-5C have mentioned several problems, such as that its algorithm does not consider the degree of processing of a food, thus, food products can qualify well from a nutritional point of view, even though they are highly processed (52) and on the other hand, that its score is calculated in 100g/mL and not per portion (53).

The results of our review are similar to the study by Temple (16), which observed that the NPSs that would be most successful in affecting consumers' intention to purchase healthy foods would be the warning system first, followed by the MTL, NutriScore and lastly HSR.

Strength of this review is that it used a rigorous systematic approach to evaluate the efficacy of the use of NPS on the FOP for the purchase of healthy foods, currently being such a relevant issue for public health, offering conclusions that support the implementation of these food education tools for consumers as a strategy to address unhealthy diets and NCDs. NPSs used in food empower consumers by providing nutritional information (54). Finally, nutritional labels can also induce the industry to produce healthier foods through nutrient reformulation (55,56).

However, the limitations of the study should also be mentioned. First, demographic factors that could affect the results were excluded from the analysis, such as socioeconomic level, since it is a highly determining factor when purchasing food. Second, most of the interventions included in the systematic review used simulated shopping as their experimental design; very few studies have been conducted in real-world supermarkets. Studies using this latter intervention generate results that have much more credibility than studies using a shopping simulation. This is because buyers are not part of an experiment (which could influence their behavior) and buyers have several weeks or months to adjust to NPSs instead of a single experiment

Conclusions

NPSs in the FOP had a positive impact on the decision to purchase healthier foods in 100% of the interventions that tested the warnings system, in 71% of studies that tested NutriScore, in 57% the interventions that tested HSR and in 50% of interventions that analyzed MTL. What accounts for the effectiveness of the system, even so, it is necessary to reinforce the system and policies with nutritional food education campaigns.

Acknowledgments

This work was supported by project grant code 80020180100160CC funded by Universidad Católica de Córdoba and by project number

VIPUCT2021PRO-WB-01, funded by Universidad Católica de Temuco, Chile. Also, we thank MINEDUC UCT21102, Government of Chile.

Conflicts of interest

The authors declare they have no conflicts of interest.

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Recibido: 01/02/2023
Aceptado: 21/03/2023