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ABSTRACT

Nutrient profiling (NP) is a growing issue in Turkey. We aimed to assess two different NP models (the Health Star Rating (HSR) and Pan American Health Organization models (PAHO)) based on the content of packaged products sold in Turkey. A cross-sectional study was conducted from April to December 2020. Three supermarkets in Turkey were chosen for this study. Nutritional label information and ingredient lists of the packaged products were obtained in the stores. A total of 2,986 products were analyzed. In total, 39.5% of all products were classified as "unhealthy"; 24.7% of products had excess free sugars, and 11.5% had excess sodium according to the PAHO model. Under the HSR model, 29.3% of all products were "unhealthy" with <3.5 stars. The greatest striking differences were found for some of the food groups. Our results could provide an assessment of packaged foods and beverages sold in Turkey for enhancing nutritional quality.

KEYWORDS

Nutrient profile; nutritional quality; public health; food environment

Introduction

Consumption of packaged products is rapidly increasing in developing countries (Crino et al., 2018; Popkin, 2004). Most of the packaged products contain high amounts of added salt, sugar, and fat (C. Monteiro et al., 2012; Neal et al., 2013; Stuckler et al., 2012). The increasing availability of packaged products contributes to poor diet quality that increases the risk of obesity and other diet-related non-communicable diseases (NCD) (Baker & Friel, 2014; Crino et al., 2018; Vergeer et al., 2020). Additionally, Turkey has the highest obesity prevalence with 32.1% across the European countries (World Health Organization [WHO], 2020) and with poor diet quality being among the top risk factors for illness and death globally for over two decades (GBD 2017 Diet Collaborators, 2019).

Reducing high consumption of salt and saturated fats, eliminating trans fatty acids, limiting sugars, and providing clear nutritional information of packaged products to the consumer are preventable factors for obesity and NCDs (Carrad et al., 2016; Hawkes et al., 2013; Stuckler et al., 2012; WHO, 2013). The World Health Organization (WHO) developed a global NCD monitoring system that environment-related risk factors that caused these diseases such as unhealthy packaged products high in salt, trans fats, saturated fats and sugars (WHO, 2013).

Nutrient profiling (NP) provides consumers with a clear comprehensible summary of the nutritional information of foods and beverages, allowing a rapid comparison between products (Carrad et al., 2016). The WHO defined "nutrient profiling" as "the science of classifying or ranking foods according to their nutritional composition for reasons related to preventing diseases related to nutrition and promoting health." NP is operationalized by NP models with various algorithms determined to classify or score products according to their nutritional composition and their

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impact on health (Rayner, 2017; Santos et al., 2021). NP models are divided into two groups according to their objective: for the nutrient content in foods and beverages (e.g., fat, fiber, sugar, sodium, etc.); and the effects of a person's health (e.g., healthy, unhealthy, less healthy, etc.) (WHO, 2010).

Various NP models are used among countries (Brown et al., 2017). The Health Star Rating (HSR) and The Pan American Health Organization models (PAHO) aim to consumers for making healthier choices in the same category. The HSR and PAHO models have some differences in each other. Therefore, these differences may reflect differences in the use of a nutrient density or volume-based approach for the classification of packaged products. The HSR model assists consumers to discriminate between foods in the same food category and to compare foods. It depends on an algorithm system that assigns a product a rating between half a star and five stars, with a higher number of stars meaning a healthier product (New Zealand Government, 2014a, 2014b). The scoring algorithms underpin the HSR was developed as a tool to determine that foods are authorized to be advertised along with television programmes of children's (UK Department of Health, 2011). The HSR model calculation algorithm takes into account four aspects: energy, saturated fat, sodium, and total sugar content of all retail food and beverage. The content of the fruit, vegetable, nut and legume, and in some instances, dietary fiber and protein content are also considered. Taking these components into account, points are allocated based on the nutritional composition of 100 g or ml, following the units used in the Nutrition Information Panel of a packaged product (New Zealand Government, 2014b). The PAHO model is based on all of the updated evidence, including the WHO guidelines on sugar and other nutrients, and was designed for multiple applications (including regulation of marketing and labeling, etc.). This model classifies all processed and ultra-processed foods and beverages with excess free sugars, salt, total sugars, saturated fats, and trans fats (Pan American Health Organization, 2016).

NP methods are being used as a nutritional policy application worldwide, and the number of different NP models has increased rapidly (Santos et al., 2021). Different field studies on the development of NP models continue in Turkey. However, only one research about this issue was found in Turkey (Dikmen et al., 2015). They analyzed the Ofcom-WXYfm and The Nutrient Rich Food Index 9.3 models for packaged products. In this study, we aimed to assess two different NP models (the HSR and PAHO) based on the nutrient content of packaged foods and beverages sold in Turkey.

Material and methods

Data collection

This was a cross-sectional study and evaluated the HSR and PAHO models of packaged foods and beverages sold in Turkey. The three chosen supermarkets are the largest in Turkey. These three chains are the largest in the country accounting for 7,438, 2,155, and 596 stores, respectively. The packaged products sold in these stores are similar to those sold in other supermarket chains throughout the country. We visited one chain of these supermarkets in middle-income areas. The data was collected from April to December 2020.

All packaged products available in the supermarket that met the criteria established by the last report of the Turkish Food Codex (Communiqué No: 28693, 2013) were included in the study. These criteria were: be labeled, had a brand, a food approval number, the net amount of the product and its ingredients, the ingredients were readable, the production and expiry date were found (Turkish Food Codex, 2013). In Turkey, the nutrition label of most packaged products includes amounts of energy, fat and some fatty acids, carbohydrate, protein, fiber, sugar, and salt in 100 g or ml and its size. Additionally, when multiple sizes were available for one specific item, the information of any of them was collected and evaluated for 100 g or ml. Food for babies and toddlers such as formulas, follow-on formulas, fresh fruits or vegetables, 100% of fruit juices, eggs, specific dietary use (e.g., protein

powders, nutritional supplements), and those that did not require nutrition labeling (bakery products produced, packaged and labeled in-store); and meat and cheese products (cut, packaged and labeled in-store) were excluded.

Nutritional label information and ingredient lists of the packaged products were obtained in the stores. All packaged products were recorded by photographing and their information was manually entered into Microsoft Office Excel 2016 spreadsheets without any quality control on the data entering, where each product was classified and coded according to label denomination. Additionally, for analyzing non-nutritive sweeteners (NNS), we opened a separate column for each NNS and all NNS were analyzed with the formula "IF(COUNTIF)" with a double filter.

Food categorization and classification

Packaged products were categorized into 11 main groups. Additionally, we used the NOVA classification which is the most employed method in many studies for food processing (Moubarac et al., 2017). The NOVA classifies all foods according to the nature, extent, and purposes of the industrial processes they undergo into four groups: unprocessed or minimally processed foods, processed culinary ingredients, processed foods, and ultra-processed foods (C. A. Monteiro et al., 2019).

Unprocessed or minimally processed foods are the edible parts of plants (such as fruit, leaves, stems, seeds, roots) or from animals (such as muscle, offal, eggs, milk), and also fungi, algae, and water, after separation from nature. Minimally processed foods are natural (unprocessed) foods altered by processes such as removal of inedible or unwanted parts, drying, crushing, grinding, fractioning, filtering, roasting, boiling, nonalcoholic fermentation, pasteurization, chilling, freezing, placing in containers, vacuum packaging. The main aim of the processed used in the production of unprocessed or minimally processed foods is to extend the life, longer use of storage for these foods, facilitating or diversifying food preparation (C. A. Monteiro et al., 2019).

Processed culinary ingredients are substances derived from unprocessed or minimally processed foods or from nature by processes such as pressing, refining, grinding, milling, and drying. Normally they are not consumed by themselves, but are mainly used as ingredients to prepare, season, and cook unprocessed or minimally processed foods (C. A. Monteiro et al., 2019).

Processed foods are made by adding sugar, oil, salt, or other processed culinary ingredients to unprocessed or minimally processed foods. Processes include various preservation or cooking methods, and with bread and cheese, nonalcoholic fermentation. The main aim of the manufacture of processed foods is to increase the durability of unprocessed or minimally processed foods or to modify or enhance their sensory qualities (C. A. Monteiro et al., 2019).

Ultra-processed foods are formulations of ingredients, most of exclusive industrial use, typically created by series of industrial techniques and processes. Ingredients of ultra-processed foods include varieties of sugars (fructose, high-fructose corn syrup, fruit juice concentrates, invert sugar, maltodextrin, dextrose, lactose), modified oils (hydrogenated or interesterified oils), and sources of protein (hydrolyzed proteins, soy protein isolate, gluten, casein, whey protein, and mechanically separated meat). The main aim of ultra-processing is to create products that are ready to eat, drink or heat, liable to replace unprocessed or minimally processed foods as well as freshly prepared dishes (C. A. Monteiro et al., 2019).

Nutrient profile models

The HSR model

The HSR model was developed in Australia in 2014. The HSR is based on energy, saturated fat, salt, and sugar as well as fiber, protein, fruit, vegetable, nut and legume content. Foods that are not appropriate for classification by the HSR: foods for babies and toddlers, nutritional supplements for sports, medicinal foods, alcoholic beverages (New Zealand Government, 2014b).

Table 1. The PAHO and HSR models criteria.

PAHO criteria	If one or more of the following criteria;
	(1) total fats; ≥30% of total energy from fat (2) saturated fats; ≥10% of total energy from saturated fat (3) trans fats; ≥1% of total energy from trans fat (4) sugars; ≥10% of total energy from free sugars (5) sodium; ≥1000 mg (6) energies; - (7) non-nutritive sweeteners; presence (8) eligibility for being rated; processed and ultra-processed foods and beverages, according to the NOVA classification
HSR criteria	(1) assigning baseline points for critical nutrient content per 100 g or ml (2) giving modifying points for fruit, vegetable, nut and legume content, also protein, and fiber where applicable (3) calculating a total score by subtracting modifying points from baseline points, with a lower score reflecting a more nutritive food product; and (4) assigning a HSR (from 0.5 to 5.0 stars in half-star increments) according to the total score using the defined scoring matrix

The Health Star Rating Calculator algorithm takes into account the nutritional value of ingredients. The model categorized products as "unhealthy" if the score is <3.5 stars and "healthy" if the score is ≥3.5 stars. According to the algorithm the HSR calculated is given in Table 1.

The PAHO model

The PAHO model was developed in Latin American Countries in 2014. Similar to the HSR model, it is based on nutrient content (total, saturated and trans-fats, sodium, sugar) and the presence of NNS (Pan American Health Organization, 2016). A processed/ultra-processed product was considered regulated according to the PAHO model if one or more of the following criteria were met according to Table 1.

Statistical analysis

The HSR was calculated in a Microsoft Excel spreadsheet (New Zealand Government, 2014a). Then, data was transferred to the SPSS. The SPSS (version 24.0, SPSS Inc., Chicago, IL) package program was used in the statistical analyses. Descriptive statistics (count, percent, etc.) were used for the HSR and PAHO models in the packaged products groups. Quantitative variables of nutrients were expressed as the mean±SD (standard deviation), and differences were analyzed by the student's t-test or Mann-Whitney U-test, as appropriate $p < .05$ was considered statistically significant.

Results

Of the 2,986 products analyzed, 1,929 (64.6%) were in the ultra-processes foods group, 799 (26.8%) were in the processed foods group; 178 (6%) of them are in the unprocessed or minimally processed foods group and 80 (2.7%) are in the culinary ingredients foods group. The proportion of foods under the scope for the PAHO model was 91.3% of all packaged products and all products were included in this study.

According to the PAHO model, a total of 60.5% of products were healthy, 39.5% of products were "unhealthy." These values were 70.7% and 29.3% for the HSR model, respectively. The amount of PAHO model "unhealthy" products was mostly in the snack foods group (8.4%), followed by the nonalcoholic beverages group (7.4%) and dairy products group (6.7%), while the amount of HSR model "unhealthy" products were mostly in the nonalcoholic beverages group (7.4%). This was followed by the dairy products group with 4.8% and the meats and meats products group with 4.7% (Figure 1).

The proportion of packaged foods and beverages meeting the criteria according to the PAHO model were presented in Table 2. Under the PAHO model, 24.7% of products were above the threshold for free sugar, 0.4% for total fat, 0.5% for saturated fat, 0.1% for trans fat, and 11.5% for sodium. Additionally, 5.5% of products contained NNS.

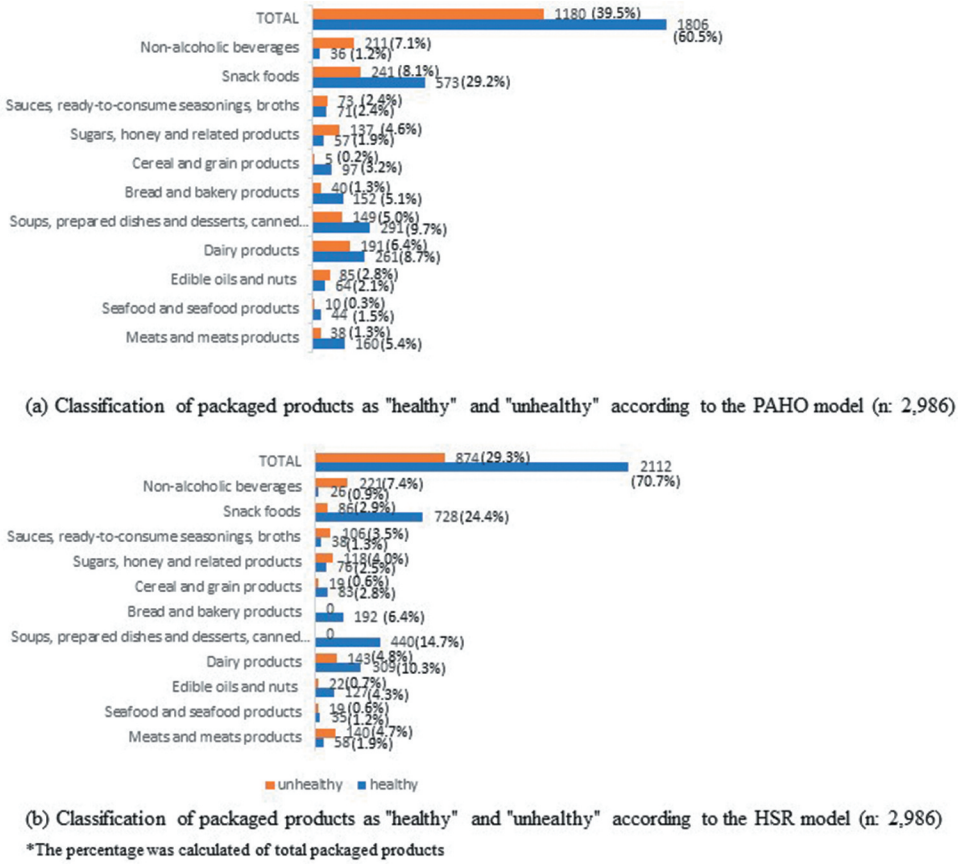

Figure 1. The proportion of packaged products according to the PAHO and HSR models in a sample of Turkish packaged products (n: 2,986).

As regards the mean content of nutrients among healthy and unhealthy food products (Table 3), the content of energy, saturated fat, sugar, and sodium of nutrients in healthy products were lower than unhealthy products whereas the content of fiber was higher ($p < .05$). According to the PAHO model, the total fat content of healthy products was lower, but no statistical difference was observed ($p > .05$). Interestingly, the protein content of unhealthy products according to the HSR model was higher than healthy products ($p < .05$).

Discussion

NP methods support consumers to make healthier food choices by way of the food labeling systems as well as establishing the regulation of health or nutrition demands and implementing restrictions of products (Labonté et al., 2018). The PAHO and HSR models are two of these NP methods that are more common in the literature. This is the first study to compare the PAHO and HSR models, which were developed in the same year in different countries, in packaged foods and beverages sold in Turkey. We found that the proportion and types of packaged products that would be classified as "healthy" and "unhealthy" and would be required to receive warning labels vary depending on which NP model was chosen. In our study, according to the PAHO model, a total of 60.5% of products were healthy, 39.5% of products were unhealthy. These values were 70.7% and 29.3% for the HSR model, respectively. Additionally, the greatest striking differences were found for some of the food groups. The amount of PAHO model "unhealthy" products was mostly in the snack foods group (8.4%),

Table 2. The healthfulness of the packaged products for each category in a sample of Turkish packaged products (n: 2,986).

Food groups	Meets the nutrient threshold criteria for PAHO Model*														HSR model		
	Free sugar		Total fat		Saturated fat		Trans fat		Sodium		NNS		Total**		Mean HSR±SD	HSR <3.5	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%		n	%
Meats and meats products	0	0	2	0.1	2	0.1	0	0	36	1.2	1	0	38	1.3	3.95 ± 2.79	140	4.7
Seafood and seafood products	0	0	0	0	2	0.1	0	0	9	0.3	0	0	10	0.3	6.14 ± 2.53	19	0.6
Edible oils and nuts	0	0	0	0	1	0	0	0	85	2.8	0	0	85	3.0	8.58 ± 2.46	22	0.7
Dairy products	156	5.2	0	0	0	0	0	0	37	1.2	6	0.2	191	6.7	7.29 ± 3.38	143	4.8
Soups, prepared dishes and desserts, canned and frozen foods	95	3.2	4	0.1	2	0.1	2	66.7	62	2.1	0	0	149	5.2	-	-	-
Bread and bakery products	2	0.1	0	0	0	0	0	0	38	1.3	0	0	40	1.4	-	-	-
Cereal and grain products	0	0	0	0	0	0	1	33.3	5	0.2	2	0.1	5	0.2	7.08 ± 1.72	19	0.6
Sugars, honey and related products	78	2.6	0	0	2	0.1	0	0	3	0.1	63	2.1	137	4.8	4.26 ± 2.62	118	4.0
Sauces, ready-to-consume seasonings, broths	45	1.5	0	0	0	0	0	0	36	1.2	0	0	73	2.5	4.72 ± 2.26	106	3.5
Snack foods	172	5.8	0	0	4	0.1	0	0	32	1.1	47	1.6	241	8.4	6.44 ± 1.68	86	2.9
Nonalcoholic beverages	191	6.4	5	0.2	3	0.1	0	0	0	0	44	1.5	211	7.4	3.50 ± 1.82	221	7.4
TOTAL	739	24.7	11	0.4	16	0.5	3	0.1	343	11.5	163	5.5	1,180	39.5	6.18 ± 2.53	874	29.3

Number and percentage of packaged products exceeding the threshold value according to the PAHO criteria. Some packaged products exceeded more than one threshold according to the PAHO criteria. Therefore, the numbers and percentages of packaged products in the PAHO criteria were different according to the total number of "unhealthy" products. **Classified as "unhealthy" if the product was met the criteria for at least one nutrient threshold. The percentage of products classified as unhealthy according to the PAHO and HSR models was calculated of the total packaged products.

**Classified as "unhealthy" if the product was met the criteria for at least one nutrient threshold. NNS: non-nutritive sweeteners. SD: standard deviation.

Table 3. Mean content of critical nutrients in healthy and unhealthy packaged products by nutrient profile models in a sample of Turkish packaged products (n: 2,986).

	PAHO model		HSR model	
Food groups	Healthy	Unhealthy	Healthy	Unhealthy
Energy (kcal/100 g)	245.88 ± 165.00 (0–1396)*	340.07 ± 199.53 (0–2271)*	300.28 ± 193.98 (0–2271)**	310.78 ± 179.79 (0.80–1536)**
Saturated fat (g/100 g)	3.31 ± 8.06 (0–147.80)*	7.50 ± 7.21 (0–63.30)*	5.36 ± 7.81 (0–147.80)**	7.47 ± 8.07 (0–74)**
Trans fat (g/100 g)	0.01 ± 0.32 (0–10.43)	0.00 ± 0.04 (0–1.30)	0.01 ± 0.24 (0–10.43)	0.01 ± 0.26 (0–6.80)
Total fat (g/100 g)	5.73 ± 9.46 (0–63)	17.75 ± 13.47 (0–80)	11.17 ± 12.03 (0–65.40)**	17.27 ± 15.76 (0–80)**
Sugar (g/100 g)	13.07 ± 15.86 (0–76.90)*	22.20 ± 24.91 (0–89.90)*	14.34 ± 19.69 (0–89.90)**	22.28 ± 20.91 (0–85)**
Sodium (mg/100 g)	353.17 ± 450.15 (0–1391.22)*	631.94 ± 263.78 (0–5403.75)*	405.29 ± 168.09 (0–5403.75)**	549.03 ± 103.62 (0–1391.22)**
Fiber (g/100 g)	1.87 ± 4.02 (0–92)*	0.9 ± 2.85(0–32.50)*	1.98 ± 4.62 (0–92)**	1.01 ± 2.46 (0–15.50)**
Protein (g/100 g)	8.92 ± 6.54 (0–37)*	4.81 ± 6.82 (0–45)*	7.48 ± 6.66 (0–37)**	7.53 ± 7.54 (0–45)**

*$p < 0.05$ difference between healthy and unhealthy product according to the PAHO criteria, **$p < 0.05$ difference between healthy and unhealthy product according to the HSR criteria.

followed by the nonalcoholic beverages group (7.4%) and dairy products group (6.7%), while the amount of HSR model "unhealthy" products were mostly in the nonalcoholic beverages group (7.4%), followed by the dairy products group with 4.8% and the meats and meats products group with 4.7%. More packaged foods and beverages would be regulated under the PAHO model than the HSR model.

A NP model with less strict criteria would classify a higher number of packaged foods and beverages with a lower nutritional quality as "healthy" and would misinform consumers (Contreras-Manzano et al., 2018). It was found that in Australia 15.2% of products (Carrad et al., 2016), in the United States (US) 40.2% of products (Baldridge et al., 2019) are unhealthy according to the HSR model. In our study, 29.3% of packaged products were unhealthy according to the HSR model. However, a NP model with very strict criteria would not attractive for manufacturers and would limit the effectiveness of reformulation of the products (Lehmann et al., 2017). A NP model must be set to realistic for the reformulation target (Combet et al., 2017). We found that a total of 39.5% of products were unhealthy according to the PAHO model, and it is stricter compared to the HSR model. Additionally, the greatest differences were found for soups, prepared dishes and desserts, canned and frozen foods group, and bread and bakery products group. Many studies have shown that the PAHO model is quite strict compared to other NP models (Contreras-Manzano et al., 2018; Duran et al., 2020; Poon et al., 2018). In Brazil, %62 of the products (Duran et al., 2020), in Mexico, 80.8% of products were classified as less healthy according to their nutrient profiling methods based on PAHO (Cruz-Casarrubias et al., 2021).

Although the PAHO model scores many products as "high" content of nutrients (sugar, sodium, total, saturated, and trans-fats), it can be misleading to specify maximum limits for the energy value of the product as a whole. In other words, if a product has a high energy value, the sugar, total, saturated and trans-fats content present in it would be masked or if a product has low energy value, the content would be exaggerated and products with low calories could be subjected to regulation due to the including high nutrient-to-calorie ratio (Silva et al., 2021). For example, under the PAHO model, products such as frozen foods and bread and bakery products that contain fewer calories but contain sodium and sugar potentially exceed the thresholds, despite containing low content of sodium and sugar overall. Other possible food groups that could be a problem include snack foods, sweets, and ready-to-eat foods. Therefore, one possible concern about the PAHO model is that the possibility of a product being regulated depending on the nutrient density of the model. The HSR model gives stars from half a star to five stars in half-star increments to food that relative healthiness. However, when assigning star ratings to foods based on relative healthiness, it is inevitable that products in the middle of the distribution may fall on either side of a dual-threshold for health claims (Dunford et al., 2018). The present study showed that under the PAHO model, the number of "unhealthy" products is higher than "unhealthy" products classified according to the HSR model. Additionally, in Turkey, there is no used NP model for packaged products. To use a NP model initially, the HSR model may be useful for both consumers and manufacturers due to the easy and clear nutrient expressions and less strict compare to the PAHO model.

According to the PAHO model criteria if a product contains at least one NNS means "unhealthy." Based on this result, our study is the first study to test which packaged products would be required to receive warning labels for the presence of NNS. We found that 5.5% of total packaged products contain NNS. These results were lower compared to Mexico with 11%, Brazil with 10% (Duran et al., 2020), and higher compared to the US (4%), New Zealand (1%), and Australia (<1%) (Dunford et al., 2018). Although, intake of NNS is associated with weight gain (Cabral et al., 2018; Pearlman et al., 2017), glucose intolerance (Cabral et al., 2018), diabetes (Hirahatake et al., 2019; Sanyaolu et al., 2018), cardiovascular diseases, and all-cause mortality (Mulligan, 2019). Overall, clear nutrition information could help consumers to make healthier choices that prevent potential future negative health effects.

The reformulation of products is crucial to decrease the consumption of sugar, sodium, and other nutrients associated with public health, and NP methods can be used as a tool to improve the nutrition quality of diets and health (Lowery et al., 2020). The food industry has used NP methods to reformulate product portfolios. Additionally, it is thought that voluntary product reformulation by

the food industry may have the most impact on public health (Drewnowski, 2017). Considering the negative health effects of some nutrients such as sugar, sodium, fat, NNS, etc., our results could be helpful for the reformulation of packaged products sold in Turkey.

Our study also highlights the relation between the two NP models' criteria for nutrients. In our study, under the PAHO model, "unhealthy" products had higher energy (340.07 ± 199.53 versus 310.78 ± 179.79 kcal/100 g), total fat (17.75 ± 13.47 versus 17.27 ± 15.76 g/100 g), saturated fat (7.50 ± 7.21 versus 7.47 ± 8.07 g/100 g), and sodium (631.94 ± 263.78 versus 549.03 ± 103.62 mg/100 g) content; lower fiber (0.9 ± 2.85 versus 1.01 ± 2.46 g/100 g) and protein (4.81 ± 6.82 versus 7.53 ± 7.54 g/100 g) content compared to "unhealthy" products classified to the HSR model. Additionally, our comparison of mean nutrient content showed statistical differences in the content of energy, saturated and trans-fats, sugar, and sodium between "healthy" and "unhealthy" products. Only, the mean content of total fat between "healthy" and "unhealthy" products according to the PAHO model criteria did not found a statistical difference.

The current study has some limitations. First, we analyzed products across the three largest supermarkets in middle-income areas in Turkey which are commonly found in all supermarkets, nevertheless, they may not reflect all samples of packaged foods and beverages. Second, although there are many different NP models, we decided to include only two of them in this study. Therefore, these models do not represent a complete view of all nutrient profile models available globally. Third, the variety of the selected models, how they classify packaged foods and beverages is not directly comparable. Since the HSR model assigns between 1/2 and 5 stars, whereas the PAHO model classifies the products as containing "excessive" or "not excessive" amounts of critical nutrients.

Conclusion

The present study highlighted the feasibility and utility of different NP models to measure the nutritional quality in Turkey's food and beverage supply. Our results could provide an assessment of packaged products sold in Turkey for enhancing nutritional quality. Considering that the use of any NP models sold in packaged products in Turkey, whatever a NP model, to start using one of those in our country is important to consumers to be guided to make healthier choices.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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