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Original Research Article

The presence of sodium content and sodium-containing food additives in packaged foods and beverages sold in Turkey

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ABSTRACT

Excess sodium (Na) intake is a significant leading cause of the development of non-communicable diseases. However, there is no scientific evidence on Na content (and its variation) in packaged products sold in Turkey. This study aimed to determine Na levels and Na-containing food additives of packaged products that are available in supermarkets across Turkey in 2020 in addition to evaluating the proportion of foods that comply with the World Health Organization global Na benchmark targets (2021). Of the 2975 packaged products analyzed, 60.3 % of products contained salt and 53.5 % of them contained a Na-containing food additive. A total of 31.8 % of products were classified as having a high Na content and the highest median Na levels were among the soy sauces and fish sauce group (4280 mg/100 g or ml; followed by olive group (2160 mg/100 g or ml), and soft to medium ripened cheese group (1880 mg/100 g or ml). The most used Na-containing food additive was sodium carboxymethyl cellulose. New regulations can be developed for the reformulation of packaged products containing high Na content and the progress of reducing Na intake of the population and improved health outcomes can be monitored over time.

1. Introduction

Globally the main contributor to mortality and morbidity is non-communicable diseases (NCDs) (such as hypertension, cardiovascular disease, and stroke) with interventions to reduce the burden of NCDs are highly cost-effective (WHO, 2012). The consumption of excessive salt (usually used to define sodium chloride) is a significant leading cause of the development of hypertension and has been reported as the seventh leading cause of global mortality while being responsible for one in ten cardiovascular deaths worldwide according to the World Health Organization (WHO) Global NCD Action Plan 2013–2020 (WHO, 2012; 2013). Therefore, the reduction of sodium (Na) intake has been identified as one of the top 10 "best buys" for preventing NCDs (Zarocostas, 2011) in addition to being cost-effective (Eyles et al., 2016). Regardless, the daily intake of Na in most countries is higher than the WHO guideline of 2000 mg/d (5 g salt/d) (WHO, 2012).

In Turkey, the mean daily salt intake for adults was 18 g in 2008 and 15 g in 2012 according to the SalTurk studies (Turkish Public Health Institution, 2016). Although there is a decrease over the years, it is clear that this is a serious public health problem. The main sources of salt are added salt outside of the home and processed packaged food products (WHO, 2012; Martins et al., 2015).

Countries around the world are taking measures to decrease the consumption of salt and Na due to the increased intake of these nutrients among populations (Brown et al., 2009; Turkish Public Health Institution, 2016). Food labeling has been used as an important strategy to inform consumers, with one of the aims being Na intake reduction (Trieu et al., 2015). The Turkish Food Codex Salt Communiqué's (number: 2013/48) phrase "*Reduce Salt, Protect Your Health*" is mandatory on salt packages. Additional studies are being carried out to develop alternative methods to reduce salt in packaged food products (Turkish Food Codex, 2013b; Turkish Public Health Institution, 2016). However, there are currently no practices to reduce salt or Na in packaged products in Turkey.

Although labeling is an important tool in reducing salt intake, packaged products sold in supermarkets have a higher Na content and high variability among them (Mhurchu et al., 2011; Nieto et al., 2018; Rauber et al., 2018; Cardoso et al., 2019). Knowing these contents (and their variations) has an impact on efforts to decrease Na intake and to monitor its content in products (Martins et al., 2015; Cardoso et al., 2019). Although there is no standard labeling for packaged products in Turkey, the label information is complex and consumers who want to

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make healthy choices demanded a standardized format for labels as well as simplified expression of terms and statements according to a study (Besler et al., 2012).

There is no scientific evidence on Na content (and its variation) in packaged products sold in Turkey. Additionally, although the main source of Na is salt, Na-containing food additives can also be important sources of this element (Araya-Quesada et al., 2020). The present study aimed to determine Na levels and Na-containing food additives of packaged foods and beverages sold in Turkey in addition to evaluating the proportion of foods and beverages that comply with the WHO global Na benchmark targets (2021). Moreover, we classified the Na content of packaged foods and beverages according to the various standards of Turkey for comparing with the WHO global Na benchmark targets.

2. Methods

2.1. Data collection

This was a cross-sectional study and evaluated Na labeling of packaged products sold in Turkey. The three chosen supermarket chains were the largest in Turkey accounting for 7438, 2155, and 596 stores, respectively. The food 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.

Nutritional label information and ingredient lists of the packaged products were obtained in the stores. The following fields of information were included: product identification, ingredient lists (Na-containing food additives), and salt information (salt from nutrients, g/100 g or 100 ml and/or g/serving). We entered these data 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.

2.2. Food categorization

We included the most consumed packaged products by the Turkish population. For example, food expenditures for milk and dairy products, meat, poultry, fish, and other meat products as well as floury foods had the largest share in Turkey (Gumus et al., 2010). It was reported that chips, biscuits, crackers, sweets, cakes, and chocolates are consumed at least one packet in a week among adults (Sahingoz, 2011). According to a study, most of the children consumed fruit juices as additional food from one month after birth (Savashan et al., 2015). Also, among the primary school children, children consumed sugar-chocolate at least once or twice and more a week, in addition to most of them consuming crisps-potato and cola (Kutlu and Civi, 2009).

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, had 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, 2013b). Food for babies and toddlers such as formulas, follow-on formulas, fresh fruits or vegetables, 100 % fruit juices, 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. Additionally, packaged products were categorized into 65 subgroups and 11 main groups according to the WHO global Na benchmark targets (Supplementary Table 1).

2.3. Calculation of the amount of sodium in the food and beverage products and classification of sodium contents

According to the Turkish Food Codex Salt Communique (number: 2013/48), labeling of salt content is mandatory in the nutritional labels of packaged foods, while Na content is not mandatory (Turkish Food Codex, 2013b). In this study, Na content was calculated as follows: 1 g salt yielding 393 mg Na (Turkish Public Health Institution, 2016). A quantity equivalence of Na in milligrams per 100 g or 100 ml of food was determined for all the food products based on serving size information. The Na amount was obtained from the nutritional label content of the packaged products, separately from the Na-containing food additives. Currently in Turkey, the nutrition label of most packaged products includes amounts of energy, fat and some fatty acids, carbohydrate, protein, fiber, sugar, and salt, these are amounts excluding food additives. Na content in milligrams per 100 g or 100 ml of products were classified as follows according to the WHO global Na benchmark targets and various Turkish standards (Turkish Food Codex, 2012, 2014; 2015; 2019; Turkish Ministry of Health, 2019; WHO, 2021) (Supplementary Table 2).

2.4. Determination of the presence of sodium-containing food additives

Data on Na-containing food additives were obtained from the ingredient labels of packaged products. All packaged products were recorded by photographing and their information was manually entered into Microsoft Office Excel 2016. Then, a separate column was opened for each food additive and all Na-containing food additives were analyzed with the formula "IF(COUNTIF)" with a double filter.

Na-containing food additives were identified using the Food Additives Regulation of Turkish Food Codex (Turkish Food Codex, 2013a) and Codex Alimentarius (FAO and WHO, 2019). According to the Food Additives Regulation of the Turkish Food Codex, Na caseinate and emulsifying salts were considered additives despite their absence from the Codex Alimentarius because they are additive mixtures (Turkish Food Codex, 2013a). These food additives: sodium carboxymethyl cellulose (cellulose gum), sodium polyphosphate, sodium nitrite, sodium citrates, sodium metabisulfite, sodium benzoate, sodium stearoyl lactylate, sodium caseinate/sodium cyclamate, monosodium glutamate, carrageenan, sodium malates, sodium lactate, sodium ascorbate, sodium phosphates, sodium sulfates, disodium inosinate, sodium propionate, disodium 5′-inosinates, sodium acetates, sodium erythorbate, calcium disodium ethylene diamine tetraacetate (calcium disodium EDTA), sodium saccharin, sodium hydroxide, sodium ferrocyanide, sodium alginate, sodium hydrogen sulfide, sodium gluconate, sodium ethyl p-hydroxybenzoate, sodium methyl p-hydroxybenzoate, sodium nitrate, sodium potassium tartrate, sodium adipate, sodium carbonates, disodium guanylate, sodium aluminum phosphate acidic, sodium aluminosilicate, sodium sulfite, sodium tetraborate, sodium tartrates, aluminum sodium sulfate.

2.5. Statistical analyses

We conducted a descriptive statistical analysis of groups and subgroups. The salt content in foods was obtained from the nutrition label information (g/serving) and was converted to Na and standardized units (mg/100 g). Median levels were calculated, as well as the 10th, 25th, 50th, and 75th percentiles and minimum and maximum levels. We classified Na contents as "High" if they were more than the target or maximum amounts and as "Low" if they were below the target or maximum amounts according to the WHO global Na benchmark targets and various Turkish standards (Turkish Food Codex, 2012, 2014; 2015; 2019; Turkish Ministry of Health, 2019; WHO, 2021). Additionally, we compared whether there was a statistical difference between the products that we classified as high and low according to the WHO global Na benchmark targets and Turkish standards in each subgroup, using the chi-square test. For this, the "Select Cases" button was used in the selection of each subgroup. All statistical analyses were conducted using SPSS Statistics 24.0 (Statistical Package for the Social Sciences, Inc.; Chicago, Illinois, United States). For the statistical test, a p-value ≤ 0.05

was considered statistically significant.

3. Results

A total of 3174 packaged products were included in the study, but 123 had missing data (no food additives in the ingredient list, only macronutrients in the nutrition label, or missing packaged product information while photographing) and 76 were duplicated. Therefore, we analyzed 2975 packaged products in the present study.

3.1. Classification of sodium content (mg/100 g or 100 ml) according to the WHO global sodium benchmark targets and Turkish standards

Of all the packaged products with nutritional label information of Na (n = 2975); 43 % in the "processed meat, poultry, game, fish and eggs" group, 68 % in the "butter, other fats, oils and olives" group, 67 % in the "cheese" group, 62 % in the "ready-made and convenience foods and composite dishes" group, 34 % in the "bread, bread products, cereals, legumes (raw), and their derivatives" group, 18 % in the "sugars, sweets, and other desserts" group, 55 % in the "processed fruit, vegetables, and legumes" group, 53 % in the "sauces, dips, and dressings" group, and 54 % in the "savory snacks" group contained "High" Na according to the WHO global Na benchmark targets. These values were 11 %, 0 %, 2 %, 17 %, 8 %, 0 %, 0 % (there was no set value for "processed fruit, vegetables and legumes" group), 17 % and 24 %, respectively according to the Turkish standards (Fig. 1).

3.2. The sodium content of packaged foods and beverages by groups and subgroups

Overall, the highest median Na levels per 100 g were among the soy sauces and fish sauce group (4280 mg/100 g or ml, range: 393–6600 mg/100 g or ml); followed by the olive group (2160 mg/100 g or ml, range: 314–2320 mg/100 g or ml) and soft to medium ripened cheese group (1880 mg/100 g or ml, range: 0–54000 mg/100 g or ml) (Table 1).

When the Na levels were evaluated according to the WHO global Na benchmark targets, 16 subgroups had no appropriate benchmark, while 26 subgroups were found to contain "High" Na levels, but when the Na levels were evaluated according to the Turkish standards, there was no benchmark for 27 subgroups, while only 4 subgroups had "High" Na levels. Additionally, when comparing "High" and "Low" Na levels containing products within their groups according to the both WHO global Na benchmark targets and Turkish standards, "processed fish and seafood products (non-heat-treated)", "soups (dry soup only, concentrated)", "leavened bread", "highly processed breakfast cereals", "cookies/sweet biscuits", "bouillon and soup stock (not concentrated and concentrated)", "marinades and thick pastes", "potato, vegetable, and grain chips", and "extruded snacks" groups were found to be statistically different ($p < 0.05$).

3.3. Sodium-containing food additives in packaged foods and beverages

According to ingredient lists of packaged products, 60.3 % (n = 1793) of products had salt, sodium chloride, or sea salt; salt is the most common (n = 1757) (not shown in tables). Of the 2975 products, 53.5 % (n = 1593) of products had Na-containing food additives. Thirty-six different Na-containing food additives were found. The most commonly used Na-containing food additive was sodium carboxymethyl cellulose with 12.2 %, followed by sodium polyphosphate with 11.2 % and sodium nitrite with 10.7 %. Sodium sulfite, sodium tetraborate, sodium tartrate, and aluminum sodium sulfate were not found in ingredient lists of products (Table 2).

4. Discussion

This is the first study to evaluate Na levels and Na-containing food additives in packaged foods and beverages sold in Turkey. According to the ingredient lists of the 2975 products analyzed, 60.3 % contained salt while 53.5 % contained a Na-containing food additive. A total of 31.8 % of products were classified as having a "High" Na content and the highest median Na levels were among the soy sauces and fish sauce group (4280 mg/100 g or ml); followed by olive group (2160 mg/100 g or ml), and soft to medium ripened cheese group (1880 mg/100 g or ml).

Public Health Policies (Reduction Program of Salt Consumption in Turkey) in Turkey have aimed to reduce salt consumption for years. The latest report found the mean salt intake is 15 g/daily for adults being 3 times more than the WHO recommendation (WHO, 2012). Although Na added through table salt remains a significant source of dietary Na in Turkey, its consumption in packaged products is increasing (Turkish Public Health Institution, 2016). Many packaged food products contain an excessive amount of Na according to other countries' studies. In Mexico, the highest mean Na content was found in meat products (552 mg/100 g) (Nieto et al., 2018). In the UK, the mean Na content of broths and sauces was 1090 mg/100 g (Mhurchu et al., 2011). In Australia, the

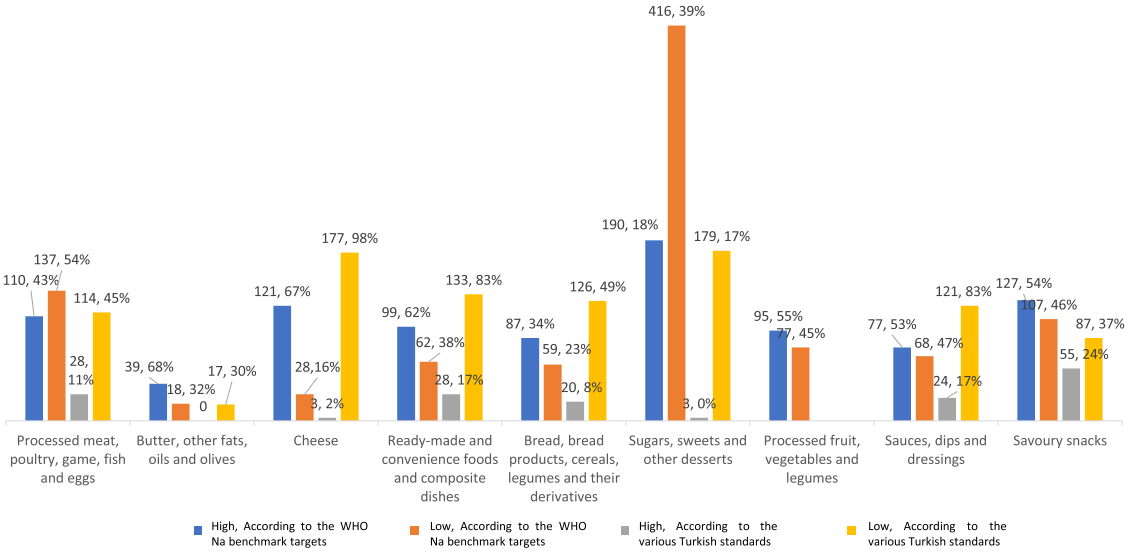

Fig. 1. Classification of the main groups of packaged foods sold in Turkey by Na content according to the WHO global Na benchmark targets and various Turkish standards (n = 2975). The values show the number of packaged foods according to the classification in each group.

Table 1
Sodium content (mg/100 g or 100 ml) and sodium content classification by group and subgroup of packaged foods and beverages sold in Turkey (n = 2975).

		Sodium Percentiles (mg/100 g)							Sodium content classification		
Food Category	n (%)	Median	Min	10th	25th	50th	75th	95th	Max			p value
Processed meat, poultry, game, fish, and eggs (254, 8.5)												
Canned fish	36 (1.2)	570	39.3	185	295	570	668	1020	1220	**HIGH**§	**LOW**ǂ	0.157
Processed fish and seafood products (raw)	5 (0.2)	393	197	197	236	393	393	–	393	**HIGH**§	**LOW**ǂ	–
Processed fish and seafood products (non-heat-treated)	14 (0.5)	1260	197	216	560	1260	1560	2160	2160	**HIGH**§	**HIGH**ǂ	**< 0.001** **
Raw meat products and preparations	36 (1.2)	511	0	189	393	511	619	1780	1850	**HIGH**§	**LOW**ǂ	0.418
Whole muscle meat products (non-heat preservation)	38 (1.3)	865	590	668	707	865	2280	3930	3930	**LOW**§	**LOW**ǂ	0.140
Comminuted meat products (heat treated, cooked)	13 (0.4)	786	0	0	668	786	943	–	1970	**HIGH**§	**LOW**ǂ	0.151
Comminuted meat products (non-heat preservation)	105 (3.5)	707	0	590	648	707	786	1010	1180	**LOW**§	–	–
Eggs	7 (0.2)	118	0	0	118	118	197	–	393	–	–	–
Butter, other fats, oils, and olives (57, 1.9)												
Salted butter, butter blends, margarine and oil-based spreads	17 (0.6)	78.6	0	0	37.3	78.6	118	–	197	**LOW**§	**LOW**ǂ	–
Olive	40 (1.3)	2160	314	931	1570	2160	2160	2320	2320	**HIGH**§	**LOW**ǂ	–
Yoghurt, sour milk, cream, and other similar foods (212, 7.2)												
Flavoured milk	83 (2.8)	39.3	0	0	0	39.3	39.3	118	3690	–	–	–
Flavoured yoghurt	35 (1.2)	39.3	0	0	0	39.3	39.3	118	118	–	–	–
Ice cream	94 (3.2)	78.6	0	0	39.3	78.6	78.6	197	786	–	–	–
Cheese (180, 6.0)												
Fresh unripened cheese	30 (1)	590	0	275	314	590	727	983	983	**HIGH**§	**LOW**ǂ	–
Soft to medium ripened cheese	50 (1.7)	1880	0	393	668	786	983	2040	54,000	**HIGH**§	**HIGH**ǂ	0.529
Semi-hard ripened cheese	32 (1.1)	786	432	590	648	786	1060	1300	1450	**HIGH**§	**LOW**ǂ	–
Extra-hard ripened cheese	31 (1)	786	0	590	629	786	1180	1650	1770	–	**LOW**ǂ	–
Mould ripened cheese (white and red)	16 (0.5)	926	393	558	914	963	983	–	1450	**HIGH**§	**LOW**ǂ	–
Processed cheese	21 (0.7)	472	0	39.3	39.3	471	1040	1180	1180	**LOW**§	**LOW**ǂ	–
Ready-made and convenience foods and composite dishes (161, 5.4)												
Canned foods	8 (0.3)	554	314	314	481	554	868	–	3930	**HIGH**§	**LOW**ǂ	–
Pasta, noodles, and rice or grains with sauce or seasoned (prepared)	7 (0.2)	472	197	197	236	472	550	–	629	**HIGH**§	**LOW**ǂ	–
Pasta, noodles, and rice or grains with sauce or seasoned (dry-mix, concentrated)	7 (0.2)	432	354	354	393	432	472	–	511	**LOW**§	**LOW**ǂ	–
Pizza and pizza snacks	14 (0.5)	472	354	393	462	472	570	–	786	**HIGH**§	**LOW**ǂ	–
Sandwiches and wraps	17 (0.6)	550	0	94.3	452	550	648	–	904	**HIGH**§	**LOW**ǂ	0.633
Ready-to-eat meals	46 (1.5)	413	0	236	314	413	560	812	865	**HIGH**§	**LOW**ǂ	0.614
Soups (dry soup only, concentrated)	62 (2.1)	314	0	0	197	314	1900	3430	3890	**LOW**§	**LOW**ǂ	**< 0.001** **
Bread, bread products, cereals, legumes (raw), and their derivatives (258, 8.7)												
Leavened bread	73 (2.5)	393	0	173	354	393	507	943	1450	**HIGH**§	**LOW**ǂ	**0.043***
Flatbreads	10 (0.3)	511	354	354	354	511	708	–	747	**HIGH**§	**LOW**ǂ	–
Minimally processed breakfast cereals	11 (0.4)	0	0	0	0	0	78.6	–	118	**LOW**§	**LOW**ǂ	–
Highly processed breakfast cereals	52 (1.7)	206	0	17.3	157	206	314	831	2480	**LOW**§	**LOW**ǂ	**0.01***
Granola and cerealtype bars	3 (0.1)	1179	314	314	414	1180	–	–	6680	–	–	–
Legumes (raw)	109 (3.7)	0	0	0	0	0	39.3	78.6	118	–	–	–
Sugars, sweets, and other desserts (1057, 35.5)												
Cookies/sweet biscuits	182 (6.1)	236	0	39.3	118	236	314	511	7070	**LOW**§	**LOW**ǂ	**0.039***
Cakes and sponges	86 (2.9)	275	0	66.8	157	275	354	458	511	**HIGH**§	–	–
Pies and pastries	34 (1.1)	157	0	0	0	118	257	796	825	**HIGH**§	–	–
Baked and cooked desserts		39.3	0	0	39.3	39.3	78.6	275	13,900	**LOW**§	–	–

(*continued on next page*)

Table 1 (*continued*)

Food Category	n (%)	Median	Sodium Percentiles (mg/100 g)							Sodium content classification		p value
			Min	10th	25th	50th	75th	95th	Max			
	156 (5.2)											
Pancakes and waffles	136 (4.6)	13.8	0	0	0	13.8	39.3	314	29,900	**LOW**§	–	–
Scones and soda bread	12 (0.4)	373	0	35.4	226	373	462	–	786	**LOW**§	–	–
Dry-mixes for making other sweet bakery wares	96 (3.2)	0	0	0	0	0	39.3	118	275	–	–	–
Chocolates	292 (9.8)	78.6	0	0	32.4	78.6	134	236	13,400	–	–	–
Chewing gums	63 (2.1)	0	0	0	0	0	0	35.4	472	–	–	–
Processed fruit, vegetables and legumes (172, 5.8)												
Canned vegetables and legumes	83 (2.8)	747	0	197	393	747	1260	1970	4090	**HIGH**§	–	–
Pickled vegetables	59 (2)	393	0	157	314	393	472	1380	1850	**LOW**§	–	–
Olives and sundried tomatoes	3 (0.1)	197	78.6	78.6	78.6	197	–	–	314	**LOW**§	–	–
Frozen vegetables and legumes	21 (0.7)	11.8	0	0	0	11.8	138	263	275	**LOW**§	–	–
Frozen potatoes and other potato products (ready-to-eat)	6 (0.2)	197	39.3	39.3	39.3	197	295	–	472	**LOW**§	–	–
Sauces, dips and dressings (145, 4.8)												
Bouillon and soup stock (not concentrated)	16 (0.5)	78.6	0	0	39.3	78.6	18,200	–	20,600	**LOW**§	**LOW**ǧ	**< 0.001** **
Bouillon and soup stock (concentrated)	10 (0.3)	393	0	0	0	393	5460	–	8170	**LOW**§	**LOW**ǧ	**0.002***
Cooking sauces including pasta sauces and tomato sauces (not concentrated)	19 (0.6)	354	0	0	0	354	629	–	1810	**HIGH**§	**LOW**ǧ	0.073
Dips and dipping sauces	20 (0.7)	19.7	0	0	0	19.7	658	975	983	**LOW**§	**LOW**ǧ	0.162
Emulsion-based dips, sauces and dressings	15 (0.5)	550	354	377	511	550	629	–	786	**HIGH**§	**LOW**ǧ	–
Condiments	52 (1.7)	786	0	365	550	786	1480	2080	2550	**HIGH**§	**LOW**ǧ	0.13
Soy sauces and fish sauce	7 (0.2)	4280	393	393	590	4280	5900	–	6600	**LOW**§	**HIGH**ǧ	0.147
Marinades and thick pastes	6 (0.2)	766	472	472	501	766	2250	–	4520	**LOW**§	**LOW**ǧ	**0.014***
Savoury snacks (234, 7.9)												
Crackers/Savoury biscuits	11 (0.4)	629	0	0	197	629	747	–	864	**HIGH**§	**LOW**ǧ	–
Nuts, seeds and kernels	92 (3.1)	157	0	0	0	157	501	1550	3540	**LOW**§	–	–
Potato, vegetable and grain chips	54 (1.8)	609	234	472	511	609	707	904	1970	**HIGH**§	**LOW**ǧ	**0.002***
Extruded snacks	40 (1.3)	472	0	0	49.1	472	766	1600	2040	**LOW**§	**HIGH**ǧ	**< 0.001** **
Pretzels	37 (1.2)	943	0	258	688	943	1120	3470	7510	**HIGH**§	**LOW**ǧ	0.061
Non-alcoholic beverages (245, 8.3)												
Soda + energy drinks	73 (2.5)	0	0	0	0	0	0	78.6	236	–	–	–
Fruit juices	88 (3)	0	0	0	0	0	0	0	39.3	–	–	–
Flavoured waters	14 (0.5)	0	0	0	0	0	98.3	.	511	–	–	–
Milk drinks and milk substitutes	24 (0.8)	39.3	0	0	0	39.3	39.3	78.6	78.6	–	–	–
Ice tea and coffee	18 (0.6)	0	0	0	0	0	0	.	66.8	–	–	–
Beverage powder mixes	28 (0.9)	39.3	0	0	0	39.3	39.3	309	43,200	–	–	–
Total	2975 **(100)**											

* $p < 0.05$.
** $p < 0.001$, Na: sodium.
§ Median Na content classified according to the WHO global sodium benchmark targets.
ǧ Median Na content classified according to the Turkish standards.

group of sauces and seasoning (1280 mg/100 g) had the highest Na content, followed by the processed meats group (846 mg/100 g) (Webster et al., 2010). Another Australian study showed that broths had the highest Na content with 16,920 mg/100 g and soups were the second with 1880 mg/100 g (Grimes et al., 2011). In Latin American and Caribbean countries, the seasoning was the highest Na content (10,800 ± 10,400 mg/100 g), followed by mayonnaise (751 ± 295 mg/100 g) and snack foods (724 ± 1040 mg/100 g) (Arcand et al., 2019). In India, meal-based sauces with 3240 mg/100 g had the highest Na content (Johnson et al., 2017). In this study, the soy sauces and fish sauce (4280 mg/100 g or ml), olive (2160 mg/100 g or ml), soft to medium ripened cheese (1880 mg/100 g or ml), processed fish and seafood products,

Table 2
Sodium-containing food additives cited on the ingredient lists of packaged foods and beverages sold in Turkey (n = 2975), along with their percentage and respective International Numbering System (INS).

Sodium-containing food additives	INS	n	%
Sodium carboxymethyl cellulose (cellulose gum)	E466	195	12.2
Sodium polyphosphate	E452	179	11.2
Sodium nitrite	E250	171	10.7
Sodium citrates	E331	161	10.1
Sodium metabisulfite	E 223	102	6.4
Sodium benzoate	E211	101	6.3
Sodium stearoyl lactylate	E481	74	4.6
Sodium caseinate/sodium cyclamate	E952	60	3.8
Monosodium glutamate	E621	57	3.6
Carrageenan	E407	54	3.4
Sodium malates	E350	45	2.8
Sodium lactate	E325	42	2.6
Sodium ascorbate	E301	39	2.4
Sodium phosphates	E339	37	2.3
Sodium sulfates	E514	37	2.3
Disodium inosinate	E631	33	2.1
Sodium propionate	E281	29	1.8
Disodium 5′-inosinates	E635	28	1.8
Sodium acetates	E262	25	1.6
Sodium erythorbate	E316	23	1.4
Calcium disodium ethylene diamine tetraacetate (Calcium disodium EDTA)	E385	21	1.3
Sodium saccharin	E954	18	1.1
Sodium hydroxide	E524	12	0.8
Sodium ferrocyanide	E535	12	0.8
Sodium alginate	E401	11	0.7
Sodium hydrogen sulfide	E 222	6	0.4
Sodium gluconate	E576	5	0.3
Sodium ethyl p-hydroxybenzoate	E215	2	0.1
Sodium methyl p-hydroxybenzoate	E219	2	0.1
Sodium nitrate	E251	2	0.1
Sodium potassium tartrate	E337	2	0.1
Sodium adipate	E356	2	0.1
Sodium carbonates	E500	2	0.1
Disodium guanylate	E627	2	0.1
Sodium aluminum phosphate acidic	E541	1	0.1
Sodium aluminosilicate	E554	1	0.1
Sodium sulfite	E221	–	–
Sodium tetraborate	E285	–	–
Sodium tartrates	E335	–	–
Aluminum sodium sulfate	E521	–	–
TOTAL		**1593**	**100**

Percentages were calculated on the total foods, which has a sodium-containing food additive.

non-heat-treated (1260 mg/100 g or ml) and granola and cereal-type bars (1180 mg/100 g or ml) were the subgroups with the highest Na content. Granola and cereal-type bars are often marketed and perceived as healthy (Moubarac et al., 2014), and additionally had no appropriate Na benchmark according to the WHO global Na benchmark targets (WHO, 2021). However, as seen in the results, their high Na content showed that they can threaten health. Additionally, most of the subgroups of "processed meat, poultry, game, fish, and eggs", "cheese", "ready-made and convenience foods and composite dishes" and "savoury snacks" groups were in the "High" classification in the Na classification according to the WHO global Na benchmark targets (WHO, 2021). These results are very important considering the high consumption of such packaged foods in Turkey (Kutlu and Civi, 2009; Gumus et al., 2010; Sahingoz, 2011; Savashan et al., 2015). Considering the health problems that may be caused by excessive Na consumption, new regulations are urgently needed for packaged foods.

A large variation was also found in Na content among similar food products. Except for the products of processed fish and seafood products (raw), semi-hard ripened cheese, pasta, noodles, and rice or grains with sauce or seasoned (prepared and dry-mix, concentrated), pizza and pizza snacks, flatbreads, olives and sundried tomatoes, cakes and sponges, scones and soda bread and frozen potatoes and other potato products (ready-to-eat) groups; there were extreme differences in the subgroups analyzed. In some subgroups (soft to medium ripened cheese, soups (dry soup only, concentrated), pancakes and waffles, etc.), these large differences were consistent with the high Na content. In Brazil study found 634 times greater variation in the subgroups of garnishes and other canned vegetables and fruits (Martins et al., 2015). An Australian study, that analyzed 7221 processed foods also found high Na content and large variations in Na concentration in most product groups (Webster et al., 2010). In Latin American and Caribbean countries study results were similar, with the highest variation found in the snack foods group (Arcand et al., 2019). The large variation of most groups showed that there are real opportunities to reformulate packaged foods sold in Turkey. Therefore, government policies to reduce Na content can be developed as in other countries (Webster et al., 2014; Xi et al., 2014; Trieu et al., 2015). The reformulation of food products reduces Na intake coming from these products; thus, Na intake is reduced. These policies, combined with new suggestions to require nutritional labels of packaged foods, can affect the industry to reduce the Na levels of the packaged food products they offer (van Raaij et al., 2009; Kloss et al., 2015; Lowery et al., 2020).

Additionally, there are no appropriate Na benchmarks for yoghurt, sour milk, cream, and other similar foods and non-alcoholic beverages groups according to the WHO global Na benchmark targets (WHO, 2021). However, variation of Na levels was also high in these groups. Considering that such packaged products such as flavoured milk, ice-cream, all beverages as well as chocolate are consumed by children, it can make many health problems inevitable at later ages (Kutlu and Civi, 2009; Savashan et al., 2015).

The WHO recommended reducing all dietary Na sources, including food additives (WHO, 2012). It is recommended to inform the public of high Na levels in packaged products for decreasing Na intake. Therefore, it may be easier for people to identify products with high Na content at the time of purchase (Martins et al., 2015). In this study, the determination of the presence of Na-containing food additives in a total of 1593 food products indicates that rapid steps should be taken in raising public awareness. The most preferred Na-containing food additives was sodium carboxymethyl cellulose (cellulose gum) (n = 195), followed by sodium polyphosphate (n = 179) and sodium nitrite (n = 171), respectively. In the food industry, sodium carboxymethyl cellulose is added to a wide variety of packaged food groups to preserve freshness in foods, however, an acceptable daily intake (ADI) level is not established. Sodium carboxymethyl cellulose negatively affects intestinal microbiota which can lead to many health problems (Bayram and Ozturkcan, 2020; Cao et al., 2020; Rinninella et al., 2020). The European Food Safety Authority (EFSA) has undertaken a re-evaluation of phosphates for use as food additives with a high priority by 31 December 2018 due to its negative health effects (EFSA, 2013). According to the evaluation report published in 2019, the Panel considered phosphates to be of low acute oral toxicity, derived a group ADI for phosphates expressed as phosphorus of 40 mg/kg body weight (bw) per day, and concluded that this ADI is protective for the human population. In addition, the panel showed that these ADI values are exceeded when used as food additives in children by the food industry (EFSA et al., 2019). The reported ADI value for sodium nitrite which is used to extend the shelf life of foods is 0.07 mg nitrite ion/kg bw per day. Epidemiological studies showed that it is associated with different types of cancers (especially, gastric and colorectal) therefore adversely affecting health (EFSA et al., 2017). There is no information about the amount of Na-containing food additives in packaged products sold in Turkey. Therefore, it is not known whether food additives from packaged products exceed the ADI values. Considering the negative health effects mentioned, it is important to monitor not only Na content but also the Na-containing food additives of packaged products.

The study has some limitations. First, we collected the nutritional label information and ingredient lists from supermarkets. Then, we coded and classified the products and used a double filter for all Na-

containing food additives in Microsoft Excel 2016. A double filter is a manual process, human error may have occurred. Second, Na was calculated from the salt content of the products, and no chemical analysis was made. In addition, Na-containing food additives have been analyzed from the ingredient lists. However, it shows that consumers can only access what is reported on the labels of packaged products, therefore the accuracy of such information must be ensured by the manufacturer and tested for regulatory compliance. Third, the sample size was small as three supermarkets in the middle-income areas were visited once. Therefore, they may not reflect all samples of packaged foods and beverages.

5. Conclusion

This study provides a baseline assessment of Na levels in packaged foods and beverages sold in Turkey and the Na classification according to the newly published WHO global Na benchmark targets. Most of the packaged products included in the study are frequently consumed by the Turkish people. New regulations can be developed for the reformulation of packaged products containing high Na in the results found. With these results and future studies to update these results, progress on the reformulation of Na levels and subsequent reduction of Na intake of the population and improved health outcomes can be monitored over time. By ensuring the continuity of such studies with future studies, reformulations of high Na levels in packaged products can be monitored regularly and consumers can be enlightened about high Na-containing packaged products as well as Na-containing food additives.

CRediT authorship contribution statement

Hatice Merve Bayram: Data curation, Writing - original draft, Visualization, Software, Validation. **Arda Ozturkcan:** Supervision, Conceptualization, Methodology, Software, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.jfca.2021.104078.

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