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Salt content of prepacked cereal-based products and their potential contribution to salt intake of the Italian adult population: Results from a simulation study

Giorgia Vici [a,1], Alice Rosi [b,1], Donato Angelino [c], Valeria Polzonetti [a], Francesca Scazzina [b], Nicoletta Pellegrini [d,*], Daniela Martini [e] on behalf of the SINU Young Working Group[2]

[a] School of Biosciences and Veterinary Medicine, University of Camerino, Camerino, 62032, Italy
[b] Department of Food and Drug, University of Parma, Parma, 43124, Italy
[c] Department of Bioscience and Technology for Food, Agriculture and Environment, University of Teramo, Teramo, 64100, Italy
[d] Department of Agricultural, Food, Environmental and Animal Sciences, University of Udine, 33100, Italy
[e] Department of Food, Environmental and Nutritional Sciences (DeFENS), Università degli Studi di Milano, 20133 Milan, Italy

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KEYWORDS
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Abstract *Background and aims:* High sodium intake is one of the main risk factors for noncommunicable diseases, and its consumption should be reduced. This study aimed to simulate changes in the daily salt intake of the Italian adult population based on consumption scenarios of prepacked cereal-based foods sold in Italy.
Methods and results: Information on food packages was retrieved from 2893 cereal-based products. Potential changes in salt intake were simulated based on food consumption scenarios that consider the daily consumption of cereal-based products suggested in the Italian Dietary Guidelines and their current daily consumption by Italian adults. The highest salt content was retrieved in bread (median, 25^{th}–75^{th} percentile: 1.3, 1.1–1.4 g/100 g) and bread substitutes (1.8, 1.0–2.2 g/100 g). If the suggested daily amounts were consumed, bread would contribute to 44% of the 5 g salt/day target, whereas bread substitutes, breakfast cereals, biscuits and sweet snacks would marginally contribute (1–2%). Compared to bread with median salt content, a −44% and +10% salt intake would be observed if products within the first and the last quartile of salt content were chosen, respectively. However, considering the actual intake of Italian consumers, bread would cover 25% and bread substitutes 7% of the daily salt target.
Conclusion: Food labels have a pivotal role and efforts are required to encourage consumers to use them to make healthy choices. Moreover, these results may contribute to setting sodium benchmarks in cereal-based products and encourage the food industry to reduce the salt content in the products.

* Corresponding author.
E-mail addresses: giorgia.vici@unicam.it (G. Vici), alice.rosi@unipr.it (A. Rosi), dangelino@unite.it (D. Angelino), valeria.polzonetti@unicam.it (V. Polzonetti), francesca.scazzina@unipr.it (F. Scazzina), nicoletta.pellegrini@uniud.it (N. Pellegrini), daniela.martini@unimi.it (D. Martini).
[1] Authors equally contributed to this work.
[2] The members of SINU Young Working Group are listed in Acknowledgments section.

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1. Introduction

High intake of sodium is one of the main leading dietary factors for death and disability in many countries. Decreasing sodium intake is considered an important strategy to reduce blood pressure, stroke and cardiovascular disease [1,2]. In this context, the World Health Organization (WHO) set a global target to lower the intake of salt by 30% by 2025 to reduce the impact of health conditions associated with excess sodium intake [3].

Worldwide, in most developed countries people consume excess sodium compared to the WHO recommended intake of less than 2 g of sodium (5 g salt) per day, included Italy [4,5]. Sodium is found naturally in a variety of food such as meat, fish, and milk. However, discretionary salt added by the consumer at table and in home-food preparation and also the salt added in processed foods (e.g., bread, bread-substitutes, processed meat) and in many condiments (i.e., soy sauces) represent the major contributors of daily sodium intake [4,6,7]. The role of food producers in reducing the population's salt intake is considered fundamental. Reformulation of food products combined with tailored education strategies could support consumers towards making informed and healthy food choices.

Food labels represent a key tool to communicate the nutritional characteristics of foods and thus to guide consumers towards a health promoting food choice. Information that must be provided to consumers is specifically regulated by the European Commission (Regulation (EU) n. 1169/2011) [8], and salt content per 100 g is one of the mandatory ones. The mandatory information on salt content (salt equivalent content calculated using the formula: salt = sodium $\times$ 2.5) instead of sodium content has been introduced with the above mentioned Regulation, in order to make its content more easily understandable by consumers [8]. Furthermore, nutrition (NC) and health claims can be added on the pack on voluntary bases in accordance with Regulation (EU) n. 1924/2006 [9]. In this framework, NCs related to salt content (e.g., "low in salt" or "reduced in salt") can be added on the pack when in conformity with the conditions set out in the Regulation [9].

Among other information that can be added to the product pack, portion size and the total number of portions can be declared on a voluntary basis, and the amount of nutrients can be expressed per portion, accordingly [8]. However, there is no legal definition of portion size. In this context, manufacturers are the ones responsible for the definition of their products' suggested portion size which should represent the usually consumed amount of that product [8,10]. For this reason, declared portions can vary between similar products and, furthermore, can be different with respect to the recommended serving size. In Italy, the Italian Society of Human Nutrition has set standard serving sizes, which are the standardized amounts of food considered as reference units recognized and identifiable by both nutrition professionals and the general population [11].

As food label represents a fundamental tool to provide information to consumers, they have a crucial role in influencing their salt intake as well. Considering the salt content of pre-packaged cereal-based products currently sold in Italy, the aim of the present study was to simulate changes in the daily salt intake of the Italian adult population based on consumption scenarios in which different food choices have been made.

2. Methods

2.1. Data collection and extraction

This work is part of the Food Labelling of Italian Products (FLIP) study that aims at systematically investigating the overall quality of the pre-packed foods of the most important food groups and related categories sold on the Italian market [12–15].

Data were retrieved from the online surveys conducted in previous studies made during the project and updated in June 2021 [12,15,16]. Briefly, cereal-based products considered for the present work were selected from 12 of the major retailers present on the Italian market which have an e-commerce (Bennet, Carrefour, Conad, Coop Italia, Crai, Despar, Esselunga, Il Gigante, Iper, Pam Panorama, Selex, Sidis).

Eligible for inclusion in the present analysis were all prepacked cereal-based products present in at least one online shop during the collection period and with all the data available to be retrieved. In the case of non-prepacked foods, those products with incomplete images of all the sides of the pack or unclear images of the nutrition declaration and/or list of ingredients, were excluded. No items labelled 'Product currently unavailable' on all the online stores selected during the whole data collection period was considered.

Pictures of all the sides of the packaging were collected for all the included products, in order to retrieve the following regulated (mandatory) information: company name, brand name, descriptive name, energy (kcal/100 g), total fat (g/100 g), saturates (g/100 g), carbohydrate (g/100 g), sugars (g/100 g), proteins (g/100 g), and salt (g/100 g).

Furthermore, when available, suggested portion size and, accordingly, the amount of nutrients expressed per suggested portion size were collected. Lastly, presence of NC related to the salt content was recorded.

The accuracy of the extracted data was double-checked by two researchers (AR & DM) and inaccuracies were solved by a third researcher through secondary extractions (GV). Retrieved data were compiled in a dataset and items were sub-grouped for specific comparisons taking into account the reported descriptive name and presence or absence of "suggested portion size" information.

Based on the descriptive name, products were classified in 5 categories: (i) bread; (ii) bread substitutes; (iii) breakfast cereals; (iv) biscuits; (v) sweet snacks.

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2.2. Salt intake estimation scenarios

In order to estimate potential changes in salt intake of the Italian population based on different consumers food choices, three scenarios of consumption of cereal-based products were foreseen as described in Table 1.

The "suggested consumption" scenario (considered as the reference scenario) was set up for each cereal-based product category according to the Italian Dietary Guidelines (IDG) for adults with a 2000 kcal/day energy intake [11]. Scenarios 1 and 2 were obtained considering the consumption data for each cereal-based product category from the most recent national survey INRAN-SCAI related to the Italian adult population (18–64.9 years) [17], as presented in the EFSA food consumption database FoodEx2 [18,19]. Scenario 1 ("adult Italian consumers only") referred to consumption data collected from a subgroup of Italian adults who habitually consume a specific food item listed within the cereal-based product categories, whereas scenario 2 ("all adult Italian population") considered consumption data of the general Italian adult population.

Based on food consumption and median salt content of products, salt intake by food product groups was calculated for the three scenarios, as reported in Table 1.

2.3. Statistical analysis

Statistical analyses were performed through the IBM SPSS statistics for Macintosh Version 27.0 (Armonk, NY, USA: IBM Corp.), with the significance level set at $p < 0.05$. The normality of data distribution was rejected through the Kolmogorov-Smirnov test. Descriptive statistics were run and data were expressed as median, interquartile range, minimum and maximum range, or as frequencies (%). In addition, a standard measure of variation across product categories was obtained by calculating the coefficients of variation (CV) as the ratio between the standard deviation and the mean value of reported portion size on food pack to investigate the extent of variability within each food category. The Wilcoxon signed-ranked non-parametric paired sample test was used to explore differences between salt content of products considering the portion suggested on the product packs and the salt content of products related to the standard serving size recommended by the Italian Society of Human Nutrition [11], by product categories.

The percentage of the maximum recommended level of daily salt intake covered by each food category was calculated as [median salt content of product category x 100/population dietary target for sodium intake, expressed as salt (5 g/day)] [11], whereas the percentage of the habitual salt intake of the Italian population was calculated as [median salt content of product x 100/mean daily salt intake of the Italian adult population (9 g/day)] [20].

Salt intake from each cereal-based product category was calculated as [median salt content of product category x quantity of product category suggested] in the case of the reference scenario, and as [median salt content of product category x quantity of product category consumed] for scenarios 1 and 2. In addition, salt intake was calculated simulating the choice of food items either with lower salt content (in the first quartile: 0^{th}–25^{th} percentile) or with higher salt content (in the last quartile: 75^{th}–100^{th} percentile), as [median salt content of product in the first or in the last quartile in each category x quantity of product category suggested] in the case of the reference

Table 1 Applied scenarios based on cereal-based product consumptions.

Scenario		Product consumption data	Salt intake from all products	Salt intake from products by 1^{st} and 4^{th} quartile
Reference Scenario	Suggested consumption	The suggested serving size and frequency of consumption from the Italian dietary guidelines [11] for all cereal-based product categories considered in the present study.	Median salt content of product category x quantity of product category suggested.	Median salt content values of products within the first and last quartile (0^{th}–25^{th} and 75^{th}–100^{th} percentile, respectively) x quantity of product category suggested.
Scenario 1	Current consumption (consumers only)	Data from the most recent national survey INRAN-SCAI [17] limited to adult Italian population of individuals who consume the specific food items, as presented in the EFSA food consumption database FoodEx2 [18,19].	Median salt content of product category x quantity of product category consumed.	Median salt content values of products within the first and last quartile (0^{th}–25^{th} and 75^{th}–100^{th} percentile, respectively) x quantity of product category consumed.
Scenario 2	Current consumption (total population)	Data from the most recent national survey INRAN-SCAI [17] for all adult Italian population, as presented in the EFSA food consumption database FoodEx2 [18,19].	Median salt content of product category x quantity of product category consumed.	Median salt content values of products within the first and last quartile (0^{th}–25^{th} and 75^{th}–100^{th} percentile, respectively) × quantity of product category consumed.

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scenario, and as [median salt content of product in the first or in the last quartile in each category x quantity of product category consumed] for scenario 1.

3. Results

3.1. Salt content of Italian cereal-based prepacked products

A total of 2893 items were retrieved from the FLIP database [12,15,16]. Among them, 337 were bread items, 869 bread substitutes, 378 breakfast cereals, 799 biscuits and 510 sweet snacks (Table 2).

The median (IQR) salt content of retrieved products was 1.3 (1.1–1.4) g/100 g for bread, 1.8 (1.0–2.2) g/100 g for bread substitutes, 0.5 (0.1–0.8) g/100 g for breakfast cereals, 0.5 (0.4–0.7) g/100 g for biscuits and 0.5 (0.4–0.7) g/100 g for sweet snacks.

A great variability in terms of number of products reporting the portion size was observed (from 21% of biscuits to 81% of sweet snacks) with CV for declared suggested portion size (compared to Italian standard serving size [11]) ranging from 22% (for bread) to 54% (for biscuits) (Table 2).

Among products with declared portion size, differences were found between suggested portion size and Italian standard serving size with almost all the product categories showing less than 20% of products with a portion size equal to the standard serving size, with the exception of breakfast cereals (41%) (Supplementary Fig. 1).

Comparing the salt content of the portion size reported in the product pack and the salt content of the standard serving size significant differences were observed. In particular, the salt amount was lower considering the portion size reported on the product pack than the Italian standard serving size for bread ($p < 0.001$) and sweet snacks ($p < 0.001$), whereas it was higher for bread substitutes ($p = 0.02$), breakfast cereals ($p = 0.02$), and biscuits ($p = 0.02$).

Only 78 products out of 2893 (less than 3%) had an NC about salt content. Considering the product categories, NCs were reported on the packs of around 5% of bread substitutes, 4% of bread and breakfast cereals, and less than 1% of biscuits, whereas sweet snacks did not carry any NC.

3.2. Salt intake by different dietary scenarios

Estimated daily salt intake, as well as the percentage of the maximum recommended limit (5 g/day) and of the mean daily Italian adult population salt intake (9 g/day) [20] covered by one serving of products are presented in Table 3, by considering the daily intake of each product category for the three scenarios.

The recommended daily intake of the bread of 175 g as part of a 2000 kcal/day dietary pattern (Reference scenario) [11] would correspond to a daily salt intake of 2.22 g and thus contribute to 44% of the maximum recommended limit of daily salt intake. However, the Italian adult population consumes 91 g/day of bread, with a consequent daily intake of 1.16 g of salt, in the scenario 2, corresponding to 23% of the maximum recommended daily salt intake. Among cereal-based products, bread would be the major contributor of the mean daily salt intake of the Italian adult population (9 g salt/day), covering 25% in the case of the reference scenario and 13–14% in scenarios 2 and 1, respectively. Bread is the only item under-consumed by the Italian population, whereas all the other products are over-consumed, with up to 5-fold the recommended consumption, as shown in Table 3. The higher intake of bread substitutes compared to the recommended amount reported in the IDG led to the consumption of 0.35 g salt per day, reaching 7% of the maximum recommended salt intake and 4% of the mean habitual salt intake of the Italian population, while the contribution of breakfast cereals, biscuits, and sweet snack to the daily salt intake was very low (1–3%).

Figure 1 shows the differences in terms of the percentage of daily salt intake covered by the different cereal-based food categories when food items either with lower salt content (in the first quartile: 0^{th}–25^{th} percentile) or with higher salt content (in the last quartile: 75^{th}–100^{th} percentile) would be chosen. In particular, taking into account the recommended consumption (reference scenario), daily salt intake covered by bread ranged from 0% (considering products in the first quartile) to 54% (considering products in the last quartile), meaning a decrease in salt intake of 44% was observed if products with less salt would be chosen, and an increase of 10% if products with the highest content would be selected

Table 2 Descriptive statistics for declared portion size for analyzed food categories items.

Product Category	Number of items	Italian standard serving size (g) [11]	Items with declared portion size on the pack (%)	Serving size reported on the product pack			
				Median (g)	25^{th}–75^{th} percentile (g)	Min-Max (g)	CV (%)
Bread	337	50	58	35	25.0–50.0	13.0–150.0	22
Bread substitutes	869	30	42	30	25.0–37.5	2.2–75.0	30
Breakfast cereals	378	30	74	30	30.0–32.0	20.0–50.0	25
Biscuits	799	30	21	31	25.0–39.5	12.8–65.0	54
Sweet snacks	510	50	81	40	35.0–50.0	12.5–110.0	39

CV = coefficient of variation of portion size reported on the pack calculated as the ratio between the standard deviation and the mean value of reported portion size on food pack. All values are rounded to the nearest whole number.

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Table 3 Estimated salt intake according to the applied dietary scenarios by cereal-based product categories.

Product category	Dietary scenario	Category consumption (g/day)	Salt intake (g/day)				
			Median (g/day)	25th–75th percentile (g/day)	Min-Max (g/day)	% of the maximum suggested limit (5 g/day)[a]	% of the mean intake of the Italian population (9 g/day)[b]
Bread	Ref. Scenario	175	2.22	1.98–2.45	0.00–4.73	44%	25%
	Scenario 1	100	1.27	1.13–1.40	0.00–2.70	25%	14%
	Scenario 2	91	1.16	1.03–1.27	0.00–2.46	23%	13%
Bread substitutes	Ref. Scenario	4.3	0.08	0.04–0.09	0.00–0.17	2%	1%
	Scenario 1	20	0.35	0.20–0.44	0.00–0.80	7%	4%
	Scenario 2	0[c]	–	–	–	–	–
Breakfast cereals	Ref. Scenario	8.6	0.04	0.01–0.07	0.00–0.22	1%	0%
	Scenario 1	10	0.05	0.01–0.08	0.00–0.25	1%	1%
	Scenario 2	0[c]	–	–	–	–	–
Biscuits	Ref. Scenario	4.3	0.02	0.02–0.03	0.00–0.07	0%	0%
	Scenario 1	20	0.10	0.07–0.15	0.00–0.34	2%	1%
	Scenario 2	10	0.05	0.04–0.07	0.00–0.17	1%	1%
Sweet snacks	Ref. Scenario	7.1	0.04	0.03–0.05	0.01–0.10	1%	0%
	Scenario 1	31	0.16	0.13–0.22	0.02–0.43	3%	2%
	Scenario 2	0[c]	–	–	–	–	–

Reference Scenario: Suggested consumption by Italian guidelines; Scenario 1: current consumption of consumers only; Scenario 2: Total population current consumption.

[a] The percentage of the maximum recommended level of daily salt intake covered by each food category was calculated as [median salt content of product category x 100/population dietary target for sodium intake, expressed as salt (5 g/day)] [11].

[b] The percentage of the habitual salt intake of the Italian population was calculated as [median salt content of product x 100/mean daily salt intake of the Italian population (9 g/day)] [20].

[c] Due to the large number of non-consumers, the median daily consumption for the total Italian adult population is 0 g/day.

compared to bread with median salt content available on the Italian market (Fig. 1a). Similarly, a −24% and a +6% salt intake would be reached if products with lower and higher salt content would be chosen, respectively, considering scenario 1.

A contribution to the reduction or the increase in salt intake was observed for the actual Italian consumption patterns (scenario 1) of all the other product categories except for breakfast cereals. Of particular interest, in bread substitutes a 6% reduction and a 3% increase of salt intake would be achieved if products within the first quartile of salt content would be preferred to the products within the fourth quartile of salt content, respectively, in scenario 1 (Fig. 1b). Similarly, the choices of products among the sweet snacks would lead to a reduction of 1% and an increase of 3% when products within the 25th or above the 75th percentile would be preferred, respectively, considering the actual intake of the Italian consumers (Fig. 1e). On the contrary, the choice of breakfast cereals within the 25th percentile of salt content would lead to a 1% reduction of daily salt intake, whereas a 1% increase would be observed if products above the 75th percentile of salt content would be chosen.

4. Discussion

Salt intake reduction represents a crucial strategy to decrease cardiovascular morbidity and mortality burden worldwide [21]. This goal can be approached not only by decreasing the quantity of salt added to food by consumers (discretionary salt) but mainly by making the right food choice in terms of packaged products [22,23].

4.1. Salt content of Italian cereal-based products

In this study, information on the food pack of 2893 cereal-based products has been evaluated to explore variability in salt content and to simulate the impact of their consumption on the salt intake of the general population. In general, median salt contents of retrieved products were comparable to the values previously reported for Italian cereal-based products [12,15]. Less than 3% of products reported a nutritional claim (NC) on salt, underlining the low number of products with a salt content within the established range for the use of NC on the product pack. Similarly, among the 2034 foods and drinks analyzed within the EU funded project CLYMBOL ("Role of health-related CLaims and sYMBOLs in consumer behavior"), barely 4% of products carried an NC referring to sodium/salt [24]. On one hand, the low percentage of NC related to salt on cereals-based foods is alarming if considering the increasing concerns for detrimental effect of elevated salt intake; on the other hand, it may represent an important chance for food producers to reformulate food products in order to boast a NC that can be shown on the food pack.

Beside NC information and salt content in 100 g, salt content per suggested portion size was analyzed and compared with salt content of Italian standard serving size [11] (Table 2). One aspect that emerged is that fewer than half of the products reported the suggested portion size on

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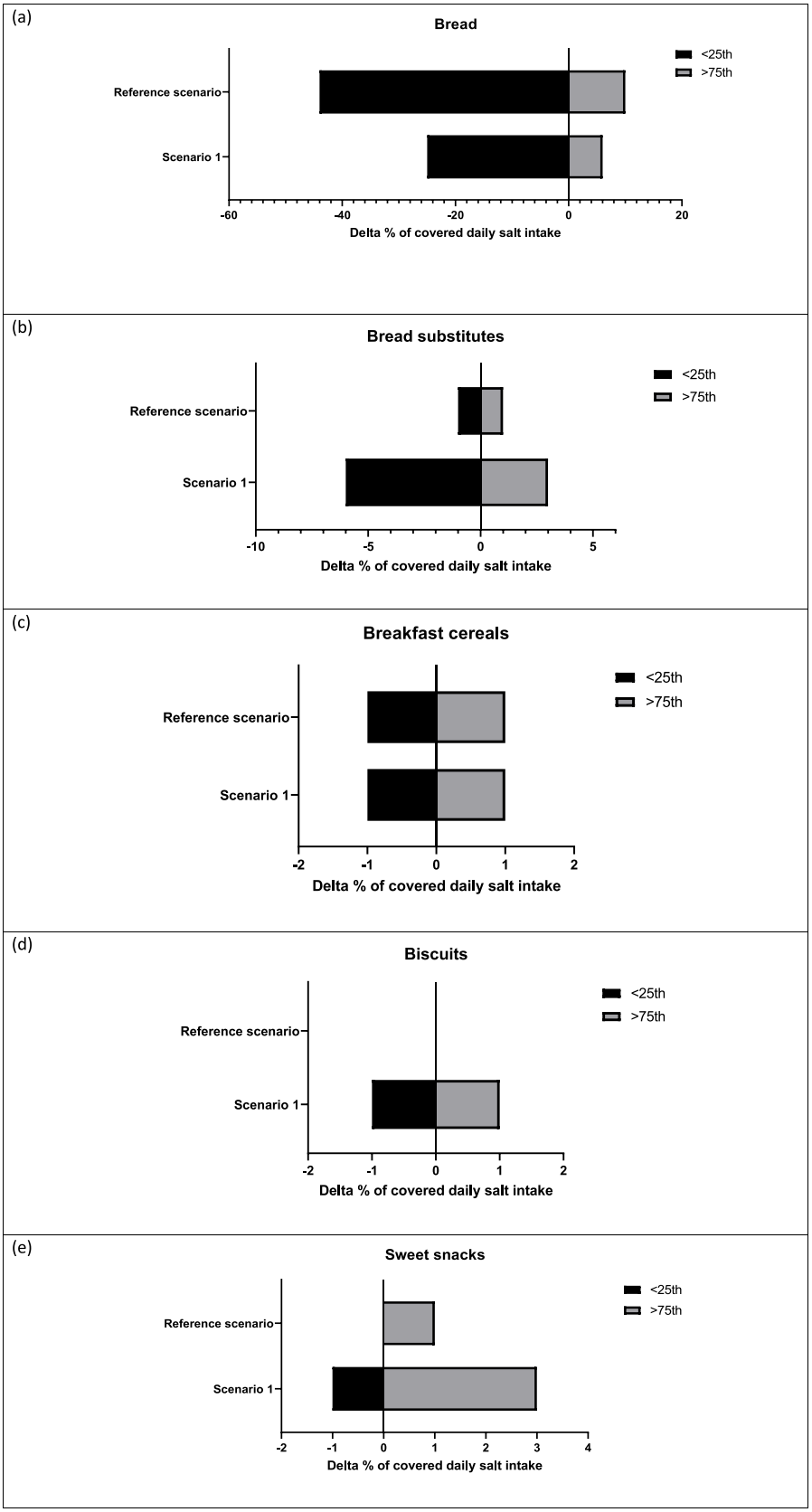

Figure 1 Simulated changes of daily salt intake in % for consumption reference scenario and scenario 1 with food choice either in the 0^{th}–25^{th} percentile or in the 75^{th}–100^{th} percentile of salt content compared to the median value in the five food groups; (a) Bread, (b) Bread substitutes, (c) Breakfast cereals, (d) Biscuits, (e) Sweet snacks.

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the food pack and, among them, in only about a quarter of the items was it in accordance with the Italian standard serving size [11]. Other studies have also reported a high variability in the declared portion sizes of packaged foods and in comparison to dietary guidelines [25,26]. This can lead to discrepancies between manufacturer's declared portion size and standard serves [25], confusing consumers.

4.2. Scenario simulations

It has been reported that about 70–75% of the salt consumed in Europe comes from processed food and other food industry products. The percentage of salt intake from products such as bread and bakery products ranged from 25% to 40% in many European countries and the USA [27,28] in line with the results of the present study.

In the present study, the contribution of foods' salt content to the daily salt intake was evaluated by calculating the salt intake and the percentage of the maximum recommended level of daily salt intake covered by each food category using median salt content values of all retrieved products and median salt content values of products in the first and last quartiles, considering three dietary scenarios.

From the simulation analysis, it was observed that the consumption of cereal-based products could potentially contribute up to 44% of the recommended daily maximum salt intake when considering the recommended amount of these products. Furthermore, when considering the actual intakes of Italian consumers, cereal-based product consumption can account for up to 25% of the recommended daily maximum salt intake with bread representing the main dietary source of salt.

In detail, it was observed that choosing bread products with a lower salt content (first quartile) instead of bread products with a salt content equal to the median value found in the Italian market, resulted in a remarkable difference in the percentage of daily salt intake.

On the other hand, choosing bread products with higher salt content (last quartile) than products with salt content equal to the median value found in the Italian market, would lead to an increase in the percentage of daily salt intake. In this context, it is worth mentioning the high differences found among products in these food categories, meaning that being able to choose the right product can lead to a huge difference in terms of salt intake.

The long-standing belief that bread can be linked to an increase of fat mass has led to a decrease in bread consumption with people restricting or even eliminating bread from the diet [29]. In this context, "bread substitutes" consumption should be taken into account (crackers, wraps, breadsticks, rice cakes, corn cakes, taralli, croutons, bruschetta and "Frisella" bread) as they can be used as alternatives to the traditional bread. From a previous study, it was underlined that the nutritional quality of bread substitutes present in the Italian market is lower with respect to that of products they want to substitute [16]. From data of the present study, differences in percentage of covered daily salt have been reported underlining the fact that product choice can have an impact on daily salt intake. In particular, up to a 6% of reduction or a 3% of increase could be achieved by choosing bread substitutes with the lowest or the highest salt content, respectively.

Moreover, salt can be found in many food products that people do not consider to be salty. Indeed, consumers do not often realize that salt is present in products such as sweet biscuits [30]. From the present data, it is interesting to underline differences in the daily salt intake depending on food choice; for example, sweet snacks can have an impact on daily salt intake from 2% to 6% of the daily salt maximum recommended intake with an increase of 3% when products above the 75th percentile would be preferred.

In addition, consumption of these product categories should be carefully considered because of their impact on the daily salt intake. In fact, the salt amount consumed could be even higher considering dietary patterns in which people consume different products within these categories during the day (i.e., biscuits, bread substitutes and sweet snacks in the same day).

It is therefore clear that the selection of products with less salt can represent a crucial action in salt intake reduction. In this context, the availability of salt-reduced products easily accessible by the whole population should be guaranteed through a reformulation of the products sold in the Italian market.

4.3. Strengths and limitations

It is worth mentioning that the present study has some limitations. Data collection methodology considers only markets with an online shop, so discount or local shops were not included. Moreover, as reported elsewhere [16], it is important to underline that bread is commonly consumed as freshly baked and unpackaged in Italy but for this item, the Council Regulation (EU) No. 1169/2011 does not apply [8]. Thus, these products were not included in the present study even though freshly baked bread represents a primary source of salt intake in some geographical areas and for certain population groups. It would be of great interest to include these products in future studies, also considering the differences in salt content which may depend on different regional recipes for freshly baked bread [31]. Nevertheless, the number of retrieved packaged bread products in this study reflects a sale trend [16,32] that could be linked to an increasing consumer interest in these products.

Although those limitations, the large number of the products considered, selected from major Italian retailers, represents a strength of the present study, reflecting the Italian packaged foods market. In addition, considering different scenarios enabled us to describe and estimate potential changes in salt intakes of the Italian population based on different product choices underlining the importance of consumers' awareness about proper food choices.

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4.4. Conclusions

In conclusion, the present study underlines the fundamental role of food labels in driving food choices of consumers. The high variability found both inter- and intra-product categories underlines the importance of the right food choice in terms of salt intake. Moreover, attention should also be focused on "hidden salt" in sweet products usually not considered source of salt by consumers. In this context, tailored actions should be studied and organized in order to enhance the food literacy of consumers [33]. Efforts are required to improve consumers' knowledge about reading and understanding food labels to make healthy choices. In addition, authorities have a pivotal role in encouraging the shift toward product reformulation to facilitate the availability of foods with lower salt content, thus nudging consumer choice. Data obtained from this study could contribute to the settings of sodium benchmarks, in particular for high contributors to the daily salt intake such as bread [34] and its substitutes, as requested by WHO [35] in order to reduce sodium intake.

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SINU Young Working Group.

Margherita Dall'Asta, Department of Animal Science, Food and Nutrition, Università Cattolica del Sacro Cuore, Piacenza, Italy.

Stefania Moccia, Institute of Food Sciences, National Research Council, Avellino, Italy

Daniele Nucci, Veneto Institute of Oncology IOV-IRCCS, Padova, Italy.

Gaetana Paolella, Department of Chemistry and Biology A. Zambelli, University of Salerno, Fisciano, Italy.

Veronica Pignone, Department of Epidemiology and Prevention, IRCCS Neuromed, Pozzilli, Italy.

Emilia Ruggiero, Department of Epidemiology and Prevention, IRCCS Neuromed, Pozzilli, Italy.

Carmela Spagnuolo, Institute of Food Sciences, National Research Council, Avellino, Italy.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.numecd.2023.08.016.

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