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Nutritional quality and on-package marketing of pre-packaged foods and non-alcoholic beverages for sale in Senegalese supermarkets

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Abstract

Background The high availability and marketing of unhealthy foods has contributed to unhealthy diets. Unhealthy diets are a major risk factor for a range of non-communicable diseases (NCDs). However, the availability and marketing of pre-packaged foods haven't been assessed in Senegal. Nutrient profiling models have been developed to identify less healthy foods that could be subject to marketing restrictions, particularly when targeted at children. The aim of this study was to assess the nutritional quality and on-pack promotion of pre-packaged food sold in major supermarkets in Senegal using the Nutrient Profile Model for the WHO African Region (NPM-WHO/AR), the Nutri-Score labelling system and the NOVA classification.

Methods A cross-sectional survey was conducted in two major supermarkets in Dakar between August and September 2021. Data were collected for all pre-packaged foods, with the exception of the fresh food and alcoholic beverages categories. Pre-packaged foods were classified into fifteen food categories and five beverage categories according to the NPM-WHO/AR, with the exception of the categories "fresh and frozen meat, fish and sea food" and "fresh and frozen fruits and vegetables, legumes and tubers". Nutritional information was extracted from product labels and products were evaluated using 3 classification systems: NPM-WHO/AR, Nova classification as an indicator of the degree of food processing and Nutri-Score, a nutritional labelling system based on a 5-colour scale from dark green to red, associated with letters ranging from A (high nutritional quality) to E (low nutritional quality), established according to nutritional value and fruits, vegetables and legumes content. Depending on the classification system used, foods were rated on the basis of the nutritional information declared as relevant for this rating. Thus, 5,542 products were evaluated for their nutritional composition, 5,280 products were evaluated according to the NPM-WHO/AR and 5,407 products were evaluated according to both the Nutri-Score and the Nova classification. A pre-packaged food was classified as "non-permitted" to be marketed to children if the content of defined nutrients exceeded the threshold set in the model for the corresponding product category. Data analysis was performed using RStudio.

Results Ultra-processed foods (71.1%) and processed foods (18.8%) were the most common in Senegalese supermarkets. According to the Nutri-Score, pre-packaged foods were most frequently classified as Nutri-Score D (24.4%) and Nutri-Score E (22.1%). Almost 63.3% of the products were classified as non-permitted to be marketed to children

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according to the NPM-WHO/AR. Of these foods, 12.5% had on-pack promotions. Non-permitted foods to be marketed to children with the highest number of on-pack promotions were "breakfast cereals" (50.0%), "chocolate and sugar confectionery" (31.3%), "milk and dairy based drinks" (28.1%) and "cakes, sweet biscuits and pastries" (17.7%). However, the comparison between the NPM-WHO/AR and the Nutri-Score showed that some NPM-WHO/AR prohibited foods were classified into Nutri-Score A and B.

Conclusions This study shows that pre-packaged foods available in major supermarkets in Senegal are predominantly non-permitted to be marketed to children. In the context of increasing levels of obesity and diet-related NCDs, effective policies should be established to regulate the promotion of these foods.

Keywords Pre-packaged foods, Nutritional quality, On-pack promotion, Supermarkets, Senegal

Background

Unhealthy diets are one of the main risk factors for a range of non-communicable diseases (NCDs), such as obesity, cardiovascular diseases, diabetes mellitus, chronic respiratory diseases and various types of cancer [1, 2]. The aforementioned NCDs are responsible for 45% of premature deaths in Senegal [3]. Although obesity is more common in high-income countries, it has increased in many low-and middle-income countries, particularly among urban populations [4]. According to the Global Nutrition Report (2021), 15.1% of adult women and 4.8% of adult men in Senegal were living with obesity in 2019. At the same time, the prevalence of overweight and obesity in children and adolescents aged 5–19 years are estimated to affect 11.7% of boys and 6% of girls.

In recent decades, diets have undergone tremendous changes due to the modernization of food systems. This has resulted in an increase in the availability and affordability of ultra-processed foods and beverages (UPFs), which are often high in energy, fat, saturated fat, added sugars, salt and/or sodium [5–7]. Globally and in Africa, the food supply is increasingly dominated by UPFs products [8]. Due to the evidence linking UPFs to poor diet quality, pre-packaged foods manufacturers are collectively considered a major driver of the NCDs epidemic [9]. Scientific evidence supports the overconsumption of UPFs in the development of obesity and NCDs [10–14]. Among the various factors contributing to overweight, obesity and diet-related diseases, the promotion of UPFs has been shown to have a negative impact, particularly among children [15]. Aggressive marketing of such foods, often accompanied by health and nutrition claims, can obscure potential harms and drive and distort consumer demand. Research has shown that the majority of products advertised to children and adolescents are of low nutritional value [16].

Together, these factors shape policy and public opinion on NCDs prevention. An important way to improve health and prevent obesity and NCDs is to focus on reducing associated risk factors [17]. Policies that alter the food environments can influence consumer behaviors towards healthy food choices and/or incentivize food manufacturers to improve the nutritional quality of their products. A range of priority actions have been recommended by WHO, including government regulations, such as mandatory sugar limits in foods; fiscal policies, such as taxes on beverages with added sugars; food marketing regulations, such as mandatory nutrient declaration by manufacturers; and promotion of healthier foods for infants and young children. However, governments are generally not taking a comprehensive approach in this area and policy measures are limited [18, 19]. In 2004, WHO recommended that the food industry limit the levels of critical nutrients in their pre-packaged food and introduce new products with better nutritional quality to ensure that consumers can access healthy food choices through manufacturers' product portfolios [20]. In direct response, some leading companies have reported some improvements in their product portfolios through self-regulation, but most are not taking strong measures, pointing towards the need for government regulations. Nutrient profiling systems have been developed as a method of assessing the nutritional quality of foods and beverages according to their energy content and nutrient composition, and underpin a wide range of food policies, including food reformulation, food labelling, child-directed marketing restrictions and school nutrition standards [21, 22]. The WHO has developed a nutrient profile model for the African Region to support countries in controlling obesogenic food environments and promoting healthy diets, with a focus on protecting children from marketing of unhealthy foods and non-alcoholic beverages. Specific thresholds for energy and critical nutrients are defined for each major food category according to their recommended dietary targets for the prevention of obesity and related NCDs, as well as guidelines for sugar and salt. Non-compliance (intake above the threshold) for a single nutrient makes the food or beverage unsuitable for advertising to children.

However, no studies have examined the healthfulness of products available on the market through major supermarkets in Senegal. Therefore, the objective of this study

was to assess the nutritional quality and on-pack promotion of pre-packaged foods sold in major supermarkets in Senegal, using the WHO Nutrient Profile Model for the African Region (NPM-WHO/AR), the Nutri-Score labelling system and the NOVA classification.

Methods

Study design

A cross-sectional survey was conducted between August and September 2021 in two large supermarket chains (Auchan and Exclusive) in Dakar, the capital city in which the largest urban population in Senegal is concentrated. These chains are among the most frequented by the Senegalese population, given the wide range of products available. With thirty-five (35) stores and one drive, Auchan is the uncontested leader of modern food retailing in Senegal. The methodological framework proposed by INFORMAS (International Network for Food and Obesity/non-communicable diseases, Research, Monitoring and Action Support) to assess nutritional composition and food promotion [23, 24] was used in the conceptualization of this study.

Data collection

Data collection was carried out by 6 interviewers, 5 of whom were nutritionists. The interviewers were initially trained on two consecutive days on the data collection tool and also took part in a pre-test of the tool. Only pre-packaged food and non-alcoholic beverages were collected in the stores. Data were collected using a tablet with the Open Data Kit collect (ODK). All sides of packaged food products were photographed to capture all the information on the package. Product-related information was collected separately using a questionnaire. For each packaged product, data collected included the product name, brand and nutritional information (energy density, carbohydrates, total sugars, protein, fat, saturated fat, trans fat, salt and sodium content). The nutrient information was collected per 100 g or 100 ml of each product from the nutrient declarations on the product labels. As the nutritional composition of the same food in a different pack size remains unchanged, only one format (pack size) of the same product was recorded. However, all flavours of the same food brand were collected. Each product was sampled only once and the barcode was checked to see if it had been found already elsewhere in the other supermarket. In addition, where the nutritional composition of the food was presented by portion or by net weight or volume of the food, additional calculations were made to find the equivalent for 100 g/ml of the food.

Promotional features and premium offers observed on product packaging were also recorded. These promotional aspects included: mascots (cartoon characters, brand mascots, superheroes), licensed characters (e.g., Barbie), celebrities, drawings or text related to children or their characteristics, primes (physical or virtual gifts for children such as games on the packaging or online games), price discount, game contest, bonus, etc.).

Food categorization

All pre-packaged foods in supermarkets were included, with the exception of unpackaged fresh foods and alcoholic beverages. Pre-packaged foods were classified into fifteen (15) food categories and five (5) beverage subcategories according to the NPM-WHO/AR (excluding the categories "Fresh and frozen meat, fish and seafood" and "Fresh and frozen fruit and vegetables, pulses and tubers"). The following categories and subcategories "Food for special dietary uses" (infants' formula and dietary supplements), "Herbs and spices", "Sugar, honey and related products", "Salt and monosodium glutamate" were excluded from all analyses as they are not included in the NPM-WHO/AR.

The categories and sub-categories included in this study were 1a) Cakes, sweet biscuits and pastries, 1b) Bread and crisp bread, 2a) Savoury snacks Potato, cereal or starch-based 2b) Processed nuts, edible seeds, 3) Beverages, 4) Breakfast cereals, 5) Chocolate and sugar confectionery, 6) Cheese, 7) Yoghurt, ice cream and sorbets, 8) Flan, custard, 9) Ready-made and convenience foods, 10) Butter, oils and emulsions, 11) Pasta, noodles, rice, 12) Processed meats, 13) Processed fish and seafood products, 14) Processed fruits and vegetables, 15) Sauces, dips and dressings. The category "Beverages" is disaggregated into 5 sub-categories, including "Juices", "Milk and dairy based drinks", "Energy drinks", "Coffee, tea, herbal infusions" and "Cereals, legumes, grain beverages". The description of the food categories is shown in Table S1.

Pre-packaged foods assessed across each classification system

Depending on the classification system used, foods were evaluated on the basis of the declaration of nutritional information deemed relevant for this assessment. Figure 1 shows the number of pre-packaged foods evaluated in each classification system after applying the inclusion and exclusion criteria.

Assessment of nutritional quality of pre-packaged food

According to extent of processing After analyzing each component in the ingredient list, all pre-packaged foods were categorized into four (4) groups according to their level of processing, as defined by the NOVA classification system: (1) unprocessed or minimally processed foods;

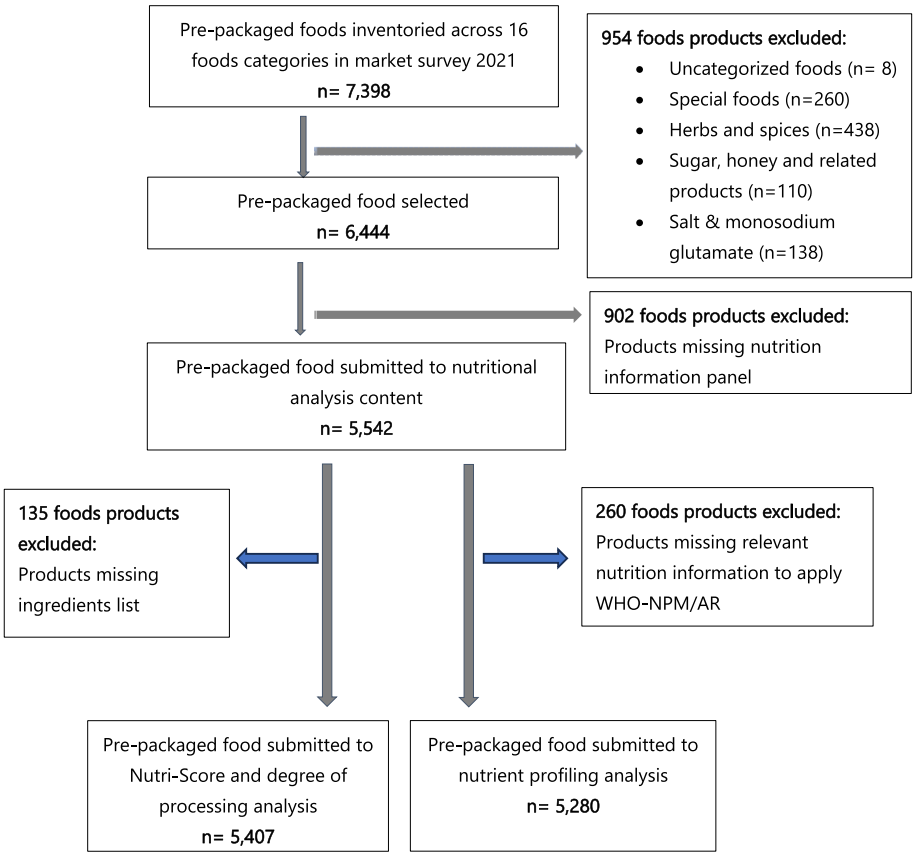

Fig. 1 Flowchart of sample size representing initial and final number dataset that used in the present study

(2) processed culinary ingredients; (3) processed foods (PFs); and (4) ultra-processed foods (UPFs) [25].

According to nutrient and energy values The calories, fat, saturated fat, total sugars, salt and sodium content of the products per 100 g or 100 ml were examined. Medians and interquartile ranges were calculated for energy and nutrient content by category and subcategory.

According to the Nutri-Score The nutritional quality of the foods was determined using the official Nutri-Score 2021 calculation tool provided by the French National Health Agency. Nutri-Score is a front-of-pack nutritional label applied in various countries in Europe that translates the nutritional quality of a product into a five-letter code A, B, C, D and E, with each letter corresponding to a different colour (group A includes scores between −15 and −1, group B between 0 and 2, group C between 3 and 10, group D between 11 and 18 and group E between 19 and 40). The letters A and B correspond to products with a high nutritional profile, while the letters D and E correspond to products with a low nutritional profile. The Nutri-Score system assigns a series of positive and negative points to each product based on its energy and nutrient content and the ingredients used in its manufacture [saturated fat, sugar, sodium, fibre, protein and fruits, vegetables, legumes and nuts (FVLN)] per 100 g or 100 ml, with slight variations for beverages and oils or solid fats. Positive points are given for the amounts of elements that should be limited, including energy, total sugars, saturated fat and sodium (0 to 10 positive points for each). Negative points are then assigned for the amount of elements that should be encouraged, including FVLN, fibre and protein (0 to 5 negative points for each).

The Nutri-Score is calculated based on the values provided in the Nutrition Facts table. The first step was to select the category to which the product belongs (generally cheese, added fats or beverages). The nutritional values of the product were then entered: calories (KJ), saturated fat (g), sugar (g), protein (g), fibre (g) and salt (g). Sodium values were given in mg. In the specific case of beverages, the first step was to indicate whether the product was a water by selecting "YES" or "NO" from the drop-down menu. However, only natural waters fall into

this category. Flavoured waters (with or without sweeteners) were considered as sweetened beverages.

According to the Nutrient Profile Model for the WHO African region Nutrient profiling was used to classify foods according to their nutrient composition. This study used the NPM-WHO/AR to assess the nutritional quality of pre-packaged foods. The nutrients for which thresholds have been set are total fat, saturated fat, total sugars, added sugars, sodium and energy, taking into account the nutrients that should be limited according to their relevance for the category. Unless otherwise stated, a food is considered to be "excessive" in one or more critical nutrients if its relative content is higher than the corresponding maximum level recommended in the salt or sugar guidelines and the WHO population nutrient intake targets.

The respective thresholds in the Nutrient Profile Model were used to determine the proportion of packaged foods that exceeded the criteria overall and in each food category. A pre-packaged food was classified as "non-permitted" to be marketed to children if the content of any defined nutrient exceeded the threshold set in the model for the corresponding product category, and in such a case, the pre-packaged food was classified as "permitted" to be marketed to children.

Statistical analyses

Energy, fat, saturated fat, total sugars, salt and sodium were analyzed per 100 g or 100 ml. Medians and interquartile ranges were calculated for energy and nutrient content by category and subcategory. Nutrient profiling was carried out on the products with nutrient values for the thresholds set in the model. The availability of "permitted" and "non-permitted" foods to be marketed to children was also calculated overall and by category.

The relationship between the two categorical variables classifying foods, NOVA and Nutri-Score, was described by simple correspondence analysis. Data analyses were performed using RStudio version 2022.07.2.

Results

Degree of processing pre-packaged foods by food categories

A total of 1,037 products (16.1%) for which the list of ingredients and/or the nutritional values were not provided, were excluded from this analysis. The degree of processing analysis was carried out on 5,407 pre-packaged foods and is presented by each food category in Table 1. The category with the highest proportion of products was "Beverages" (19.3%), followed by "Bread and bakery products" (14.3%) and "Processed fruits, vegetables and legumes" (11.9%).

Our results show that the majority of the pre-packaged foods were classified as UPFs and PFs according to the NOVA classification. The proportions of UPFs and PFs were 71.1% and 18.8%, respectively. Minimally processed foods were most frequently observed in the categories "pasta, noodles, rice" (50.0%) and "processed nuts, edible seeds" (50.7%). High proportions of PFs were observed in the categories "processed fish and seafood products" (67.0%), "processed fruits, vegetables and legumes" (51.1%) and "juices" (43.7%). The highest proportions of UPFs were found in the categories "cheese" and "frozen yoghurt, ice cream and sorbet", where 100% of the products were ultra-processed, followed by "chocolate and sugar confectionery" (99.8%) and "cakes, sweet biscuits and pastries" (99.5%). Conversely, lower proportions of UPFs were found in the categories "butter, oils and emulsions (20.8%), "processed nuts, edible seeds" (26.9%) and "processed fish and seafood products" (31.8%).

Median energy and nutrient values by food categories

Of the 6,444 products, 902 (14.0%) did not provide nutritional information on their packaging and were excluded from the nutrient analysis. As the nutrient data were not normally distributed, the median (IQR) of the energy, total fat, saturated fat, total sugar, salt and sodium content was calculated for each category. The median energy and nutrient values by category are shown in Table 2.

The results show that the energy and nutrient values varied significantly by food category. The top 5 food categories with the highest energy density per 100 g were "butter, oils and emulsions" (median 884.3 kcal [744–900]), "processed nuts, edible seeds" (565 kcal [499.4–609.8]), "savoury snacks Potato, cereal or starch-based" (504 kcal [474.5–539]), "cakes, sweet biscuits and pastries" (468 kcal [431–499]), and "chocolate and sugar confectionery" (410.4 kcal [351–532.2]). For total fat, the highest median values were found in the category "butter, oils and emulsions" (99 g/100 g [82–100]), followed by "processed nuts, edible seeds" (47.8 g/100 g [34.8–53.1]) and "cheese" (27 g/100 g [21–30]). The median values for saturated fat were mainly higher in the category "cheese" (17.3 g [13.4–20]), followed by "butter, oils and emulsions" (13.7 g [10.9–16.5]), "cakes, sweet biscuits and pastries" (8.3 g [3.5–13]) and "processed meats" (7.8 g [5.2–11.6]).

The highest contents of total sugar were found in "chocolate and sugar confectionery" (53.1 g/100 g [42.7–62]), "cakes, sweet biscuits and pastries" (29.3 g/100 g [21.3–35.3]), "frozen yoghurt, ice cream and sorbets" (24 g/100 g [17.3–27]). and "breakfast cereals" (19.2 g/100 g [12.3–25]). The highest salt levels were

Table 1 Degree of processing of pre-packaged foods by category

Food categories	n (%)	Unprocessed food n (%)	Processed culinary ingredient	PFs n (%)	UPFs n (%)
Bread and bakery products					
a) Cakes, sweet biscuits and pastries	746	3 (0.4)	0 (0.0)	1 (0.1)	742 (99.5)
b) Bread and crisp bread	125	5 (4.0)	0 (0.0)	6 (4.8)	114 (91.2)
Savoury snack foods					
a) Savoury snacks Potato, cereal or starch-based	235	41 (17.4)	0 (0.0)	10 (4.3)	184 (78.3)
b) Processed nuts, edible seeds	67	34 (50.7)	0 (0.0)	15 (22.4)	18 (26.9)
Beverages					
a) Juices	295	34 (11.5)	0 (0.0)	129 (43.7)	132 (44.7)
b) Milk and dairy based drinks	74	22 (29.7)	0 (0.0)	2 (2.7)	50 (67.6)
c) Energy drink	314	6 (1.9)	0 (0.0)	31 (9.9)	277 (88.2)
d) Coffee, tea, herbal infusion	149	36 (24.2)	0 (0.0)	33 (22.1)	80 (53.7)
e) Cereal, legumes, grain beverages	32	0 (0.0)	0 (0.0)	4 (12.5)	28 (87.5)
Breakfast cereals	112	14 (12.5)	0 (0.0)	29 (25.9)	69 (61.6)
Chocolate and sugar confectionery	432	0 (0.0)	0 (0.0)	1 (0.2)	431 (99.8)
Cheese	110	0 (0.0)	0 (0.0)	0 (0.0)	110 (100.0)
Frozen yoghurt, ice cream and sorbets	125	0 (0.0)	0 (0.0)	0 (0.0)	125 (100.0)
Flan, custard, yoghurt	112	2 (1.8)	0 (0.0)	1 (0.9)	109 (97.3)
Ready-made and convenience foods	377	0 (0.0)	0 (0.0)	86 (22.8)	291 (77.2)
Butter, oils and emulsions	53	0 (0.0)	42 (79.2)	0 (0.0)	11 (20.8)
Pasta, noodles, rice	450	225 (50.0)	0 (0.0)	28 (6.2)	197 (43.8)
Processed meats	174	4 (2.3)	0 (0.0)	24 (13.8)	146 (83.9)
Processed fish and seafood products	233	3 (1.3)	0 (0.0)	156 (67.0)	74 (31.8)
Processed fruits, vegetables and legumes	679	72 (10.6)	2 (0.3)	347 (51.1)	258 (38.0)
Sauces, dips and dressings	513	1 (0.2)	0 (0.0)	114 (22.2)	398 (77.6)
All	**5 407**	**502 (9.3)**	**44 (0.8)**	**1 017 (18.8)**	**3 844 (71.1)**

n represents products with both Nutrition Information Panel (NIP) and ingredient list by food category

found in "processed meats" (2.5 g [1.7–4.0]), "sauces, dips and dressings" (1.8 g [1–0.4]), "savoury snacks Potato, cereal or starch-based" (1.6 g [1.3–2.1]) and "cheese" (1.5 g [1.1–2.1]).

However, the following 3 categories: "cakes, sweet biscuits and pastries", "savoury snack foods" and "chocolate and sugar confectionery" had excessive levels of at least three nutrients.

For sodium, the median values were mostly higher in the categories "sauces, dips and dressings" (1.8 g/100 g [1.0–6.3]), and for "processed meats" and "bread and crisp bread" (0.7 g/100 g each).

Nutritional quality according to the Nutri-Score labelling system

The nutritional quality according to the Nutri-Score by food category is shown in Table 3. The results are displayed for foods with both the ingredients list and the nutritional values. According to the Nutri-Score, the most common category was D (24.4%), followed by E and A with 22.1% and 20.9% respectively.

The food categories that most represented Nutri-Score group A were "pasta, noodles, rices" (28.7%), followed by "processed fruits, vegetables and legumes" (19.4%) and "ready meals and convenience foods" (18.2%). For Nutri-Score B, the most common categories were "processed fruits, vegetables and legumes" (22.6%), followed by "sauces, dips and dressings" (12.9%) and "ready-made and convenience foods" (12.4%). Nutri-Score C was more represented in the "sauces, dips and dressings" category (22.3%). Nutri-Score D and E were more represented in the categories "cakes, sweet biscuits and pastries" and "chocolate and sugar confectionery".

Proportion of products not meeting energy and nutrient content according to NPM-WHO/AR

The proportion of packaged foods exceeding the threshold set in the nutrient profile model is shown in Table 4. Overall, the results show that exceeding the threshold was most common for total sugars and energy (almost 90% of non-compliant products), followed by non-compliance for total fat (approximately 50% of non-compliant

Table 2 Median values of energy, total fat, saturated fat, total sugar, salt and sodium per 100 g or 100 ml

Foods categories	Number of products[a]	Energy (Kcal/100 g)	Total Fat (g/100 g)	Saturated fat (g/100 g)	Total sugar (g/100 g)	Salt (g/100 g)	Sodium (g/100 g)
Bread and bakery products							
a) Cakes, sweet biscuits, pastries	748	468 [431–499]	19 [13–24]	8.3 [3.5–13]	29.3 [21.3–35.3]	0.6 [0.4–0.8]	0.2 [0.1–0.3]
b) Bread and crisp bread	128	384 [348–402]	4,9 [2.4–8.7]	0.6 [0.4–2.2]	6.4 [2.1–10.0]	1.1 [0.4–1.6]	0.7 [0.1–1.1]
Savoury snack foods							
a) Savoury snacks Potato, cereal	236	504 [474.5–539]	27 [21–33]	5.3 [2.5–13]	2.8 [1.4–5.6]	1.6 [1.3–2.1]	0.7 [0.5–0.9]
b) Processed nuts, edible seeds	68	565 [499.4–609.8]	47.8 [34.8–53.1]	5.3 [4.1–6.5]	5.0 [4.7–9]	0.1 [0.0–1.0]	0.3 [0.0–0.8]
Beverages							
a) Fruit and vegetables juices	309	47 [41–52]	0 [0–0.5]	0 [0–0.1]	10.5 [8.7–12]	0.0 [0.0–0.0]	0.0 [0.0–0.01]
b) Milk and dairy based drinks	90	66.1 [46.3–162]	3.5 [1.5–8]	2.2 [0.8–4.2]	5 [4.8–10.3]	0.1 [0.1–0.2]	0.0 [0.0–0.1]
c) Energy drink	315	47 [28.7–287.8]	0.1 [0–0.5]	0.1 [0–0.1]	9.8 [4.9–70]	0.0 [0.0–0.1]	0.01 [0.0–0.02]
d) Coffee, tea, herbal infusion	158	26 [2–356]	0.2 [0–2.1]	0.0 [0–0.9]	3.4 [0.0–9.5]	0.0 [0.0–0.2]	0 [0–0.1]
e) Cereal, legumes, grain beverages	32	42 [25–39.3]	1.5 [1.2–1.9]	0.3 [0.1–0.3]	3.3 [1.9–4.5]	0.1 [0.1–0.1]	-
Breakfast cereals	113	386 [375–422]	4,1 [1.9–11.7]	0.9 [0.5–2.5]	19.2 [12.3–25]	0.4 [0.2–0.8]	0.1 [0.0–0.3]
Chocolate and sugar confectionery	433	410.4 [351–532.2]	8.9 [0.5–31]	4.7 [0.1–16]	53.1 [42.7–62]	0.1 [0.0–0.3]	0.0 [0.0–0.1]
Cheese	122	316 [255–366]	27 [21–30]	17.3 [13.4–20]	0.6 [0.3–3]	1.5 [1.1–2.1]	0.4 [0.4–0.7]
Frozen yoghurt, ice cream and sorbets	125	211 [125.8–282.8]	11 [1.5–18]	7.4 [1–11]	24 [17.3–27]	0.0 [0.1–0.2]	-
Flan, custard	113	303 [135–369]	3,4 [1.4–23.7]	2 [0.1–20]	11 [3.1–23]	0.1 [0.1–0.2]	0.0 [0.0–0.1]
Ready-made and convenience foods	377	134.5 [90–240]	5.0 [2.8–10]	1.5 [0.7–3.3]	1.9 [0.9–3.3]	0.9 [0.7–1.3]	0.4 [0.3–2.0]
Butter, oils and emulsions	72	884.3 [744–900]	99 [82–100]	13.7 [10.9–16.5]	0.6 [0.5–3.4]	0.0 [0.0–0.5]	0.4 [0.4–0.4]
Pasta, noodles, rice	488	356 [349–369]	2 [1.5–4.1]	0.4 [0.3–1.2]	2.7 [0.6–3.7]	0.0 [0.0–0.7]	0.0 [0.0–0.1]
Processed meats	175	264 [207.2–346.5]	20.2 [14.8–30]	7.8 [5.2–11.6]	0.7 [0.5–1.1]	2.5 [1.7–4.0]	0.7 [0.6–0.8]
Processed fish and seafood products	234	201 [137–244]	12.3 [6.9–17.1]	2.5 [1–3.5]	0.5 [0.5–1.1]	1 [0.9–1.2]	0.5 [0.4–1.1]
Processed fruits, vegetables, legumes	692	64 [29–165]	0.5 [0.3–1]	0.1 [0.1–0.3]	3.4 [0.9–12]	0.5 [0.0–0.7]	0.3 [0.1–0.9]
Sauces, dips and dressings	514	151.9 [73–304.8]	4.5 [0.6–24.0]	0.7 [0.1–3.7]	5.5 [2.7–11.3]	1.8 [1.0–4]	1.8 [1.0–6.3]
All foods	**5542**	**284 [80–416]**	**4.4 [0.5–19.4]**	**1.3 [0.1–6.0]**	**5.6 [1.5–25.0]**	**0.9 [0.5–1.5]**	**0.1 [0.0–0.5]**

[a] Number of products with nutritional information. Median (IQR) values are presented per sub-category for 100g or 100ml of packaged food. *IQR* Interquartile range

products). The proportion of non-compliant products for more than one nutrient was more pronounced for "savoury snacks Potato, cereal or starch-based", followed by "cakes, sweet biscuits and pastries" and "processed meats". Overall, 100% of the products were non-compliant for energy in the category "savoury snacks potato, cereal". For total sugars, approximately 95% of products were non-compliant in the categories "yoghurt, ice cream and sorbets" and "energy drinks". For fat and saturated fat, non-compliance was more pronounced for "savoury snacks Potato, cereal or starch-based" (95.8% of non-compliant products for fat) and "processed meats" (almost 93% of non-compliant products for fat and saturated fat).

Proportion of permitted and non-permitted products to be marketed to children by food category

The proportion of permitted and non-permitted products to be marketed to children by food category is presented in Table 5. The results showed that almost 63.3% of the foods were classified as "non-permitted" to be marketed to children. The top 5 categories and sub-categories with the highest proportion of "permitted foods" according to the criteria set by the NPM-WHO/AR were "cereal, legumes and grain beverages" (93.8%), followed by "butter, oils and emulsions" (88.1%), "processed fruits, vegetables and legumes" (87.5%), "ready-made and convenience foods" (71.2%) and "pasta, noodles, rice" (68.9%). In contrast, the top 5 categories and sub-categories with the highest proportion of non-permitted foods to be marketed to children

Table 3 Distribution of each foods category according to Nutri-Score

Foods categories	n (%)	Nutri-Score A n (%)	Nutri-Score B n (%)	Nutri-Score C n (%)	Nutri-Score D n (%)	Nutri-Score E n (%)
Bread and bakery products						
a) Cakes, sweet biscuits and pastries	746 (95.4)	9 (0.1)	50 (5.5)	97 (11.5)	216 (16.4)	374 (31.2)
b) Bread and crisp bread	125 (89.9)	29 (2.6)	23 (2.5)	30 (3.5)	37 (2.8)	6 (0.5)
Savoury snack foods						
a) Savoury snacks Potato, cereal or starch-based	235 (80.5)	2 (2.6)	9 (1.0)	48 (5.7)	102 (7.7)	74 (6.2)
b) Processed nuts, edible seeds	67 (69.1)	4 (0.4)	8 (0.9)	28 (3.3)	24 (1.8)	3 (0.3)
Beverages						
a) Juices	295 (85.3)	0 (0.0)	2 (0.2)	12 (1.4)	61 (4.6)	219 (0.2)
b) Milk and dairy based drinks	74 (74.7)	18 (1.6)	26 (2.9)	13 (1.5)	10 (0.8)	7 (0.6)
c) Energy drink	314 (91.5)	8 (0.7)	22 (0.2)	28 (3.3)	54 (4.1)	201 (16.8)
d) Coffee, tea, herbal infusion	149 (35.0)	0 (0.0)	37 (4.1)	30 (3.5)	25 (1.9)	54 (4.5)
e) Cereal, legumes, grain beverages	32 (100.0)	7 (0.6)	25 (2.7)	0 (0.0)	0 (0.0)	0 (0.0)
Breakfast cereals	112 (99.1)	24 (2.1)	21 (2.3)	50 (5.9)	16 (1.2)	1 (0.1)
Chocolate and sugar confectionery	432 (95.4)	10 (0.9)	38 (4.2)	15 (1.8)	173 (13.1)	195 (16.3)
Cheese	110 (80.3)	3 (0.3)	0 (0.0)	6 (0.7)	84 (6.4)	16 (1.4)
Frozen yoghurt, ice cream and sorbets	125 (71.8)	3 (0.3)	0 (0.0)	6 (0.7)	84 (6.4)	16 (1.3)
Flan, custard, yoghurt	112 (70.9)	3 (0.3)	15 (1.6)	28 (3.3)	65 (4.9)	2 (0.2)
Ready-made and convenience foods	377 (95.9)	206 (18.2)	113 (12.4)	23 (2.7)	30 (2.3)	6 (0.5)
Butter, oils and emulsions	53 (55.2)	0 (0.0)	1 (0.1)	12 (1.4)	33 (2.5)	8 (0.7)
Pasta, noodles, rice	450 (86.5)	325 (28.7)	76 (8.4)	30 (3.5)	12 (0.9)	4 (0.3)
Processed meats	174 (70.2)	16 (1.4)	32 (3.5)	40 (4.7)	84 (6.4)	1 (0.1)
Processed fish and seafood products	233 (89.3)	138 (12.2)	71 (7.8)	12 (1.4)	13 (1.0)	0 (0.0)
Processed fruits, vegetables and legumes	679 (88.3)	219 (19.4)	206 (22.6)	125 (14.7)	130 (9.8)	4 (0.3)
Sauces, dips and dressings	513 (90.6)	100 (8.8)	117 (12.9)	189 (22.3)	104 (7.9)	3 (0.3)
All	**5 407**	**1131 (20.9)**	**910 (16.8)**	**847 (15.7)**	**1 320 (24.4)**	**1 197 (22.1)**

were "savoury snacks Potato, cereal or starch-based" (100%), "cakes, sweet biscuits and pastries" (98.5%), "energy drinks" (98.2%), "processed meats" (96.4%) and "yoghurt, ice cream and sorbets" (95.8%).

The non-permitted and permitted foods to be marketed to children according to the different Nutri-Score categories are shown in Table 6. The results also showed that most of the non-permitted foods were classified respectively in Nutri-Score E (35.3%), followed by Nutri-Score D (31.1%) and Nutri-Score C (16.2%). In addition, most of the permitted foods were respectively classified in Nutri-Score A (40.7%), Nutri-Score B (27.3%) and Nutri-Score C (13.0%). Nevertheless, it should be noted that almost half of the permitted foods were also rated Nutri-Score A.

Cross frequency table between Nutri-Score and NOVA classification

The cross-frequency table between Nutri-Score and NOVA classification is shown in Table 7. Ultra-processed foods were most prevalent regardless of Nutri-Score, ranging from 9.8% in Nutri-Score A to 21.0% in Nutri-Score D.

In addition, 50% of the PFs were classified as Nutri-Score A or Nutri-Score B, while almost 50% of the UPFs were classified as Nutri-Score A, Nutri-Score B or Nutri-Score C (Fig. 2).

Proportion of permitted and non-permitted foods to be marketed to children with on-pack promotion

The proportions of permitted and non-permitted products with on-pack promotions by food category are shown in Table 8. The results showed that the non-permitted foods to be marketed to children were the ones with the most on-pack promotions (12.5% vs. 4.6%).

Discussion

This study was the first to analyze the nutritional quality and on-pack marketing of pre-packaged foods available in major supermarkets in Dakar, Senegal, using the NOVA classification, the Nutri-Score labelling system and the Nutrient Profile Model for the WHO African Region. This study was conducted on a sample of 5,542

Table 4 Compliance with the WHO Nutrient Profile thresholds

Foods categories	N	Mention energy (n)	Non-Compliant products n (%)	Mention fat (n)	Non-Compliant products n (%)	Mention saturated fat (n)	Non-Compliant products n (%)	Mention total sugar	Non-Compliant products n (%)	Mention sodium (n)	Non-Compliant products n (%)
Bread and bakery products											
a) Cakes, sweet biscuits and pastries	748	747	709 (94.9)	748	654 (87.4)	713	-	723	641 (88.7)	139	55 (39.6)
b) Bread and crisp bread	128	125	-	128	35 (27.3)	103	-	106	55 (51.9)	24	14 (58.3)
Savoury snack foods											
a) Savoury snacks Potato, cereal or starch-based	236	236	236 (100)	236	226 (95.8)	220	-	277	-	65	64 (98.5)
b) Processed nuts, edible seeds	68	68	-	68	-	55	-	61	-	17	12 (70.6)
Beverages											
a) Juices	309	308	-	295	-	260	-	267	232 (86.9)	78	3 (3.8)
b) Milk and dairy based drinks	90	86	-	90	32 (35.5)	63	-	64	-	20	
c) Energy drink	315	314	-	273	-	212	-	287	273 (95.1)	59	4 (6.8)
d) Coffee, tea, herbal infusion	158	153	-	149	-	126	-	133	101 (75.9)	30	
e) Cereal, legumes, grain beverages	32	32	-	32	-	32	-	32	2 (6.3)	0	-
Breakfast cereals	113	113	-	113	28 (24.8)	113	-	113	89 (78.8)	7	2 (28.6)
Chocolate and sugar confectionery	433	432	396 (91.7)	431	218 (50.6)	418	-	419	376 (89.7)	73	
Cheese	122	121	-	121	96 (79.3)	119	-	119	-	3	1 (33.3)
Yoghurt, ice cream and sorbets	125	125	59 (47.2)	125	83 (66.4)	109	-	113	108 (95.6)	4	4 (100)
Flan, custard	113	98	70 (71.4)	97	52 (53.6)	101	-	97	50 (51.5)	7	1 (14.3)
Ready-made and convenience foods	377	377	-	377	65 (17.2)	377	89 (23.6)	376	37 (9.8)	16	11 (68.7)
Butter, oils and emulsions	72	72	-	72	-	67	8 (11.9)	30	-	1	1 (100)
Pasta, noodles, rice	488	483	-	486	151 (31.1)	444	-	450	-	41	8 (19.5)
Processed meats	175	174	-	173	162 (93.6)	163	153 (93.9)	163	-	11	10 (90.9)
Processed fish and seafood products	234	234	-	234	170 (72.6)	234	83 (35.5)	156	-	7	5 (71.4)
Processed fruits, vegetables and legumes	692	691	-	640	80 (12.5)	519	-	618	-	55	22 (40.0)
Sauces, dips and dressings	514	514	-	514	208 (40.5)	477	-	482	-	73	65 (89.0)
All	**5542**	**5 415**	**1 470 (89.1)**	**5 311**	**2 260 (49.9)**	**4 820**	**333 (39.6)**	**5275**	**2 531 (89.7)**	**726**	**277 (45.9)**

(-) indicate that thresholds have not been defined for the nutrient in the category or no products to perform nutritional profiling

Table 5 Proportion of permitted and non-permitted products to be marketed to children according to NPM-WHO/AR by food category

Foods categories	N	n	Permitted products n (%)	Non-permitted products n (%)	*p*-value
Bread and bakery products					
a) Cakes, sweet biscuits and pastries	748	747	11 (1.5)	736 (98.5)	< 0.001
b) Bread and crisp bread	128	106	51 (48.1)	55 (51.9)	0.697
Savoury snack foods					
a) Savoury snacks Potato, cereal or starch-based	236	236	0 (0.0)	236 (100.0)	< 0.001
b) Processed nuts, edible seeds	68	17	5 (29.4)	12 (70.6)	0.089
Beverages					
a) Juices	309	267	35 (13.1)	232 (86.9)	< 0.001
b) Milk and dairy based drinks	90	90	58 (64.4)	32 (35.6)	0.006
c) Energy drink	315	286	13 (1.8)	273 (98.2)	< 0.001
d) Coffee, tea, herbal infusion	158	134	33 (24.6)	101 (75.4)	< 0.001
e) Cereal, legumes, grain beverages	32	32	30 (93.8)	2 (6.2)	< 0.001
Breakfast cereals	113	113	24 (21.2)	89 (78.8)	< 0.001
Chocolate and sugar confectionery	433	431	28 (6.5)	403 (93.5)	< 0.001
Cheese	122	121	25 (20.7)	96 (79.3)	< 0.001
Yoghurt, ice cream and sorbets	125	119	5 (4.2)	114 (95.8)	< 0.001
Flan, custard	113	97	25 (25.8)	72 (74.2)	< 0.001
Ready-made and convenience foods	377	378	269 (71.2)	109 (28.8)	< 0.001
Butter, oils and emulsions	72	67	59 (88.1)	8 (11.9)	< 0.001
Pasta, noodles, rice	488	486	335 (68.9)	151 (31.1)	< 0.001
Processed meats	175	169	6 (3.5)	163 (96.4)	< 0.001
Processed fish and seafood products	234	234	62 (26.5)	172 (73.5)	< 0.001
Processed fruits, vegetables and legumes	692	639	559 (87.5)	80 (12.5)	< 0.001
Sauces, dips and dressings	514	511	303 (59.3)	208 (40.7)	< 0.001
All	**5 542**	**5 280 (95.3)**	**1 936 (36.7)**	**3 344 (63.3)**	**< 0.001**

pre-packaged foods and non-alcoholic beverages classified into 15 main categories and 9 sub-categories according to the NPM-WHO/AR.

In this study, most of the pre-packaged foods were ultra-processed foods and beverages (711%), highlighting that the majority of pre-packaged products involve UPFs, which is in line with previous studies [26, 27]. These foods are generally of poor nutritional quality (high in saturated fat, sugar, salt and low in micronutrients and fibre) and are likely to contain additives with health risks. Poor diet quality is a major risk factor for the onset and development of NCDs [28]. Preventive nutrition policies are an important public health issue for these diseases. The top 3 categories with the highest UPFs are "chocolate and sugar confectionery" (99.8%), followed by "cakes, sweet biscuits and pastries" (99.5%) and "frozen yoghurt, ice cream and sorbets" (97.2%). This is alarming given the negative impact of over-consumption of ultra-processed foods and beverages, particularly through the development of chronic NCDs. Meta-analyses have shown that the consumption of UPFs is associated with an increased risk of overweight, obesity, cardiometabolic diseases and cancer in adults, and with metabolic syndrome in adolescents and dyslipidemia in children [2, 29, 30]. In view of the current challenges, we need to move towards urgent and effective public health measures. It is essential to create an environment conducive to better nutrition by implementing policies that promote quality products. A fiscal policy aimed at improving eating habits would be an essential means of reducing the consumption of these unhealthy foods. Taxes influence consumption behaviors, especially when applied to sweetened beverages, which is a key factor in the fight against obesity and diabetes [31]. These taxes can also encourage the food industry to improve the nutritional quality of their products.

In our study, the majority of pre-packaged foods were classified in Nutri-Score D (24.4%) and Nutri-Score E (22.1%) and contained a significant percentage of UPFs, ranging from 21.0% for Nutri-Score D and 18.5% for Nutri-Score E. These results are in line with those reported by [32, 33]. However, the majority of the products examined were imported and manufactured by

Table 6 Cross-frequency table between Nutri-Score and NPM-WHO/AR for permitted and non-permitted foods to be marketed to children

Foods categories	Permitted foods to be marketed to children							Non-permitted foods to be marketed to children						
	n	Nutri-Score A	Nutri-Score B	Nutri-Score C	Nutri-Score D	Nutri-Score E	*p*-value	n	Nutri-Score A	Nutri-Score B	Nutri-Score C	Nutri-Score D	Nutri-Score E	*p*-value
Bread and bakery products														
a) Cakes, sweet biscuits and pastries	11	0 (0.0)	2 (18.2)	9 (81.8)	0 (0.0)	0 (0.0)	< 0.001	736	9 (1.2)	48 (6.5)	87 (11.8)	217 (29.5)	375 (50.9)	< 0.001
b) Bread and crisp bread	51	24 (47.1)	7 (13.7)	6 (11.8)	14 (27.4)	0 (0.0)	< 0.001	55	5 (9.1)	11 (20.0)	20 (36.4)	14 (25.5)	5 (9.1)	0.005
Savoury snack foods														
a) Savoury snacks Potato, cereal	0	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	-	236	2 (0.8)	9 (3.8)	49 (20.8)	102 (43.2)	74 (31.3)	< 0.001
b) Processed nuts, edible seeds	5	0 (0.0)	0 (0.0)	2 (40.0)	3 (60.0)	0 (0.0)	0.09	12	0 (0.0)	0 (0.0)	3 (25.0)	8 (66.7)	1 (8.3)	< 0.001
Beverages														
a) Juices	35	0 (0.0)	1 (2.9)	8 (22.8)	21 (60.0)	5 (14.3)	< 0.001	232	0 (0.0)	0 (0.0)	0 (0.0)	8 (3.4)	224 (96.6)	< 0.001
b) Milk and dairy based drinks	58	18 (31.0)	30 (51.7)	7 (12.1)	3 (5.2)	0 (0.0)	< 0.001	32	5 (15.6)	7 (21.9)	6 (18.7)	7 (21.9)	7 (21.9)	0.973
c) Energy drink	13	0 (0.0)	10 (76.9)	1 (7.7)	0 (0.0)	2 (15.4)	< 0.001	273	8 (2.9)	10 (3.7)	23 (8.4)	43 (15.7)	189 (69.2)	< 0.001
d) Coffee, tea, herbal infusion	33	0 (0.0)	28 (84.8)	3 (9.1)	1 (3.0)	1 (3.0)	< 0.001	101	0 (0.0)	0 (0.0)	29 (28.7)	19 (18.8)	53 (52.5)	< 0.001
e) Cereal, legumes, grain beverages	30	7 (23.3)	23 (76.7)	0 (0.0)	0 (0.0)	0 (0.0)	< 0.001	2	0 (0.0)	2 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	-
Breakfast cereals	24	15 (62.5)	4 (16.7)	4 (16.7)	1 (4.2)	0 (0.0)	< 0.001	89	10 (11.2)	17 (19.1)	46 (51.7)	15 (16.8)	1 (1.1)	< 0.001
Chocolate and sugar confectionery	28	1 (3.6)	23 (82.1)	4 (14.3)	0 (0.0)	0 (0.0)	< 0.001	403	8 (2.0)	15 (3.7)	11 (2.5)	174 (40.4)	195 (48.4)	< 0.001
Cheese	25	1 (4.0)	0 (0.0)	6 (24.0)	15 (60.0)	3 (12.0)	< 0.001	96	2 (2.1)	0 (0.0)	0 (0.0)	81 (84.4)	13 (13.5)	< 0.001
Yoghurt, ice cream and sorbets	5	2 (40.0)	1 (20.0)	1 (20.0)	1 (20.0)	0 (0.0)	0.735	114	0 (0.0)	15 (13.1)	34 (29.8)	46 (40.3)	19 (16.6)	< 0.001

Table 6 (continued)

Foods categories	Permitted foods to be marketed to children							Non-permitted foods to be marketed to children						
	n	Nutri-Score A	Nutri-Score B	Nutri-Score C	Nutri-Score D	Nutri-Score E	*p*-value	n	Nutri-Score A	Nutri-Score B	Nutri-Score C	Nutri-Score D	Nutri-Score E	*p*-value
Flan, custard	25	1 (4.0)	4 (16.0)	20 (80.0)	0 (0.0)	0 (0.0)	< 0.001	72	0 (0.0)	2 (2.8)	3 (4.2)	65 (90.3)	2 (2.8)	< 0.001
Ready-made and convenience foods	269	192 (71.4)	70 (26.0)	4 (1.5)	3 (1.1)	0 (0.0)	< 0.001	109	14 (12.8)	43 (39.4)	19 (17.4)	27 (24.8)	6 (4.5)	< 0.001
Butter, oils and emulsions	59	0 (0.0)	3 (5.1)	9 (15.2)	46 (78.0)	1 (1.7)	< 0.001	8	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	8 (100.0)	< 0.001
Pasta, noodles, rice	335	289 (86.3)	39 (11.6)	6 (1.8)	1 (0.3)	0 (0.0)	< 0.001	151	66 (43.7)	44 (29.1)	26 (17.2)	11 (7.3)	4 (2.6)	< 0.001
Processed meat	6	6 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.001	163	8 (4.9)	31 (19.0)	40 (24.5)	83 (50.9)	1 (0.6)	< 0.001
Processed fish and seafood products	62	55 (88.7)	5 (8.1)	0 (0.0)	2 (3.2)	0 (0.0)	< 0.001	172	83 (48.3)	65 (37.8)	12 (6.9)	12 (6.9)	0 (0.0)	< 0.001
Processed fruits, vegetables and legumes	559	217 (38.8)	178 (31.8)	79 (14.1)	84 (15.0)	1 (0.2)	< 0.001	80	1 (1.2)	4 (5.0)	28 (35.0)	43 (53.7)	4 (5.0)	< 0.001
Sauces, dips and dressing	303	77 (25.4)	101 (33.3)	83 (27.4)	40 (13.2)	2 (0.7)	< 0.001	208	21 (10.9)	15 (7.2)	107 (51.4)	64 (30.8)	1 (0.4)	< 0.001
All	**1 936**	**905 (46.7)**	**529 (27.3)**	**252 (13.1)**	**235 (12.1)**	**15 (0.8)**		**3 344**	**242 (7.3)**	**338 (10.1)**	**543 (16.2)**	**1 039 (31.1)**	**1 182 (35.3)**	

Table 7 Cross-frequency table between Nutri-Score and NOVA classification

Nutri-Score	n (%)	Unprocessed foods n (%)	Processed culinary ingredients n (%)	PFs n (%)	UPFs n (%)
Nutri-Score A	1131 (20.9)	274 (5.1)***	0 (0.0)	328 (6.0)***	529 (9.8)
Nutri-Score B	910 (16.8)	84 (1.6)	3 (0.1)	271 (5.0)	552 (10.2)
Nutri-Score C	847 (15.7)	54 (1.0)	6 (0.1)	165 (3.0)	622 (11.5)
Nutri-Score D	1320 (24.4)	35 (0.6)	30 (0.6)***	119 (2.2)	1 136 (21.0)***
Nutri-Score E	1199 (22.2)	55 (1.0)	6 (0.1)	138 (2.6)	1 000 (18.5)
All	**5 407**	**502 (9.3)**	**45 (0.9)**	**1 021 (18.8)**	**3 839 (71.0)**

Statistically significant at $p < 0.05$; *** corresponds to a value of $p < 0.001$

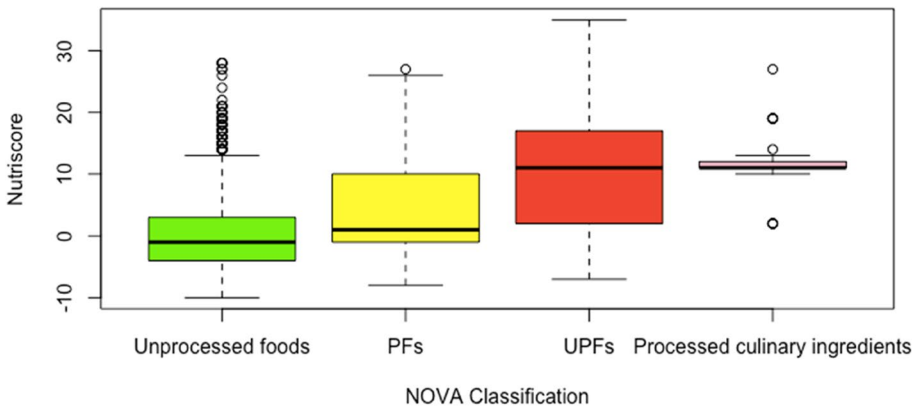

Fig. 2 Boxplot showing the Nutri-Score values according to the different food processing categories. The lower limit of the box indicates the 25th percentile, the line inside the box marks the median and the upper limit of the box indicates the 75th percentile. Whiskers (error bars) at the top and bottom of the box indicate the lower limit (25th percentile—1.5* (inter-quartile range)) and the upper limit (75th percentile + 1.5* (inter-quartile range)). The circles are individual outliers

large multinational companies that have committed to voluntary reformulation of their products. This leaves one perplexed, given the many declarations of nutritional commitments and policies by these food companies. Recent reports show that consumption of foods ranked lower on the Nutri-Score scale is associated with an increased risk of cardiovascular disease [34] and mortality [35]. Interventions should be implemented to make products of better nutritional quality more visible in supermarkets and, conversely, products with a Nutri-Score D or E less visible.

In this study, approximately 20% of the products in the two healthiest Nutri-Score classes (Nutri-Score A and B) were UPFs. This may be explained by the fact that although the Nutri-Score algorithm includes nutrients and elements whose consumption has an impact on health, it does not include other aspects of food that are likely to have an impact on health, such as the presence of additives (colorings, preservatives, emulsifiers, flavor enhancers, sweeteners, etc.). Adding these elements to the Nutri-Score rating could improve the ability to classify/discriminate between healthy and unhealthy items.

In this study, nutritional profiling was performed on 95% of the products for which nutritional information was provided and the results showed that 63.3% did not meet the criteria of the WHO Nutrient Profile Model. These results are similar to those reported by Frank et al. [36] in South Africa and Vergeer et al. [37] on food products available on the Canadian market. Li et al. [38] also reported a higher proportion of non-compliant foods (90%) for the WHO Western Pacific Region NPM (WPHO NPM). In light of these findings, the fact that nearly 63% of products do not meet the model criteria indicates that these products contain high levels of nutrients of concern, particularly saturated fat, sugar and/or sodium. Unhealthy diets high in saturated fat, sugar and sodium are associated with obesity, high blood pressure and chronic diseases such as heart disease, cerebrovascular accidents and type 2 diabetes [39]. Reformulation of pre-packaged foods is essential to address this issue and is an effective way to improve the food supply. The need

Table 8 Proportion of permitted and non-permitted foods to be marketed to children with on-pack promotion

Foods categories	Permitted foods		Non-permitted foods		
	N	with on-pack promotion n (%)	N	with on-pack promotion n (%)	*p*-value
Bread and bakery products					
a) Cakes, sweet biscuits and pastries	11	0 (0.0)	736	130 (17.7)	0.163
b) Bread and crisp bread	51	3 (5.9)	55	7 (12.7)	0.251
Savoury snack foods					
a) Savoury snacks Potato, cereal or starch-based	0	0 (0.0)	236	41 (17.4)	-
b) Processed nuts, edible seeds	5	0 (0.0)	12	0 (0.0)	-
Beverages					
a) Juices	35	1 (2.8)	232	6 (2.6)	0.926
b) Milk and dairy based drinks	58	8 (13.8)	32	9 (28.1)	0.134
c) Energy drink	13	2 (15.4)	273	7 (2.6)	0.01
d) Coffee, tea, herbal infusion	33	1 (3.0)	101	6 (5.9)	0.525
e) Cereal, legumes, grain beverages	30	0 (0.0)	2	0 (0.0)	-
Breakfast cereals	24	10 (41.7)	89	45 (50.6)	0.579
Chocolate and sugar confectionery	28	0 (0.0)	403	126 (31.3)	0.003
Cheese	25	7 (28.0)	96	4 (4.2)	0.000
Yoghurt, ice cream and sorbets	5	0 (0.0)	114	9 (7.9)	0.529
Flan, custard	25	4 (16.0)	72	10 (13.8)	0.810
Ready-made and convenience foods	269	3 (1.1)	109	0 (0.0)	0.270
Butter, oils and emulsions	59	0 (0.0)	8	0 (0.0)	-
Pasta, noodles, rice	335	23 (6.9)	151	14 (9.3)	0.373
Processed meats	6	1 (16.7)	163	4 (2.4)	0.046
Processed fish and seafood products	62	0 (0.0)	172	1 (0.6)	0.548
Processed fruits, vegetables and legumes	559	23 (4.1)	80	0 (0.0)	0.069
Sauces, dips and dressings	303	4 (1.3)	208	0 (0.0)	0.097
All	**1 936**	**90 (4.6)**	**3 344**	**419 (12.5)**	**< 0.001**

Statistically significant at $p < 0.05$

to improve product nutrition labelling is also crucial and interpretative nutrition labelling could be an effective way to help consumers make quick and informed choices, and underlies to motivate manufacturers to develop products with lower levels of the nutrients that contribute to chronic disease.

This study showed that the majority of non-permitted foods to be marketed to children were classified in the Nutri-Score groups C, D, and E (82.6%). However, a more detailed examination of the food categories showed that the Nutri-Score would have classified 52.2% and 85.5% of non-permitted foods "ready-made and convenience foods" and "processed fish and seafood products" respectively in Nutri-Score groups A and B. This result suggests a slight discrepancy between the two classification systems, even though both are based on the nutritional composition of foods. This could be explained by the fact that the Nutri-Score system includes fibre, protein and FVNL (fruits, vegetables, nuts and legumes) in its classification. For example, in the "processed fish and seafood products" category, the protein content of fish means that some packaged foods are healthy according to the Nutri-Score, without any indication of high saturated fat content. Nevertheless, the results of this study also showed that the Nutri-Score would classify 74% of the permitted foods to be marketed to children according to NPM-WHO/AR in Nutri-Score groups A and B. However, the research carried out by Richonnet et al. [27] on French market reported a higher proportion (almost 95%), thus highlighting the consistency between the two classification systems.

In an operational context, front-of-pack nutrition labelling systems make it easier for consumers to understand nutritional information, enabling them to make better food choices. The Nutri-Score could be adopted, as this logo reflects the nutritional quality of products and not only encourages manufacturers to offer better quality

products, but also encourages the public to make healthier choices. The government should take action to make this nutritional logo mandatory on the front of products as a public health tool to guide consumers in their food choices in order to prevent chronic diseases. However, the Nutri-Score currently only applies to packaged foods and many foods products are not labelled. Therefore, other public health measures need to be implemented in addition, such as strengthening the nutritional labelling of products by making it mandatory to include other information deemed relevant to consumers, in particular the content of nutritional components and the processing degree of products. Joint initiatives are needed, in particular campaigns to raise awareness and educate the public about nutrition and the impact of food choices on health, including the importance of good eating habits.

Our results showed a significant proportion of UPFs in the permitted foods according to the WHO nutrient profiling. This result may suggest that high-processed foods do not always have a mediocre nutritional composition, as highlighted by other authors [40].

In this study, 12.5% of promotional characters were displayed on the packaging of non-permitted foods according to NPM-WHO/AR. The most common promotional characters used were cartoon characters and premium offers with a strong appeal to children, strategies known to influence children under 12 years of age, particularly in their choices, preferences and eating habits. International research has shown that children's exposure to unhealthy foods and beverages contributes to preferences for unhealthy foods and beverages [41]. Through this aggressive marketing, children are more likely to be exposed to products with low nutritional value. Unhealthy foods in childhood have an impact on obesity, dental caries and taste preferences in later life [42, 43]. Implementing marketing restrictions that protect children should be a priority. The Senegalese government should establish solid, comprehensive regulations based on the WHO's nutrient profile model to define which foods should not be marketed in order to protect children's health.

The limitations of this study were that only around 80% of foods declared their nutritional composition and, on the other hand, foods in certain categories did not declare their content of specific nutrients for which thresholds have been defined in the NPM-WHO/AR, although nutritional information was displayed on the packaging. This study was based on the previous version of the Nutri-Score tool for assessing the nutritional quality of pre-packaged foods. The current version would have placed more foods in Nutri-Score categories C, D or E as the revised, slightly stricter Nutri-Score calculation changes the score for certain product categories. For example, under the old calculation, some breakfast cereals would have been Nutri-Score A, but under the new algorithm these would have been downgraded to Nutri-Score C (the tightening of the criteria removes positive points for protein, but also takes more account of sugar and salt content). Under the new Nutri-Score, cereal have received more negative points for sugar and salt and less positive points for protein and fiber; and the presence of sweeteners in beverages is taken into account. This study was limited to data on pre-packaged foods available in two hypermarkets in the Senegalese capital. Consequently, it could not shed light on the nutritional quality of food available on the Senegalese market as whole (given that chains such as Casino and Utile promote their own brand products although the most identified products are also sold in the aforementioned chains; but also had a significant market share).

Conclusion

This study reports that pre-packaged foods available in major supermarkets in Senegal are predominantly non-permitted to be marketed to children and are widely promoted. Policies should be implemented to incentivize the reformulation of pre-packaged foods in the context of increasing levels of obesity and diet-related NCDs. Government should strengthen nutrition labelling of foods so that consumers have relevant information to guide their food choices. Other public health measures, such as restrictions on marketing targeting to children, need to be implemented alongside.

Our study shows wide variation in the agreement of the nutritional assessment between the three classification systems (NOVA, Nutri-Score and NPM-WHO/AR). Nutritional profiling is an important tool that can help define and monitor policies actions to improve the healthiness of products. The Senegalese government could rely on the NPM-WHO/AR to define which foods are permitted or not for marketing to children. Furthermore, in order to implement a front-of-pack labelling system in Senegal (whether Nutri-Score or another system), it would be important as a priori, to make nutrition declarations mandatory on the back of product packaging, subsequently to facilitate the calculation of scores supporting the chosen front-of-pack nutritional labelling system.

Abbreviations

INFORMAS	International Network for Food and Obesity/non-communicable diseases, Research, Monitoring and Action Support
IQR	Interquartile range
FVNL	Fruits, Vegetable, Nuts and Legumes
NCDs	Non-Communicable Diseases
NIP	Nutrition Information Panel
NPM	Nutrient Profile Model
ODK	Open Data Kit
PFs	Processed foods
UPFs	Ultra-Processed foods

SpF	Santé Publique France
WHO	World Health Organization
NPM-WHO/AR	Nutrient Profile Model by WHO for African region

Supplementary Information

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Supplementary Material 1: Table S1. Description of the foods categories according to WHO Nutrient Profile Model for African region. * Table S2. Distribution of each foods category according to Nutri-Score.

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Authors' contributions
A.D. is the principal investigator of the study and successful funding application. Y.O., M.H.F. and A.D. designed the study. Y.O. and F.F. carried out data collection in supermarkets; M.H.F. supervised data collection; Y.O. performed statistical analysis; M.H.F., and A.D. corrected and validated data analysis; Y.O., M.H.F. and A.D. drafted the manuscript with inputs from G.S., N.I.D., B.S. and S.V. All authors reviewed the manuscript.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
Hypermarkets Directors and Managers provided informed consent to Laboratoire de Recherche en Nutrition et Alimentation Humaine (LARNAH) to participate in this study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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