International Journal of Food Sciences and Nutrition

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/iijf20

Nutrient profile of packaged foods according to the degree of processing

Catarina Vale, Carla Almeida, José Azevedo & Patrícia Padrão

To cite this article: Catarina Vale, Carla Almeida, José Azevedo & Patrícia Padrão (08 Jan 2024): Nutrient profile of packaged foods according to the degree of processing, International Journal of Food Sciences and Nutrition, DOI: 10.1080/09637486.2023.2299771

To link to this article: https://doi.org/10.1080/09637486.2023.2299771

INTERNATIONAL JOURNAL OF FOOD SCIENCES AND NUTRITION
https://doi.org/10.1080/09637486.2023.2299771

Taylor & Francis
Taylor & Francis Group

RESEARCH ARTICLE

Nutrient profile of packaged foods according to the degree of processing

Catarina Vale[a‡], Carla Almeida[a,b,c‡], José Azevedo[b,c,d] and Patrícia Padrão[a,b,c]

[a]Faculdade de Ciências da Nutrição e Alimentação da Universidade do Porto, Porto, Portugal; [b]EPIUnit – Instituto de Saúde Pública, Universidade do Porto, Porto, Portugal; [c]Laboratório para a Investigação Integrativa e Translacional em Saúde Populacional (ITR), Porto, Portugal; [d]Faculdade de Letras de Universidade do Porto, Porto, Portugal

ABSTRACT

An increased consumption of ultra-processed foods (UPF) leads to a rising prevalence of chronic noncommunicable diseases. This study aims to characterise the nutrient profile of white-label pre-packaged foods and bakery products available in a market leader Portuguese food retail chain, according to the extent of processing proposed by *NOVA* classification system. The nutrient profile (energy, sugar, total fat, saturated fat and sodium) according to processing degree was analysed using non-parametric tests. UPF were the most energy dense (278 kcal/100 g, $p < .001$) and the highest in sugar (15.9 g/100 g, $p < .001$). Processed foods were the highest in sodium (538 mg/100 g, $p < .001$). Processed and UPF showed significantly higher total (12.4 and 10.8 g/100 g, respectively) and saturated fat content (6.10 and 4.61 g/100 g, respectively) than unprocessed/minimally processed foods ($p < .001$). Regarding the variation of the nutritional value across the extent of processing, different results were observed for some categories suggesting the importance of a stratified analysis. The consumption of less processed foods and the manufacture of processed/UPF with better nutrient profile should be promoted.

ARTICLE HISTORY
Received 22 September 2023
Revised 8 December 2023
Accepted 21 December 2023

KEYWORDS
Food processing; nutritional value; noncommunicable diseases; food industry

Introduction

Eating patterns have changed in the last decades and continue to change rapidly, as food products have become commodities produced and traded in a market that has expanded from an essentially local base to an increasingly global one (World Health Organization 2003).

Changes in the world food economy contribute to this shift in dietary patterns, characterised by increased consumption of industrialised foods and animal products in detriment of homemade options based on vegetables, whole grains and legumes (World Health Organization 2003). The former are usually characterised as being energy dense foods with high contents of saturated fat, free sugar and sodium, and low in fibre and potassium (Mannar et al. 2020).

As a reflection of these changes, there has been a growing effort to develop tools that group foods according to their nutrient profile or extent of processing, that enables the study of the relation between food consumption and health outcomes. One of the systems largely used to classify foods by degree of processing is the *NOVA* food classification system (Monteiro et al. 2010; Monteiro, Cannon, Lawrence, et al. 2019). *NOVA* divides food into four groups (unprocessed or minimally processed, processed culinary ingredients, processed foods, and ultra-processed foods (UPF)). UPF are formulations of ingredients, mostly of exclusive industrial use, that result from a series of industrial processes. They are characterised by the fractioning of whole foods into substances, with the subsequent assembly of these unmodified and modified food elements using industrial techniques, and the addition of cosmetic additives. They are made to be convenient, low priced and hyper-palatable and, therefore, prone to displace the consumption of unprocessed or minimally processed foods and homemade cooked meals (Monteiro, Cannon, Levy, et al. 2019).

In this context, considering that both price, convenience and flavour are demanding characteristics for consumers' choice (Glanz et al. 1998; Roos et al. 2012), a growing consumption of UPF has been observed. In Portugal, the average household availability of UPF was 10.2% in 2000 (Monteiro et al. 2018). A more recent study (2015–2016) reported a contribution of UPF to daily energy intake of 24.0%

CONTACT Patrícia Padrão patriciapadrao@fcna.up.pt Rua do Campo Alegre, 823/4150-180 Porto, Portugal
‡Both authors contributed equally to this work.

in adults and 16.0% in elderly, reflecting an increase of the UPF intake with a concomitant displacement of the other groups (de Miranda et al. 2021).

In line with this, recent studies have been focusing on the impact of the consumption of UPF on health. Recent meta-analyses found positive associations between the consumption of UPF and chronic noncommunicable diseases (NCDs) (Lane et al. 2021; Pagliai et al. 2021; Isaksen and Dankel 2023), favouring its upward trend. This is particularly important given that currently, NCDs cause more deaths than all other causes combined and are projected to increase from 38 million in 2012 to 52 million by 2030 (World Health Organization 2014).

Considering this shift in consumer's intake and its impact on health, it is important to increase the knowledge on the nutritional value of foods available on the market that have been subjected to different degrees of processing. It is particularly relevant to know the composition of these foods regarding nutritional parameters identified in the literature as risk factors for diet-related non-communicable diseases with worrying prevalence in the population, such as obesity, diabetes, hypertension and cardiovascular diseases (Boniface and Tefft 2002; Basu et al. 2013; Romieu et al. 2017; Wang et al. 2020). Therefore, this study aims to characterise the nutrient profile of white-label pre-packaged foods and bakery products available for sale in a Portuguese market leader food retail chain, focusing on energy, sugar, total fat, saturated fat and sodium according to the extent of processing.

Materials and methods

A cross-sectional study was conducted, including a sample of white-label pre-packaged foods and bakery products available for sale in supermarkets from a market leader Portuguese food retail chain (European Supermarket Maganize 2023) with a nationwide coverage, during 2020.

Food products' selection and data collection

A database with nutritional information and list of ingredients of foods was provided by the food retail company regarding pre-packaged white-label food and bakery products available for sale in national supermarkets. Beverages, delicatessen, frozen food, dairy and alternatives, grocery products, prepacked vegetables and meals, desserts, and baked goods were included. Chewing gum and whole spices, usually not used for ingesting, were excluded, as well as alcoholic beverages, tea, coffee and coffee substitutes, due to lack of accurate nutritional information.

The nutritional information, namely energy (kcal), sugar (g), total fat (g), saturated fat (g) and salt (g), was presented per 100 g of product or 100 ml for beverages. Missing values of nutritional parameters in the database were consulted in product labels directly in store.

Food classification

Food products were assembled into food categories using the World Health Organization's (WHO) global sodium benchmarks for different foods, which divides food and beverages into 18 main food categories: (1) chocolate and sugar confectionery, energy bars, and sweet toppings and desserts; (2) cakes, sweet biscuits and pastries; other sweet bakery wares; and dry-mixes for making such; (3) savoury snacks; (4) beverages; (5) edible ices; (6) breakfast cereals; (7) yoghurt, sour milk, cream and other similar foods; (8) cheese; (9) ready-made and convenience foods and composite dishes; (10) butter and other fats and oils; (11) bread, bread products and crisp breads; (12) fresh or dried pasta, noodles, rice and grains; (13) fresh and frozen meat, poultry, game, fish and similar; (14) processed meat, poultry, game, fish and similar; (15) fresh and frozen fruit, vegetables and legumes; (16) processed fruit, vegetables and legumes; (17) plant-based food/meat analogues; (18) sauces, dips and dressings (World Health Organization 2021). An additional food category for culinary ingredients (19, culinary ingredients) was created.

Categorisation of food products according to the extent of processing was performed using the *NOVA* food classification system (Monteiro, Cannon, Lawrence, et al. 2019; Monteiro, Cannon, Levy, et al. 2019).

Data analysis

A total of 1489 food products were considered for analysis and descriptive statistics were performed for food categories and *NOVA* groups.

Processed culinary ingredients (group 2 of *NOVA* classification), which include, among others, salt, oils and sugar, were excluded from the analysis of nutrient profile according to food categories and degree of processing (N = 41), remaining 1448 food products for the final analysis.

As the retail company has different manufacturers that produce bakery products with the same designation, but with different nutritional content, the average of the diverse nutritional compositions was used. Sodium was obtained from salt, considering 1 g salt equals 400 mg of sodium.

Normality tests were performed for nutrients. For studying nutritional parameters according to the degree of processing and food categories, Mann–Whitney and Kruskal–Wallis tests were performed ($n > 5$), as applicable. For Kruskal–Wallis's multiple comparisons, stepwise-stepdown comparisons were applied, and the Mann–Whitney test was used to describe which groups were significantly different on each parameter. A significance value of .05 was considered. Means and standard deviation (SD) were used to describe contents of energy (kcal), sugar (g), total fat (g), saturated fat (g) and sodium (mg), per 100 g or 100 ml of product, as appropriate.

Associations between nutrients were assessed using Spearman's correlation coefficient. Statistical analysis was performed using IBM SPSS Statistics v27 (Armonk, NY).

Results

A total of 1489 pre-packaged foods and baked goods were analysed, of which 65.7% were ultra-processed, 16.2% were processed, 15.3% were unprocessed or minimally processed and 2.8% were processed culinary ingredients (Figure 1).

Cakes, sweet biscuits and pastries represented the largest food groups' contributor to this brand's food availability, while the least available food group was plant-based food/meat analogues, accounting respectively for 14.6% and 0.3% of all foods analysed (Figure 2).

Figure 3 illustrates the distribution of foods within each category by degree of processing. The categories providing the largest percentage of UPF were edible ices (100%), plant-based food/meat analogues (100%), cakes, sweet biscuits and pastries (98.2%), chocolate and sugar confectionary, energy bars and sweet toppings and desserts (96.7%), breakfast cereals (94.1%), bread and bread products (92.2%), ready-made and convenience foods (90.4%) and yoghurt, sour milk, cream and similar (88.3%). On the contrary, unprocessed or minimally processed foods represented most of the following categories: fresh and frozen meat and similar (100%), pasta, rice and grains (98.0%) and fresh and frozen fruit, vegetables and legumes (97.6%). Cheese was the group with the highest proportion of processed foods (84.9%).

The nutrient profile of foods according to the degree of processing is described in Table 1. The group with the highest mean energy density was UPF, followed by processed foods, and unprocessed or minimally processed foods (278 vs. 231 vs. 214 kcal/100 g, respectively; $p < .001$). Sugar content was also highest in UPF, followed by unprocessed or minimally processed foods, and processed foods

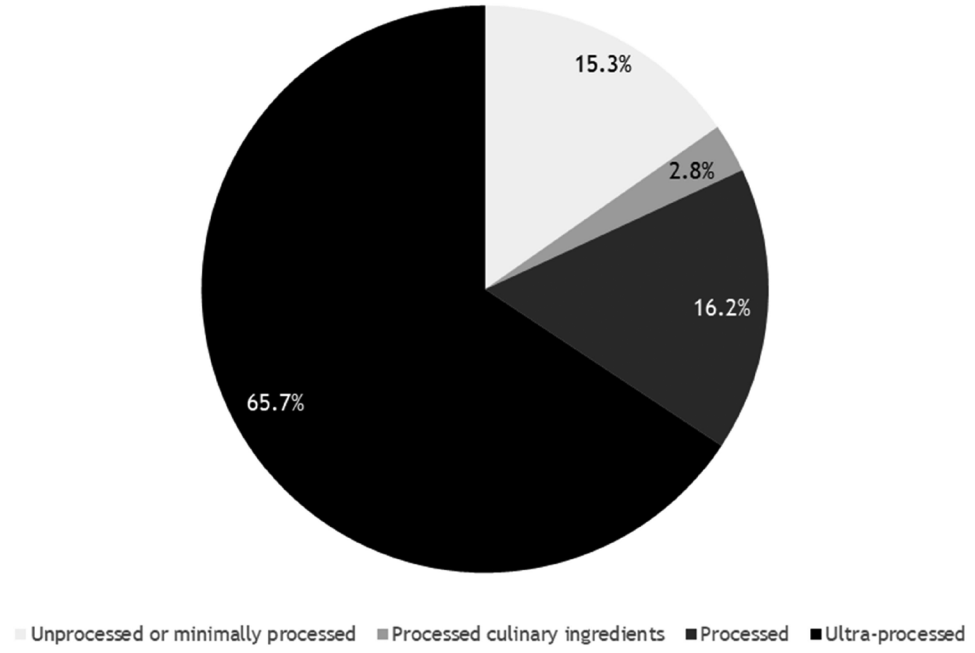

Figure 1. Distribution of food products by degree of processing (n = 1489).

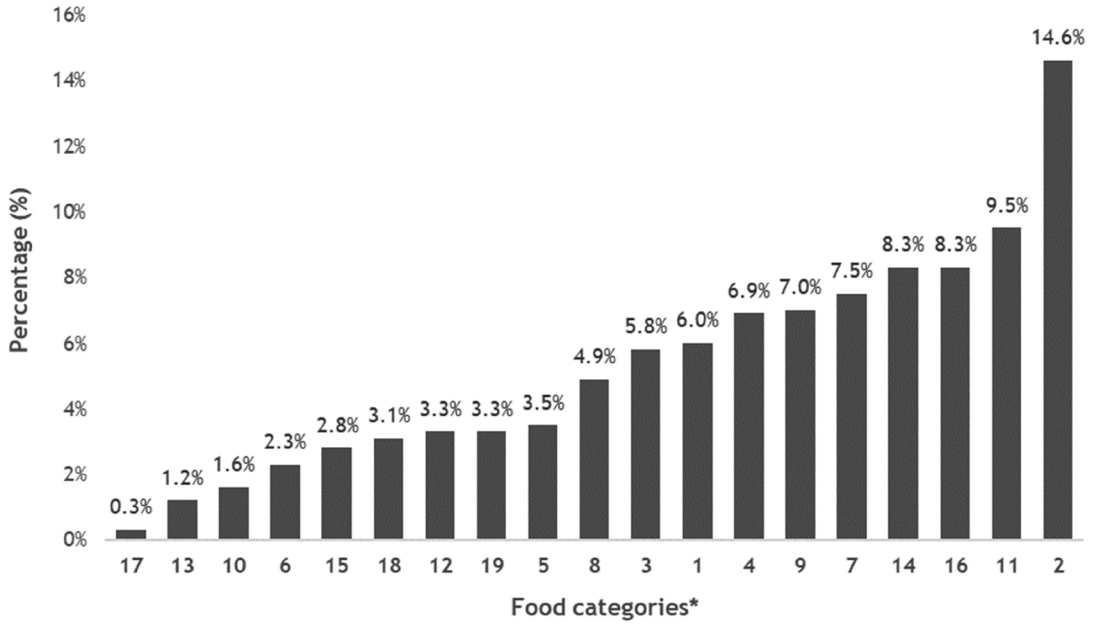

Figure 2. Distribution of food products by food categories (n = 1489). *(1) chocolate and sugar confectionery, energy bars, and sweet toppings and desserts; (2) cakes, sweet biscuits and pastries; other sweet bakery wares; and dry-mixes for making such; (3) savoury snacks; (4) beverages; (5) edible ices; (6) breakfast cereals; (7) yoghurt, sour milk, cream and other similar foods; (8) cheese; (9) ready-made and convenience foods and composite dishes; (10) butter and other fats and oils; (11) bread, bread products and crisp breads; (12) fresh or dried pasta, noodles, rice and grains; (13) fresh and frozen meat, poultry, game, fish and similar; (14) processed meat, poultry, game, fish and similar; (15) fresh and frozen fruit, vegetables and legumes; (16) processed fruit, vegetables and legumes; (17) plant-based food/meat analogues; (18) sauces, dips and dressings; (19) culinary ingredients.

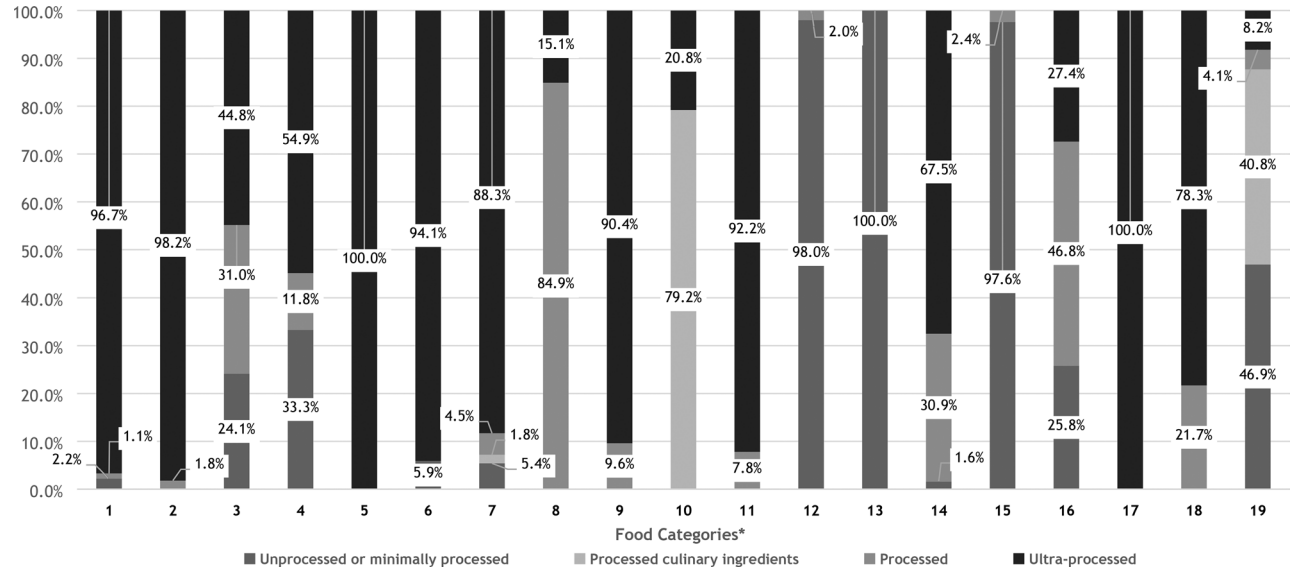

Figure 3. Distribution of foods by degree of processing within each food category (n = 1489). *(1) chocolate and sugar confectionery, energy bars, and sweet toppings and desserts; (2) cakes, sweet biscuits and pastries; other sweet bakery wares; and dry-mixes for making such; (3) savoury snacks; (4) beverages; (5) edible ices; (6) breakfast cereals; (7) yoghurt, sour milk, cream and other similar foods; (8) cheese; (9) ready-made and convenience foods and composite dishes; (10) butter and other fats and oils; (11) bread, bread products and crisp breads; (12) fresh or dried pasta, noodles, rice and grains; (13) fresh and frozen meat, poultry, game, fish and similar; (14) processed meat, poultry, game, fish and similar; (15) fresh and frozen fruit, vegetables and legumes; (16) processed fruit, vegetables and legumes; (17) plant-based food/meat analogues; (18) sauces, dips and dressings; (19) culinary ingredients.

Table 1. Nutrient profile of foods according to processing degree (n = 1448).

	Energy (kcal/100 g)[1]	Sugar (g/100 g)[1]	Total fat (g/100 g)	Saturated fat (g/100 g)	Sodium (mg/100 g)
Degree of processing (NOVA)			Mean ± SD		
Unprocessed or minimally processed (n = 228)	214 ± 184[a]	5.6 ± 7.9[b]	6.5 ± 14.8[a]	1.45 ± 4.86[a]	49 ± 54[a]
Processed (n = 242)	231 ± 153[b]	5.0 ± 11.6[a]	12.4 ± 1.6[b]	6.10 ± 7.64[b]	538 ± 733[c]
Ultra-processed (n = 978)	278 ± 151[c]	15.9 ± 18.1[c]	10.8 ± 11.8[b]	4.61 ± 5.57[b]	521 ± 1756[b]
p Value	<.001	<.001	<.001	<.001	<.001

SD: standard deviation.
[1]Sample size was lower due to missing values in the following variables: energy (n = 1446); sugar (n = 1447).
a,b,c homogeneous subsets according to Mann–Whitney's test, with 95% of confidence.

(15.9 vs. 5.6 vs. 5.0 g/100 g, respectively; p < .001). Similar values for total fat and saturated fat were observed in processed foods and UPF (total fat: 12.4 vs. 10.8 g/100 g; saturated fat: 6.10 vs. 4.61 g/100 g, respectively) but significantly different from the unprocessed or minimally processed foods (6.5 and 1.45 g/100 g, of total and saturated fat, respectively; p < .001). Regarding sodium, processed foods presented the highest content, followed by UPF, and unprocessed or minimally processed with the lowest (538 vs. 521 vs. 49 mg/100 g, respectively; p < .001).

Regarding the variation of the nutritional value across extent of processing, different results were observed for some categories (Appendix A). Regarding the energy, unprocessed savoury snacks showed the highest mean energy content within this category (category 3, p < .001). On the other hand, both unprocessed and processed foods showed a highest mean energy content than UPF for beverages (category 4, p < .001). Processed cheese showed a higher mean energy content than UPF cheese (category 8, p = .029) (Appendix A, Table A1).

Regarding sugar, unprocessed and processed savoury snacks showed identical mean content, significantly lower than UPF (category 3, p < .001). Specifically for beverages, the lowest sugar content was observed for UPF, followed by unprocessed and processed beverages (category 4, p < .001). Within category 7, processed yoghurts, cream and similar showed the highest mean sugar content (p = .002). For processed fruits, vegetables and legumes (category 16), UPF showed a higher mean sugar content than processed foods (p < .001), but was not significantly different from unprocessed fruits, vegetables and legumes (Appendix A, Table A2).

Focusing on total fat, unprocessed savoury snacks (category 3) showed the highest fat content followed by processed and UPF snacks (p < .001). Within processed fruits, vegetables and legumes (category 16), UPF showed significantly higher fat content than foods with lower extent of processing (p < .001). Identical results were observed for sauces, dips and dressings (category 18) where UPF had a higher total fat content than processed ones (p = .010) (Appendix A, Table A3).

Specifically for saturated fat, UPF savoury snacks showed the lowest content comparing to snacks with lower extent of processing (category 3, p = .005). For both ready-made foods (category 9) and sauces, dips and dressings (category 18), UPF showed significantly higher saturated fat content than processed foods (p < .001 and p = .020, respectively). Unprocessed fruits, vegetables and legumes (category 16) showed a significantly higher saturated fat content than foods with higher extent of processing (p < .001) (Appendix A, Table A4).

Despite the highest sodium content observed for overall processed foods, UPF and processed savoury snacks (category 3) showed similar sodium content, significantly higher than unprocessed snacks (p < .001). Focusing on category 4, the highest sodium content was observed for unprocessed beverages, comparing to beverages with higher extent of processing (p = .009). UPF yoghurts showed the lowest sodium content (category 7, p = .023), not significantly different from unprocessed ones. Opposite results were observed for ready-made foods and dishes (category 9) where UPF showed the highest sodium content, comparing to processed foods (p = .002) (Appendix A, Table A5).

Statistically significant positive correlations were observed between energy and sodium (ρ = 0.272, p < .001), total fat and sodium (ρ = 0.429, p < .001) and saturated fat and sodium (ρ = 0.423, p < .001). Statistically significant negative correlations were observed between sugar and sodium (ρ = –0.368, p < .001).

Discussion

Two-thirds of the pre-packaged and bakery products analysed were classified as ultra-processed. Even considering that no fresh foods, apart from bakery and pre-packaged vegetables, were included, it is still a large number, that reflects the rising in the availability of UPF in line with other countries (Luiten et al. 2016). This is,

however, not surprising, considering that the food category that contributed most to the share of all food products available was cakes, sweet biscuits and pastries. These foods are often added cosmetic additives to enhance palatability and contain a variety of different sweeteners apart from sugar which place them in the UPF group. Also, it is interesting to note that the majority of the categories that were almost entirely comprised of UPF were constituted by foods high in sugar, such as ice-cream, chocolate, candy and breakfast cereals, supporting our results that showed that UPF were the largest source of sugar. This find is also supported by a previous study performed in Italy where the highest sugar content per 100 g was observed for ultra-processed breakfast cereals, comparing with cereals with a lower extent of processing (Angelino et al. 2023). Also, an association between increased consumption of UPF and higher sugar intake was found by Cediel et al. (2018), Latasa et al. (2018) and Martínez Steele et al. (2016). UPF were also the most energy dense of the groups, which supports evidence linking the increasing consumption of these foods to the rising prevalence of obesity (Monteiro et al. 2018; Vandevijvere et al. 2019; Lane et al. 2021; Pagliai et al. 2021). A curious result was observed for sodium, since Phulkerd et al. (2023) found that 94.3% of UPF products exceed the nutrient cut-off and, according to our results, UPF showed a lower mean sodium content than processed foods.

Our findings support that processed and UPF present a less interesting nutrient profile than unprocessed or minimally processed ones, placing them in a more favourable position for the increased risk of NCDs (Rauber et al. 2018; Machado et al. 2019; Anastácio et al. 2020; Delpino et al. 2022). Also, by preforming a targeted analysis by food category, this study enables us to have some concrete evidence on the availability and nutritional value of the food on the market and reflect on what can be done to improve the quality of the food supply. Looking in detail at some differences in the nutritional value according to the degree of processing, within each food category, unprocessed or minimally processed savoury snacks were higher in fat compared to processed and ultra-processed ones. This apparently surprising finding is explained by the fact that this category comprised nuts and seeds, that are naturally high fat food sources. Another category that deserves a closer look is beverages. In fact, it was a very heterogeneous group. Water together with some natural fruit juices, without added sugar, and plain milk, classified as unprocessed or minimally processed were included in the group. On the other hand, nectars and fruit juices with added sugar were considered processed and soft drinks were placed in the UPF group. It is interesting to observe, that beverages had the least amount of sugar, and, consequently, were less energy dense, when they were ultra-processed, and this may be due to the tax on sugary drinks that forced the industry to swap part of the sugar used for sweeteners (Portuguese Republic 2016). Taken together, these results suggest that the diversity of products included within each food category is an important factor with impact on the overall nutrient profile of the category. In fact, differences in the nutritional composition within specific food categories were observed in other studies based on their extent of processing (Angelino et al. 2023), but also depending on the type of production for pasta (Dello Russo et al. 2021), the sub-type of meat analogue (Cutroneo et al. 2022) or the use of nutrition claims in packaged foods and beverages (Franco-Arellano et al. 2018), revealing the importance of a stratified analysis by food category containing a wide product diversity.

It is worth mentioning some limitations of this study. First, this study was restricted to the analysis of white-label food products, which may not represent the overall supermarket availability. Furthermore, the fact that it did not include fresh foods, apart from bakery products and pre-packaged vegetables, most likely overestimated the proportion of UPF. Nevertheless, we believe that this study allows us to have a view of a considerable part of the foods available on the Portuguese market, launching clues for a more comprehensive study in the future. Finally, for some foods, the salt content provided was rounded, which had impact on the sodium conversion, under or overestimating them according to the specific situations.

Despite being widely used, it is also important to discuss possible disadvantages of the *NOVA* food classification system. In addition to some subjectivity in terms of the ingredients and additives allowed in each of the groups, the most critical issue concerns the fact that nutritionally balanced and unbalanced foods coexist in the same group (processed or ultra-processed). In fact, there is already a proposal for a tool based on *NOVA*, called *SIGA*, that addresses these criticisms and deserves to be explored (Davidou et al. 2020).

To ensure that healthy and sustainably produced food is the most accessible, affordable and desirable choice for all, different stakeholders must work together to mainstream nutrition into all elements of the food system (Mannar et al. 2020), while, at the same time, promoting consumer food literacy. Food industry plays an important role in producing and marketing healthier and more sustainable food products (Machado et al. 2017; Hendriksen et al. 2021) and we believe that it is possible to create nutritionally balanced

products, even being classified as ultra-processed, focusing on the use of whole foods as the base.

Conclusions

Two-thirds of pre-packaged and bakery foods analysed were classified as ultra-processed, approximately 16% were processed and a minor percent of 15% were classified as unprocessed or minimally processed. The later proved to be less energy dense, lower in total and saturated fat, and sodium compared to foods subjected to a higher extent of processing. Increasing the availability of unprocessed whole foods, together with industrial food reformulations of targeted foods with higher extent of processing, may contribute to decrease the intake of sugar, fat and sodium, and thus improve health status individually and globally by reducing the prevalence of NCDs.

Ethics statement

The manuscript does not contain clinical studies or patient data.

Author contributions

CV and CA designed and conducted the research, analysed and interpreted data and wrote original draft; PP supervised the research and critically revised the manuscript; JA critically revised the manuscript. All authors read, revised and approved the final manuscript.

Disclosure statement

A national food retail company provided the data used for this study but the authors state that they have no financial or other conflicts of interest. The opinions expressed in this manuscript are those of the authors and do not necessarily represent the position or policy of the food retail company.

Funding

This study was financed through national funding from the Foundation for Science and Technology—FCT (Portuguese Ministry of Science, Technology and Higher Education), under the projects with references UIDB/04750/2020 and LA/P/0064/2020 and DOI identifiers https://doi.org/10.54499/UIDB/04750/2020 and https://doi.org/10.54499/LA/P/0064/2020. Individual PhD grant attributed to Carla Almeida (2020.08208.BD) was funded by FCT and the "Programa Operacional Regional Norte" (NORTE 2020/FSE).

ORCID

Catarina Vale http://orcid.org/0009-0008-3369-8050
Carla Almeida http://orcid.org/0000-0002-5359-3319
José Azevedo http://orcid.org/0000-0002-6738-1827
Patrícia Padrão http://orcid.org/0000-0001-6310-4956

Data availability statement

Databases used in the manuscript will not be made available due to privacy policy of the food retail company that supported this study.

References

Anastácio COA, Oliveira JM, Moraes MM, Damião JJ, Castro IRR. 2020. Nutritional profile of ultra-processed foods consumed by children in Rio De Janeiro. Rev Saude Publica. 54:89. doi:10.11606/s1518-8787.2020054001752.

Angelino D, Dinu M, Gandossi B, Pellegrini N, Martini D, SINU Young Working Group. 2023. Processing and nutritional quality of breakfast cereals sold in Italy: results from the food labelling of Italian Products (Flip) Study. Nutrients. 15(8):2013. doi:10.3390/nu15082013.

Basu S, Yoffe P, Hills N, Lustig RH. 2013. The relationship of sugar to population-level diabetes prevalence: an econometric analysis of repeated cross-sectional data. PLOS One. 8(2):e57873. doi:10.1371/journal.pone.0057873.

Boniface DR, Tefft ME. 2002. Dietary fats and 16-year coronary heart disease mortality in a cohort of men and women in Great Britain. Eur J Clin Nutr. 56(8):786–792. doi:10.1038/sj.ejcn.1601509.

Cediel G, Reyes M, da Costa Louzada ML, Martinez Steele E, Monteiro CA, Corvalán C, Uauy R. 2018. Ultra-processed foods and added sugars in the Chilean diet (2010). Public Health Nutr. 21(1):125–133. doi:10.1017/S1368980017001161.

Cutroneo S, Angelino D, Tedeschi T, Pellegrini N, Martini D, Sywg DM, Russo MD, Nucci D, Moccia S. 2022. Nutritional quality of meat analogues: results from the food labelling of Italian Products (Flip) Project. Front Nutr. 9:852831. doi:10.3389/fnut.2022.852831.

Davidou S, Christodoulou A, Fardet A, Frank K. 2020. The holistico-reductionist Siga classification according to the degree of food processing: an evaluation of ultra-processed foods in French supermarkets. Food Funct. 11(3):2026–2039. doi:10.1039/c9fo02271f.

de Miranda RC, Rauber F, de Moraes MM, Afonso C, Santos C, Rodrigues S, Levy RB, UPPER Group. 2021. Consumption of ultra-processed foods and non-communicable disease-related nutrient profile in Portuguese adults and elderly (2015–2016): the upper project. Br J Nutr. 125(10):1177–1187. doi:10.1017/S000711452000344X.

Dello Russo M, Spagnuolo C, Moccia S, Angelino D, Pellegrini N, Martini D, On Behalf of the Italian Society of Human Nutrition SINU Young Working Group. 2021. Nutritional quality of pasta sold on the Italian market: the food labelling of Italian Products (Flip) Study. Nutrients. 13(1):171. doi:10.3390/nu13010171.

Delpino FM, Figueiredo LM, Bielemann RM, da Silva BGC, Dos Santos FS, Mintem GC, Flores TR, Arcêncio RA, Nunes BP. 2022. Ultra-processed food and risk of type 2 diabetes: a systematic review and meta-analysis of lon-

gitudinal studies. Int J Epidemiol. 51(4):1120–1141. doi:10.1093/ije/dyab247.
European Supermarket Maganize. 2023. Top 10 supermarket retail chains in Portugal. https://www.esmmagazine.com/retail/top-10-supermarket-retail-chains-in-portugal-234618.
Franco-Arellano B, Labonté M, Bernstein JT, L'Abbé MR. 2018. Examining the nutritional quality of Canadian packaged foods and beverages with and without nutrition claims. Nutrients. 10(7):832. doi:10.3390/nu10070832.
Glanz K, Basil M, Maibach E, Goldberg J, Snyder D. 1998. Why Americans eat what they do: taste, nutrition, cost, convenience, and weight control concerns as influences on food consumption. J Am Diet Assoc. 98(10):1118–1126. doi:10.1016/S0002-8223(98)00260-0.
Hendriksen A, Jansen R, Dijkstra SC, Huitink M, Seidell JC, Poelman MP. 2021. How healthy and processed are foods and drinks promoted in supermarket sales flyers? A cross-sectional study in the Netherlands. Public Health Nutr. 24(10):3000–3008. doi:10.1017/S1368980021001233.
Isaksen IM, Dankel SN. 2023. Ultra-processed food consumption and cancer risk: a systematic review and meta-analysis. Clin Nutr. 42(6):919–928. doi:10.1016/j.clnu.2023.03.018.
Lane MM, Davis JA, Beattie S, Gómez-Donoso C, Loughman A, O'Neil A, Jacka F, Berk M, Page R, Marx W, et al. 2021. Ultraprocessed food and chronic noncommunicable diseases: a systematic review and meta-analysis of 43 observational studies. Obes Rev. 22(3):e13146. doi:10.1111/obr.13146.
Latasa P, Louzada M, Martinez Steele E, Monteiro CA. 2018. Added sugars and ultra-processed foods in Spanish households (1990–2010). Eur J Clin Nutr. 72(10):1404–1412. doi:10.1038/s41430-017-0039-0.
Luiten CM, Steenhuis IH, Eyles H, Ni Mhurchu C, Waterlander WE. 2016. Ultra-processed foods have the worst nutrient profile, yet they are the most available packaged products in a sample of New Zealand supermarkets. Public Health Nutr. 19(3):530–538. doi:10.1017/S1368980015002177.
Machado PP, Claro RM, Canella DS, Sarti FM, Levy RB. 2017. Price and convenience: the influence of supermarkets on consumption of ultra-processed foods and beverages in Brazil. Appetite. 116:381–388. doi:10.1016/j.appet.2017.05.027.
Machado PP, Steele EM, Levy RB, Sui Z, Rangan A, Woods J, Gill T, Scrinis G, Monteiro CA. 2019. Ultra-processed foods and recommended intake levels of nutrients linked to non-communicable diseases in Australia: evidence from a nationally representative cross-sectional study. BMJ Open. 9(8):e029544. doi:10.1136/bmjopen-2019-029544.
Martínez Steele E, Baraldi LG, Louzada ML, Moubarac JC, Mozaffarian D, Monteiro CA. 2016. Ultra-processed foods and added sugars in the US diet: evidence from a nationally representative cross-sectional study. BMJ Open. 6(3):e009892. doi:10.1136/bmjopen-2015-009892.
Mannar V, Micha R, Allemandi L, Afshin A, Baker P, Battersby J, Bhutta Z, Corvalan C, Di Cesare M, Chen K, et al. 2020. 2020 global nutrition report: action on equity to end malnutrition. Bristol (UK): Development Initiatives Poverty Research.
Monteiro CA, Cannon G, Lawrence M, Costa Louzada M, Pereira Machado P. 2019. Ultra-processed foods, diet quality, and health using the nova classification system. Rome: FAO.
Monteiro CA, Cannon G, Levy RB, Moubarac J-C, Louzada ML, Rauber F, Khandpur N, Cediel G, Neri D, Martinez-Steele E, et al. 2019. Ultra-processed foods: what they are and how to identify them. Public Health Nutr. 22(5):936–941. doi:10.1017/S1368980018003762.
Monteiro CA, Levy RB, Claro RM, Castro I, Cannon G. 2010. A new classification of foods based on the extent and purpose of their processing. Cad Saude Publica. 26(11):2039–2049. doi:10.1590/s0102-311x2010001100005.
Monteiro CA, Moubarac JC, Levy RB, Canella DS, Louzada M, Cannon G. 2018. Household availability of ultra-processed foods and obesity in nineteen European countries. Public Health Nutr. 21(1):18–26. doi:10.1017/S1368980017001379.
Pagliai G, Dinu M, Madarena M, Bonaccio M, Iacoviello L, Sofi F. 2021. Consumption of ultra-processed foods and health status: a systematic review and meta-analysis. Br J Nutr. 125(3):308–318. doi:10.1017/S0007114520002688.
Phulkerd S, Thongcharoenchupong N, Dickie S, Machado P, Woods J, Mo-Suwan L, Prasertsom P, Ungchusak C, Khitdee C, Lawrence M. 2023. Profiling ultra-processed foods in Thailand: sales trend, consumer expenditure and nutritional quality. Global Health. 19(1):64. doi:10.1186/s12992-023-00966-1.
Portuguese Republic. 2016. Diário da república n° 248/2016 série i de 2016-12-28. Lei 42/2016. Orçamento do estado para 2017. Secção III. Impostos especiais de consumo. Artigo 211. Imposto sobre o álcool, as bebidas alcoólicas e as bebidas adicionadas de açúcar ou outros edulcorantes (IABA).
Rauber F, da Costa Louzada ML, Steele EM, Millett C, Monteiro CA, Levy RB. 2018. Ultra-processed food consumption and chronic non-communicable diseases-related dietary nutrient profile in the UK (2008–2014). Nutrients. 10(5):587. doi:10.3390/nu10050587.
Romieu I, Dossus L, Barquera S, Blottière HM, Franks PW, Gunter M, Hwalla N, Hursting SD, Leitzmann M, Margetts B, et al. 2017. Energy balance and obesity: what are the main drivers? Cancer Causes Control. 28(3):247–258. doi:10.1007/s10552-017-0869-z.
Roos E, Lehto R, Ray C. 2012. Parental family food choice motives and children's food intake. Food Qual Preference. 24(1):85–91. doi:10.1016/j.foodqual.2011.09.006.
Vandevijvere S, Jaacks LM, Monteiro CA, Moubarac JC, Girling-Butcher M, Lee AC, Pan A, Bentham J, Swinburn B. 2019. Global trends in ultraprocessed food and drink product sales and their association with adult body mass index trajectories. Obes Rev. 20(Suppl. 2):10–19. doi:10.1111/obr.12860.
Wang YJ, Yeh TL, Shih MC, Tu YK, Chien KL. 2020. Dietary sodium intake and risk of cardiovascular disease: a systematic review and dose–response meta-analysis. Nutrients. 12(10):2934. doi:10.3390/nu12102934.
World Health Organization. 2003. Diet, nutrition, and the prevention of chronic diseases: report of a joint WHO/FAO expert consultation. Geneva (Switzerland): World Health Organization.
World Health Organization. 2014. Global status report on noncommunicable diseases 2014. Switzerland: World Health Organization.
World Health Organization. 2021. WHO global sodium benchmarks for different food categories. Geneva: World Health Organization.

Appendix A

Table A1. Energy (kcal) of pre-packaged foods and bakery products by food category and degree of processing.

	Food categories[a]																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	n (%)																		
N = 1446	90 (6.2%)	216 (14.9%)	87 (6%)	102 (7.1%)	52 (3.6%)	34 (2.4%)	109 (7.5%)	73 (5%)	104 (7.2%)	5 (0.3%)	141 (9.8%)	49 (3.4%)	18 (1.2%)	123 (8.5%)	41 (2.8%)	123 (8.5%)	4 (0.3%)	46 (3.2%)	29 (2%)
Energy (kcal)	Mean ± SD																		
	413 ± 144	383 ± 95	489 ± 87	36 ± 17	221 ± 82	404 ± 35	89 ± 58	302 ± 88	245 ± 86	504 ± 99	275 ± 33	353 ± 18	113 ± 43	213 ± 125	104 ± 109	125 ± 111	237 ± 30	246 ± 201	283 ± 103
NOVA[b]	(*n*) Mean ± SD																		
1	(2)	–	(21)	(34)	–	(2)	(6)	–	–	–	–	(48)	(18)	(2)	(40)	(32)	–	–	(23)
(*n* = 228)	481 ± 205		565 ± 100c	40 ± 18b		386 ± 28	68 ± 32					353 ± 18	113 ± 43	101 ± 19	103 ± 110	98 ± 134a			303 ± 82
3	(1)	(4)	(27)	(12)	–	–	(5)	(62)	(10)	–	(11)	(1)	–	(38)	(1)	(58)	–	(10)	(2)
(*n* = 242)	477	354 ± 95	495 ± 72b	48 ± 5b			208 ± 123	311 ± 83	188 ± 67		268 ± 27	362		192 ± 106	154	103 ± 86a		104 ± 82	80 ± 3
4	(87)	(212)	(39)	(56)	(52)	(32)	(98)	(11)	(94)	(5)	(130)	–	–	(83)	–	(33)	(4)	(36)	(4)
(*n* = 976)	411 ± 144	384 ± 95	445 ± 57a	30 ± 17a	221 ± 82	405 ± 35	85 ± 48	249 ± 97	252 ± 86	504 ± 99	276 ± 34			225 ± 132		187 ± 105b	237 ± 30	285 ± 207	269 ± 141
p Value	–	–	<.001	<.001	–	–	.070	.029	.027	–	.458	–	–	–	–	<.001	–	.003	–

SD: standard deviation.
a,b,c homogeneous subsets according to Mann–Whitney's test, with 95% of confidence. Statistically significant $p < .05$.
[a]Food categories: (1) chocolate and sugar confectionery, energy bars, and sweet toppings and desserts; (2) cakes, sweet biscuits and pastries; other sweet bakery wares; and dry-mixes for making such; (3) savoury snacks; (4) beverages; (5) edible ices; (6) breakfast cereals; (7) yoghurt, sour milk, cream and other similar foods; (8) cheese; (9) ready-made and convenience foods and composite dishes; (10) butter and other fats and oils; (11) bread, bread products and crisp breads; (12) fresh or dried pasta, noodles, rice and grains; (13) fresh and frozen meat, poultry, game, fish and similar; (14) processed meat, poultry, game, fish and similar; (15) fresh and frozen fruit, vegetables and legumes; (16) processed fruit, vegetables and legumes; (17) plant-based food/meat analogues; (18) sauces, dips and dressings; (19) culinary ingredients.
[b]*NOVA* groups: (1) unprocessed or minimally processed foods; (3) processed foods; (4) ultra-processed foods.

Table A2. Sugar (g) of pre-packaged foods and bakery products by food category and degree of processing.

	Food categories[a]																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	n (%)																		
N = 1447	90 (6.2%)	217 (15%)	87 (6%)	102 (7%)	52 (3.6%)	34 (2.3%)	109 (7.5%)	73 (5%)	104 (7.2%)	5 (0.3%)	140 (9.7%)	49 (3.4%)	18 (1.2%)	123 (8.5%)	41 (2.8%)	124 (8.6%)	4 (0.3%)	46 (3.2%)	29 (2%)
Sugar (g)	Mean ± SD																		
	43.8 ± 27.5	26.3 ± 12.9	4.2 ± 5.6	6.7 ± 3.8	23.4 ± 6.6	24.1 ± 8.5	11.0 ± 8.9	1.4 ± 1.4	3.6 ± 3.6	0.5 ± 0.6	4.8 ± 4.6	2.7 ± 1.9	0.1 ± 0.2	0.8 ± 0.9	3.2 ± 3.2	16.8 ± 22.4	2.3 ± 2.0	5.8 ± 6.3	7.5 ± 10.8
NOVA[b]	(*n*) Mean ± SD																		
1	(2)	–	(21)	(34)	–	(2)	(6)	–	–	–	–	(48)	(18)	(2)	(40)	(32)	–	–	(23)
(*n* = 228)	3.2 ± 3.0		3.9 ± 5.1a	7.5 ± 4.3b		3.2 ± 3.3	5.0 ± 1.9a					2.7 ± 1.9	0.1 ± 0.2	0.0 ± 0.0	3.3 ± 3.2	15.3 ± 15.4b			5.9 ± 5.5
3	(1)	(4)	(27)	(12)	–	–	(5)	(62)	(10)	–	(11)	(1)	–	(38)	(1)	(58)	–	(10)	(2)
(*n* = 242)	38.4	13.4 ± 12.8	2.6 ± 3.6a	10.9 ± 2.1c			37.8 ± 24.2c	1.2 ± 1.2	2.5 ± 1.5		9.3 ± 9.2	3.2		0.4 ± 0.7	1.2	8.2 ± 17.8a		3.1 ± 2.2	0.9 ± 0.1
4	(87)	(213)	(39)	(56)	(52)	(32)	(98)	(11)	(94)	(5)	(129)	–	–	(83)	–	(34)	(4)	(36)	(4)
(*n* = 977)	44.8 ± 27.3	26.6 ± 12.8	5.5 ± 6.8b	5.3 ± 3.0a	23.4 ± 6.6	25.5 ± 6.8	10.0 ± 4.8b	2.8 ± 1.5	3.7 ± 3.8	0.5 ± 0.6	4.4 ± 3.9			1.0 ± 0.9		33.0 ± 26.5b	2.3 ± 2.0	6.6 ± 6.9	19.8 ± 24.8
p Value	–	–	<.001	<.001	–	–	.002	.003	.402	–	.416	–	–	–	–	<.001	–	.262	–

SD: standard deviation.
a,b,c homogeneous subsets according to Mann–Whitney's test, with 95% of confidence. Statistically significant $p < .05$.
[a]Food categories: (1) Chocolate and sugar confectionery, energy bars, and sweet toppings and desserts; (2) cakes, sweet biscuits and pastries; other sweet bakery wares; and dry-mixes for making such; (3) savoury snacks; (4) beverages; (5) edible ices; (6) breakfast cereals; (7) yoghurt, sour milk, cream and other similar foods; (8) cheese; (9) ready-made and convenience foods and composite dishes; (10) butter and other fats and oils; (11) bread, bread products and crisp breads; (12) fresh or dried pasta, noodles, rice and grains; (13) fresh and frozen meat, poultry, game, fish and similar; (14) processed meat, poultry, game, fish and similar; (15) fresh and frozen fruit, vegetables and legumes; (16) processed fruit, vegetables and legumes; (17) plant-based food/meat analogues; (18) sauces, dips and dressings; (19) culinary ingredients.
[b]*NOVA* groups: (1) unprocessed or minimally processed foods; (3) processed foods; (4) ultra-processed foods.

Table A3. Total fat (g) of pre-packaged foods and bakery products by food category and degree of processing.

	Food categories[a]																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	n (%)																		
N = 1448	90 (6.2%)	217 (15%)	87 (6%)	102 (7%)	52 (3.6%)	34 (2.3%)	109 (7.5%)	73 (5%)	104 (7.2%)	5 (0.3%)	141 (9.7%)	49 (3.4%)	18 (1.2%)	123 (8.5%)	41 (2.8%)	124 (8.6%)	4 (0.3%)	46 (3.2%)	29 (2%)
Total fat (g)	Mean ± SD																		
	15.9 ± 15.7	15.0 ± 7.8	25.3 ± 18.1	0.5 ± 0.7	10.5 ± 6.5	7.7 ± 6.2	3.0 ± 4.9	24.0 ± 8.3	10.2 ± 6.0	55.5 ± 11.5	3.6 ± 3.4	1.8 ± 1.4	5.0 ± 5.2	14.1 ± 13.4	0.8 ± 1.1	2.5 ± 7.3	11.3 ± 1.4	19.6 ± 23.2	6.4 ± 7.0
NOVA[b]	(*n*) Mean ± SD																		
1	(2)	–	(21)	(34)	–	(2)	(6)	–	–	–	–	(48)	(18)	(2)	(40)	(32)	–	–	(23)
(*n* = 228)	31.0 ± 28.1		43.9 ± 20.2c	0.5 ± 0.8		7.9 ± 0.6	2.5 ± 3.0					1.8 ± 1.4	5.0 ± 5.2	2.7 ± 0.8	0.7 ± 0.9	2.3 ± 11.9a			6.7 ± 6.7
3	(1)	(4)	(27)	(12)	–	–	(5)	(62)	(10)	–	(11)	(1)	–	(38)	(1)	(58)	–	(10)	(2)
(*n* = 242)	21.5	14.2 ± 10.7	24.6 ± 13.9b	0.2 ± 0.6			3.7 ± 3.6	24.5 ± 8.1	7.6 ± 5.5		2.6 ± 2.0	1.3		10.8 ± 10.1	4.5	2.3 ± 4.3a		5.2 ± 7.5	4.8 ± 0.1
4	(87)	(213)	(39)	(56)	(52)	(32)	(98)	(11)	(94)	(5)	(130)	–	–	(83)	–	(34)	(4)	(36)	(4)
(*n* = 978)	15.5 ± 15.5	15.0 ± 7.8	15.9 ± 10.5a	0.5 ± 0.7	10.5 ± 6.5	7.7 ± 6.4	2.9 ± 5.1	21.1 ± 9.5	10.5 ± 6.0	55.5 ± 11.5	3.7 ± 3.5			15.8 ± 14.5		3.1 ± 5.9b	11.3 ± 1.4	23.7 ± 24.5	5.6 ± 11.0
p Value	–	–	<.001	.741	–	–	.511	.241	.121	–	.171	–	–	–	–	<.001	–	.010	–

SD: standard deviation.

a,b,c homogeneous subsets according to Mann–Whitney's test, with 95% of confidence. Statistically significant $p < .05$.

[a]Food categories: (1) chocolate and sugar confectionery, energy bars, and sweet toppings and desserts; (2) cakes, sweet biscuits and pastries; other sweet bakery wares; and dry-mixes for making such; (3) savoury snacks; (4) beverages; (5) edible ices; (6) breakfast cereals; (7) yoghurt, sour milk, cream and other similar foods; (8) cheese; (9) ready-made and convenience foods and composite dishes; (10) butter and other fats and oils; (11) bread, bread products and crisp breads; (12) fresh or dried pasta, noodles, rice and grains; (13) fresh and frozen meat, poultry, game, fish and similar; (14) processed meat, poultry, game, fish and similar; (15) fresh and frozen fruit, vegetables and legumes; (16) processed fruit, vegetables and legumes; (17) plant-based food/meat analogues; (18) sauces, dips and dressings; (19) culinary ingredients.

[b]*NOVA* groups: (1) unprocessed or minimally processed foods; (3) processed foods; (4) ultra-processed foods.

Table A4. Saturated fat (g) of pre-packaged foods and bakery products by food category and degree of processing.

	Food categories[a]																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	n (%)																		
N = 1448	90 (6.2%)	217 (15%)	87 (6%)	102 (7%)	52 (3.6%)	34 (2.3%)	109 (7.5%)	73 (5%)	104 (7.2%)	5 (0.3%)	141 (9.7%)	49 (3.4%)	18 (1.2%)	123 (8.5%)	41 (2.8%)	124 (8.6%)	4 (0.3%)	46 (3.2%)	29 (2%)
Saturated fat (g)	Mean ± SD																		
	8.38 ± 9.36	6.38 ± 4.62	4.77 ± 4.13	0.19 ± 0.38	7.61 ± 4.35	2.24 ± 1.87	1.82 ± 3.16	16.37 ± 5.91	4.59 ± 3.23	22.64 ± 8.02	1.17 ± 1.27	0.36 ± 0.24	1.91 ± 2.02	5.38 ± 5.59	0.07 ± 0.12	1.03 ± 5.85	2.65 ± 1.19	4.51 ± 5.17	2.14 ± 4.72
NOVA[b]	(*n*) Mean ± SD																		
1	(2)	–	(21)	(34)	–	(2)	(6)	–	–	–	–	(48)	(18)	(2)	(40)	(32)	–	–	(23)
(*n* = 228)	7.05 ± 0.07		5.36 ± 2.86b	0.33 ± 0.56		1.40 ± 0.00	1.62 ± 2.02					0.36 ± 0.24	1.91 ± 2.02	0.95 ± 0.49	0.06 ± 0.10	2.01 ± 11.20b			2.58 ± 5.22
3	(1)	(4)	(27)	(12)	–	–	(5)	(62)	(10)	–	(11)	(1)	–	(38)	(1)	(58)	–	(10)	(2)
(*n* = 242)	18.00	3.94 ± 4.33	6.32 ± 5.57b	0.06 ± 0.07			2.50 ± 2.50	16.68 ± 5.76	1.90 ± 1.49		0.89 ± 1.12	0.30		4.03 ± 4.24	0.50	0.51 ± 0.64a		1.17 ± 1.35	0.45 ± 0.07
4	(87)	(213)	(39)	(56)	(52)	(32)	(98)	(11)	(94)	(5)	(130)	–	–	(83)	–	(34)	(4)	(36)	(4)
(*n* = 978)	8.30 ± 9.46	6.43 ± 4.62	3.38 ± 3.03a	0.14 ± 0.23	7.61 ± 4.35	2.29 ± 1.92	1.79 ± 3.26	14.65 ± 6.75	4.88 ± 3.23	22.64 ± 8.02	1.19 ± 1.28			6.11 ± 6.04		0.98 ± 2.76a	2.65 ± 1.19	5.43 ± 5.47	0.48 ± 0.82
p Value	–	–	.005	.242	–	–	.548	.450	<.001	–	.288	–	–	–	–	<.001	–	.020	–

SD: standard deviation.

a,b,c homogeneous subsets according to Mann–Whitney's test, with 95% of confidence. Statistically significant $p < .05$.

[a]Food categories: (1) chocolate and sugar confectionery, energy bars, and sweet toppings and desserts; (2) cakes, sweet biscuits and pastries; other sweet bakery wares; and dry-mixes for making such; (3) savoury snacks; (4) beverages; (5) edible ices; (6) breakfast cereals; (7) yoghurt, sour milk, cream and other similar foods; (8) cheese; (9) ready-made and convenience foods and composite dishes; (10) butter and other fats and oils; (11) bread, bread products and crisp breads; (12) fresh or dried pasta, noodles, rice and grains; (13) fresh and frozen meat, poultry, game, fish and similar; (14) processed meat, poultry, game, fish and similar; (15) fresh and frozen fruit, vegetables and legumes; (16) processed fruit, vegetables and legumes; (17) plant-based food/meat analogues; (18) sauces, dips and dressings; (19) culinary ingredients.

[b]*NOVA* groups: (1) unprocessed or minimally processed foods; (3) processed foods; (4) ultra-processed foods.

Table A5. Sodium (mg) of pre-packaged foods and bakery products by food category and degree of processing.

	Food categories[a]																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	n (%)																		
N = 1448	90 (6.2%)	217 (15%)	87 (6%)	102 (7%)	52 (3.6%)	34 (2.3%)	109 (7.5%)	73 (5%)	104 (7.2%)	5 (0.3%)	141 (9.7%)	49 (3.4%)	18 (1.2%)	123 (8.5%)	41 (2.8%)	124 (8.6%)	4 (0.3%)	46 (3.2%)	29 (2%)
Sodium (mg)	Mean ± SD																		
	176 ± 341	277 ± 196	358 ± 238	29 ± 18	69 ± 36	198 ± 141	48 ± 18	555 ± 316	682 ± 981	712 ± 267	401 ± 123	39 ± 38	151 ± 81	915 ± 495	42 ± 22	213 ± 361	450 ± 68	4422 ± 6926	81 ± 159
NOVA[b]	(*n*) Mean ± SD																		
1	(2)	–	(21)	(34)	–	(2)	(6)	–	–	–	–	(48)	(18)	(2)	(40)	(32)	–	–	(23)
(*n* = 228)	120 ± 113		41 ± 57a	33 ± 15b		40 ± 0	54 ± 17a,b					34 ± 16	151 ± 81	280 ± 57a	42 ± 23	21 ± 31a			50 ± 42
3	(1)	(4)	(27)	(12)	–	–	(5)	(62)	(10)	–	(11)	(1)	–	(38)	(1)	(58)	–	(10)	(2)
(*n* = 242)	40	318 ± 199	409 ± 170b	19 ± 20a			72 ± 33b	566 ± 321	332 ± 119		408 ± 75	280		787 ± 597a	40	325 ± 416c		2516 ± 2319	40 ± 0
4	(87)	(213)	(39)	(56)	(52)	(32)	(98)	(11)	(94)	(5)	(130)	–	–	(83)	–	(34)	(4)	(36)	(4)
(*n* = 978)	179 ± 346	277 ± 197	493 ± 176b	29 ± 18a	69 ± 36	208 ± 139	47 ± 16a	492 ± 288	719 ± 1025	712 ± 267	401 ± 126			989 ± 425b		202 ± 360b	450 ± 68	4952 ± 7679	280 ± 404
p Value	–	–	<.001	.009	–	–	.023	.258	.002	–	.606	–	–	–	–	<.001	–	.783	–

SD: standard deviation.

a,b,c homogeneous subsets according to Mann–Whitney's test, with 95% of confidence. Statistically significant $p < .05$.

[a]Food categories: (1) chocolate and sugar confectionery, energy bars, and sweet toppings and desserts; (2) cakes, sweet biscuits and pastries; other sweet bakery wares; and dry-mixes for making such; (3) savoury snacks; (4) beverages; (5) edible ices; (6) breakfast cereals; (7) yoghurt, sour milk, cream and other similar foods; (8) cheese; (9) ready-made and convenience foods and composite dishes; (10) butter and other fats and oils; (11) bread, bread products and crisp breads; (12) fresh or dried pasta, noodles, rice and grains; (13) fresh and frozen meat, poultry, game, fish and similar; (14) processed meat, poultry, game, fish and similar; (15) fresh and frozen fruit, vegetables and legumes; (16) processed fruit, vegetables and legumes; (17) plant-based food/meat analogues; (18) sauces, dips and dressings; (19) culinary ingredients.

[b]*NOVA* groups: (1) unprocessed or minimally processed foods; (3) processed foods; (4) ultra-processed food.