U.PORTO

Ultra-processed food consumption and daily sodium and potassium intake: results from iMC SALT study
Consumo de alimentos ultraprocessados e ingestão diária de sódio e potássio: resultados do estudo iMC SALT

Inês Areias Anjos

ORIENTADO POR: PROF.ª DOUTORA CARLA CRISTINA DA SILVA GONÇALVES

TRABALHO DE INVESTIGAÇÃO
1.º CICLO EM CIÊNCIAS DA NUTRIÇÃO | UNIDADE CURRICULAR ESTÁGIO
FACULDADE DE CIÊNCIAS DA NUTRIÇÃO E ALIMENTAÇÃO DA UNIVERSIDADE DO PORTO

TC

PORTO, 2021

Abstract

INTRODUCTION: Higher consumption of ultra-processed foods (UPF) was associated with higher risk of non-communicable diseases (NCD) and NCD-promoting nutrient profile such as higher in sodium and lower in potassium.

AIM: To assess the caloric and weight contribution of foods according to their level of processing in participant's diet and their consumption according to the sodium and potassium intake.

METHODOLOGY: Data collection included 107 subjects (female 51.4%; mean age 47 years) who were participating in an ongoing clinical study (iMC SALT). We used one 24h urinary collection to estimate sodium and potassium intake, validated by the coefficient of creatinine. The correspondent 24h diet recall was used to evaluate food intake and foods were categorized using the NOVA classification according to degree and purpose of processing, into four groups.

RESULTS: The largest energy contribution came from the group of unprocessed or minimally processed foods (51.6%), followed by UPF (24%), processed foods (21.8%) and processed culinary ingredients (2.6%). Individuals with the lowest caloric contribution of the consumption of UPF had higher average values of potassium (K) intake (62.1 vs 46.0 mg/1000kcal; p=0.007), as individuals with the highest weight contribution of the consumption of unprocessed or minimally processed foods (61.6 vs 46.2 mg/1000kcal; p=0.010). For sodium (Na) intake no significant results were found.

CONCLUSION: In this study, higher consumption of unprocessed or minimally processed foods and lower consumption of UPF was associated with higher of values of K intake. Conversely, higher consumption of UPF was not associated with higher of values of Na intake.

Key words: food processing, ultra-processed food, sodium intake, potassium intake, 24-h urine collection

Resumo

INTRODUÇÃO: O consumo elevado de alimentos ultraprocessados (UP) foi associado a um maior risco de doenças não transmissíveis (DNT) e a um perfil nutricional promotor de DNT com teores elevados de sódio e baixos de potássio.

OBJETIVO: Avaliar a contribuição calórica e em peso de alimentos conforme o nível de processamento na dieta do participante e o seu consumo de acordo com a ingestão de sódio e potássio.

METODOLOGIA: A recolha de dados incluiu 107 indivíduos (51.4% mulheres; idade média 47 anos) que participavam num estudo clínico (iMC SALT). Utilizou-se uma recolha urinária 24h para estimar a ingestão de sódio e potássio, validada pelo coeficiente de creatinina. Os recordatórios alimentares 24h correspondentes foram utilizados para avaliar a ingestão alimentar e categorizar os alimentos pela classificação NOVA consoante o grau e finalidade do processamento, em quatro grupos.

RESULTADOS: A maior contribuição energética veio do grupo dos alimentos não processados ou minimamente processados (51.6%), seguido de UP (24%), processados (21.8%) e ingredientes culinários processados (2.6%). Indivíduos com menor contribuição calórica do consumo de UP apresentaram valores médios maiores de ingestão de potássio (K) (62.1 vs 46.0 mg/1000kcal; $p=0.007$), tal como indivíduos com maior contribuição em peso do consumo de alimentos não processados ou minimamente processados (61.6 vs 46.2 mg/1000kcal; $p=0.010$). Na ingestão de sódio (Na) não foram encontrados resultados significativos.

CONCLUSÃO: Neste estudo, um consumo elevado de alimentos não processados ou minimamente processados e um consumo mais baixo de UP estão associados a maiores valores de ingestão de K. Pelo contrário, um consumo maior elevado de UP não foi associado a maiores valores de ingestão de Na.

Palavras-chave: processamento alimentar, alimentos ultraprocessados, ingestão de sódio, ingestão de potássio, colheita de urina 24h

List of abbreviations

BMI - Body mass index

Na/K ratio - sodium-to-potassium ratio

NCD - Non-communicable diseases

UPF – Ultra-processed food

WHO - World Health Organization

Summary

Introduction

The consumption of ultra-processed food (UPF) has increased globally during the last decades(1-4). These products are displacing healthy dietary patterns based on meals prepared from unprocessed or minimally processed foods and culinary ingredients(1-3, 5, 6). The UPF dominate the food supplies in high-income countries(5) and are rapidly increasing in middle-income countries(1-4, 6).

Food processing is relevant to link diet and public health(3, 7), a food classification only by the food group and sub-food groups is not specific enough for current dietary patterns, foods with different nutritional profiles and impacts on eating patterns and health are classified within the same food group (e.g. cookies and cereals or cereal products)(8). Several methods to group foods according to their processing level have been proposed(9). The NOVA classification developed by researchers from the University of São Paulo(3) was already studied to explore the relation between food processing and health(7). The NOVA classification categorises food and food products into four distinct groups (unprocessed or minimally processed foods, processed culinary ingredients, processed foods and UPF and drink products) according to the nature, extent and purpose of the industrial processing(3).

The consumption of UPF is a matter of concern in the nutritional quality of the diet and long-term health impacts. The evidence has shown that a high dietary intake of UFP is associated with multiple adverse health outcomes and non-communicable diseases (NCD)(10, 11). It is particularly significant, since the prevalence of diet-related chronic non-communicable diseases (NCDs), such as obesity, type II diabetes, hypertension and cancer, is increasing worldwide(12).

Several observational studies have showed that higher proportions of UPF in the diet is associated with higher incidences of coronary heart and cerebrovascular diseases[13] as well as with a higher risk of hypertension[14]. Consumption of UPF has also been positively associated obesity[15] in a cross-sectional study, with a higher risk of overweight and obesity in a prospective cohort[16] and with an increase in body mass index (BMI), waist circumference and prevalence of obesity[17] in a cross-sectional study. In the French NutriNet-Santé cohort, higher proportions of UPF in the diet was associated with higher risk of overall cancer and breast cancer[18].

A great part of actual diets is comprised of UPF, which are associated with unbalanced nutritional intakes[19, 20], strongly associated with NCD-promoting nutrients: a higher content of total fat, saturated fat, added sugar, energy density, and sodium and lower in NCD-protective nutrients: fibre and potassium[20-23].

To prevent hypertension and CVD the World Health Organization (WHO) recommends less than 2 g of sodium per day (corresponding to 5 g of salt per day)[24] and a daily intake at least of 3.51 g of potassium per day and a ratio of sodium to potassium would be approximately one to one[25].

Globally sodium intakes are commonly in excess[26]. High levels of dietary sodium is highly associated with increased blood pressure and total CVD mortality[27, 28]. Hypertension-related CVD is a leading cause of mortality and morbidity worldwide[29].

In addition, potassium intake may have some cardiovascular protective effect. The evidence has shown that increasing current potassium to recommended levels may lower blood pressure[30, 31], similar to reducing levels of sodium in the diet[28, 32].

The potential mechanism to explain this effects could be that potassium increases urinary sodium excretion[33].

Urinary sodium-to-potassium ratio (Na/K ratio) is considered an important measure, since it has been shown to be more strongly associated with blood pressure outcomes than either sodium or potassium alone[34], particularly in hypertensive adult populations[35].

In Portugal, evidence shows that the prevalence of hypertension is 42.2%[36] and that CDV are the main cause of mortality[37]. The most recent data in adults shown that average sodium intake was 3107 mg/day, exceeding the WHO recommendations, and daily average potassium intake was 3130 mg/day below the recommended intake[38].

Since the relation between sodium and potassium and CVD it is well acknowledge[27, 28, 30-35], our study aim to evaluate the association between level of processing (categorized by NOVA method) and sodium and potassium intakes (estimated by 24-h urinary excretion).

Aims

This study aim to assess the caloric and weight contribution of minimally processed foods, processed culinary ingredients, processed foods and UFP in participant's diet and their consumption according to the sodium and potassium intake.

Materials and methods

Study Population

The iMC SALT is an ongoing clinical study launched in 2019 (trial registration number NCT03974477) with the objective of studying the effectiveness of an innovative equipment (SALT CONTROL H - INPI, Nº 20191000033265) to monitor and control salt usage when cooking at home[39].

Participants were recruited from the staff of one public Portuguese university in annual occupational health appointment carried out by the doctor responsible for the appointment[39].

Sample

Baseline data collection included 114 participants, however the sample used for this study has 107 participants (female 51.4%; mean age 47 years), since 7 participants were excluded due to invalid urine.

Sociodemographic and anthropometric variables

Sociodemographic characteristics were assessed by the sociodemographic questionnaire was based on the WHO STEPS questionnaire[40].

Height (SECA 213 portable stadiometer, Hamburg, Germany) and waist and hip perimeter (SECA 201 tape) were measured according to international standard procedures[41]. All measurements were performed with participants wearing light clothing and without shoes, body composition (body mass index (BMI)) was assessed using Tanita MC180MA body composition analyser (Tanita, Illinois, USA). Only weight was taken from participants with pacemaker.

Sodium and potassium variables

Sodium and potassium intake were assessed trough a 24h urinary collection, validated by the coefficient of creatinine[42].

Participants received instructions to start the 24-h urinary collection the day before the appointment and to maintain their usual dietary and physical activity patterns. The first morning urine was discarded and afterwards all the urine were collected in an appropriated container during the entire day, during the night and including the first morning urine when getting up on the following day.

Dietary variables

Dietary intakes referring to the day of urine collection were collected using a 24-hour dietary recall administrated by trained researchers using a photographic book and household measures to quantify portion sizes[43].

The nutritional composition of the 24-h dietary recall was assessed using an adapted Portuguese version of the nutritional analysis software Food Processor Plus (ESHA Research Inc., Salem, OR, USA). Then the food and beverage items were categorized using the NOVA classification according to degree and purpose of processing, into four groups: unprocessed and minimally processed foods, processed culinary ingredients, processed foods and UPF[3, 7].

The first NOVA group is of unprocessed or minimally processed foods include the natural edible food parts of plants, animals, fungi, algae and water. The processes they normally undergo have the main purpose of preservation[3]. In this group are also included the main meals and soup (excluding the UPF ingredients that are separately considered in fourth NOVA group).

The second NOVA group is of processed culinary ingredients derived directly from nature or from group 1 food by pressing, refining, grinding, milling, and spray drying. They are typically used to prepare, cook or season unprocessed or minimally processed foods[3]. Generally, in these group quantities are underestimated due to the difficulties that participants have in estimating the amounts used for cooking and most often report meals without specifying the ingredients of the recipe or report the consumption of ready-to-eat meals and away from home meals. The culinary ingredients included in this category were mainly sugar and butter. Discretionary salt (added to seasoning meals) was not included since it was not reported.

The third NOVA group is of processed foods, these are usually made by adding ingredients from the second group to foods from the first group to increase the durability or palatability[3]. Some foods included in this group were breads, cheeses, canned fish, beer, cider and wine.

The fourth NOVA group is of UPF and drink products, these are industrial formulations made from processed substances extracted or refined from whole foods and additives, with a small proportion or even no group 1 foods[1, 3, 7, 44]. These products are attractive, convenient, hyper-palatable, cheap, ready-to-consume or to heat, have a long shelf-life, and are highly competitive with foods that are naturally ready to consume and freshly prepared meals[1, 3, 7, 44]. Ingredients only found in UPF include additives whose purpose is to imitate sensory qualities (e.g. ice-cream, chocolate, candies margarines and spreads, cookies).

Whenever possible, the standardised recipes from Instituto Nacional de Saúde Dr.Ricardo (INSA) were used to identify and disaggregate homemade food preparations and applied the NOVA classification to the ingredients. In case of doubt, the food preparation was categorised according to the main constituent ingredient.

The Nutri-score a five colour (from green/A to red/E) front-of-pack labelling system, was used to categorize UPF in order to provide more information on the nutritional quality of products. Participants without consumption of UPF and with the consumption of alcoholic beverages (more than 1.2% alcohol) were excluded from this classification[45].

Nutri-score converts the nutritional value of the food and beverages into a score, which represents the balance between the content in nutrients to limit (calories, saturated fat, sugars and sodium) and the content in nutrients to encourage (fibre, proteins, nuts, fruit and vegetables). The Open Food Facts (a collaborative and open database of food products)[46] was used to categorize food and beverages from green/A (better profile) to red/E(worst profile). When it was not possible to have access to the food or beverage brand, products were categorised according to most common classification for that group food. Artisanal preparations that were UPF, were categorized using a Nutri-score calculation tool[47].

Statistical analysis

For each participant, the proportion of unprocessed and minimally processed foods, processed culinary ingredients, processed foods and UPF in total energy (%Kcal/day) and in total weight (%g/day) of food and beverages consumed was calculated. The use of these proportion of caloric and weight contribution of each NOVA group allows us to assess the quality of the diet, since it reduces the differences in the total energy and weight consumed between individuals.

Additionally, participants for each NOVA group were split into two groups (lowest and highest intakes) by the median.

For each participant, the proportion of each Nutri-score group in total energy of UFP was calculated.

The Kolmogorov-Smirnov test was used to assess the assumption of normality. Independent Sample T-test or Mann–Whitney U test were performed to compare continuous variables.

Data were analysed using IBM SPSS Statistics, Version 27. A p-value <0.05 was considered to indicate statistical significance.

Results

Descriptive characteristics of the sample (n=107) are presented in Table I, 51.4% were women, mean age was 47.4±10.4 (range 24–69 years), mean BMI was 25.9±3.9 kg/m^2, mean energy consumption was 2196±756 kcal and mean weight consumption 2903±948 g.

The education level was similar in both sexes, 90.4% of male and 83.6% female have university level of education.

On average, 24h urinary sodium excretion was 3244±1329 mg/day (corresponding to average 8.25 g of salt), 24h urinary potassium excretion was 2654±760 mg/day and Na/K ratio was 2.2±1.0.

The largest energy contribution came from the group of minimally processed foods (51.6%), followed by UPF (24%), processed foods (21.8%) and processed culinary ingredients (2.6%).

The largest weight contribution came from the group of minimally processed foods (81%), followed by UPF (10.1%), processed foods (8.6%) and processed culinary ingredients (0.3%).

Table I - Characterization of participants by gender (age, body mass index, dietary intake and urinary excretion)

	All (n= 107)	Male (n= 52)	Female (n= 55)	p
Age (y) [a,c]	47.4±10.4	49.2±11.0	45.8±9.6	0.091
BMI (kg/m^2) [a,c]	25.9±3.9	27.0±3.6	24.9±4.0	**0.006**
Energy consumption (kcal) [a,c]	2196±756	2430±761	1976±688	**0.002**
Weight consumption (g) [b,d]	2800 (2324, 3365)	2960 (2443, 3554)	2743 (2300, 3090)	0.191
Na (mg/day) [a,c]	3244±1329	3876±1340	2646±1012	**<.001**
Na (mg/1000kcal) [b,d]	1472 (1019, 2146)	1498 (1153, 2363)	1410 (815, 1970)	0.100
K (mg/day) [a,c]	2654±760	2957.3±789.0	2368.4±613.0	**<.001**
K (mg/1000kcal) [b,d]	1308 (914, 1585)	1287 (890, 1645)	1324 (922, 1497)	0.980
Na/K ratio [b,d]	2.0 (1.5, 2.6)	2.1 (1.6, 3.1)	1.8 (1.4, 2.4)	**0.028**
NOVA1 (%kcal/day) [a,c]	51.6±19.7	53.8±18.8	49.5±20.5	0.256
NOVA2 (%kcal/day) [b,d]	1.6 (0.0, 2.9)	0.4 (0.0, 2.3)	2.1 (0.0, 4.3)	**0.008**
NOVA3 (%kcal/day) [b,d]	20.2 (10.8, 31.6)	21.7 (9.6, 36.7)	16.5 (11.1, 26.8)	0.273
NOVA4 (%kcal/day) [b,d]	19.1 (12.3, 35.4)	16.9 (11.6, 29.4)	24.0 (12.3, 39.4)	0.216
NOVA1 (%g/day) [b,d]	84.5 (76.3, 90.4)	84.5 (71.9, 89.9)	84.5 (78.9, 90.8)	0.229
NOVA2 (%g/day) [b,d]	0.2 (0.0, 0.4)	0.1 (0.0, 0.3)	0.3 (0.0, 0.4)	**0.017**
NOVA3 (%g/day) [b,d]	5.9 (3.0, 10.8)	7.8 (3.2, 18.3)	5.3 (2.9, 9.5)	0.063
NOVA4 (%g/day) [b,d]	7.0 (2.9, 14.2)	6.9 (2.7, 13.2)	7.1 (2.9, 14.8)	0.879
	(n=97)	(n=48)	(n=49)	
Nutri-score A (%kcal/day) [b,d]	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 3.5)	0.281
Nutri-score B (%kcal/day) [b,d]	0.0 (0.0, 9.8)	0.0 (0.0, 0.0)	0.0 (0.0, 42.5)	0.059
Nutri-score C (%kcal/day) [b,d]	0.0 (0.0, 41.6)	0.0 (0.0, 42.4)	0.0 (0.0, 42.5)	0.753
Nutri-score D (%kcal/day) [b,d]	33.4 (0.8, 67.1)	51.0 (20.3, 86.6)	19.4 (0.0, 44.8)	**0.005**
Nutri-score E (%kcal/day) [b,d]	0.0 (0.0, 33.4)	0.0 (0.0, 20.3)	0.0 (0.0, 42.7)	0.644

[a] Analysis by Student t test for continuous variables.
[b] Analysis by Mann-Whitney U test.
[c] Values are mean ± standard deviation.
[d] Values are median (P25, P75).
BMI – Body mass index; Na – Sodium; K – Potassium.

As shown in Table II individuals with the lowest caloric contribution of UFP to daily intake had higher average values of potassium intake (mg/1000kcal) (p=0.007).

Table II - Urinary data on sodium and potassium excretion by lowest or highest intakes of ultra-processed foods (% kcal/day).

Estimated intake	Ultra-processed foods (% kcal/ day)		
	Lowest intake	Highest intake	p
Na mg/day [a,c]	3279.5	3209.5	0.788
Na mg/1000kcal [b,d]	1604.7	1317.6	0.100
Na/K ratio [b,d]	1.9	2.0	0.485
K mg/day [a,c]	2799.9	2511.9	0.051
K mg/1000kcal [b,d]	1438.1	1136.0	**0.007**

[a] Analysis by Student t test for continuous variables.
[b] Analysis by Mann-Whitney U test.
[c] Values are mean.
[d] Values are median.
Na – Sodium; K – Potassium.

UPF were categorized by Nutri-score in Figure I (n=97), the largest energy contribution came from group D (39.7%), followed by C (21.2%), E (17.9%), B (13%) and A (8.2%).

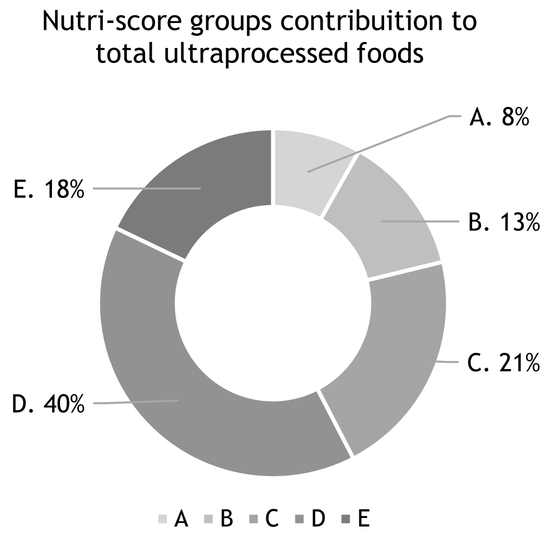

Fig I - Relative contribution (%) of each Nutri-score group to consumption of ultra-processed food in diet.

In Table III are presented the contribution of NOVA groups in weight, individuals with the highest weight contribution of the consumption of unprocessed or minimally processed foods had higher average values of potassium intake (mg/1000kcal) (p=0.010) and individuals with the lowest weight contribution of the consumption of processed culinary ingredients had higher average values of potassium intake (mg/day) (p=0.009).

Table III - Urinary data on sodium and potassium excretion by lowest or highest intakes of minimally processed foods, processed culinary ingredients, processed foods and ultra-processed foods (%g/day).

Estimated intake	Unprocessed or minimally processed foods (%g/day)			Processed culinary ingredients (%g/day)			Processed foods (%g/day)			Ultra-processed foods (%g/day)		
	LI	HI	p	LI	HI	p	LI	HI	p	LI	HI	p
Na mg/day [a,c]	3180.5	3306.9	0.625	3453.9	3038.6	0.106	3114.6	3371.6	0.320	3268.2	3220.9	0.855
Na mg/1000kcal [b,d]	1316.2	1586.2	0.080	1604.7	1391.2	0.631	1484.0	1391.2	0.789	1560.8	1359.2	0.298
Na/K ratio [b,d]	2.0	1.9	0.667	1.8	2.0	0.337	1.8	2.0	0.083	1.9	2.0	0.535
K mg/day [a,c]	2561.5	2745.9	0.211	2847.7	2464.9	**0.009**	2661.6	2647.7	0.925	2738.1	2572.6	0.262
K mg/1000kcal [b,d]	1108.7	1434.3	**0.010**	1307.9	1309.6	0.363	1359.2	1089.5	0.058	1359.2	1284.1	0.132

[a] Analysis by Student t test for continuous variables.
[b] Analysis by Mann-Whitney U test.
[c] Values are mean.
[d] Values are median.
LI – Lowest intakes; HI – Highest intakes; Na – Sodium; K – Potassium.

Discussion

The purpose of this study was to better understand the contribution of foods according to their level of processing and the correspondent differences of sodium and potassium intake.

In this sample from the staff of one public Portuguese university, 77.6% of the participants exceed daily sodium intake recommendations (2000 mg/day)[24], 84.1% did not meet recommendations for daily potassium intake (3510 mg/day) and 98.1% were largely above the one to one Na/K ratio recommended[25].

Previous studies on Portuguese adult population also shown that averages intakes of sodium and potassium were far from meeting the daily WHO recommendations[36, 38].

Our results show that in this sample about one-quarter of daily energy intake came from UPF. The NOVA group that contributed the most to the total energy and weight was unprocessed and minimally processed foods, followed by UPF, processed foods and processed culinary ingredients. These pattern is consistent with the previous reported in studies Belgium[48], Canada[15] and Brazil[49].

UPF and beverages are usually products with a lower nutritional quality[20-23]. As predictable in our results the largest energy and weight contribution of UPF came from the Nutri-score groups with the lowest nutritional quality (C, D and E).

The participants that ingest more unprocessed and minimally processed foods had higher average values of potassium (mg/1000kcal) intake (in g). These results can be explained by the dietary food sources of potassium, national data shows that fruits, vegetables and pulses were the main sources (19,9%)[38] of potassium on the diet. Previous studies in Japan shown that individuals with a higher dietary potassium intake consumed more vegetables, fruits, fish, and milk[50], similar findings in a study in Australia but also found in meat, poultry and non-alcoholic beverages[51]. Dietary potassium intake are mostly from unprocessed or minimally processed foods a study in Poland shown that was around 82%[52].

The participants that showed lowest energy contributions of UPF had higher average values of potassium intake (mg/1000kcal). The possible explanation of this result is that, as evidence shows, main food sources of potassium in Portugal come from unprocessed and minimally processed food[(38)]. These results are consistent with a previous study in Canada that shown that potassium intake (mg/1000kcal) decreased with the increase of dietary share of UPF[(21)], similar results were found in a sample of USA adults[(53)], in SUN prospective cohort study[(54)], in Brazil[(20, 55)] and in UK[(56)].

The results shown that individuals with the lowest weight contribution of the consumption of processed culinary ingredients had higher average values of potassium (mg/day). This finding may be explained by the idea that foods quantities from the second group of NOVA cannot be estimated accurately and the foods included in this group aren't used in food preparation and cooking.

UPF are usually products with higher content in sodium, so it was expected that participants high dietary share of UPF presented high intake of sodium. However, our results shown no significant differences in average intakes of sodium between highest and lowest (in Kcal or g) consumptions of UPF. This pattern of results is also found in other studies[(49, 53, 57)]. One interpretation of these findings is that dietary sodium derives from three sources: the sodium found naturally in food, the salt added to processed and UPF by food industry and the salt added to food during cooking and food preparations (discretionary salt), since in our study discretionary salt cannot be correctly estimated this could affect the results. Data from Portuguese population shown that the main source of salt consumption is the salt added during food preparation and cooking (29.2%)[(38)].

Our data suggest that highest dietary intakes of foods from NOVA group 1 could have higher intakes of sodium (p=0.080) and a possible explanation is that since discretionary salt was not accounted for in group 2 of processed culinary ingredients, the inclusion of meals in the group 1 of unprocessed and minimally processed food could explain this finding.

Our study is strengthened by the 24-hour urine collection, considered the clinical gold standard, to assess sodium intake.

Conversely, the use of a 24-h dietary recall can be a limitation in our study, the success of the recall depends on the memory, cooperation and communication ability of the participants and also a single recall cannot describe a typical diet. Although, 24-hour recalls were administered by trained researchers using a photographic book and household measures to quantify portion sizes, which minimized this potential limitation.

Additionally, salt added to food and food preparations cannot be accurately estimated since it was not reported and was not included in the second NOVA group.

Conclusion

In conclusion, in this study we found that our sample does not meet the WHO recommendations of sodium and potassium intake, have high consumptions of UPF and individuals that ingest more unprocessed and minimally processed foods had higher average values of potassium intake.

Reducing the dietary consumption of UPF and increasing the consumption of unprocessed or minimally processed foods can be an effective way to significantly improve the nutritional quality of diets and contribute to the prevention of CVD and other chronic diet-related NCDs.

Funding: This work was supported by Fundação para a Ciência e Tecnologia (Grant POCI-01-0145-FEDER-029269).

Akcnowledgments

À minha orientadora, Prof.ª Doutora Carla Gonçalves, por todo o apoio, paciência e toda a disponibilidade prestada.

A toda a minha família e amigos, pela ajuda na concretização deste trabalho.

References

1. Monteiro CA, Moubarac JC, Cannon G, Ng SW, Popkin B. Ultra-processed products are becoming dominant in the global food system. Obes Rev. 2013; 14 Suppl 2:21-8.
2. Moodie R, Stuckler D, Monteiro C, Sheron N, Neal B, Thamarangsi T, et al. Profits and pandemics: prevention of harmful effects of tobacco, alcohol, and ultra-processed food and drink industries. Lancet. 2013; 381(9867):670-9.
3. Monteiro C, Cannon G, Levy R, Moubarac J-C, Jaime P, al A. NOVA. The star shines bright. Position paper 2. World Nutrition. 2016; 7:28-38.
4. Vandevijvere S, Jaacks LM, Monteiro CA, Moubarac JC, Girling-Butcher M, Lee AC, et al. Global trends in ultraprocessed food and drink product sales and their association with adult body mass index trajectories. Obes Rev. 2019; 20 Suppl 2:10-19.
5. Juul F, Hemmingsson E. Trends in consumption of ultra-processed foods and obesity in Sweden between 1960 and 2010. Public Health Nutr. 2015; 18(17):3096-107.
6. Martins AP, Levy RB, Claro RM, Moubarac JC, Monteiro CA. Increased contribution of ultra-processed food products in the Brazilian diet (1987-2009). Rev Saude Publica. 2013; 47(4):656-65.
7. Monteiro CA, Cannon G, Moubarac JC, Levy RB, Louzada MLC, Jaime PC. The UN Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing. Public Health Nutr. 2018; 21(1):5-17.
8. Monteiro CA, Levy RB, Claro RM, Castro IR, Cannon G. A new classification of foods based on the extent and purpose of their processing. Cad Saude Publica. 2010; 26(11):2039-49.
9. Moubarac JC, Parra DC, Cannon G, Monteiro CA. Food Classification Systems Based on Food Processing: Significance and Implications for Policies and Actions: A Systematic Literature Review and Assessment. Curr Obes Rep. 2014; 3(2):256-72.
10. Elizabeth L, Machado P, Zinöcker M, Baker P, Lawrence M. Ultra-processed foods and health outcomes: A narrative review [Review]. Nutrients. 2020; 12(7):1-36.
11. de Araújo TP, de Moraes MM, Magalhães V, Afonso C, Santos C, Rodrigues SSP. Ultra-Processed Food Availability and Noncommunicable Diseases: A Systematic Review. International Journal of Environmental Research and Public Health. 2021; 18(14):7382.
12. Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet. 2012; 380(9859):2224-60.
13. Srour B, Fezeu LK, Kesse-Guyot E, Allès B, Méjean C, Andrianasolo RM, et al. Ultra-processed food intake and risk of cardiovascular disease: prospective cohort study (NutriNet-Santé). Bmj. 2019; 365:l1451.
14. Mendonça RD, Lopes AC, Pimenta AM, Gea A, Martinez-Gonzalez MA, Bes-Rastrollo M. Ultra-Processed Food Consumption and the Incidence of Hypertension in a Mediterranean Cohort: The Seguimiento Universidad de Navarra Project. Am J Hypertens. 2017; 30(4):358-66.

15. Nardocci M, Leclerc BS, Louzada ML, Monteiro CA, Batal M, Moubarac JC. Consumption of ultra-processed foods and obesity in Canada. Can J Public Health. 2019; 110(1):4-14.
16. Mendonça RD, Pimenta AM, Gea A, de la Fuente-Arrillaga C, Martinez-Gonzalez MA, Lopes AC, et al. Ultraprocessed food consumption and risk of overweight and obesity: the University of Navarra Follow-Up (SUN) cohort study. Am J Clin Nutr. 2016; 104(5):1433-40.
17. Rauber F, Steele EM, Louzada M, Millett C, Monteiro CA, Levy RB. Ultra-processed food consumption and indicators of obesity in the United Kingdom population (2008-2016). PLoS One. 2020; 15(5):e0232676.
18. Fiolet T, Srour B, Sellem L, Kesse-Guyot E, Allès B, Méjean C, et al. Consumption of ultra-processed foods and cancer risk: results from NutriNet-Santé prospective cohort. Bmj. 2018; 360:k322.
19. Julia C, Martinez L, Allès B, Touvier M, Hercberg S, Méjean C, et al. Contribution of ultra-processed foods in the diet of adults from the French NutriNet-Santé study. Public Health Nutr. 2018; 21(1):27-37.
20. Louzada M, Ricardo CZ, Steele EM, Levy RB, Cannon G, Monteiro CA. The share of ultra-processed foods determines the overall nutritional quality of diets in Brazil. Public Health Nutr. 2018; 21(1):94-102.
21. Moubarac JC, Batal M, Louzada ML, Martinez Steele E, Monteiro CA. Consumption of ultra-processed foods predicts diet quality in Canada. Appetite. 2017; 108:512-20.
22. Cediel G, Reyes M, da Costa Louzada ML, Martinez Steele E, Monteiro CA, Corvalán C, et al. Ultra-processed foods and added sugars in the Chilean diet (2010). Public Health Nutr. 2018; 21(1):125-33.
23. Louzada ML, Martins AP, Canella DS, Baraldi LG, Levy RB, Claro RM, et al. Impact of ultra-processed foods on micronutrient content in the Brazilian diet. Rev Saude Publica. 2015; 49:45.
24. WHO. Guideline: Sodium intake for adults and children. 2012. Disponível em: http://www.who.int/nutrition/publications/guidelines/sodium_intake/en/.
25. WHO. Guideline: Potassium intake for adults and children. 2012. Disponível em: http://www.who.int/nutrition/publications/guidelines/potassium_intake/en/.
26. Brown IJ, Tzoulaki I, Candeias V, Elliott P. Salt intakes around the world: implications for public health. Int J Epidemiol. 2009; 38(3):791-813.
27. Poggio R, Gutierrez L, Matta MG, Elorriaga N, Irazola V, Rubinstein A. Daily sodium consumption and CVD mortality in the general population: systematic review and meta-analysis of prospective studies. Public Health Nutr. 2015; 18(4):695-704.
28. He FJ, MacGregor GA. A comprehensive review on salt and health and current experience of worldwide salt reduction programmes. J Hum Hypertens. 2009; 23(6):363-84.
29. Forouzanfar MH, Liu P, Roth GA, Ng M, Biryukov S, Marczak L, et al. Global Burden of Hypertension and Systolic Blood Pressure of at Least 110 to 115 mm Hg, 1990-2015. Jama. 2017; 317(2):165-82.
30. van Mierlo LA, Greyling A, Zock PL, Kok FJ, Geleijnse JM. Suboptimal potassium intake and potential impact on population blood pressure. Arch Intern Med. 2010; 170(16):1501-2.

31. Aburto NJ, Hanson S, Gutierrez H, Hooper L, Elliott P, Cappuccio FP. Effect of increased potassium intake on cardiovascular risk factors and disease: systematic review and meta-analyses. Bmj. 2013; 346:f1378.
32. He FJ, Li J, Macgregor GA. Effect of longer term modest salt reduction on blood pressure: Cochrane systematic review and meta-analysis of randomised trials. Bmj. 2013; 346:f1325.
33. Morris RC, Jr., Schmidlin O, Frassetto LA, Sebastian A. Relationship and interaction between sodium and potassium. J Am Coll Nutr. 2006; 25(3 Suppl):262s-70s.
34. Iwahori T, Miura K, Ueshima H, Tanaka-Mizuno S, Chan Q, Arima H, et al. Urinary sodium-to-potassium ratio and intake of sodium and potassium among men and women from multiethnic general populations: the INTERSALT Study. Hypertens Res. 2019; 42(10):1590-98.
35. Perez V, Chang ET. Sodium-to-potassium ratio and blood pressure, hypertension, and related factors. Adv Nutr. 2014; 5(6):712-41.
36. Polonia J, Martins L, Pinto F, Nazare J. Prevalence, awareness, treatment and control of hypertension and salt intake in Portugal: changes over a decade. The PHYSA study. J Hypertens. 2014; 32(6):1211-21.
37. PORDATA. Óbitos por algumas causas de morte (%). Fundação Francisco Manuel dos Santos; 2009 Disponível em: https://www.pordata.pt/Portugal/%C3%93bitos+por+algumas+causas+de+morte+(percentagem)-758
38. Lopes C TD, Oliveira A, Severo M, Alarcão V, Guiomar S, Mota J, Teixeira P, Rodrigues S, Lobato L, Magalhães V, Correia D, Carvalho C, Pizarro A, Marques A, Vilela S, Oliveira L, Nicola P, Soares S, Ramos E. Inquérito Alimentar Nacional e de Atividade Física, IAN-AF 2015-2016: Relatório de resultados. 2017. Disponível em: www.ian-af.up.pt.
39. Gonçalves C, Silva-Santos T, Abreu S, Padrão P, Graça P, Oliveira L, et al. Innovative equipment to monitor and control salt usage when cooking at home: iMC SALT research protocol for a randomised controlled trial. BMJ Open. 2020; 10(5):e035898.
40. WHO. Noncommunicable Diseases and Mental Health Cluster. In: Team S, editor. STEPS instruments for NCD risk factors (core and expanded version 14) : the WHO STEPwise approach to Surveillance of noncommunicable diseases (STEPS). World Health Organization; 2001. Disponível em: https://apps.who.int/iris/handle/10665/68346.
41. Stewart A, Marfell-Jones, M., Olds, T. and Ridder, H. International standards for anthropometric Assesment (2011): ISAK. International Society for the Advancement of Kinanthropometry; 2016.
42. Europe WROf. Estimation of Sodium Intake and Output: Review of Methods and Recommendations for Epidemiological Studies. Report on a Who Meeting by the Who Collaborating Center for Research and Training in Cardiovascular Diseases. 1984.
43. Marques M PO, MDVd A. Ingredientes E valor Nutricional de Porções do manual de Quantificação de Alimentos. 1999.
44. Monteiro CA, Cannon G, Levy RB, Moubarac JC, Louzada ML, Rauber F, et al. Ultra-processed foods: what they are and how to identify them. Public Health Nutr. 2019; 22(5):936-41.

45. France Sp. NUTRI-SCORE FREQUENTLY ASKED QUESTIONS SCIENTIFIC & TECHNICAL 2021. Disponível em: https://www.santepubliquefrance.fr/en/nutri-score.
46. Gigadent S. Open Food Facts. 2012. Disponível em: https://world.openfoodfacts.org/.
47. France Sp. Nutri-Score calculation tool. Outil_Calcul_Nutri-Score_SpF-2021_EN. Excel. Santé publique France; 2021. Disponível em: https://www.santepubliquefrance.fr/en/nutri-score.
48. Vandevijvere S, De Ridder K, Fiolet T, Bel S, Tafforeau J. Consumption of ultra-processed food products and diet quality among children, adolescents and adults in Belgium. Eur J Nutr. 2019; 58(8):3267-78.
49. Cattafesta M, Petarli GB, Zandonade E, Bezerra O, Abreu SMR, Salaroli LB. Energy contribution of NOVA food groups and the nutritional profile of the Brazilian rural workers' diets. PLoS One. 2020; 15(10):e0240756.
50. Okuda N, Okayama A, Miura K, Yoshita K, Miyagawa N, Saitoh S, et al. Food Sources of Dietary Potassium in the Adult Japanese Population: The International Study of Macro-/Micronutrients and Blood Pressure (INTERMAP). Nutrients. 2020; 12(3)
51. Bolton KA, Trieu K, Woodward M, Nowson C, Webster J, Dunford EK, et al. Dietary Intake and Sources of Potassium in a Cross-Sectional Study of Australian Adults. Nutrients. 2019; 11(12)
52. Górska-Warsewicz H, Rejman K, Laskowski W, Kowalcze K. Food Sources of Potassium in the Average Polish Diet. Nutrients. 2019; 11(12)
53. Kim H, Hu EA, Rebholz CM. Ultra-processed food intake and mortality in the USA: results from the Third National Health and Nutrition Examination Survey (NHANES III, 1988-1994). Public Health Nutr. 2019; 22(10):1777-85.
54. Rico-Campà A, Martínez-González MA, Alvarez-Alvarez I, Mendonça RD, de la Fuente-Arrillaga C, Gómez-Donoso C, et al. Association between consumption of ultra-processed foods and all cause mortality: SUN prospective cohort study. Bmj. 2019; 365:l1949.
55. Costa Louzada ML, Martins AP, Canella DS, Baraldi LG, Levy RB, Claro RM, et al. Ultra-processed foods and the nutritional dietary profile in Brazil. Rev Saude Publica. 2015; 49:38.
56. Rauber F, da Costa Louzada ML, Steele EM, Millett C, Monteiro CA, Levy RB. Ultra-Processed Food Consumption and Chronic Non-Communicable Diseases-Related Dietary Nutrient Profile in the UK (2008⁻2014). Nutrients. 2018; 10(5)
57. Moubarac JC, Martins AP, Claro RM, Levy RB, Cannon G, Monteiro CA. Consumption of ultra-processed foods and likely impact on human health. Evidence from Canada. Public Health Nutr. 2013; 16(12):2240-8.