

## Evaluation of salt content in school meals

### *Avaliação do conteúdo de sal em refeições escolares*

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#### **ABSTRACT**

##### **Objective**

High blood pressure is a major risk factor for cardiovascular disease, and it is closely associated with salt intake. Schools are considered ideal environments to promote health and proper eating habits. Therefore the objective of this study was to evaluate the amount of salt in meals served in school canteens and consumers' perceptions about salt.

##### **Methods**

Meals, including all the components (bread, soup, and main dish) were retrieved from school canteens. Salt was quantified by a portable salt meter. For food perception we constructed a questionnaire that was administered to high school students.

##### **Results**

A total of 798 food samples were analysed. Bread had the highest salt content with a mean of 1.35 g/100 g (SD=0.12). Salt in soups ranged from 0.72 g/100 g to 0.80 g/100 g ( $p=0.05$ ) and, in main courses, from 0.71 g/100 g to 0.97 g/100g ( $p=0.05$ ). The salt content of school meals is high with a mean value of 2.83 to 3.82 g of salt per meal. Moreover, a high percentage of students consider meals neither salty nor bland, which shows they are used to the intensity/amount of salt consumed.

##### **Conclusion**

The salt content of school meals is high, ranging from 2 to 5 times more than the Recommended Dietary Allowances for children, clearly exceeding the needs for this population, which may pose a health risk. Healthy

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choices are only possible in environments where such choices are possible. Therefore, salt reduction strategies aimed at the food industry and catering services should be implemented, with children and young people targeted as a major priority.

**Keywords:** Health promotion. School feeding. Sodium chloride. Taste perception.

## RESUMO

### Objetivo

Considerando que a pressão arterial elevada constitui um dos maiores fatores de risco para as doenças cardiovasculares e sua associação ao consumo elevado de sal, bem como o fato de as escolas serem considerados ambientes de excelência para fomentar a aquisição de bons hábitos alimentares e promover a saúde, o objetivo deste estudo foi avaliar o conteúdo de sal presente nas refeições escolares e a percepção dos consumidores sobre o sabor salgado.

### Métodos

Foram recolhidas refeições nas cantinas das escolas, analisando-se todos os seus componentes (pão, sopa e prato principal). A quantificação de sal foi realizada com um medidor de sal portátil. Para a avaliar a percepção dos consumidores foi desenvolvido e aplicado um questionário aos alunos das escolas preparatórias e secundárias.

### Resultados

Foram analisados 798 componentes de refeições. O pão apresentou o valor mais elevado de sal, com média de 1,35 g/100 g (SD=0.12). O conteúdo de sal nas sopas apresentou média de 0,72 g/100 g a 0,80 g/100 g ( $p=0,05$ ) e, nos pratos principais, de 0,71 g/100 g a 0,97 g/100 g ( $p=0,05$ ). Em média, as refeições escolares disponibilizaram entre 2,83 e 3,82 g de sal por porção servida, o que representa de duas a cinco vezes mais em relação à dose diária recomendada para crianças e jovens. Para a maioria dos estudantes, o sabor das refeições foi percebido como sendo nem salgado nem insosso, o que parece demonstrar adaptação à intensidade/quantidade de sal consumida.

### Conclusão

Escolhas alimentares saudáveis e adequadas só são possíveis se sustentadas por um ambiente que as facilite. Considerando o impacto que o consumo de sal tem na saúde, em particular nas doenças crônicas, a implementação de estratégias de redução de sal - nas indústrias, serviços de catering e restaurantes -, é imperativa, em particular direcionada para o público mais jovem.

**Palavras-chave:** Promoção da saúde. Alimentação escolar. Cloreto de sódio. Percepção gustatória.

## INTRODUCTION

Diet and nutrition are recognised as decisive factors for individual health with direct influence on one's physical and psychological well-being both in the present and in the future<sup>1</sup>, which is why these factors are considered of particular importance in preventing diseases<sup>1,2</sup>.

Among chronic diseases, cardiovascular diseases continue to be the leading cause of death worldwide<sup>3,4</sup>. There are many risk factors that contribute to cardiovascular disease, among which high blood pressure is thought to have the biggest influence (12.8%), estimated to be responsible for 51.0% of mortality from stroke

and 45.0% of mortality due to coronary heart disease<sup>5</sup>.

Portugal has a high prevalence of hypertension<sup>6</sup>. Vascular diseases, including stroke, are among the leading causes of death. According to data from the National Statistics Institute, cardiovascular diseases account for 30.7% of overall mortality and 11.5% of life years lost. Within vascular diseases, cerebrovascular diseases represent 42.0%<sup>7</sup>. According to the latest study, 42.1% of the Portuguese population has high blood pressure, with an average systolic blood pressure of 134.7 mmHg, which progressively increases with age<sup>8</sup>.

Among the different factors that contribute to high blood pressure, salt intake has been extensively studied<sup>2,5</sup>. In recent years, several authors have reinforced the scientific evidence, suggesting that the influence of salt is far greater than that of other lifestyle factors, such as excess weight, low fruit and vegetable consumption, or physical inactivity. Animal, epidemiological, and population intervention studies have shown that blood pressure increases progressively with higher doses of salt, and decreases correspondingly when salt intake is reduced<sup>9-19</sup>. Studies of younger populations also clearly show the negative effect of salt on blood pressure and the future negative effect of high salt intake at young ages<sup>20,21</sup>. Hypertension represents a major challenge in terms of public health, and several researchers and official organizations have stated that prevention strategies, detection, treatment, and control should be prioritized<sup>22-24</sup>, particularly among the younger population<sup>8,25,26</sup>.

Portugal has a tradition for high salt consumption, which has become part of families' eating habits, introducing salt at an early age. It is known that when individuals are exposed to large amounts of salt, the salt receptors are suppressed, whereby one becomes accustomed to the doses, which makes higher amounts of salt necessary for flavour perception<sup>27-29</sup>. Although we know that western societies consume about 10 to 12 g of salt, greatly exceeding the daily requirements (Table 1)<sup>30,31</sup>, there are few studies that have evaluated salt intake in young populations, which is important considering the

impact that salt consumption can have on the future blood pressure of individuals.

It is well known that the environment is crucial for individual behaviour and lifestyle, often conditioning our choices<sup>32-34</sup>. Schools are considered to be one of the best places to promote health<sup>35</sup>, to encourage proper eating habits, and to provide the environment for hands-on learning over time and repeatedly<sup>36</sup>.

As such, we conveyed two hypotheses: 1) Do school meals provide excessive salt? 2) What are the children's perceptions about salt? The consumption of meals high in salt as well as the use of too much salt in cooking may contradict the information conveyed in the classroom, which led us to the last hypothesis, questioning the effect of school on salt intake and perception. Furthermore, the consumption of excess salt conditions the taste buds, thus constituting a less positive influence on younger generations, and not making a positive contribution to the public education of this population group. Therefore, the objective of this study was to: (1) evaluate the amount of salt in meals served in school canteens; (2) evaluate consumers' perceptions about salt; (3) discuss the influence of the school on salt intake and taste perception.

## METHODS

This study used quantitative techniques to describe the salt content of meals served in schools and to understand consumer perceptions.

**Table 1.** Sodium (Na) and salt (NaCl) daily reference intakes.

Age	RDA*		Age	AI**		UL***	
	Na (mg)	NaCl (g)		Na (mg)	NaCl (g)	Na (mg)	NaCl (g)
2-5 years	300	0.76	4-8 years	1200	3.05	1900	4.83
6-9 years	400	1.02	9-13 years	1500	3.81	2200	5.59
10-18 years	500	1.27	14-50 years	1500	3.81	2300	5.84

Note: \*Recommended Dietary Allowance (RDA) - corresponds to the amount of daily ingestion that is sufficient to cover the needs of 97 to 98% of the individuals of the same age and the same gender. \*\*Adequate Intake (AI) - corresponds to a value based on the intake of a particular nutrient, adjusted experimentally or resulting from observation in populations in apparently healthy individuals. \*\*\*Tolerable Upper (TU) Limit intake level - corresponds to the highest continued daily ingestion of a nutrient that apparently does not have adverse effects on health in almost all individuals of the same age and the same gender.

The study took place in the *Cascais* Region, which is one of the most well known regions in Portugal for tourism and considered to be one of the best places to live. To evaluate the amount of salt in school meals we included all the schools, from pre-schools to high schools; for consumers' perceptions about salt we included all children and adolescents of both genders (N=10,924) from all eight high schools, due to the fact that children above ten years old were able to clearly read, understand, and answer the questionnaire.

Salt was quantified in all the kindergartens and elementary schools (Group 1 [G1]) and all high schools (Group 2 [G2]), which were assigned to two different companies, both of whom agreed to participate in the study anonymously. All the schools provided a single daily menu, which included bread, soup, a main dish, a salad, and dessert. Using sample size calculation for average estimation, we determined a minimum of 95 school meals. We collected 798 samples, which included all the components of the meals - bread (102), soup (265), main dish (384) and salad (47), excluding the dessert since it does not have any impact on the amount of salt intake.

Salt was analysed by a portable salt meter that uses electrical conductivity - PAL ES2 from ATAGO<sup>37</sup>. The selected salt meter is highly accurate, giving the same repeat results and having been compared with the Mohr method (laboratory reference method for salt analysis). These tests found slightly higher levels of salt in the samples than those provided by PAL ES2 since proteins, fats, and other food components, which do not have electrical conductivity, tend to mask salt. To overcome this problem, the sample should be diluted for more accurate results. We previously analysed 15 meals with both methods and performed statistical analyses to validate agreement of both methods using the Bland-Altman plot and *t*-test for mean difference<sup>38,39</sup>, concluding there was no difference between the methods ( $p < 0.01$ ). The mean difference between the two tests is 0.067 (Standard Deviation-SD=0.14); (Confidence Interval-CI=[-0.147, 0.013]) ( $p=0.05$ ).

## Questionnaire to evaluate food perception

Using similar studies<sup>40-42</sup> to compose the questions, we drew up a questionnaire to assess food perceptions. The questionnaire was divided into two sections: (1) sociodemographic characterization; (2) eating habits and perceptions in school periods. Given that this survey involved a relatively young population, we sought to keep the questions simple and limit the technical language.

Each section of the questionnaire was developed in accordance with the objectives of the study, and the questions were split into four groups: sociodemographic characterization, eating habits and lifestyle, nutritional concerns and knowledge, and perceptions about the meals served in the cafeteria.

A pre-test was performed which included a page for students to record how long it took to fill in the form and to indicate the main difficulties completing the form, and also to detect errors. From the pre-test we reformulated questions for better understanding. The pre-test also allowed for validation of data input and appropriate statistical analysis, according to the study objectives and hypotheses.

Using sample size calculation we determined a maximum error of 2.88%, having administered the questionnaire to 1,049 students from high schools (ages 10 to 21). Parent and school consent was obtained to administer the questionnaire.

Statistical analysis was performed using R software (2.15.1 - MacOSX). For the salt quantification variables, we performed descriptive analysis and calculated the confidence interval. The variables from the questionnaire were coded and grouped according to food perceptions of the nutritional balance of the meals, salty taste, food consumption habits and choices, and nutritional concerns and knowledge. Descriptive statistics was performed. The data had a non-parametric distribution so the Wilcoxon test was used for the mean difference<sup>43</sup>. We used a 95% level of confidence for the entire analysis.

## RESULTS

A total of 798 food samples were analysed, 102 bread samples, 265 soup samples (106 local cooking G1, 72 cook & chill G1, 87 local cooking G2), 384 main dishes (117 local cooking G1, 154 cook & chill G1, 113 local cooking G2), and 47 salads. There were no bread samples for the schools with cook and chill meals, or salads, because they were similar to the G1 schools with local cooking. The G2 schools did not fully comply with sample collection and did not save the bread and salad samples. Nevertheless, the bread suppliers are local, so we can expect to have similar results.

As shown in Table 2, the food item with the highest global salt value is bread with a mean value of 1.35 ( $\pm 0.12$ ). Soups and main courses

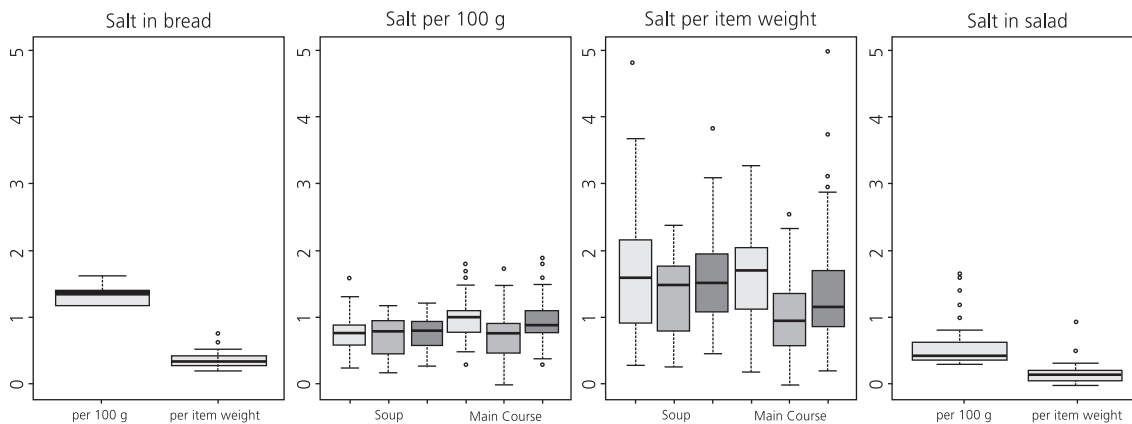
have a wider variability, local cooking presenting slightly higher values than cook and chill. The mean value for salt was 0.76 g/100 g ( $\pm 0.22$ ) for the local cooking G1, 0.72 g/100 g ( $\pm 0.29$ ) for the cook and chill G1, and 0.80 g/100 g ( $\pm 0.21$ ) for the local cooking G2. Tests for the mean difference were performed between all the groups showing there were no significant differences between soups from each group (Wilcoxon test,  $p < 0.01$ ).

For the main course we also found higher values on local cooking *versus* cook and chill. Local cooking G1 presents a mean value for salt of 0.97 g/100 g ( $\pm 0.27$ ), similar to local cooking G2 which is 0.92 g/100 g ( $\pm 0.25$ ) while cook and chill G1 presents a mean value of 0.71 g/100 g ( $\pm 0.37$ ). As expected there were significant differences between local cooking and cook and chill (Wilcoxon test,  $p < 0.01$ ).

**Table 2.** Salt per 100 g - food items and school groups. Cascais schools, 2011/2012.

Food item	School group	(g/100 g)				
		Mean	$\pm$	SD	Median	Inter Quartile Range
Bread	G1 LC	1.35	$\pm$	0.12	1.40	0.2
Soup	G1 LC	0.76	$\pm$	0.26	0.76	0.29
	G1 CC	0.72	$\pm$	0.29	0.80	0.42
	G2 LC	0.80	$\pm$	0.21	0.80	0.35
Main course	G1 LC	0.97	$\pm$	0.27	1.00	0.3
	G1 CC	0.71	$\pm$	0.37	0.77	0.4
	G2 LC	0.92	$\pm$	0.25	0.90	0.3
Salad	G1 LC	0.55	$\pm$	0.33	0.40	0.2

Note: G1: Group 1; G2: Group 2; LC: Local Cooking; CC: Cook and Chill; SD: Standard Deviation.



**Figure 1.** Salt in different items per 100 g and item weight.

We also weighed all the samples and calculated the amount of salt *per weight* as shown in the boxplots of Figure 1 and Table 3. As we can see, although bread has the highest mean value of salt *per 100 g* (1.35 g), the average serving size is 27.6 g ( $\pm 5.5$ ), which accounts for 0.36 g/salt *per portion*, while soups and main courses have mean values of 0.72 g/100 g to 0.97 g/100 g, but account for much more salt intake, with mean values ranging from 0.95 to 1.7 g, maximum values going up to nearly 4 g of salt. Global mean values are shown in Table 3.

The food perception questionnaire obtained a total of 1,049 responses, 52.2% female and 42.8% male, with a mean age of 14 years ( $\pm 1.93$ ), ranging from 10 to 21. The most common places for children to eat their lunch are school (26.0 to 42.0%) and home (30.0 to 52.0%). The mother is usually responsible for the home cooking (70.0%).

The main factor when choosing what to eat is flavour ( $\mu=1.936$ ), followed by health ( $\mu=2.726$ ), price ( $\mu=2.83$ ), company ( $\mu=3.782$ ), and ranked last is the place where the student chooses to eat ( $\mu=4.083$ ) (Figure 2). Among the other factors mentioned, the most frequent answers

were the appearance, quantity, quality, and hygiene.

Sixty-two per cent of the students consider the degree of concern about nutrition to be important (50%) or very important (12%) when consuming a meal, but 29% are indifferent, while 9% consider it to be of low importance (5%) or not important at all (4%). Only 34% of the students frequently take nutritional aspects into account when choosing the meal, 40% take them into consideration sometimes and 26% rarely or never.

The large majority (96%) considers food to have a significant impact on health and cite obesity and diabetes as the diseases most related to food. In relation to salt, most students who had their last meal in the school canteen (29% of the total) found it neither salty nor bland (76%), 17% considered it very salty or salty, and 7% said it had no salt or very little salt.

## DISCUSSION

The salt content in school meals, although slightly different among the different groups, is high, with a mean value of 2.83 to 3.82 g of salt

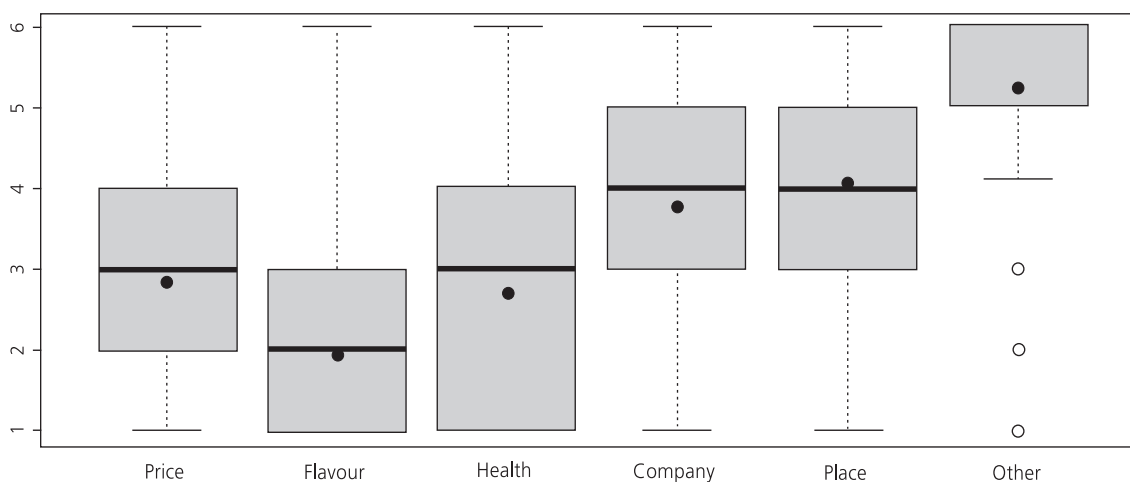
**Table 3.** Mean salt content per average meal served/comparison to the Reference Daily Intake (RDA) and Upper Limit (UL). Cascais schools, 2011/2012.

Food item	G1			G2			G2		
	Local cooking			Cook and Chill			Local cooking		
	Salt/100 g	Weight	Salt <i>per average weight</i>	Salt/100 g	Weight	Salt <i>per average weight</i>	Salt/100 g	Weight	Salt <i>per average weight</i>
Bread	1.35	26.6	0.36	-	-	0.36*	-	-	0.36*
Soup	0.76	209.1	1.63	0.72	189.1	1.35	0.80	196.8	1.59
Main course	0.97	170.5	1.66	0.71	133.9	0.95	0.92	151.2	1.38
Salad	0.55	31.1	0.17	-	-	0.17*	-	-	0.17*
<b>Total</b>			<b>3.82</b>			<b>2.83</b>			<b>3.51</b>
% RDA	2-5 Y		503			372			462
	6-9 Y		375			277			344
	$\geq 10$ Y		301			223			276
% UL	4-8 Y		79			59			73
	9-13 Y		68			51			63
	$\geq 14$ Y		65			48			60

Note: \*Values used from the G1 (Group 1) local cooking.

y: years.





**Figure 2.** Main factors when deciding what/where to eat.

per meal, which represents between 2 to 5 times the Recommended Dietary Allowance, some values representing a large proportion of the Tolerable Upper Intake Level<sup>30</sup> as shown in Table 3. Soups and main courses are the leading sources of salt in the evaluated meals. Bread, although accounting for only 0.36 g (due to the small amount served) is also a major source of salt providing 1.35 g per 100 g on average. We found no studies that evaluated the content of salt in school meals, but other studies that report salt ingested by children and adolescents indicate a daily value of between 3.8 g/day (children 4 to 6 years) and 8.8 g/day (13-year-old adolescents) (p.867)<sup>44</sup> which might be lower daily intakes than the ones expected from our study, considering the salt intake we found is only a percentage of the daily intake. The National Council of Food and Nutrition reports consumption values (data from 1989) for the Portuguese population - of 15 to 18 g of salt per day<sup>45,46</sup>, and the most recent study reports that the Portuguese population consumes 9 to 12 g/day<sup>6</sup>. There are no Portuguese studies that evaluate consumption at home, but we can expect similar values considering the most recent data available for global consumption. We believe that the consumption of these meals represents a risk of high salt intake. Considering that we are talking about just one of several daily meals, and that the proportion of students who usually consume meals at school ranges from 26

to 42%, these meals contribute with a significant amount of salt, often exceeding 50% of the UL, potentially placing at risk the health of the children and adolescents who consume these meals.

Apart from this risk it is also important to consider the context in which these meals take place since schools should ensure the development and acquisition of good eating habits, making sure that the dissemination of theoretical messages and knowledge<sup>36</sup> is not confined merely to the theoretical context of the *curriculum*, but is part of the practices of the school environment, so as not to convey contradictory messages<sup>35</sup>.

Also, a very high percentage of students consider meals to be neither salty or lacking in salt, which shows they are accustomed to the intensity/amount of salt consumed. Several authors discuss the conditioning towards salt perception as a reflex of the amount of salt usually consumed and the importance of gradual reduction to decrease the threshold and enhance perception at lower intake levels<sup>31,47-49</sup>. So, the provision of these meals is not contributing to educate their consumers for a "less salty" taste, but in fact the opposite, which is unfortunate since young ages are considered to be crucial for taste definition and learning<sup>50</sup>.

We can also see that students show some concern about food and nutrition. Although most of this concern is related to calories, some

students are aware of salt. Not only awareness about nutrition is increasing, but we can also observe that students can relate nutrition to common diseases. Consumer concerns and awareness about food and nutrition are increasing<sup>51,52</sup> and should be regarded as an opportunity to intervene, especially when considering a younger population<sup>25,26</sup>. At the same time we observe that taste (flavour) is the main factor when choosing a meal, which might override nutritional concerns. Cognition about food, diseases and nutrition is not enough when choosing foods, especially when considering young populations. Several authors have reached the conclusion that flavour is very important for food choice<sup>53-55</sup> and that young people, although aware of nutritional aspects and concerns, consider that at their age it is not imperative to make the right choices<sup>56</sup>, which is why proper environments are so important in facilitating choices<sup>57</sup>. This means that sensory characteristics of food should always be taken into consideration when developing new foods or reformulating existing ones.

## CONCLUSION

The school meals evaluated in this study clearly account for a high intake of salt, reaching the upper level of tolerable intake, which might put children at risk of disease. Children and adolescents seem to be aware of nutritional concerns, but taste acts as a major factor in food choice. Knowing that food available to consumers determines individual choices and may provide an incentive or a barrier to good choices, we believe that there should be a greater effort from the catering service to provide healthy foods that are both tasty and appealing. Therefore salt reduction strategies, especially aimed at the food industry and catering services, should be implemented, targeting children and young people as a major priority.

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## CONTRIBUTORS

CACL VIEGAS wrote the article. P GRAÇA, MRO MARTINS and J TORGAL supervised the article.

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