



Association between sugar-sweetened beverages and dental caries in 7-year-old children – a prospective study

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**Association between sugar-sweetened
beverages and dental caries in
7-year-old children – a prospective study**

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*“O que eu faço é uma gota no meio de um oceano.
Mas sem ela, o oceano será menor.”*

Madre Teresa de Calcutá



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Abstract

Introduction

The relationship between dental caries and dietary sugars is well documented in the literature. Over the years, children's eating patterns have been changing, and soft drinks have increasingly been present at the forefront of this age group. Dietary practices are an important key in preventing tooth decay and, therefore, they must include a reduction of sugar in the children's diet.

Objectives

The aim of this study is to understand the relationship between sugary drinks and the increase in dental caries after 3 years of exposure. Moreover, also understand if there is any difference between the influence of carbonated and still drinks.

Materials and Methods

The participants were part of the population-based birth cohort, Generation XXI. At both 4 and 7 years of age, dental examinations were performed, and dietary patterns were assessed using a validated food frequency questionnaire. Subsequently, two similar groups of sugary beverages were created at both ages, carbonated (coca-cola and carbonated soft drinks) and still (ice tea, nectar, and still soft drinks), where their evolution over the 3 years of analysis was evaluated. To analyze the development of sugary beverage consumption, we calculated the tertiles for each type of drink at both ages to re-categorize and create 4 groups: "Maintained low", "Maintained high", "Increased" and "Decreased". To assess the caries increment, only the deciduous canines and molars were considered. A binary logistic regression was performed to evaluate the relationship between sugary drinks and the increase in dental caries from 4 to 7 years, obtaining odds ratio (OR) and 95% confidence intervals. The models were adjusted for the child's sex, the parents' education level, and sugary food consumption.

Results

After adjusting for confounders, a statistically significant relationship was found between carbonated drinks and dental caries experience. The evolution patterns of the consumption of carbonated drinks presented the following values: “Maintained high” (OR = 1.80; 95% CI: 1.05 – 4.00), “Increased” (OR = 1.98; 95% CI: 1.10 – 3.57) and “Decreased” (OR = 3.18; 95% CI: 1.76 – 5.76). The “Maintained low” pattern was established as the reference category. Interestingly, this relationship was even greater than in the consumption of sweets (OR = 1.52; 95% CI: 1.02 – 2.26). Despite this, still sugary drinks lost their significant influence on the increase in dental caries in children aged 7 years.

Conclusion

A relationship was found between the consumption of sugary drinks and dental caries experience in childhood, with a more evident relationship with the carbonated drinks, even more than the ingestion of sweets. The influence that gas associated with sugar can have on dental caries becomes even more important after our study. Its characteristic acidity can drastically lower the salivary pH and associated with the carbohydrates metabolizing acid, can lead to the appearance of dental caries over time. To prevent the appearance of dental caries in children, it is essential to reduce the amount of sugar in the diet, including the consumption of sugary drinks, with special emphasis on carbonated beverages.

Key words

“Dental caries”; “Sugar-sweetened beverages”; “Dietary patterns”; “Children”; “Carbonated drinks”, “Still drinks”



Resumo

Introdução

A relação entre a cárie dentária e os açúcares da dieta é já bem documentada na literatura. Ao longo dos anos, os padrões alimentares das crianças têm vindo a modificar e os refrigerantes têm estado cada vez mais presentes na linha da frente desta faixa etária. As práticas alimentares são uma chave importante na prevenção desta doença e, por isso, devem incluir a redução do açúcar na dieta das crianças.

Objetivos

O objetivo deste estudo é perceber a relação entre as bebidas açucaradas e o incremento de cárie dentária após 3 anos de exposição. Além disso, também entender se existe alguma diferença entre a influência das bebidas gaseificadas e das bebidas sem gás.

Materiais e Métodos

Os participantes faziam parte da coorte de nascimentos da base populacional, Geração XXI. Tanto aos 4, como aos 7 anos foram feitos exames dentários e os padrões alimentares foram avaliados através de um questionário de frequência alimentar validado. Posteriormente foram criados dois grupos semelhantes de bebidas açucaradas em ambas as idades, com gás (coca-cola e refrigerantes gaseificados) e sem gás (ice tea, néctar e refrigerantes sem gás), onde se avaliou a sua evolução ao longo dos 3 anos de análise. De modo a analisar a evolução do consumo de bebidas açucaradas, calcularam-se os tercís para cada tipo de bebida em ambas as idades, para recategorizar e criar 4 grupos em ambos os tipos de bebidas: “Manteve baixo”, “Manteve alto”, “Aumentou” e “Diminuiu”. Para avaliar o incremento de cárie, foram apenas considerados os caninos e molares decíduos. Foi feita uma regressão binária logística para avaliar a relação entre bebidas açucaradas e o aumento da cárie dentária de 4 a 7 anos, obtendo o odds ratio (OR) e os intervalos de confiança

de 95%. Os modelos foram ajustados para o sexo da criança, escolaridade dos pais e consumo de comidas açucaradas.

Resultados

Após o ajuste para os fatores de confusão, foi encontrada uma relação estatisticamente significativa entre as bebidas com gás e a experiência de cárie dentária. Os padrões de evolução do consumo das bebidas açucaradas apresentaram os seguintes valores: “Manteve alto” (OR = 1,80; IC 95%: 1,05 – 4,00), “Aumentou” (OR = 1,98; IC 95%: 1,10 – 3,57) e “Diminuiu” (OR = 3,18; IC 95%: 1,76 – 5,76). O padrão “Manteve baixo” foi estabelecido como a categoria de referência. Curiosamente, esta relação foi até maior do que no consumo de doces (OR = 1,52; 95% CI: 1,02 – 2,26). Apesar disso, as bebidas açucaradas sem gás perderam a influência significativa no incremento da cárie dentária nas crianças aos 7 anos.

Conclusão

Foi encontrada uma relação entre o consumo de bebidas açucaradas e a experiência de cárie dentária na infância, com uma relação mais evidente nas bebidas gaseificadas, sendo esta ainda maior do que na ingestão de doces. A influência que o gás associado ao açúcar pode ter na formação da cárie dentária torna-se ainda mais importante após o nosso estudo. A sua acidez característica pode diminuir drasticamente o pH salivar e, associada ao ácido da metabolização dos hidratos de carbono pode levar com o tempo ao aparecimento da cárie dentária. Para prevenir o aparecimento desta doença nas crianças é essencial a redução da quantidade de açúcar na dieta, incluindo o consumo de bebidas açucaradas, especialmente as carbonatadas.

Palavras-chave

“Cárie dentária”; “Bebidas açucaradas”; “Padrões alimentares”; “Crianças”; “Bebidas com gás”, “Bebidas sem gás”



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1. Introduction





1 Introduction

Tooth decay is the most prevalent non-communicable disease worldwide. (1) In addition to affecting oral health, it also has a deleterious effect on overall health and quality of life. This disease affects all ages, although children are the highest risk group. (2) Even though there has been a reduction in the prevalence of tooth decay over the past two decades due to improved education, dental hygiene, sealants, and water fluoridation, dental caries remain the most predominant chronic infectious disease among children. (3)

The World Health Organization reports that 60–90% of children are affected by dental caries. (2, 4) This organization emphasizes the need to reduce the global burden of dental caries in attaining optimal health. (5) According to the statistics provided by European countries, 61% of children aged 6 to 12 years have at least one decayed tooth. (6)

Dental caries is a complex dental disease that is associated with a multifactorial etiology. (7) The acid produced by bacteria resulting from the fermentation of simple carbohydrates plays an important role. (8) It starts with a small superficial demineralization and may then progress in a centripetal way to cavitation followed by pulp involvement and edema, abscess, and systemic signs and symptoms. (7) Untreated caries are associated with pain and can lead to speech, sleep, and eating problems in children. (9) The disease shows a characteristic pattern of affecting the dentition, with a preference for plaque accumulation sites. (8)

The cause of dental caries can be associated with three main factors that must be present for a period of time, which are oral pathogenic bacteria, the presence of fermentable carbohydrates, and the susceptibility of the tooth surface inherent to the host. (7, 8) Considerable evidence suggests that dietary sugars, together with other main factors, can initiate the development of tooth decay. Despite this, there are other factors responsible for increasing or decreasing the risk of developing dental caries, such as oral hygiene habits, tooth shape, surface characteristics, eating habits, quality, and quantity of saliva. (7-9)

Consistent evidence associates childhood dental caries with a decrease in the quality of life of children and their families. (10) Pain resulting from

untreated tooth decay can affect eating and speech, and consequently growth and development. (11) School-age children are at a stage of transition from deciduous to the mixed dentition. In addition, they are also at an age where there are often changes in eating patterns in both drinks and other kinds of foods. (12)

Factors such as malnutrition, genetic predisposition, low access to health care, specific eating habits, fluoride and vitamin D deficiency, excessive sugar consumption, and prolonged bottle-feeding, among others, facilitate the appearance of dental caries. (6) Although the etiological factors are well known for years, reducing the number of decayed and missing teeth in children remains a barrier. (1) From a preventive point of view, infant feeding practices are an interesting target for intervention, specifically a high-sugar childish diet, which has been related, among other factors, to tooth decay. (10) Although there is no doubt about the etiological role of sugars and other fermentable carbohydrates in carious activity, the cariogenic potential of specific foods in the general diet is difficult to determine from any food. (13)

Among the various components of food, there has been a change in the role of beverages in children's intake, more specifically in quantities and types. (11) Over the past 30 years, consumption of water, milk, fruits, and vegetables has declined, and consumption of sugary drinks has steadily increased, (3, 11) raising public health concerns. (14) It has been reported that current patterns of fluid consumption by children are now more diverse than in the past, as carbonated soft drinks and fruit juices have largely replaced water and milk consumption among children. (15) The cariogenicity of sugar-sweetened beverages is determined by their potential to induce enamel demineralization but is also conditioned by the frequency and amount of consumption of these same drinks. (12) Less recognized and studied are the implications that changes in drink consumption in childhood may have on tooth decay. (10, 15) Although the association between sugar consumption and tooth decay in permanent teeth has been well documented, the association between soda consumption and dental caries in the primary dentition is less clear. (15)

So, the objectives of this study are:

- Assess whether, after 3 years of exposure, there is an association between the frequency of consumption of sugary drinks and the development of dental caries in 7-year-old children;
- Realize if there is any difference between the influence of carbonated and still drinks.

2. Materials and Methods





2 Materials and Methods

2.1 *Study Design and Participants*

Participants are part of Generation XXI, a population-based prospective birth cohort. (16) In short, 8647 children and their mothers were evaluated in the public maternity hospitals in Porto metropolitan region, Portugal between 2005 and 2006. All participants in the baseline cohort had the proposal to do assessments at 4 and 7 follow-ups, in which 86% and 80% of children have done a re-evaluation, respectively. These evaluations were offered to children an oral exam at 4 and 7 years old, with 5226 and 910 children, respectively.

Our study comprised a sample of children evaluated at both ages. From the total of 910 children who participated in the oral examination at 7 years old, we included 619 participants who were evaluated at both ages. Children with diseases that could influence food intake and tooth decay (celiac disease, congenital malformations, food intolerance, food allergy, phenylketonuria, and cerebral palsy; $n = 2$) were excluded. In addition, children with caries on deciduous canines and molars at 4 years old were also excluded, letting a final sample of 469 children. This will allow us to assess the incidence of tooth decay over the three years.

This project was led in accordance with the Declaration of Helsinki. All procedures with human beings or patients were allowed by the Faculty of Medicine of the University of Porto and the Ethics Committee of the São João Hospital. This study was also approved by the Portuguese Data Protection Authority. The purpose and design of the study were explained to each participant's legal representatives, and they also received written informed consent at both the baseline and follow-up assessments.

2.2 *Data Collection*

Trained interviewers conducted the face-to-face interviews at birth and at both 4 and 7 years old by using structured questionnaires that contained

information on demographic characteristics, mothers' socioeconomic, children's health history, and lifestyle factors (including food consumption). The following baseline variables were used in this study: child sex, mother's and father's years of education (≤ 9 years, 10–12 years, or > 12 years). At the 4-year follow-up, family income was assessed.

2.3 Dietary Intake

Information on the children's dietary intake was collected using a food frequency questionnaire (FFQ), previously tested, calibrated, and applied by trained interviewers. Parents/guardians were asked how many times their child had consumed each of the various food items on the questionnaire in the last 6 months on average, and included the following response options: “ ≥ 4 times a day;” “2-3 times a day;” “once a day;” “5–6 times a week;” “2–4 times a week;” “once a week;” “1–3 times a month;” “ < 1 per month;” or never”. All consumption frequencies were converted into daily frequencies.

Two similar groups of sugary beverages were defined at both ages as “carbonated drinks” (including coca-cola and carbonated soft drinks) and “still drinks” (including ice tea, nectar, and still soft drinks). The consumption was considered as the frequency per day and both variables were analyzed as continuous variables. Then, the tertiles of these newly created variables were obtained at both ages, allowing us to later form new categorical variables from these observed values. To analyze the development of sugary beverage consumption, 4 groups were created in both types of drinks: “Maintained low”, “Maintained high”, “Increased” and “Decreased”. These were created from the evolution of categorical variables. If 4 to 7-year-old children remained in the first tertile, it belonged to the “Maintained low” group, while if children were in the second and third tertile at both ages, it was part of the “Maintained high” pattern. In the case of going down or up in the tertiles between ages, it was included in the groups of “Decreased” and “Increased”, respectively. For example, if a child changes from the first to the second or third tertile, or from the second to the third tertile, it belongs to the pattern “Increased”. If a child changes from the third to

the first or to the second tertile, or from the second to the first tertile, it belongs to the pattern “Decreased”.

Meanwhile, other sugary foods such as cookies, cakes, gummies, chocolate, and ice cream were put together on a new variable at 4 years old. The median of this new variable was analyzed to set a cut-off point (median = 2.5). Then, a new categorical variable was created for 4 years old. If children were below the median, it belonged to the pattern “Low consumption”, while if children were above the median, it was part of the “High consumption” pattern.

2.4 Dental Examination

Dental examinations were performed at both 4 and 7 years old. A team of doctoral students in dentistry, six dentists, and ten masters oversaw the dental examination at 4 years of age. Their responsibility was to collect data from dental interviewing procedures and clinical observations. At 4 years of age, children were evaluated in the dental chair with clean and dry teeth, using a probe and a mirror. At 7, the oral assessment was performed by four dentists, and the participants were observed in a standard chair with a halogen lamp, using a probe and a dental mirror.

These dental exams included a dental assessment for the children and a questionnaire for their legal guardians about various oral habits, one of them being the frequency of brushing. Other oral health habits included: whether the child's toothpaste had fluoride; whether parents supervise the child while brushing their teeth; whether the child has already attended a dentist; and, finally, if the child eats after brushing his teeth at bedtime.

In both dental examinations, intra- and inter-examiner calibration were performed. (17) ICDAS II criteria was used to record caries lesions per surface at each dental examination. (18) ICDAS II scores were transformed into dmft / DMFT scores (decayed, missing, and filled teeth), for this study. (17) “Tooth caries status” was defined as the presence or absence of cavitated dental caries in the primary teeth of children aged 4 and 7 years ($d3-6mft = 0$ vs. $d3-6mft > 0$).

To perform a crude evaluation of the increase in dental caries in these children, a new variable was created. This included only cavitated, lost, or filled canines and molars, in the clinical dental examination at 7 years old, because at this age children could already have permanent molars and not have the deciduous incisors present in the oral cavity.

2.5 Statistical Analysis

Statistical analysis was performed using the statistical software package IBM SPSS® Statistics vs. 28.0 (IBM Corp. released 2017, IBM Corp., Armonk, NY, USA). The normality of quantitative variables was tested, and the data were expressed as the median and interquartile range (IQR). Group comparisons were performed by the Mann-Whitney U test. Categorical variables were described as frequencies and proportions or percentages (n and %). Regarding sex and family income, the chi-square test was used to compare our sample with the rest of the cohort. The level of significance established for the inferential statistics was $p < 0.05$. The incidence of dental caries was evaluated and expressed as a percentage. Further binary logistic regression analyses were performed to assess the crude and adjusted odds ratio (OR) and 95% CIs for the association between the evolution of beverage consumption from 4 to 7 years and the development of dental caries. For theoretical reasons, the frequency of brushing and use of fluoride toothpaste were tested as potential confounders but were removed due to a lack of statistical significance. So, the final models were adjusted for the child's sex, parents' education level, and sugary food consumption.

3. Results



3 Results

3.1 Participants

In this study, monthly family income and parents' education level were higher than in the rest of the cohort. In addition, no significant difference was found in the child's sex. All this information is shown in Table 1.

*Table 1: Comparison between the characteristics of our sample and the remaining cohort evaluated at baseline **

		Sample (n = 469)		Remaining Cohort (n = 8040)		
		n	%	n	%	
Child's Sex	Female	218	46.5	3947	49.1	0.262
	Male	251	53.5	4093	50.9	
Mothers' Education	Median	12.00		11.00		< 0.001
	IQR	7.00		7.00		
Fathers' Education	Median	10.00		9.00		< 0.001
	IQR	4.00		6.00		
Family income	≤ 1000€	98	20.9	2276	26.3	< 0.001
	1001-1500€	129	27.5	2013	23.3	
	1500€	236	40.4	2922	33.8	

IQR, Interquartile Range. *Due to missing data, the total may not add to 469 / 8040 for each variable.

Regarding oral hygiene habits in this sample, 154 children ate before going to bed (32.8%) and almost all of them (n = 462; 98.5%) used fluoride toothpaste. Besides that, the brushing frequency showed even values, despite the greater number being in the group of the most recommended brushing habits. 131 children brush their teeth less than one time a day (27.9%), 134 brush one time a day (28.6%), and 200 brush more than one time a day (42.7%).

3.2 Beverage consumption clusters

Regarding the prevalence of consumption of each drink, there was a greater consumption of still drinks compared to those containing gas in their constitution, in both ages. The most consumed drink by children at 4 years old was “Still soft drink” and the least consumed drink was “Carbonated soft drink”. At 7 years old, “Ice Tea” was the most consumed drink, while “Carbonated soft drink” was the least consumed. In Table 2, are represented descriptive statistics values for each sugary beverage according to consumption development, in both ages.

Table 2: Descriptive statistics values for each sugary beverage (frequency per day) according to consumption development, in both ages

		4 years Median (IQR)				7 years Median (IQR)			
		Maintained low	Maintained high	Increased	Decreased	Maintained low	Maintained high	Increased	Decreased
Carbonated drinks	Coca-cola	0.00 (0.00)	0.07 (0.12)	0.00 (0.00)	0.14 (0.07)	0.00 (0.00)	0.07 (0.12)	0.07 (0.12)	0.07 (0.07)
	Carbonated soft drinks	0.00 (0.00)	0.02 (0.07)	0.00 (0.00)	0.07 (0.14)	0.00 (0.00)	0.07 (0.14)	0.02 (0.14)	0.00 (0.07)
Still drinks	Ice Tea	0.00 (0.07)	0.14 (0.36)	0.07 (0.14)	0.43 (0.65)	0.02 (0.07)	0.43 (0.86)	0.14 (0.36)	0.14 (0.36)
	Nectar	0.00 (0.07)	0.43 (0.36)	0.07 (0.43)	0.14 (0.41)	0.02 (0.07)	0.14 (0.36)	0.43 (0.65)	0.07 (0.14)
	Still soft drinks	0.02 (0.07)	0.57 (0.73)	0.13 (0.17)	0.57 (0.71)	0.02 (0.07)	0.43 (0.29)	0.43 (0.36)	0.07 (0.12)

The bar charts represented below show the frequencies per day of consumption of each type of beverage (carbonated drinks and still drinks) at both 4 and 7 years old. We can see the differences in this consumption during the 3 years of evaluation.

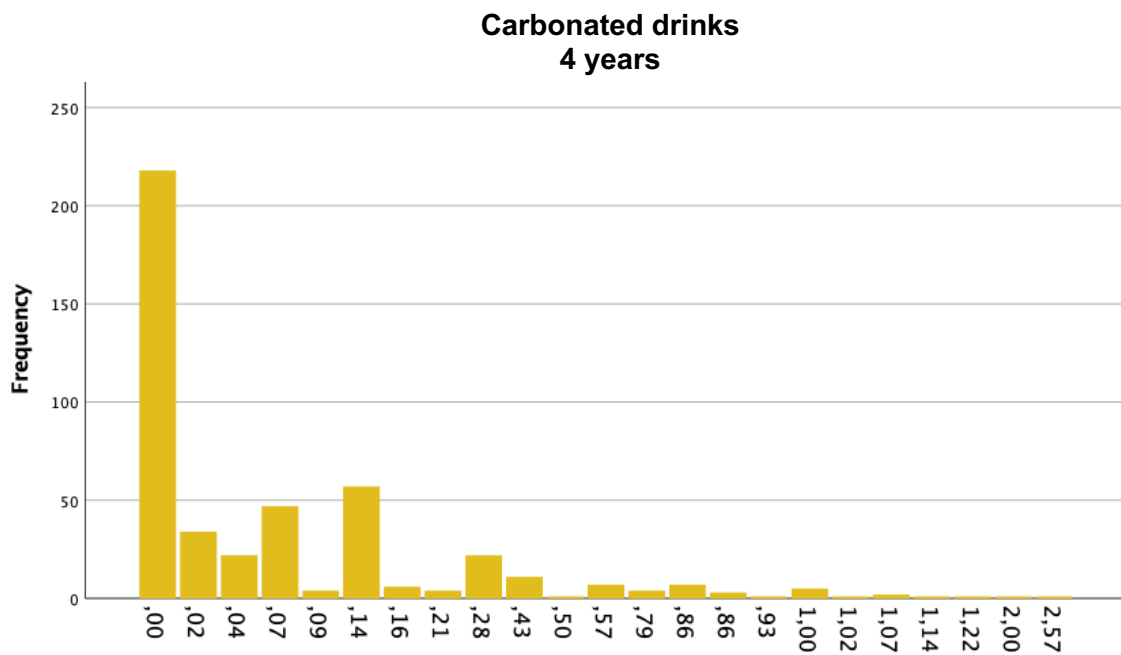


Figure 1: Bar chart of the frequency of consumption of carbonated drinks per day at age 4

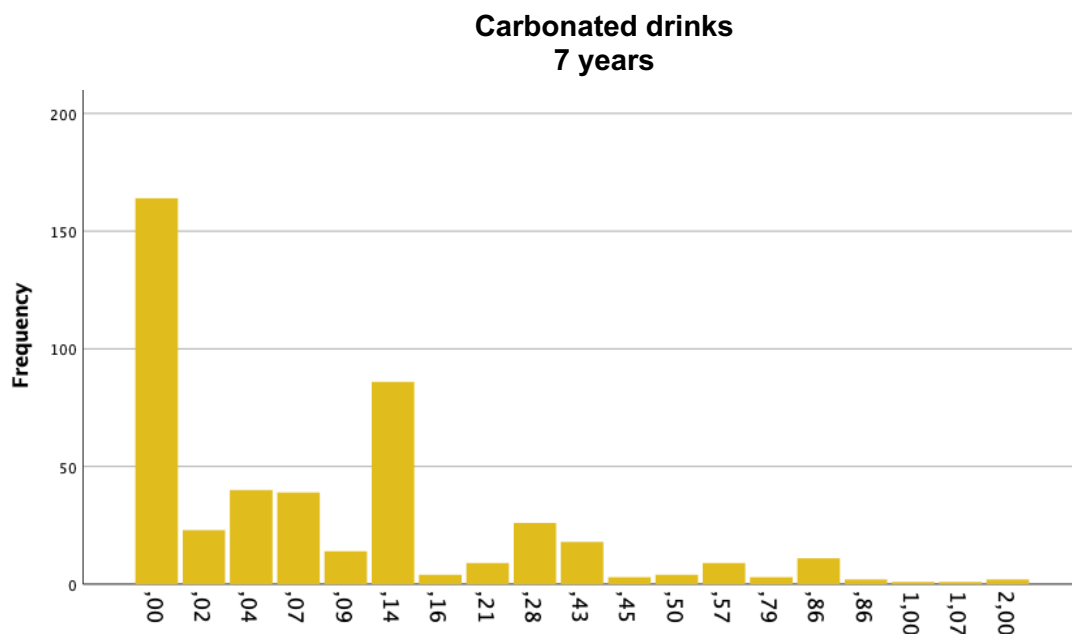


Figure 2: Bar chart of the frequency of consumption of carbonated drinks per day at age 7

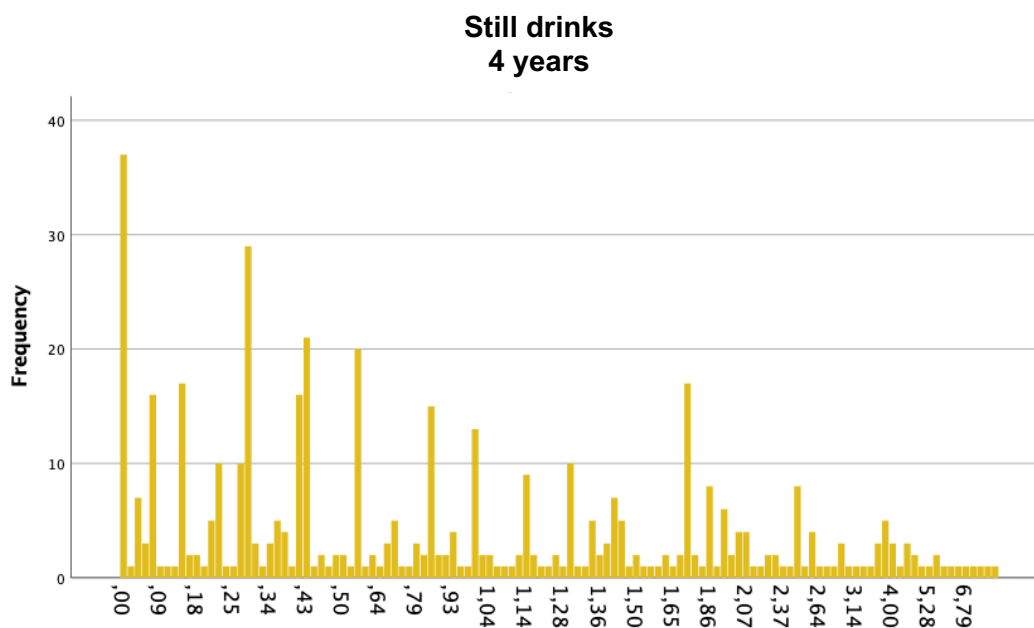


Figure 3: Bar chart of the frequency of consumption of still drinks per day at age 4

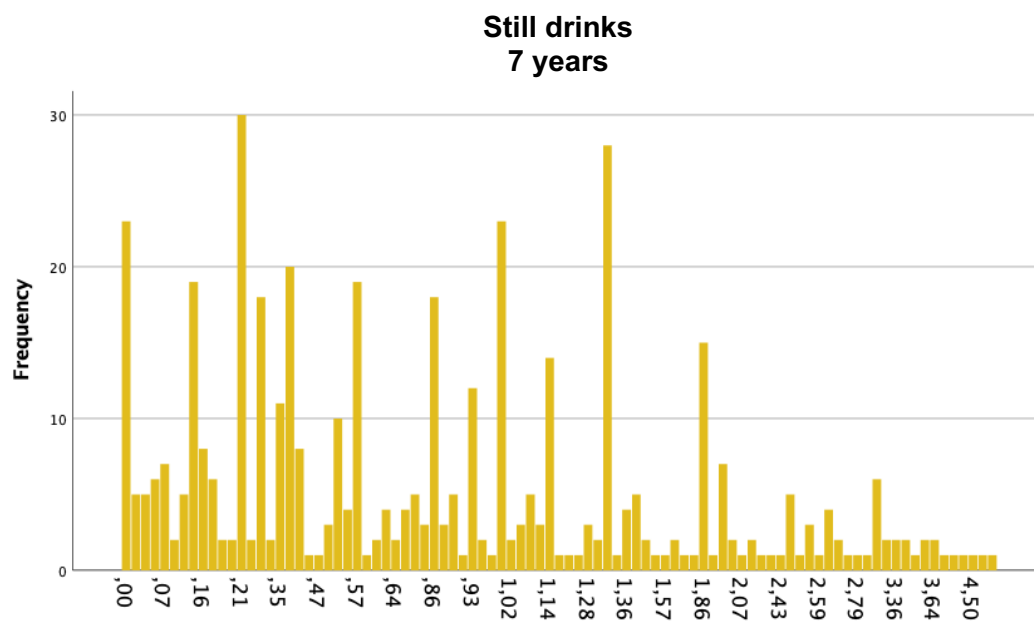


Figure 4: Bar chart of the frequency of consumption of still drinks per day at age 7

3.3 Caries and beverage clusters

At 7 years old, the incidence of dental caries was 53.2% in the clinical dental examination.

The statistical analysis found an undeniable relationship between sugary drinks and the increase in dental caries. After adjustment for confounders, a significant association was found between the patterns of the evolution of carbonated beverage consumption and the onset of dental caries from 4 to 7 years of age, namely in the children who "Decreased" (OR =3.18; 95% CI: 1.76 – 5.76), "Increased" (OR = 1.98; 95% CI: 1.10 – 3.57) and "Maintained high" (OR = 1.80; 95% CI: 1.05 – 4.00) their consumption, in comparison to children who maintained a low consumption (table 3). In the case of still drinks, there was no statistically significant relationship. Curiously, we can see that carbonated drinks are even more likely to cause tooth decay than sugary foods (OR= 3.18; CI: 1.76 – 5.76 vs OR = 1.52; 95% CI: 1.02 – 2.26, respectively). In the crude analysis, a positive association was found on carbonated drinks, unlike the still drinks.

Table 3 shows the crude and adjusted binary regression model for the two types of drinks and sweet foods.

Table 3: Binary logistic regression model to see the increase in caries through consumption of sugary drinks

		Dental Caries at 7 years old	
		Crude OR (IC 95%)	Adjusted* OR (IC 95%)
Carbonated drinks	Maintained low	<i>Ref</i>	<i>Ref</i>
	Maintained high	2.00 (1.18 – 3.40)	1.80 (1.05 – 4.00)
	Increased	2.20 (1.25 – 3.89)	1.98 (1.10 – 3.57)
	Decreased	3.63 (2.05 – 6.44)	3.18 (1.76 – 5.76)
Still drinks	Maintained low	<i>Ref</i>	<i>Ref</i>
	Maintained high	1.15 (0.62 – 2.11)	1.11 (0.58 – 2.11)
	Increased	1.26 (0.67 – 2.38)	1.28 (0.66 – 2.50)
	Decreased	1.50 (0.79 – 2.84)	1.56 (0.80 – 3.05)
Sweet foods		1.54 (1.06 – 2.25)	1.52 (1.02 – 2.26)

Ref, Reference pattern. *Adjusted for child's sex, parents' education level, and sugary food consumption.

4. Discussion



4 Discussion

This longitudinal study helps to better understand the influence of sugary drinks on the development of dental caries with detailed information about each child's dietary intake. In addition, we were able to see the difference between carbonated and still drinks, regardless of other factors, including the consumption of other sugary foods.

The National Food, Nutrition, and Physical Activity Survey (IAN-AF 2015–2016) evaluated the intake of total sugar, added sugar, and free sugar, corresponding food sources, adherence to recommendations, and consumption determinants, in a Portuguese representative sample. Table sugar, sweets, and soft drinks were the main food sources of added and free sugars. Soft drinks represented 5.9g of added sugar and sweets 13.1g. (19) Despite this, and curiously, we were able to verify in our study that carbonated soft drinks had a greater influence on the appearance of dental caries than sweets.

The National Institute of Health Doctor Ricardo Jorge presents a table of food composition in Portugal. The nectars showed varied sugar values due to the different flavors of each one. Apricot nectar presented the highest value of 12.9g of sugar, while “light” peach nectar presented the lowest value of 3.5g. Making a comparison between a carbonated soft drink and coca-cola, this last one presented a higher value of 9g, with the carbonated one having 7g of sugar. (20)

Recently, a published report on the progress of food reformulation in Portugal described a reduction in the sugar content between 2018 and 2021. The value presented was 11.1%, whereas in 2018 there was a value of 7.46g per 100g, in 2021 it dropped to 6.36g per 100g. It is important to mention that soft drinks were included in this analysis of the evolution of the sugar content. (21)

The World Health Organization guideline to use less free sugar has two ways of working. They are reducing the amount of sugar in products or reducing the frequency of consumption of products that contain sugar, and it is important as dentists to be preventive in this sense. (22) Interventions in different directions can help to reduce the consumption of sugary drinks at the population level and should be considered useful preventive strategies to improve the nutritional level of the population. (23)

After adjusting for potential confounders, the results presented showed that children who consumed carbonated beverages were more likely to have tooth decay at age 7 years. Interestingly, this effect was even higher than the effect of the consumption of sweets. In the case of still drinks, the relationship was not statistically significant. Despite this, we were able to verify that consumption was even higher in this last group of cited drinks. The three patterns of evolution of carbonated beverage consumption had a statistically significant influence on the increment in dental caries. The patterns “Increased” and “Maintained high” highlight that consumption was high or rising, which influenced the appearance of dental caries. The “Decreased” pattern means that the consumption of carbonated sugary drinks decreased between ages but was still enough to cause tooth decay. Basically, consumption was already high than the other groups at 4 years old and, even decreasing during the 3 years of evaluation, it was not enough to avoid the appearance of dental caries at 7 years old.

The role of sugar in increasing dental caries is undeniable in the scientific literature, being considered the most important risk factor for this disease. (4, 24) A systematic review done to reveal the updated World Health Organization guidelines on sugar consumption reports that 7 out of 8 studies linked a higher number of dental caries to a major sugar intake. (24)

This study demonstrated that consumption of sugary drinks was highly associated with the development of dental caries in children. Similar to our results, other studies have found a relationship between the consumption of these beverages and the increase in dental caries. (3, 5, 9, 25-27) Interestingly, other previous studies did not find this mentioned significant association. (28-30) A systematic review and meta-analysis from last year included 26 studies rated as high quality to see the effect of sugar-sweetened beverages on oral health. The results showed that both comparisons of moderate-to-low and high-to-moderate consumption had a significant increase in the risk of tooth decay. (31) Another review of literature, older than the one mentioned above, demonstrated comparisons between the consumption of soft drinks by US states and the increase in dental caries. The results presented that no relationship was found. In countermeasure, a study more recent in the US showed a positive relationship between cumulative caries scores and the frequency of consumption of carbonated beverages at mealtime and between meals. (32) A resembling study

to ours with 4-year prospective research but in adults, found a linear trend between the increment of tooth decay and the frequency of sugar-sweetened beverages. This association remained significant after sequential adjustments for different factors. (33)

The fact that our study concluded that carbonated drinks are more likely to cause tooth decay might be because these drinks have a higher acidity in their constitution due to the gas. The potential acidity combined with sugar and, consequently, cariogenicity of soft drinks consumed by children has been extensively studied in the last 30 years. There is a drop in pH shortly after consumption, and the acid is then neutralized by salivary components. Usually, within 20 to 30 minutes the pH returns to normal levels. Thus, the risk lies in the frequent consumption of acidic and high-sugar soft drinks over time since children are at a greater risk of demineralization and, in the future, caries development. It is also important to remember that dental caries is a cumulative disease. (32, 34)

The possible limitations of this study are that monthly family income and parents' education level were higher in our sample than in the rest of the cohort, which may lead to the possibility of substantial differences between the participants. Despite that, this may be since our sample has a considerable size. Also, the answers given by the participants may have a bias because they may be tempted to respond to the answer considered most correct.

5. Conclusion





5 Conclusion

The relationship between dietary sugars and the appearance of dental caries is undeniable. In our study, a relationship was found between the increase in dental caries and the consumption of sugary drinks. This link was more evident in the drinks that had gas in their constitution, and it had even more impact than the ingestion of sweets. In addition, still drinks ended up losing significance in this relationship. Therefore, in addition to sugars, the influence that gas has on the formation of dental caries is also on the table. Its characteristic acidity can drastically lower the salivary pH and associated with the carbohydrates metabolizing acid, lead to the future appearance of this disease that impacts oral health over time.

The best way to avoid the appearance of dental caries in children is essential to prevent it. One of the ways to do this is to reduce the amount of sugar in the diet, including the consumption of sugary drinks, especially carbonated ones. There seems to be a relationship between the consumption of these drinks and the increase in tooth decay and, therefore, it is important to realize that we should pay extra attention to their consumption by children.

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7. Attachments



DECLARAÇÃO
Mestrado Integrado em Medicina Dentária

Monografia/Relatório de Estágio

Identificação do autor

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Identificação da publicação

Dissertação de Mestrado Integrado ☒ (Monografia) ☐
Relatório de Estágio

Título completo: “Association between sugar-sweetened beverages and dental caries in 7-year-old children – a prospective study“

Orientador: Professor Doutor Paulo Rui Galvão Ribeiro de Melo
Coorientadora: Professora Doutora Ana Sofia Mourão Vilela

Palavras-chave: “Dental caries”; “Sugar-sweetened beverages”; “Dietary patterns”; “Children”, “Carbonated drinks”, “Still drinks”

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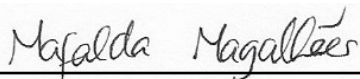
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Porto, 29 de maio de 2022



A Estudante

(Mafalda de Sequeira e Costa da Silva Magalhães)

Parecer do Orientador

Informo que o Trabalho de Monografia desenvolvido pela Estudante Mafalda de Sequeira e Costa da Silva Magalhães, com o título: “Association between sugar-sweetened beverages and dental caries in 7-year-old children – a prospective study” está de acordo com as regras estipuladas na FMDUP, foi por mim conferido e encontra-se em condições de ser apresentado em provas públicas.

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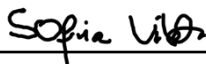
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Parecer da Coorientadora

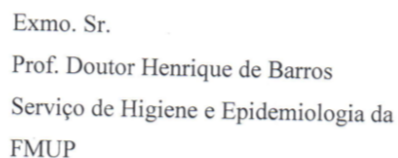
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Porto, 29 de maio de 2022



A Coorientadora

(Professora Doutora Ana Sofia Mourão Vilela)



Autorização para a realização de Projecto de Investigação

Projecto de Investigação – “Projecto Geração XXI – nascer e crescer no início do milénio (Follow-up aos 4 anos)”

Junto envio em anexo cópia do parecer da Comissão de Ética para a Saúde sobre o referido projecto.

Com os melhores cumprimentos.

Porto, 21 de Abril de 2010

O Secretário da Comissão de Ética para a Saúde

Pedro Brito
Dr. Pedro Brito

Parecer

Título do Projecto: Projecto Gração XXI – nascer e crescer no início do milénio (avaliação 4 anos após o nascimento)

Nome do Investigador Principal: Prof. Doutor Henrique Barros

Serviço onde decorrerá o Estudo: Serviço de Higiene e Epidemiologia, da Faculdade de Medicina do Porto

Objectivo do Estudo:

1. Estudar a relação entre as características dos progenitores, do desenvolvimento fetal e pós-natal e do meio social em que a criança está inserida, e o desenvolvimento das crianças nos primeiros anos de vida
2. Avaliar o perfil de risco cardiovascular das mães quatro anos após o parto

Concepção e Pertinência do estudo:

Com o intuito de estudar e monitorizar a saúde de gerações futuras, foram recentemente estabelecidos projectos de saúde em vários países baseados em informações a recolher prospectivamente, através de acompanhamento regular de coortes de grávidas e recém-nascidos. Com a implementação de um projecto semelhante em Portugal, conseguir-se-ão dados cientificamente relevantes para um conhecimento da realidade local, fundamental para a definição de adequadas estratégias sanitárias. Com recurso ao trabalho efectuado já em 2006, que recrutou 8648 recém-nascidos, este estudo propõe-se avaliar agora crianças e mães, 4 anos após este recrutamento. A avaliação será presencial, através de exame físico e aplicação de questionários por uma equipa de entrevistadores treinados. A "informação obtida permitirá caracterizar a população pediátrica aos 4 anos, perceber determinantes da gravidez e da primeira infância para o estado de saúde a esta idade e localizar potenciais factores de risco, nomeadamente a obesidade infantil".

Benefício/risco:

O risco é desprezível, não havendo benefício imediato para os doentes envolvidos.

SA.

Respeito pela liberdade e autonomia do sujeito de ensaio:

Será solicitado consentimento aos participantes, mediante modelo disponibilizado a esta CES.

Confidencialidade dos dados:

Os dados recolhidos serão anonimizados. Apenas o investigador principal poderá associar os dados identificativos dos participantes com a codificação numérica estabelecida.

Indemnização por danos: Não se aplica

Continuação do tratamento: Não se aplica

Curriculum do investigador:

O CV do investigador principal adequa-se às características da investigação em apreço.

Data previsível da conclusão do estudo:

Dezembro de 2011

Conclusão:

O projecto de investigação tem cabimento ético, já que procura informação que sustente a possibilidade de "delinear estratégias direccionadas de prevenção da doença". Foram colocadas algumas questões para esclarecimento, as quais mereceram adequadas respostas, nomeadamente,

1. Atendendo ao propósito de construir uma base de dados ("desenvolvimento de programa informático que permita criar um sistema de armazenamento da informação recolhida... que permita no futuro manter vigilância epidemiológica e do estado de saúde"), foi solicitado parecer da CNPD
2. O financiamento deste projecto será assegurado pelas verbas globais dos projectos submetidos à FCT
3. Estando previsto convocar as mães e as crianças para avaliação, não haverá possibilidade económica para ressarcimento das deslocações destas mães com as suas crianças, bem como de eventuais perdas salariais daí decorrentes. Desta

decisão, será dado claro esclarecimento aos responsáveis legais das crianças participantes, no documento informativo para solicitação de consentimento que, para tal, foi devidamente alterado

4. Os membros da equipa de investigação terão formação adequada para responder às exigências próprias das avaliações que serão realizadas às crianças participantes

Nesta conformidade, e na sequência das indicações da CES na sua pretérita reunião plenária, estão reunidas as condições que permitem um parecer favorável da CES, não devendo, todavia, iniciar-se esta investigação sem que a esta Comissão seja dado conhecimento do parecer da Comissão Nacional da Protecção de Dados.

Porto e H.S.João, 2010-04-21

O Relator

Prof. Doutor Filipe Almeida

