## Original Article

# Standard obesogenic diet: the impact on oral health in children and teenagers at the *Recôncavo Baiano* - Brazil

Dieta de padrão obesogênico: o impacto na saúde bucal em crianças e em adolescentes no Recôncavo Baiano, Brasil

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**Abstract**

The aim of this study is to evaluate the influence of dietary patterns on the occurrence of dental caries. Using a population-based, cross-sectional study design, we assessed a sample of 1.439 children aged 6-13 years who were enrolled in public schools in the municipality of São Francisco do Conde, Bahia state, Brazil. Oral examinations for dental caries were performed by two dental surgeons (Kappa = 0.72) in the school environment under natural light with the aid of a wooden spatula and gauze. Dietary intake was assessed using the qualitative-quantitative food frequency questionnaire. A questionnaire on the demographic and socioeconomic conditions was applied to the families. The *Poisson* multivariate analysis was performed for statistical purposes. Considering both dentitions, the prevalence of caries was 82.14% and 37.3% in the permanent and deciduous dentitions, respectively. The identified dietary patterns were classified into "standard obesogenic" and "prudent." The results showed statistically significant association between the obesogenic dietary pattern and dental caries; the proportion of students with dental caries was 1.4 times higher among those who most frequently consumed foods that constitute a standard obesogenic diet (PR = 1.40, 95% CI: 1.04-1.96) compared to those who less frequently consumed these types of foods. A positive association between the obesogenic dietary pattern and dental caries was found in the students investigated. Therefore, the promotion of healthy eating habits and nutritional habits should be encouraged to prevent dental caries in children and adolescents.

**Keywords:** dental caries; food consumption patterns; children; adolescents.

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Financial support: Fundação de Amparo à Pesquisa do Estado da Bahia – FAPESB, project nº 7638/2009.

Conflict of interests: None.

**Resumo**

O objetivo deste estudo é avaliar a influência de padrões alimentares sobre a ocorrência de cárie dentária. Realizou-se um estudo transversal de base populacional, com uma amostra de 1.439 crianças de 6 a 13 anos, matriculadas em escolas públicas da cidade de São Francisco do Conde, no Estado da Bahia. Os exames de cárie dentária foram realizados por dois cirurgiões-dentistas (Kappa=0,72) no ambiente escolar, sob luz natural, com o auxílio de uma espátula de madeira e gaze. A ingestão alimentar foi avaliada por meio do questionário qualitativo-quantitativo de frequência alimentar. Um questionário sobre as condições demográficas e socioeconômicas foi aplicado nas famílias. A análise multivariada de Poisson foi realizada para fins estatísticos. Considerando ambas as dentições, as prevalências de cárie foram 82,14 e 37,3% nas dentições permanentes e decíduas, respectivamente. Os padrões alimentares identificados foram classificados em "padrão obesogênico", e os resultados mostraram uma associação estatisticamente significativa entre o padrão alimentar obesogênico e a cárie dentária "prudente". A proporção de alunos com cárie foi 1,4 vez maior entre aqueles que consomem frequentemente alimentos constituídos de uma dieta obesogênica padrão (RP=1,40 e IC95%=1,04-1,96) em comparação com aqueles que consomem, com menor frequência, esses tipos de alimentos. Uma associação positiva entre o padrão alimentar obesogênico e a cárie dentária foi encontrada nos estudantes Portanto, a promoção de hábitos alimentares saudáveis e de hábitos nutricionais devem ser incentivados como forma de prevenção da cárie dentária em crianças e em adolescentes.

**Palavras-chave:** cárie dentária; padrões de consumo de alimentos; crianças; adolescentes.

## INTRODUCTION

The most important changes that have been observed in dietary patterns are the increased consumption of foods with high energy density, including saturated fat and simple carbohydrates, instead of the consumption of foods of plant origin, which present low caloric density and are sources of micronutrients and fibers[1,2]. These eating habits, which are related to obesity, may also result in higher prevalence of dental caries because of the frequent intake of sucrose, an important etiologic factor of this dental disease[3-7]. The American Dietetic Association[8] asserts that nutrition is a key to good oral health, and that nutrition in combination with foods have a direct influence on the progression of dental caries. Although the epidemiological data on dental caries have shown a significant decline in its prevalence in schoolchildren under eighteen years old, morbidity is still the greatest problem of oral health in Brazil. The results of the National Oral Health Survey - SB Brazil 2010 show the northeast region with a Decay, Missing and Filled Teeth index - DMFT of 2.63 and the state capital of Bahia with an even better DMFT of [1,7,9,10]. Approximately 50% of the twelve-year old children were caries free. Changes in dietary pattern facilitate the development of dental caries, even if individuals are exposed to protective factors, such as the widespread use of fluoride[11].

Most studies use food alone or associated with micronutrients to study the association between dietary pattern and chronic diseases, including the occurrence of dental caries. However, food and nutrients are consumed together. The World Health Organization - WHO suggests that in nutritional epidemiology, the assessment of dietary intake in populations should be based on eating patterns[12] for better prediction of the risk of diseases than on the analysis of food and nutrients separately. To determine the dietary patterns, factor analysis with the principal components extraction method was used. Although dietary patterns have been widely investigated as the predictors of chronic diseases,

only a few studies have evaluated their influence on dental caries prevalence[13-16]. Therefore, the objective of this study was to fill this void by evaluating the influence of dietary patterns on the occurrence of dental caries in the population of children in a municipality of northeastern Brazil. It is hoped that such studies can provide information on the design and implementation of strategies to promote good oral health and nutritional habits.

## MATERIALS AND METHODS

### Study design/Population/Sample

A cross-sectional study design was used to assess 6- to 13-year-old children living in São Francisco do Conde (SFC), a municipality located in the metropolitan area of Salvador, northeastern Brazil. This municipality has 33.183 inhabitants and a high urbanization rate (80.2%). The city council is the largest local employer. Out of the 417 municipalities in Bahia state, São Francisco do Conde ranks third in the economic development index, but far lower positions regarding social (30th), education (139th) and health (178th) development indexes.

Sample size estimation was carried out using data from the Education Department of the municipality of SFC in 2010. Of the 3.734 students enrolled, 2,649 students were from rural areas and 1.085 students were from urban areas. These students were distributed across 22 schools in the municipal school system. To minimize travel costs and the time required for subject recruitment, the nine schools with 150 or more students were included in the sample. All students aged 6-13 years in each selected school were eligible for the study. Because the prevalence of respiratory allergies varies from 15% to 40%, sample sizes of 531 and 834 students from the urban and rural areas, respectively, were selected after taking into account a 3% error and a 95% confidence level. We added 10% to the total sample size to compensate for the loss of students who refused to participate in the study.

## Procedures

Data were collected from August to December 2010 by a qualified and trained team. The principals of the selected schools received an invitation letter requesting the participation of the schools in the research. This letter contained information about the objectives and methodology of the research. Additional meetings for clarification on the research and persuasion of subjects were conducted, and informed consent was obtained from both the schools and the parents. The parents were invited to attend the school interviews at which the questionnaires were administered, and the information was recorded in appropriate forms.

## Data collection

Oral examinations were performed according to the WHO criteria[10,13] by two qualified dental surgeons (Kappa = 0.72) in the school environment under natural light with the aid of a wooden spatula and gauze. To determine the severity of dental caries, the following indices were used: DMFT (permanent teeth) and DMFT (deciduous teeth). Decayed teeth (c), teeth indicated for extraction (e) and filled teeth (o) were included, whereas extracted teeth for which there was difficulty in identifying the cause of extraction, such as either decay or natural process of tooth exfoliation, were excluded. The prevalence of dental caries was considered as the outcome variable, i.e., the occurrence of at least one decayed tooth or a previous history of dental caries in the primary or permanent dentition.

## The main independent variable

### Food consumption pattern

The Quantitative Food Frequency Questionnaire (QFFQ), developed by Slater et al.[14], was adapted to the population and adopted to evaluate the frequency of food intake in students in Sao Paulo. The QFFQ is an instrument that has been validated by Voci et al.[17], and it comprises 132 food items. For the present study, regional foods that were originally not a part of the validated questionnaire were included in the QFFQ. This new questionnaire is under the process of validation. The rate of consumption of these regional food items was divided into the following five categories: never consumed = 0; consumed one to three times a month = 1; consumed one to two times a week = 2; consumed two to four times a week = 3; and consumed four or more times a week = 4. For analysis, these food items were grouped into 23 categories according to the similarity of nutritional content: sugars/sweets, typical dishes of the Brazilian cuisine (*feijoada*: a black bean stew with pork; "drover beans": a dish made with beans, cassava flour, sausage, garlic, onions, bacon and eggs; *acarajé*: a dish made of bean seeds made into balls and fried in palm oil), artificial drinks, soft drinks, confectionery, fast food, oils/fats, milk and dairy products, meat, chicken, fish,

eggs, sausages in general, breads, cereals (rice, pasta, cakes, flours), roots and tubers, legumes, vegetables, fruits, greens, sauces, artificial sweeteners. The frequency of consumption of foods or food groups was summarized with a single value for each student, and the formula used for obtaining this value is as follows: (Σ frequency of consumption of foods contained in the food group)/No. of food group * maximum frequency of consumption according to the FFQ[14,18]. For the energy intake, the nutrition program Virtual Nutri version 1.0 was used.

### Confounding variables

The adjustment variables used in the study included the following: gender (male, female (reference category), age (<10 years, ≥ 10 years (reference category), education of the caregiver (≤ 4th grade, >4th grade (reference category), place of residence (urban, rural (reference category), per capita income ( <1 minimum salary (SM), ≥1 SM (reference category), number of people living in the household (>3, ≤3 (reference category), and age of the caregiver (<30 years, > 30 years (reference category). To assess the anthropometric status, the WHO tables[19] with percentile values of body mass index [BMI = weight (kg)/height (m)$^2$] according to age and sex were used as the reference. For classification of the anthropometric status, we used the WHO[19] guidelines: underweight (<3rd percentile); normal weight (≥3rd percentile and <85th percentile, reference category); overweight (≥ 85th percentile and <97th percentile); and obese (≥ 97th percentile). For analysis, the overweight and obese categories were aggregated. Therefore, children with excess weight were at or above the 85th percentile.

### Statistical analysis

For the processing and construction of the database, Epi Info version 6.04 was used (Centers for Disease Control and Prevention, Atlanta, United States), and duplicate data entry was adopted, after reviewing the questionnaires and correcting the errors because of coding, which was initially performed in the field.

The characteristics of the population were identified by descriptive analysis using categorised data of prevalence. Food consumption patterns were derived from Principal Component Analysis (PCA)[20]. Prior to performing exploratory factor analysis, the coefficient of Kaiser-Mayer-Olkin (KMO) was estimated, and Bartlett's test of sphericity was used to indicate the appropriateness of factor analysis. Principal component analysis was performed, followed by orthogonal rotation (Varimax) to examine the exploratory factor structure (pattern). The number of factors extracted was based on the interpretability of data, as recommended by Hearty and Gibney[21]. The internal consistency of the dimensions of QFFQ was assessed and considered acceptable at levels of Cronbach's alpha > 0.65. The scores of

each consumption pattern were dichotomised as Percentile > P75 *versus* Percentile ≤ P75.

Poisson multivariate analysis was used for statistical purposes. The magnitude of the association between dietary patterns and dental caries was expressed in terms of prevalence ratio (PR) and corresponding 95% confidence intervals (95% CI). For the statistical analyses, two-tailed tests and significance level of 5% were used. The choice of confounding variables in the model was based on the information existing in the available literature. The Statistical Package for the Social Sciences - SPSS, v. 17.0 was used for statistical analyses.

### *Ethical issues*

The study protocol was submitted to the Ethics Committee of the School of Nutrition, Federal University of Bahia, which commented favorably on the relevance of research ethics under the 006-06/CEP record. The parents and caregivers signed the informed consent form, thereby allowing the participation of children in this research.

### ■ RESULTS

From the total number of initially selected students (1,500 students), 61 (4.0%) students withdrew from the study or discontinued their participation (the reasons included refusal to participate, family moved to another town, or the child was transferred to another school), thereby 1,439 students of both sexes aged 6-13 years remained in the study.

Among the children and adolescents surveyed, 45.6% were female and 50.5% were over 10 years old. Among the students' caregivers, 96.2% were female; 50.6% were aged 30-39 years; 26.7% attended primary school –1st to 4th grade; 26.6% attended secondary school – 5th to 8th grade; and 4.6% were illiterate. It is worth noting that 72.5% of the households received between 2 and 3 minimum salaries. Additional information is provided in Table 1.

Considering both dentitions, the data indicate that 82.14% of participants presented dental caries activity; there was an increase in dental caries prevalence with age in the permanent dentition ($p<0.001$), and a decrease in dental caries prevalence with age in the deciduous dentition ($p<0.001$). The mean DMFT index was 0.94 (±1.55) (Table 2).

The confidence factorial index confirmed by the KMO coefficient (0.873) and Bartlett's test of sphericity ($p<0.001$) showed that the values for the correlations between the items were sufficient and adequate for performing factor analysis. From this analysis, two patterns were obtained, which represented 45.70% of the total variance, and these patterns determined the classification of the foods as "obesogenic" and "prudent" (Table 3). The obesogenic pattern was composed of sugars/sweets, artificial

**Table 1.** Characteristics of the study population – children and adolescents aged 7-13 years and enrolled in the public schools of the municipality of São Francisco do Conde, Bahia state, 2010

| Variables | n | % |
|---|---|---|
| **Age(*)** | | |
| <10 years | 697 | 49.5 |
| ≥10 years | 712 | 50.5 |
| **Gender** | | |
| Male | 783 | 54.4 |
| Female | 656 | 45.6 |
| **Caregiver's age (in years)(*)** | | |
| 19-24 | 18 | 1.3 |
| 25-29 | 281 | 20.8 |
| 30-39 | 683 | 50.6 |
| ≥40 | 369 | 27.3 |
| **Education of caregiver (*)** | | |
| illiterate | 63 | 4.6 |
| 1st to 4th grade | 367 | 26.7 |
| 5th to 8th grade | 366 | 26.6 |
| Secondary school or higher | 580 | 32.2 |
| **Per capita income (**)** | | |
| ≤1 BMS | 215 | 15.6 |
| 2-3 BMS | 997 | 72.5 |
| ≥4 BMS | 164 | 12.0 |
| **Place of residence** | | |
| Urban | 486 | 33.8 |
| Rural | 953 | 66.2 |

*Lacking data; **Measured in Brazilian minimum salary (BSM). Value in 2010= R$510.00 (Brazilian reais; equivalent to US$ 290.7)

drinks, soft drinks, typical preparations, bakery items, fast food, oils and fats, milk/dairy products, and cereals. The indices for internal consistency (a >0.60) indicated an acceptable level of measurement accuracy for the two standards, thereby ensuring satisfactory internal consistency of the dimensions in the questionnaire used. The following foods and food groups were not considered in the analysis due to low commonality ($h_2<20$): chicken, fish, eggs, sausages, bread, vegetables, sauces, and sweeteners.

After adjusting for anthropometric characteristics, such as the student's age, maternal age, family income, maternal education, school location and energy intake, there was a statistically significant association between the obesogenic dietary pattern and dental caries; the proportion of students with dental caries was 1.4 times higher among those who most frequently consumed foods that constitute a standard obesogenic diet (PR = 1.40, 95% CI: 1.04-1.96) compared with those who least frequently consumed these types of foods. Moreover, there was no association between the prudent dietary pattern and the presence of dental caries (PR = 0.88, 95% CI: 0.64-1.20) (Table 4).

**Table 2.** Prevalence and severity of dental caries in the permanent dentition and deciduous dentition in children and adolescents aged 6-13 years and enrolled in the public schools of the municipality of São Francisco do Conde, Bahia state, 2010

| Age | $n$ | CPO-D | SD (CPO-D) | *Healthy (%) – Permanent Dentition | * Healthy (%) – Deciduous Dentition |
|---|---|---|---|---|---|
| 7 | 173 | 0.31 | 0.69 | 80.35 | 29.48 |
| 8 | 265 | 0.61 | 1.00 | 67.55 | 28.30 |
| 9 | 239 | 0.85 | 1.33 | 59.00 | 35.00 |
| 10 | 290 | 0.89 | 1.27 | 56.48 | 55.25 |
| 11 | 253 | 1.23 | 1.54 | 49.01 | 73.52 |
| 12 | 143 | 1.27 | 1.79 | 49.65 | 86.01 |
| 13 | 76 | 1.80 | 2.22 | 43.42 | 94.74 |
| Total | 1,439 | 0.91 | 1.41 | 59.02 | 52.20 |

*Mantel-Haenszel's linear association test (χ2 $p<0.001$)

**Table 3.** Distribution of factorial changes in the food consumption patterns of children and adolescents aged 6-13 years and enrolled in the public schools of the municipality of São Francisco do Conde, Bahia state, 2010

| Foods and groups of foods | Obesogenic dietary pattern | Healthy dietary pattern | $h_2$ |
|---|---|---|---|
| Sugars and sweets | 0.698 | - | 0.503 |
| Artificial drinks (juices) | 0.484 | - | 0.234 |
| Sodas | 0.445 | | 0.226 |
| Typical preparations | 0.601 | - | 0.396 |
| Pastry | 0.603 | - | 0.366 |
| Fast food | 0.740 | | 0.554 |
| Oil and fats | 0.568 | - | 0.436 |
| Milk and dairy products | 0.615 | - | 0.434 |
| Meats | - | 0.483 | 0.240 |
| Cereals and derivatives (rice, cakes, pastas, flour, cassava) | 0.548 | - | 0.441 |
| Roots and tubercles | - | 0.653 | 0.464 |
| Legumes | - | 0.793 | 0.629 |
| Fruits | | 0.493 | 0.438 |
| Leafy vegetables | | 0.701 | 0.502 |
| % Variance explained | 28.62 | 17.08 | |
| % Variance cumulative | 45.70 | | |

## DISCUSSION

In this study, considering both dentitions, the prevalence of dental caries was 82.14% and 37.3% in the permanent and deciduous dentitions, respectively, and the mean DMFT index was 0.94 (±1.55). Although the DMFT index value was acceptable, the high percentage of students with untreated cavities in this study is disturbing, and it indicates the need for greater access to dental services. The DMFT index value of dental caries in the 12-year-olds of the municipality of SFC (1.27) was lower than the national average of dental caries in the last survey conducted in 2003, in which the DMFT index was 2.10, and close to the value of the capital of the state, Salvador[10]. Additionally, the prevalence of dental caries in the municipality of SFC was lower than that of the northeast region, in which the mean DMFT index was 2.63[10], and those of many other representative epidemiological surveys conducted in different Brazilian regions[19]. The data demonstrate that the World Health Organization[22] goals for the

year 2000, which included a mean DMFT index value equal to or smaller than 3 in children up to 12 years old was achieved in São Francisco do Conde. Furthermore, there was an increase in dental caries prevalence with age, and this result not only highlights the cumulative prevalence of dental caries and the severity indicators used in dentistry, but also indicates the inability of the health services to control this dental disease in the population through its range of policies, without adopting a high-risk strategy[9].

This study sought to evaluate the influence of dietary patterns on dental caries activity in the context of a multifactorial disease. The following two food consumption patterns were identified among the children and adolescents in São Francisco do Conde: "prudent" and "obesogenic". In this study, an association was found between the obesogenic dietary pattern and dental caries. The proportion of students with dental caries was 1.4 times higher among those who more frequently consumed foods

**Table 4.** Association between dietary patterns and caries experiences in children and adolescents aged 6-13 years and enrolled in the public schools of São Francisco do Conde, Bahia state, 2011

| Variables | Univariate Model (Crude) | | Model (adjusted)* | |
|---|---|---|---|---|
| | PR (CI 95%) | *p* | PR (CI 95%)* | *p* |
| **Obesogenic dietary pattern** | | | | |
| Percentile <75% | 1 | 0.057 | 1 | |
| Percentile ≥75% | 1.31(0.99-1.74) | | **1.41(1.04-1.96)** | **0.035** |
| **Prudent dietary pattern** | | | | |
| Percentile <75% | 0.91(0.69-1.20) | 0.527 | 0.88(0.64-1.20) | 0.439 |
| Percentile ≥75% | 1 | | 1 | |
| **Anthropometric status** | | | | |
| Not overweight | 0.74(0.53-1.03) | 0.075 | | |
| Overweight | 1 | | | |
| **Age** | | | | |
| <10 years | **1.83(1.43-2.36)** | 0.000 | | |
| ≥10 years | 1 | | | |
| **Education of caregiver** | | | | |
| ≤ 4th grade | 0.96(0.73-1.26) | 0.784 | | |
| >4th grade | 1 | | | |
| **Per capita income** | | | | |
| <1 minimum salary (BMS) | 0.84(0.60-1.18) | 0.320 | | |
| ≥1 minimum salary (BMS) | 1 | | | |
| **Age of caregiver** | | | | |
| <30 years | **1.76(1.30-2.38)** | 0.001 | | |
| ≥30 years | 1 | | | |
| **Place of residence** | | | | |
| Urban | **0.75(0.58-0.97)** | 0.034 | | |
| Rural | 1 | | | |

*Estimates adjusted for anthropometric characteristics, such as student age, age of caregiver, per capita income, education of caregiver, household location, and energy intake

that constitute a standard obesogenic diet (PR = 1.40, 95% CI: 1.04-1.96) compared with those who less frequently consumed these types of foods. These results held true even after adjusting for anthropometric status, such as the student's age, maternal age, family income, maternal education, school location and energy intake. The findings support the hypothesis that obesogenic dietary patterns have the potential to affect oral health in this age group, even in areas where the subjects are exposed to fluoride. Only a few studies demonstrating the influence of dietary patterns on dental caries activity have been reported in the literature. Slater et al.[14], after using the same type of analysis (Factorial Analysis) to investigate dietary patterns, concluded that the dietary pattern characterized by sweets and sugar products, breads and pastries emerged as a significant predictor of dental caries. A positive association between obesogenic dietary patterns and dental caries has also been reported[5,6,23]. These authors directly associated a particular standard diet based on extrinsic sugars with the emergence and progression of carious lesions. It is a fact that dental caries prevalence in this age group depends on a combination of factors, including the type and frequency of carbohydrate consumption, the microbial composition of the dental biofilm, and salivary factors. It is generally considered that the risk of dental caries is higher if there is high frequency of sugar consumption and the sugar forms can be retained in the mouth for long periods[22]. Sucrose is the most cariogenic sugar, as it produces extracellular polysaccharides that facilitate bacterial adhesion to the teeth and limit the diffusion of acid and buffer onto the plaque. Therefore, the role of sucrose in the risk of dental caries is well known. Although high energy density foods such as snacks (fast foods, chips) are not sweet, they are potentially cariogenic due to their starch content. Starch has a very high cariogenic potential, and its hydrolysis produces fermentative sugars that promote the formation of an acidogenic plaque, which favors the development of dental caries. Consequently, snacks have become an important risk factor for the development of dental caries in children and adolescents[24]. More recently, it has been documented that sugary drinks are an important risk factor for the development of dental caries in children[1,22]. In addition to an unhealthy dietary pattern, there are multiple factors that affect the prevalence of dental caries in populations, and these factors include access to dental products containing fluoride, access to a fluoridated water supply, access to oral health services, and the adoption of a proper brushing technique to control biofilm

formation[3,25]. These factors indicate a variety of social problems that have not been addressed, and they thereby demonstrate the inequalities in oral health in many poor regions of the country[25].

It is important to note the limitations of this study and the fact that this was a cross-sectional study. Therefore, this study could not infer causal relationships because this type of study does not consider the temporal sequence between exposure and effect. However, the results of this study are in agreement with the biological plausibility and the results reported in prospective studies which support the theory that obesogenic dietary patterns are associated with dental caries[25] . Some of the limitations of the use of factor analysis to identify food consumption patterns include the arbitrary method of extracting the number of factors retained and the method of rotation of the correlation matrix involved in the factor analysis. However, these decisions were made taking into account the objectives of the research and the interpretability of the data, as recommended by Hearty and Gibney[21]. Furthermore, the oral examinations were conducted in the school environment under natural light with the aid of a wooden spatula and gauze, according to the WHO criteria[13].

The oral examinations did not include radiographic examination. As a result, in particular, the interproximal carious lesions could not be diagnosed, which may have underestimated the prevalence of dental caries.

## ■ CONCLUSION

A positive association (PR = 1.40, 95% CI: 1.04-1.96) was found between obesogenic dietary patterns and the development of dental caries. Therefore, the promotion of healthy eating habits and nutritional habits should be encouraged to prevent dental caries in children and adolescents. It is recommended that municipal oral health policy should include essential measures, such as monitoring of oral diseases, as well as programs and services based on the principles of fairness, identifying potential interventions to minimize inequalities in oral health and their effects. Considering the vulnerability of school children to the adoption of poor eating habits, schools should be designed as privileged environments for the promotion of oral health in young people.

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