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Assessing the Association Between Nutritional Status, Caries, and Gingivitis in Schoolchildren: A Cross-Sectional Study

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Abstract

Objective. To evaluate if nutritional status is associated with caries and gingivitis in Brazilian schoolchildren. *Material and methods.* Children of both genders, age ranging from 8 to 11 years old, were included in this study. Caries was diagnosed using ICDAS (International System for Detection and Assessment of Carious Lesions) and gingivitis was diagnosed using the Community Periodontal Index. The nutritional status of each child was defined by BMI Z-score calculation. Data on oral health behavior and dietary habit were collected through parent's questionnaires. Parametric analyzes were performed to compare the groups. The established alpha was 5%. *Results.* The sample consisted of 353 schoolchildren: 16 underweight children, 247 eutrophic children, 64 overweight children, and 26 were obese children. Overweight, Obese and Overweight + Obese children presented less cavitated caries lesion than Eutrophic children ($P < .05$). Gingivitis was not associated with nutritional status ($P > .05$). *Conclusion.* Caries was associated with overweight and obesity in Brazilian schoolchildren.

Keywords

caries, gingivitis, nutritional status, obesity, children

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Introduction

Childhood obesity, overweight and malnourished are serious public health challenges of this century.[1-3] Nutrition is necessary for the normal growth and development of children and teenagers.[4,5] The association between nutrition/diet and many systemic diseases during childhood,[6,7] as well as the association with oral health,[8-10] have been widely investigate by many in researchers.[11-17]

Caries and gingivitis are oral diseases that commonly affect children worldwide. Both oral diseases share some etiological factors with nutrition status indicators, such as obesity and malnourished. These factors include dietary habits, social economical determinants, and presence of dental biofilm.[11-14] The common causative relation between oral health and nutritional status deviations has sparked the interest of many researchers.[5,15-17]

Several studies worldwide have already shown that caries is associated with nutritional status, such as malnourished, overweight, and obesity.[18-22] However, the results of studies are inconclusive, as found in many systematic reviews performed in the past decade.[14,20,23-25]

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Several studies also evaluated the association between nutritional status in the etiology of periodontal diseases, including gingivitis.[12,26,27] The results found in systematic reviews, suggests a positive association between obesity in children and periodontal disease, such as gingivitis.[26,28,29]

There is also evidence that underweight individuals might have different caries experience than normal weight ones.[20] Underweight children are generally malnourished and lacking vitamin A and D, calcium, and phosphorus, which influenced the morphology, chemical composition, and eruption of their teeth, and thus increased the risk of caries.[20,23] Thus, this study aimed to evaluate if nutritional status is associated with caries and gingivitis in Brazilian schoolchildren.

Materials and Methods

This is a cross-sectional study that evaluated the association between caries, gingivitis, and nutritional status. The STROBE guideline was followed to conduct this manuscript (Vandenbroucke et al., 2007). The Local Human Ethics Committee (#78568217.7.0000.5142) approved this study. Informed written consent was taking from all legal guardians and assent document from all children.

Participants

This school based-study evaluated school-age-children from 4 public schools located in Alfenas city. Alfenas is a medium-sized city located in the southeast region of Brazil.[30] The sample represents the total of schoolchildren, aging from 8 to 11 years, both genders, from these schools and previously was described in Reis et al.[31] Children with systemic and cognitive disorders were excluded.

Anamnesis and Determination of Oral Clinical Aspects

The caregiver or parent of each child answered the anamnesis regarding the demographic, diet, and dental health habits information.

The physical and dental examination were made in each included child. Intra-examiner training and calibration were conducted before the study (kappa coefficient = 0.87). A one trained dentist made the dental exams. The dental evaluation was made in the schools, under natural light, using cotton rollers, gauze, standard mouth mirrors, and ballpoint probe according to the WHO (World Health Organization). The dental exam included the evaluation of bleeding on probe, dental plaque (visible biofilm), and caries. The Community Periodontal Index was used to evaluate the gingival bleeding (bleeding on probe) according to the WHO.[32]

Each child was classified as "yes" or "no" for bleeding on probe. The presence of dental plaque was performed using the Silness and Löe[33] index. The scores ranges from 0 (absence of biofilm) to 3 (biofilm abundant on the surface of the tooth) and 6 sextants were examined.

To diagnosis caries, ICDAS (International System for Detection and Assessment of Carious Lesions) criteria was adopted. The caries lesions were diagnosed during visual examination and presents a scale that ranges from 0 to 6.[34] Caries was categorized according to the severity: $ICDAS_0$ versus $ICDAS_{1-6}$ (caries); or $ICDAS_{1-2}$ (non-cavitated caries lesion) versus $ICDAS_{3-6}$ (cavitated caries lesion) as previously described in Reis et al.[31]

Determination of the Nutritional Status

The anthropometric data (height and weight) were recorded on the day of the dental examination. The heights were evaluated and determined in meters, while the weights were evaluated and determined in kilograms using a weighing machine. Children were wearing light clothes and no shoes. Therefore, the nutritional status was calculated for each child using the Body Mass Index (BMI) *z*-score calculator (http://zscore.research.chop.edu/index.php). Height, weight, age, and gender were used as variables in the BMI *z*-score formula and the classifications were performed as recommended by the WHO[1] (Table 1).

Statistical Analysis

GraphPad Prism 5.0 (Graph-Pad, San Diego, CA, EUA) was used for statistical analysis. Caries and gingivitis were analyzed as categorical data. Chi-square and One-way ANOVA with Tukey's post-test were used to compare the groups ($\alpha = 5\%$).

Results

Three hundred fifty-three school-age individuals were included, 48.2% were males and 51.8% were females. The sample consisted of 16 underweight children, 247 eutrophic children, 64 overweight children, and 26 obese children. The characteristics, dietary and dental hygiene aspects according to the status nutritional, gingivitis, and caries are presented in Table 2. Dental plaque

Table 1. Parameters for Classification of Nutritional Status According to the World Health Organization.

Nutritional status	BMI z score
Underweight (malnourished)	<3 percentiles
Eutrophic (normal weight children)	≥3 and ≤ 85th percentiles
Overweight	>85th and ≤ 97th percentiles
Obese	>97th percentiles

Disponible in: https://www.who.int/childgrowth/standards/technicalreport/en/.

was associated with overweight, caries and gingivitis ($P < .05$). Use of dental floss was associated with gingivitis ($P = .03$). Caries and gingivitis distribution are presented in the Figure 1.

Table 3 presents caries and gingivitis experience distribution according to nutritional status. Overweight ($P = .04$; OR = 0.56; 95% CI = 0.32-0.99) and Obese ($P = .05$; OR = 0.42; 95% CI = 0.15-1.0) children presented less cavitated caries lesion ($ICDAS_{0-2}$ vs $ICDAS_{3-6}$) than Eutrophic children. Caries experience also was less in Overweight + Obese children in the 2 cut-offs ($ICDAS_{0-2}$ vs $ICDAS_{3-6}$: $P = .01$; OR = 0.51; 95% CI = 0.31-0.87. $ICDAS_0$ vs $ICDAS_{1-6}$: $P = .05$; OR = 0.62; 95% CI = 0.37-1.0). Nutritional status was associated with caries and gingivitis experience ($P < .05$).

Discussion

Obesity, malnourished, caries, and periodontitis are serious public health problems worldwide. A possible association between nutritional status and caries,[28] as well as nutritional status and periodontal diseases[26,29] have been already suggested. These conditions share similar behavioral habits as etiological conditions.[35] The health burden from nutritional changes is the driving factor behind several researches regarding the impact of nutritional status conditions on children's oral health and development.[36,37] For this reason, we decided to evaluate if variations in the nutritional status are associated with caries and gingivitis in Brazilian schoolchildren.

Our study observed that overweight and obese children had lower caries experience than normal weight children. Our results are in agreement with the finds observed in the previous studies with Brazilians from other regions of the country.[38] It is possible that caries is associated with overweight and obesity due to social economic factors. Families with higher income might have more access to sweeties and also to dental treatment. Other possible theory suggested for the association between low caries and high BMI may be due to the

Table 2. Distribution of the Characteristics of the Study Subjects among Dental Caries, Gingivitis, and Nutritional Status.

Characteristics	Total of subjects	Eutrophic	Underweight	P*	Overweight	P*	Obese	P*	Health ($ICDAS_0$)	Dental caries ($ICDAS_{1-6}$)	P	Healthy and non-cavitated caries ($ICDAS_{0-2}$)	Cavitated caries lesion ($ICDAS_{3-6}$)	P	Non gingivitis	Gingivitis	P
n (%)	353 (100)	247 (69.9)	16 (4.53)		64 (18.1)		26 (7.36)		189 (53.5)	164 (46.5)		203 (57.5)	150 (42.5)		206 (58.3)	147 (41.7)	
Age (mean, SD)	8.9 (0.89)	8.8 (0.89)	9.43 (0.81)	**.006**	9.03 (0.88)	.06	8.65 (0.89)	.41	8.95 (0.92)	8.79(0.84)	.87	8.92 (0.81)	8.83 (0.95)	.78	8.91 (0.88)	8.84 (0.90)	.89
Gender (n, %)																	
Male	170 (48.2)	116 (47.0)	8 (50.0)	.81	29 (45.3)	.81	17 (65.4)	.07	92 (48.7)	78 (47.6)	.83	98 (48.3)	72 (48.0)	.81	96 (46.6)	74 (50.3)	.48
Female	183 (51.8)	131 (53.0)	8 (50.0)		35 (64.7)		9 (34.6)		97 (51.3)	86 (52.4)		105 (51.7)	78 (52.0)		110 (53.4)	73 (49.7)	
Biofilm index (mean, SD)	1.79 (0.30)	1.80 (0.28)	1.85 (0.29)	.49	1.72 (0.29)	**.04**	1.77 (0.28)	.60	1.75 (0.30)	1.83 (0.26)	**.007**	1.74 (0.30)	1.85 (0.24)	**.002**	1.73 (0.31)	1.86 (0.23)	**.0001**
Ingestion of sweeties between meals (n, %)																	
Yes	132 (38.5)	6 (33.3)	99 (41.1)	.51	19 (31.1)	.86	9 (37.5)	.78	65 (35.3)	67 (42.1)	.09	69 (35.0)	63 (44.1)	.06	76 (38.4)	56 (38.6)	.95
No	11 (61.5)	12 (66.7)	142 (58.9)		42 (68.9)		15 (62.5)		119 (64.7)	92 (57.9)		128 (65.0)	83 (56.9)		122 (61.6)	89 (61.4)	
Brush teeth before sleep (n, %)																	
Yes	257 (76.9)	172 (74.1)	14 (93.3)	.09	49 (79.0)	.42	22 (88.0)	.12	135 (75.8)	122 (78.2)	.30	147 (76.6)	110 (77.5)	.30	153 (77.7)	104 (75.9)	.86
No	77 (23.1)	60 (25.9)	1 (6.7)		13 (21.0)		3 (12.0)		43 (24.2)	34 (21.8)		45 (23.4)	32 (22.5)		44 (22.3)	33 (24.1)	
How many times brush teeth per day (n, %)																	
1 time	43 (12.6)	33 (13.8)	1 (6.3)	Ref.	8 (12.9)	Ref.	1 (4.0)	Ref.	20 (11.0)	23 (14.4)	Ref.	22 (11.2)	21 (14.4)	Ref.	24 (12.2)	19 (13.1)	Ref.
2 times	136 (39.8)	93 (38.9)	7 (43.7)	.38	25 (37.1)	.81	11 (44.0)	.17	74 (40.7)	62 (38.7)	.36	76 (38.8)	60 (41.1)	.58	76 (38.6)	60 (41.4)	.67
3 or more times	163 (47.7)	113 (47.3)	8 (50.0)	.41	29 (46.8)	.89	13 (52.0)	.17	88 (48.3)	75 (46.9)	.38	98 (50.0)	65 (44.5)	.28	97 (49.2)	66 (45.5)	.66
Use of dental floss (n, %)																	
Yes	218 (63.0)	149 (61.6)	11 (68.8)	.56	40 (64.5)	.66	18 (69.2)	.44	124 (67.0)	94 (58.4)	.09	134 (67.3)	84 (57.2)	.052	136 (67.7)	82 (56.6)	**.03**
No	128 (37.0)	93 (38.4)	5 (31.2)		22 (35.5)		8 (30.8)		61 (67.0)	67 (41.6)		65 (32.7)	63 (42.8)		63 (32.3)	63 (43.4)	

Abbreviations: SD, standard deviation; Ref, reference (control). Bold forms mean statistical significance difference ($P < .05$).
*In comparison with eutrophic group.

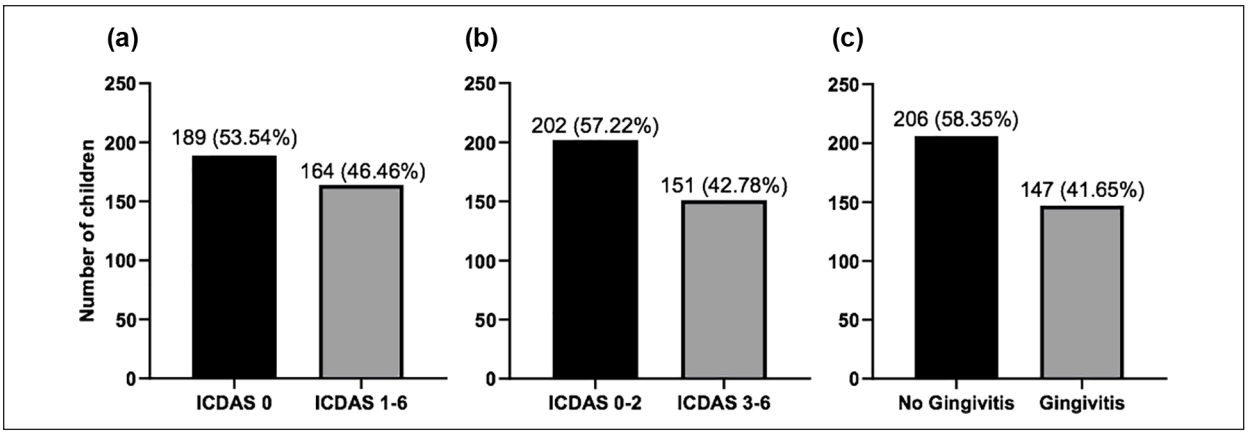

Figure 1. Frequency of children per caries and gingivitis groups. (A) Frequency of $ICDAS_0$ and $ICDAS_{1-6}$. (B) Frequency of $ICDAS_{0-2}$ and $ICDAS_{3-6}$. (C) Frequency of No Gingivitis and Gingivitis.

Table 3. Association between Nutritional Status and Caries Experience/Gingivitis.

	Eutrophic	Underweight			Overweight			Obese			Overweight + Obese		
Groups	n (%)	n (%)	*P*-value	OR (95% CI)	n (%)	*P*-value	OR (95% CI)	n (%)	*P*-value	OR (95% CI)	n (%)	*P*-value	OR (95% CI)
Non-cavitated caries lesion vs Cavitated caries lesion													
$ICDAS_{0-2}$	132 (53.4)	8 (50.0)	.78	1.14	43 (67.2)	**.04**	0.56	19 (73.1)	**.05**	0.42	62 (68.9)	**.01**	0.51
$ICDAS_{3-6}$	115 (46.6)	8 (50.0)		(0.41-3.15)	21 (32.8)		(0.32-0.99)	7 (26.9)		(0.15-1.0)	28 (31.1)		(0.31-0.87)
Health vs Caries													
$ICDAS_0$	125 (50.6)	8 (50.0)	.96	1.02	38 (59.4)	.21	0.70	18 (69.2)	.07	0.45	56 (62.2)	**.05**	0.62
$ICDAS_{1-6}$	122 (49.4)	8 (50.0)		(0.37-2.81)	26 (40.6)		(0.40-1.22)	8 (30.8)		(0.20-1.11)	34 (37.8)		(0.37-1.0)
Health vs Gingivitis													
Non gingivitis	141 (57.0)	8 (50.0)	.57	0.7	37 (57.8)	.91	1.0	20 (76.9)	.06	0.39	57 (63.3)	.30	0.77
Gingivitis	106 (43.0)	8 (50.0)		(0.2-2.0)	27 (42.2)		(0.5-1.7)	6 (23.1)		(0.16-0.96)	33 (36.7)		(0.46-1.27)

All comparisons were performed with Eutrophic group (Eutrophic was the reference for all analysis). Bold forms mean statistical significance difference ($P < .05$). OR 95% CI: odds ratios with 95% confidence intervals.

high consumption of high-fat diets, which are positively associated with obesity, but it is not with caries.[39] Besides that, a possible protective effect of fat against caries has been previously suggested in the literature.[40,41] According to the national data evaluating nutrient consumption, the caloric participation of lipids in the Southeast Brazilian region is higher compared to others Brazilian regions and the national mean.[42] Although our study did not observe a statistical association between diet and nutritional status, this could be due the limitation of our study that evaluated only the self-reported ingestion of sweeties between meals, which is a risk factor for caries.

Another possible theory for this result was suggests that severe untreated caries affects eating ability,[43,44] however, this would lead to underweight children. This hypothesis is supported by the study of Duijister et al[45] in Filipino children, which showed that treatment of severely carious lesion in underweight children was associated with significant weight gain. Our study did not observe statistical association between underweight and caries experience; however, this could be due to the small sample size of underweight children in our population.

Periodontal diseases, including gingivitis, are infectious and inflammatory conditions characterized by a modification in the microbial ecology of biofilms.[46] Among children and teenagers, the most prevalent periodontal disease is biofilm-induced gingivitis,[47] which is a precondition for periodontitis, however not all cases of gingivitis will progress to periodontitis.[29,48] In this study, the nutritional status was not associated with gingivitis. These results contrast with a recent published systematic review and meta-analyzes, in which obesity demonstrated a risk factor for gingivitis among children and adolescents.[29] However, the published literature still has no consensus on the relationship between nutritional status and periodontal diseases, including gingivitis in the pediatric population.

One possible limitation of our study is the fact that a full mouth periodontal examination was not performed,

however, the Community Periodontal Index was used as recommended by the World Health Organization. Therefore, it is possible that the presence of gingivitis has been underestimated.

One important aspect this study is that, different from the most previous studies evaluating BMI and caries, that used the sum of decayed, missing and filled teeth (DMFT) criteria for the diagnosis of caries, our study used ICDAS as a diagnostic method. ICDAS is a more elaborate scale and could produce more accurate results, as supported by previous authors.[23]

Conclusions

Caries was associated with overweight and obesity, while gingivitis was not associated with nutritional status.

Author Contributions

ECK, DSBO, FBF and CLMS designed the data. MCFB, DCL and DSBO examined and collected the sample. MCFB, CLBR and IRM organized the data. CLBR, CMCFL and ECK analyzed the data. MCFBB, CLBR, IRM, ECK and DSBO interpreted the results and wrote the manuscript. All authors read and approved the final version of the manuscript.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Supplemental Material

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