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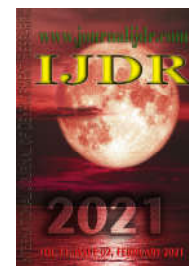
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## ANALYSIS OF CARIOGENICITY AND NUTRITIONAL QUALITY OF THE DIET OF SCHOOLCHILDREN IN MANAUS, BRAZIL

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### ABSTRACT

**Objetivos:** Avaliar a dieta, hábitos alimentares e de higiene bucal, bem como o grau de satisfação dos alunos quanto à alimentação fornecida por escolas de tempo integral da cidade de Manaus, a fim de melhorar a percepção destes e a incentivá-los a ter um hábito alimentar mais saudável. **Métodos:** Escolares de uma escola pública de tempo integral (n= 715) da cidade de Manaus, Amazonas, com idade entre 11 e 18 anos responderam a um questionário com perguntas sobre hábitos alimentares e de higiene bucal, e também sobre o grau de satisfação quanto às refeições diárias fornecidas gratuitamente pelas escolas. Após a coleta dos dados, a tabulação e análise foram realizadas através do programa SPSS versão 20.0. Utilizou-se análise do coeficiente de correlação de Pearson para comparação entre as porcentagens dos resultados obtidos, além de análise descritiva de variáveis qualitativas, através de tabelas de frequência absoluta e relativa. As variáveis foram relacionadas ao sexo, utilizando o teste Qui-quadrado, adotando-se um nível de significância de 5%. **Resultados:** Do total de 715 escolares que responderam o questionário, a maioria é do sexo feminino 397 (55,5%), realizava a primeira alimentação na escola 364 (50,9%), almoça a refeição oferecida pela escola 511 (71,5%), sendo esta a melhor refeição de acordo com 342 (47,8%) escolares. Os alimentos consumidos pelos escolares, no mínimo uma vez por semana são: leite, suco artificial, suco natural, refrigerante, doces caseiros, bolos, balas/chicletes, chocolate, Achocolatado e bolachas. Ao correlacionar o consumo de alimentos com o gênero dos escolares, o valor de p foi estatisticamente significativo (p=0,004) somente com balas/chicletes; sendo que as meninas relataram consumir esses alimentos com maior frequência. Quanto aos hábitos de higiene bucal, grande parte dos participantes afirmou que realizava diariamente a higiene oral após o café da manhã, 315 (44,1%) e almoço 616 (86,2%) consumidos na escola, mas não após o lanche da tarde, 139 (19,5%). **Conclusões:** Os carboidratos são consumidos em alta frequência nas escolas, em particular os ricos em sacarose, como suco artificial, suco natural, refrigerante, doces caseiros, bolos, balas/chicletes, chocolate, achocolatados e bolachas. Programas educativo-preventivos devem ser compreendidos, adaptados e implementados em todas as escolas de tempo integral, a partir do conceito de educação em saúde. Comportamentos devem ser modificados quanto a higiene bucal e práticas alimentares, seja por ação individual ou coletiva, com o objetivo de controlar preditores importantes do desenvolvimento de doenças bucais.

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## INTRODUCTION

Food and nutrition are determinant and conditioning factors of health, and are closely related to the oral cavity, either directly by the quality of food, consistency and retentiveness or indirectly by the process of nutrition.

These factors can affect oral health through the development of dental caries, periodontal diseases, mucosal diseases and infectious diseases (Batista, 1999; Brasil, 1990; Gondivkar et al. 2019; Speirs and Beeley, 1992).

The local effect of food on the oral cavity is the most important factor in the etiopathogenesis of caries, and influences the type and amount of dental plaque, the production of acids by microorganisms, as well as the quality and amount of salivary secretion (Thylstrup and Fejerskov, 1995). Studies on the etiology of dental caries have identified some risk factors, such as consuming foods and drinks with a high content of refined carbohydrates, having poor hygiene, level of education of parents, among others (Masood *et al.*, 2012). Fermentable carbohydrates such as sucrose, sugary drinks and juices are among the main etiological factors (Batista, 1999; Narvai, 2001; Newbrun, 1998; Speirs and Beeley, 1992). Thus, education assumes a prominent role in obtaining good levels of oral health, and favors the development of critical awareness in individuals and communities about the causes of their problems and, as a result, arouses interest and responsibility for maintaining health and creating readiness to act in the direction of change (Figueira and Leite, 2008).

The educational process should be started preferably in childhood, since this stage represents a period in which the human being is growing and developing, both physically and intellectually. The attitudes and values acquired during this period will be present in the following phases of life. This means that it is of fundamental importance to invest in this moment. Among children, those in elementary school are considered the most favorable group for the development of oral health education programs, because at this school stage, they have greater facility for learning and better motor coordination (Figueira and Leite, 2008). Although dental caries and periodontal diseases, the two most prevalent diseases in dentistry, are preventable or controllable and the necessary measures are relatively simple, it is found that the objectives of better oral health, at the population level, are not achieved. This is because the prevalence and incidence of these pathologies are associated with social, economic and educational conditions and not only as a result of biological interactions in dental plaque (Unfer and Saliba, 2000).

Periodontal diseases have nutrition as a risk factor, so any change in periodontal health should be considered as a warning sign for food quality control, in order to reduce the risk of development of chronic diseases (Hujoel and Lingström, 2017; Martinon *et al.*, 2021). The existence of dental caries may also demonstrate an association with malnutrition in early childhood, principally in preschool children from low-income families, indicating that it is a factor in the development of the disease. (Janakiram *et al.* 2018; Rego *et al.* 2020). The oral health of the Brazilian population is precarious, therefore, oral health promotion programs are vital. These programs, when applied to preschoolers, can enable the early rectification of bad habits and, consequently, promote healthy permanent dentition and gums. The good relationship of the patient with the dentist is a determining factor in motivating the continuation of healthy habits and thus benefitting from a lack of disease (Bonow and Casalli, 2002).

In the light of the fact that the students of the participating schools spend ten hours per day in a school setting, and have three meals during this time, as well as the precarious nature of the information in these schools about diet and its relationship with oral hygiene, the aim of this study was to assess the diet, eating habits and oral hygiene of students from 11 to 18 years old in full-time state schools in the city of Manaus, Brazil. It also analyzed the food and the degree of satisfaction with the food that is provided in order to improve the perception of the students in relation to diet and oral hygiene and to encourage them to have healthier eating habits.

## MATERIALS AND METHODS

This is a cross-sectional study that employed observational research in which 831 students from the Áurea Pinheiro Braga Center for Full-time Education, in the city of Manaus, Brazil participated in 2011. A total of 831 informed consent forms were distributed to all schoolchildren and, for the age group of 11 to 18 years old, 715 forms were signed by the parents or guardians, which represented a response

rate of 86.0%. The final sample included the questionnaires of 715 students, aged between 11 and 18 years, without distinction of gender. The questionnaires were used to verify the students' satisfaction in relation to the meals provided by the school, frequency and type of food consumed and oral hygiene habits. All students who were in the classroom on the days of the application of the questionnaire and whose parents or guardians consented to participate in the study by signing the ICF were included. Students who were absent at the time of application of the questionnaire did not participate in the survey. The school was chosen for having a significant number of students and for offering free meals such as breakfast, lunch and an afternoon snack. The meals offered were evaluated using DietPro<sup>®</sup> software according to the standard portions, in order to analyze the supply of nutrients. The research was approved by the Research Ethics Committee of the Amazonas State University (process number 081/11, approved on September 16<sup>th</sup>, 2011).

The questionnaire presented a total of 16 questions about frequency of consumption, food types and meal times. It also investigated whether the student carried out his/her first meal of the day at home or at school, as well as if he/she brought food from home to eat at school. In addition, oral hygiene habits, such as frequency of brushing after meals, and the degree of satisfaction of the students with respect to the three daily meals offered by the full-time school were evaluated. After data collection, the tabulation and analysis of the data were performed using the SPSS program (version 20.0) in order to analyze the results obtained from an epidemiological point of view. The Pearson's correlation coefficient was used to compare the percentages of the results obtained, and a descriptive analysis of qualitative variables, through absolute and relative frequency tables was performed. The variables were related to gender, using the Chi-square test, and adopted a significance level of 5%.

## RESULTS AND DISCUSSION

Of the 715 schoolchildren who answered the questionnaire, the majority (397/55.5%) are female, 364 (50.9%) had their first meal at school, 511 (71.5%) ate the meal offered by the school at lunchtime, which, according to the majority of schoolchildren (342/47.8%), was the best meal. The students of the full-time schools of the city of Manaus have their main meals in the school itself, which generates concern about the elaboration of a menu that meets the nutritional needs and dietary preferences of the different age groups involved (Table I). The dietary patterns and preferences of each individual exert influence on dental tissues, and act as a primary risk factor for the appearance of caries. Patterns of increased sucrose consumption from birth to two years of age, already established in childhood persist. (Saito *et al.*, 1999). According to Table I, the majority of schoolchildren are satisfied with their lunch (452/63.2%) and afternoon snack (404/56.5%); and the majority are dissatisfied with breakfast (587/82.1%) and lunch (545/76.3%). Table II shows that the foods consumed by schoolchildren, at least once a week are milk, artificial juice, natural juice, soda, homemade sweets, cakes, candies/chewing gum, chocolate, chocolate milk and cookies. Study participants reported an infrequent habit of consuming tea, and cereal. Regarding the consumption of condensed milk, 24.8% reported having it at least once a day. When relating gender to food types, the *p* value was statistically significant (*p* = 0.004) only in relation to candy/chewing gum; girls reported consuming these foods more frequently, more than twice per week (male = 117/16.3%; female = 197/27.6%). It is important that dental professionals be consulted during the preparation of the menus, so that they make suggestions regarding an effective control of the supply of free sucrose in optimal quantity and frequency, since intervention measures aimed at these risk factors would be more appropriate for the prevention of caries than specific measures (Leite *et al.*, 1999; Rocha *et al.*, 1998). This study found that the majority of the students interviewed (77.2%) still had meals between breakfast and lunch, and 430 (59.7%) had meals between lunch and their afternoon snack. This diverges from that observed between the afternoon snack and dinner, where the majority (435/60.8%) did not consume any type of food.

**Table 1. Description of variables: gender, and eating routine**

Variables	n (%)
Gender	
Male	315 (44.1)
Female	397 (55.5)
No answer	3 (0.4)
Do you have all you meals at school?	
Yes	126 (17.6)
No	435 (60.8)
Sometimes	142 (99.9)
No answer	12 (1.6)
Where do you have breakfast?	
At home	343 (48.0)
At school	364 (50.9)
No answer	8 (1.1)
Do you eat anything after breakfast?	
No	56 (7.9)
Packed lunch	42 (6.0)
Juice	242 (33.9)
I buy something at school	338 (47.3)
I don't eat anything in the morning	27 (3.8)
No answer	9 (1.3)
Do you eat the lunch provided by the school?	
Yes	511 (71.5)
No	17 (2.4)
Sometimes	182 (25.5)
No answer	5 (0.7)
Do you eat a packed lunch brought from home?	
Yes	21 (2.9)
No	588 (82.2)
Sometimes	94 (13.1)
No answer	12 (1.6)
Do you have dessert with your lunch?	
Yes	189 (26.4)
No	282 (39.4)
Sometimes	241 (33.7)
No answer	3 (0.4)
Do you eat the afternoon snack offered by the school?	
Yes	114 (15.9)
No	209 (29.2)
Sometimes	391 (54.7)
No answer	1 (0.1)
Do you eat anything after your afternoon snack?	
Yes	126 (17.6)
No	435 (60.8)
Sometimes	142 (19.9)
No answer	12 (1.6)
Which is your favorite meal?	
Breakfast	128 (17.9)
Lunch	342 (47.8)
Afternoon snack	210 (29.4)
No answer	11 (4.9)
Which is your least favorite meal?	
Breakfast	292 (40.8)
Lunch	234 (32.7)
Afternoon snack	174 (24.3)
No answer	1 (0.1)
How satisfied are you with your breakfast?	
Very satisfied	13 (1.8)
Satisfied	103 (14.4)
Not very satisfied	232 (32.4)
Unsatisfied	177 (24.8)
Very unsatisfied	178 (24.9)
No answer	12 (1.6)
How satisfied are you with your lunch?	
Very satisfied	10 (1.4)
Satisfied	151 (21.1)
Not very satisfied	291 (40.7)
Unsatisfied	157 (22.0)
Very unsatisfied	97 (13.6)
No answer	9 (1.3)
How satisfied are you with your afternoon snack?	
Very satisfied	20 (2.8)
Satisfied	150 (21.0)
Not very satisfied	234 (32.7)
Unsatisfied	141 (19.7)
Very unsatisfied	139 (19.4)
No answer	31 (4.4)

Among the foods that are predominantly consumed in these intervals, whether sold at school or brought from home are candies and gum, which are consumed three times or more a day by 203 (28.4%) of the students, while soft drinks and artificial juices are consumed by 120 (16.8%) and 127 (17.7%) of those involved in this study, with the same frequency. Considering the reported daily consumption, we observed that candy and chewing gum are consumed at least once a day by 220 (30.8%), and for soft drinks and artificial juices, we observed consumption by 257 (35.9%) and 311 (43.5%) students, respectively. It was also observed that the first meal was had at school by 364 (50.9%) of the students, and that 343 (48.0%) of those who had breakfast at home could also have it again at school. This is justified because these students need to leave home very early in order to arrive at school on time; however, usually there is no control of the build up of dental biofilm.

For the Pearson correlation analysis, we excluded three schoolchildren who did not respond regarding gender. Thus, 712 questionnaires were analyzed in this sense. Regarding the correlation between the foods consumed by adolescents and their eating routines, it was observed that the place where breakfast is eaten, whether at school or at home, is inversely related to consumption of natural juice ( $p = 0.013$ ;  $r = -0.093$ ); yogurt ( $p = 0.010$ ;  $r = -0.097$ ) and cookies ( $p = 0.05$ ;  $r = -0.072$ ), which was demonstrated by the negative value of the correlation coefficient. However, the first meal, when it is eaten at home, is directly related to cereals ( $p = 0.026$ ;  $r = 0.083$ ) and natural juice ( $p = 0.024$ ;  $r = 0.084$ ). Eating the lunch offered by the school is directly related to the intake of artificial juice ( $p = 0.013$ ;  $r = 0.094$ ). There was an inverse relationship between eating something after lunch and foods such as homemade candies ( $p = 0.01$ ;  $r = -0.119$ ); as well as between eating something after the afternoon snack and the consumption of cakes ( $p = 0.039$ ;  $r = -0.078$ ). The consumption of condensed milk is directly related to having the three meals at school ( $p = 0.04$ ;  $r = 0.108$ ), satisfaction with lunch ( $p = 0.014$ ;  $r = 0.093$ ), and the choice of the favorite meal offered by the school ( $p = 0.00$ ;  $r = 0.136$ ).

Satisfaction with the afternoon snack is directly related to the consumption of chocolate ( $p = 0.052$ ;  $r = 0.073$ ), chocolate milk ( $p = 0.02$ ;  $r = 0.084$ ), yogurt ( $p = 0.020$ ;  $r = 0.088$ ) and cookies ( $p = 0.03$ ;  $r = 0.08$ ). Brushing of their teeth presented a direct correlation with packed lunch ( $p = 0.014$ ;  $r = 0.092$ ), an afternoon snack ( $p = 0.000$ ;  $r = 0.184$ ) and their satisfaction with afternoon snack ( $p = 0.000$ ;  $r = 0.184$ ). Gender showed a positive correlation with the place where they have breakfast ( $p = 0.001$ ;  $r = 0.123$ ), if the lunch comes from home ( $p = 0.001$ ;  $r = 0.119$ ), and brushing teeth after their afternoon snack ( $p = 0.04$ ;  $r = 0.076$ ). Brushing presented an inverse relationship with their satisfaction with breakfast ( $p = 0.03$ ;  $r = -0.111$ ).

The absence of brushing and frequent consumption of sugary foods contribute to the development of tooth decay. Studies have found that those who consume sugary products two to three times a day, every day, had a 4.41 times higher chance of having severe caries, when compared to children who consumed these products once a day at most. In one study, it was observed that most children consumed snacks, sweets, cookies and milk with sweetened chocolate in snacks between school meals, assigning schools the responsibility for influencing eating habits and oral hygiene (Moreira *et al.*, 1996). Special attention should be paid to the diet of these children and adolescents, since one of the main etiological factors of tooth decay is the high consumption of fermentable carbohydrates such as sucrose, sugary drinks and artificial juices offered by the school itself. The importance of defining food criteria appropriate to the reality of the region, through the consumption of more nutritious foods, which reduce the frequency of sugar intake is also addressed. Although the results of the project SB Brazil 2010 (Ministry of Health, 2012) indicate that, according to the classification adopted by WHO, Brazil moved from a condition of average prevalence of caries in 2003 (CPO between 2.7 and 4.4) to a condition of low prevalence in 2010 (CPO between 1.2 and 2.6).

**Table 2. Frequency of food consumption (n = 715)**

Foods	Never n (%)	Once per day n (%)	Twice a day n (%)	3 times a day or more n (%)	No answer n (%)	Chi-square test (gender) "P"
Milk	128 (17.9)	280 (39.2)	197 (27.6)	53 (7.4)	4 (0.6)	0.30
Tea	654 (91.5)	41 (5.7)	10 (1.4)	7 (1.0)	3 (0.4)	0.58
Artificial juice	104 (14.5)	311 (43.5)	169 (23.6)	127 (17.7)	4 (0.6)	0.62
Natural juice	306 (42.8)	258 (36.1)	75 (10.5)	71 (9.9)	5 (0.7)	0.63
Soda	213 (29.8)	257 (35.9)	123 (17.2)	120 (16.8)	2 (0.3)	0.16
Homemade candy	301 (42.1)	259 (36.2)	95 (13.3)	58 (8.1)	2 (0.3)	0.19
Cake	260 (36.4)	351 (49.1)	66 (9.2)	37 (5.2)	1 (0.1)	0.62
Condensed milk	476 (66.6)	177 (24.8)	37 (5.2)	21 (2.9)	4 (0.6)	0.54
Candy/gum	177 (24.8)	220 (30.8)	113 (15.8)	203 (28.4)	2 (0.3)	0.004
Chocolate	201 (28.1)	298 (41.7)	110 (15.4)	103 (14.8)	3 (0.4)	0.36
Yoghurt	357 (49.9)	223 (31.2)	76 (10.6)	55 (7.7)	4 (0.6)	0.48
Chocolate milk drinks	187 (26.2)	339 (47.4)	112 (15.7)	73 (10.2)	4 (0.6)	0.15
Cookies	296 (41.4)	272 (38.0)	77 (10.8)	70 (9.8)	-	0.07
Cereal	493 (69.0)	143 (20.0)	41 (5.7)	36 (5.0)	2 (0.3)	0.15

**Table 3. Oral hygiene habits in relation to gender (n =712)**

Brushed teeth	YES			NO			SOMETIMES			NO ANSWER			Chi-square test p value
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	
After breakfast	314 (43.8)	155 (21.8)	159 (22.3)	345 (48.5)	135 (19.0)	210 (29.5)	22 (3.1)	13 (1.8)	9 (1.3)	31 (4.4)	12 (1.7)	19	0.012
After lunch	615 (86.4)	264 (37.1)	351 (49.3)	33 (4.6)	19 (2.7)	14 (2.0)	56 (7.9)	26 (3.7)	30 (4.2)	8 (1.2)	4 (0.6)	4 (0.6)	0.67
After break	139 (19.5)	77 (10.8)	62 (8.7)	397 (55.8)	161 (22.6)	236 (33.1)	151 (21.2)	69 (9.7)	82 (11.5)	25 (3.5)	8 (1.2)	17 (2.4)	0.009

Some regions of the country still have high rates, as is the case of the northern region (average CPO of 3.16) and average CPO among adolescents 5.64, the second highest average in the country, lagging behind only the midwestern region (5.94) in the same age group. However, the decline in the prevalence of caries was accompanied by an increase in the inequality of its indicators among social strata. This phenomenon is referred to as polarization of the caries experience (Narvai *et al.*, 2006). In Manaus, the average DMF index among adolescents was 4.85, higher than the national average among adolescents aged 15 to 19 years which was 4.25 (Ministry of Health, 2012). In this school, the average of the DMF index was 1.2, suggesting that preventive educational programs already implemented justify the average of the DMF index, despite the dietary pattern of those involved in this study demonstrating a high consumption of carbohydrates and cariogenic foods, when compared to other foods that are more nutritious and less fermentable. The results of this study suggest the need to implement preventive oral health education programs in all full-time schools. These should include information regarding the existing relationship between food and oral health, with the aim of the subsequent health improvement of the population involved. The implementation of preventive educational programs (educational approach) improved oral hygiene practices and reduced the development and progression of caries as well as exodontics in early childhood (Muhoozi *et al.* 2018). In another study, the average DMF in school children of 12 years of age in Manaus in a school where there are no preventive educational programs was 3.05, and 72.7% of those examined had 1 or more decayed teeth. Studies have shown that Brazilians are increasingly replacing the consumption of foods rich in fiber and nutrients with industrialized foods rich in fats, carbohydrates and sugars, which increase the risk of caries, in addition to leading to a decrease in the consumption of other basic nutrients, which in turn increase the prevalence of related diseases such as obesity (López *et al.*, 1997; Mateos, 1999). Thus, excessive consumption of high-calorie foods is related to important metabolic disorders such as obesity and metabolic syndrome and may reflect a "trigger" of the lack of nutrients in the body, contributing to the nutritional transition, with the passage of low-weight states to those of obesity, with the maintenance of malnutrition, particularly in more susceptible populations.

Regarding the analysis of the standard portions on the school menu that are served to the students, we found the daily mean carbohydrates of 136.5 and 47g above the daily recommendations for the age groups from 9 to 14 years, total fiber below the daily recommendations 12.9 and 5.5 (DRI -25 to 31 g/day) and a low supply of vitamin B 1 of 0.5 and 0.3 (DRI - 1.0 to 1.2 mg/day) (DRI, Food and Nutrition Board, Institute of Medicine, 2011). Vitamin B1 has important role in cognitive potential, for which intake is limited in diets rich in polished rice, flour and infrequent in meats, legumes and vegetables. In some meals, the menu seemed appropriate, for example, when regional dishes. However, one favorable point was the presence of vegetable salad at least three times a week and fruits for dessert at least once a week. A fact that could be stimulated or included in other meals. It is suggested that the menu be revised, in an attempt to improve the nutritional quality and variety of dishes offered by the food supply company, meeting not only the students' wishes, but mainly avoiding the risk of tooth decay.

As for oral hygiene habits, a large part of the participants stated that they performed oral hygiene daily after breakfast (315/44.1%) and lunch (616/86.2%) consumed at school, but not after the afternoon snack (139/19.5%) (Table III). Due to the difficulty of modifying oral hygiene habits, the implementation of educational-preventive programs is suggested and that these focus on health education, creating the possibility of students becoming, through the newly acquired knowledge, responsible for the care of their oral health (individual action), as well as to becoming agents that multiply this health knowledge (collective action) (Flores and Drehmer, 2003; Rossow *et al.* 1990; Saito *et al.* 1999; Traebert *et al.* 2004). The fact that not all students present at this type of institution have toothbrushes available for use after sucrose consumption increases the risk of developing caries (Bezerra and Toledo, 1999; Campos *et al.*, 2003; Tomita, 1999). The research also evaluated the degree of satisfaction of students in regards to the meals offered by schools, in order to guide the improvement of the menu, making it healthier from the point of view of the risk of tooth decay. With regard to the degree of satisfaction with the meals offered in full-time schools, in regards to the breakfast, most students showed little satisfaction, while for the lunch and in the afternoon snack that were provided, most students were very satisfied.

As for the best dish offered, it was observed that in the morning meal the consumption of sweets predominated; at lunch, meats and for the afternoon snack, pizza. The best meal offered by the school, in the opinion of the students, was lunch and the worst meal was the morning meal.

## CONCLUSION

Carbohydrates are consumed in high frequency in schools, in particular those rich in sucrose, such as artificial juice, natural juice, soda, homemade candies, cakes, candies/chewing gum, chocolate, chocolate milk drinks and cookies. Educational-preventive programs should be understood, adapted and implemented in all full-time schools, based on the concept of health education. Behavior should be modified regarding oral hygiene and eating practices, either by individual or collective action, in order to control important predictors of the development of oral diseases.

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