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ORIGINAL ARTICLE

Association Between Caries Experience and School Performance in an Island Community: Full-Time versus Part-Time Public Schools

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ABSTRACT

Objective: To investigate the association between caries experience and school performance among children and adolescents living in an island community without fluoridated water supply and to compare data according to the type of attended school (full-time or part-time). **Material and Methods:** A cross-sectional oral health survey in a convenience sample of students (n=147) attending four public schools was performed. Students were examined by one calibrated dentist in the school environment to the obtain prevalence of dental caries (DMFT/dmft) and its consequences using the PUFA/pufa index. Self-reported oral health behavior was also accessed. Data from each student's school performance and absenteeism were extracted from official sources and the school performance was classified into "good" and "fair". The final sample consisted of 120 students. Descriptive statistics, Mann-Whitney, Kruskal-Wallis, chi-square tests and binary logistic regression were performed to evaluate collected data. **Results:** Students´ age ranged between 5 to 19 years (10±4.3). DMFT/dmft mean were 1.3 (±2.3) and 3.05 (±3.4), respectively. **Conclusion:** Participants from the full-time school presented better oral health status than their peers in the part-time schools ($p<0.05$). A significant association was found between the prevalence of caries-free participants and good school performance when the factor age range was controlled (OR=2.87). Moreover, attendance to full-time schools appeared to be a protective factor for good oral health conditions.

Keywords: Oral Health; Public Health; Dental Caries.

Introduction

It is already established that oral health plays an important role in the quality of life in the general population [1,2]; thus, attempts to amplify dental public health activities in schools may certainly contribute to the improvement of quality of life among schoolchildren [3]. Furthermore, during childhood, many critical physiological, emotional, and cognitive changes occur in the growing individual, and schools represent an appropriate locus where the input of knowledge and incorporation of healthy habits can be more effective [4,5]. Moreover, education personnel may play an essential role in conducting oral health activities as opinion formers and establishing trustful relationships with their students [6].

Poor school performance is a frequent problem faced by children and adolescents, which may cause social, emotional (low-esteem and lack of motivation), and employability issues [7]. In addition, it is known that children and adolescents' oral health conditions and socio-demographic characteristics affect their daily activities and their school performance [8].

Children and adolescents' oral health are determined by a broad framework of factors influenced by individual, family and community levels [9]. Untreated dental caries in schoolchildren can lead to severe consequences, such as pain, infection, growth and development impairment, underweight, irritability, disturbed sleeping, reduced self-esteem, and low involvement in social activities [10]. The influence of oral health on school academic performance in the general population has been previously studied [7,11,12]. However, there is still a lack of information on students from isolated communities without routine dental care and water fluoridation. Hence, the present study was designed to investigate if there is an association between caries experience and academic performance among students from an isolated island community. Moreover, the caries experience of students enrolled in full-time schools will be compared to those attending part-time schools in this community.

Material and Methods

The present study was based on a cross-sectional epidemiological survey conducted in Ilha Grande, an island located in the municipality of Angra dos Reis, Rio de Janeiro State, Brazil, in 2018.

Study Population

Ilha Grande has an estimated population of 5.201 inhabitants, representing 2.72% of the whole municipality of Angra dos Reis and a Human Development Index of 0.724 (middle level), without fluoridated water supply [13]. The region is included in the Ilha Grande Bay area, which is classified as the fifty district of Angra dos Reis. The main economic activity of the population is fishing and tourism. The socio-demographic profile of the whole community is similar, with the majority of individuals belonging to a low economic stratum and low educational level. The island community has distinct characteristics from the continental population as the students depend on boats or cross through jungle trails to reach the schools.

A convenience sample at Pequenas Praias location, including the whole students enrolled on four public schools, was chosen to take part in the study. Regarding the evaluated schools, one offered full-time school period and the other three offered only part-time school periods. The inclusion criteria for the participants were: 1) official enrollment in school, 2) completion of all language (Portuguese) and Mathematics exams and 3) agreement to have their teeth brushed and to be submitted to the oral examination. Exclusion criteria were: 1) individuals affected by any pathology which could cause learning disorder, and 2) scholars with systemic diseases.

After permission from the school board, a meeting was held with caregivers to present the project and to obtain informed consent to perform dental examinations. The aims and procedures of the study were explained to the caregivers and a lecture on aspects of oral health was presented to students, followed by distribution of fluoridated dentifrices, toothbrushes and dental floss.

The study protocol was approved by the local Ethical Committee for Research (Clementino Fraga Filho Hospital, Federal University of Rio de Janeiro) under the number 1.455.298/2016.

Data Collection

Before the oral examination, all students were instructed to brush their teeth in front of a mirror, and soon after the dental examination, they received a topical application of 1.23% acidulated phosphate fluoride gel (APF). The students were examined by one of the authors (M.G.M.) with the aid of a headlamp, universal probes and plain mirrors in the school environment. The examiner was previously trained and calibrated according to the WHO criteria using the DMFT and dmft index [14]. No radiographs were taken. In order to evaluate the severity of the oral condition resulting from untreated dental caries, PUFA/pufa index was also recorded, according to the following criteria: presence of a visible pulp chamber, roots or fragments of roots remaining from carious teeth with visible pulpar involvement (P/p); ulceration caused by dislocated tooth fragments (U/u); fistula (F/f); and abscess (A/a) [15].

Intra-reproducibility was calculated using Cohen-Kappa scores. Examiner calibration was achieved after theoretical discussions between two authors (MG.M. and A.A.N) and recorded as 0.9 for the DMFT/dmft and 0.89 for the PUFA/pufa. Duplicate dental examination was performed on 10% of the sample not identified by the examiner (k= 0.87 for DMFT/dmft and k=0.89 for PUFA/pufa).

Participants were interviewed by one of the authors (M.G.M.) and were asked to answer three questions related to oral health behavior, including: 1) toothbrushing frequency (once a day, twice a day, three times a day or more often than three a day), 2) frequency of sugar intake (never, only on the weekend, some days in the week, everyday) and 3) dental floss use (every day, some days in the week, or never). Questions 1 and 2 received scores varying from zero to three points, while for question 3, a score from zero to 2 points was attributed. Therefore, participants could score a total of zero to eight points and were finally categorized as satisfactory (8, 7, 6 or 5 points), or unsatisfactory (4, 3, 2, 1, or 0 points) regarding oral health behavior.

In 2018, academic records and absenteeism were obtained from the municipality (Angra dos Reis Education, Science and Technological Secretary). Academic performance for each student was objectively measured based on the mean value scores for the annual language: Portuguese and Mathematics examinations (scores range 0-100). Similarly, the mean annual school absenteeism (number of absent days) was obtained for those disciplines. According to the median achieved for both academic performance and absenteeism, participants were categorized into “good” or “fair” on both variables. Therefore, participants classified as “good” in school performance should be above the median on the disciplines and below the median on the variant absenteeism, whereas the remaining were classified as “fair” performance.

Analysis of Data

Data were tabulated and analyzed using the Statistical Package of Social Sciences (SPSS) version 21.0 for Windows (2012, IBM Corp, Armonk, NY). Descriptive statistics were conducted to analyze distribution, mean, median and standard deviations. Primary or permanent teeth under the status of “caries” and “filled with caries” were categorized as untreated caries. The variables DMFT, PUFA/pufa and untreated caries were

dichotomized according to the presence or the absence of each category. The variables obtained in the permanent and primary dental examination were also analyzed as consolidated and dichotomized (DMFT/dmft, PUFA/pufa and untreated permanent/primary caries). Associations between ordinal variables were determined using the nonparametric Kruskal-Wallis tests, whereas for the analysis of dichotomized variables, the chi-square test was applied. The nonparametric Mann-Whitney test was applied to determine the relation between continued and dichotomized variables. The association between the outcome "academic school performance" and other co-variables were preliminary tested using the univariate model as a result of the binary logistic regression application. The multivariate logistic was divided in model 1, including all the covariants by enter method, and in model 2, the covariant DMFT/dmft was obtained as a result of the stepward method controlled by range age. The Hosmer and Lemeshow test was applied, aiming evaluation of the final model quality. The α-level for statistical significance was set at $p < 0.05$.

Results

A total of 147 students were enrolled in the four public schools analyzed. A total of 27 scholars dropped out, as 24 were absent from school for the oral examinations and three were excluded after application of the inclusion criteria (two did not agree with oral examination, and one was excluded as presenting multiple dental and skeletal disorders). The final analysis of the data consisted of 120 students. Table 1 presents a descriptive analysis of the student's characteristics according to the type of school (full-time or part-time).

The students' ages ranged from 5 to 19 years old (mean 10.3 ± 2.93). Mean DMFT/dmft scores were 1.3 (±2.31) and 3.05 (±3.35), respectively. Analysis of the permanent dentition demonstrated that 62.5% of the students were caries-free, whereas, in the primary dentition, this number was 37.1% (n=26). In relation to PUFA/pufa index, 13.3% and 24.3% of the students scored in the permanent and primary dentition, respectively. The statistical analysis suggested that participants at the full-time school demonstrated better oral health compared to their peers at the part-time school, even after each co-variable was independently assessed. In fact, variables DMFT, dmft and untreated permanent caries showed a statistically significant difference between full-time and part-time schools, as shown in Table 1.

Table 1. Students' characteristics according to the type of school.

Variables	N (%)	Type of School		p-value¥
		Full-time N (%)	Part-time N (%)	
Gender				
Female	57 (47.5)	18 (37.5)	39 (54.2)	0.54
Male	63 (52.5)	30 (62.5)	33 (45.8)	
Age				
5-9 years	56 (46.7)	35 (72.9)	21 (43.5)	<0.001
10-19 years	64 (53.3)	13 (27.1)	51 (56.5)	
No. siblings				
none	14 (11.7)	5 (10.4)	9 (12.5)	0.086
1	41 (34.2)	22 (45.8)	19 (26.4)	
>1	65 (54.2)	21 (43.8)	44 (61.1)	
Oral health behavior				
Satisfactory	51 (42.5)	19 (39.6)	32 (44.4)	0.378
Unsatisfactory	62 (51.7)	26 (54.2)	36 (50.0)	
Missing data	7 (5.8)	3 (6.2)	4 (5.6)	
DMFT				
0 (caries free)	54 (62.5)	39 (81.3)	36 (50)	<0.001
> 0	45 (37.5)	9 (18.8)	36 (50)	

PUFA				
0	104 (86.7)	44 (91.7)	60 (83.3)	0.149
>1	16 (13.3)	4 (8.3)	12 (16.7)	
Untreated permanent caries				
No	76 (63.3)	38 (79.2)	38 (52.8)	<0.001
Yes	44 (36.7)	10 (20.8)	34 (47.2)	
dmft§				
0 (caries free)	26 (37.1)	17 (43.6)	9 (29.0)	0.048
1-4	23 (32.9)	8 (20.5)	15 (48.4)	
> 5	21 (30.0)	14 (35.9)	7 (22.6)	
pufa§				
0	53 (75.7)	30 (76.9)	23 (74.2)	0.504
>1	17 (24.3)	9 (23.1)	8 (25.8)	
Untreated primary caries§				
No	28 (40.0)	18 (46.2)	10 (32.3)	0.176
Yes	42 (60.0)	21 (53.8)	21 (67.7)	

¥P was calculated by the qui-square test; §Participants only in primary dentition (N=70).

The mean annual tests results was 71.5 (±17.3) and the median was 70. In relation to absenteeism, a mean of 38.2 (±53.6), and a median of 16.5 total days of absence were registered for all students and schools. Children between 5-9-years presented better results considering those variables, and after independent analysis with the Mann-Whitney test, only the absenteeism indicated a statistical difference.

Considering the association between school performance and oral health findings, a statistical difference was obtained with the DMFT/dmft index, with the "good" school performance group containing a considerable number of caries-free scholars (p=0.004) (Table 2).

Table 2. Association between school performance and oral conditions among scholars.

Variables	School Performance		p-value¥
	Good N (%)	Fair N (%)	
DMFT and dmft			
0 (caries free)	15 (34.1)	9 (11.8)	0.004
> 0	29 (65.9)	67 (88.2)	
PUFA and pufa			
0	33 (75)	55 (72.4)	0.464
> 0	11 (25)	21 (27.6)	
Untreated permanent and primary caries			
No	22 (50.0)	28 (36.8)	0.112
Yes	22 (50.0)	48 (63.2)	
Oral health behavior&			
Satisfactory	18 (43.9)	33 (45.8)	0.50
Unsatisfactory	23 (56.1)	39 (54.2)	

&N=113; ¥P was calculated by the qui-square test.

Regression coefficients and p-values were applied to test the significance of the association between "good" school performance and the co-variables of interest. After isolating the analyzed variable in a univariate logistic model, results indicated that type of school, gender and DMFT/dmft showed a statistical difference. Therefore, testing independently, girls had 2.1 more chances of good academic performance than boys, and participants at the full-time school had a 2.6 odds compared with their peers at the part-time school. Binary logistic regression showed that when controlling the co-variables school, gender, age range, number of siblings, oral health behavior, DMFT/dmft, PUFA/pufa and untreated permanent/primary caries with the outcome school performance, statistical differences were identified. The age range 15-19 years represented students that were more prevalent in the "fair" academic performance category compared with the other age

range. Applying the stepward method, DMFT/dmft was proposed to be adjusted by age range, and in model 2, that variable demonstrated a 2.72 odds for participants to be included in the good school performance category (Table 3). The final model demonstrated an acceptable Hosmer and Lemeshow test (p=0.158).

Table 3. Binary logistic regression models for the association between good school performance and oral health among the participants.

Variables	Univariate logistic model		Multivariate logistic model 1		Multivariate logistic model 2§	
	OR&	p-value	OR¥	p-value	OR¥	p-value
Type of school						
Full-time	2.6	0.014	1.211	0.720		
Part-time	1		1			
Gender						
Female	2.1	0.055	2.278	0.088		
Male	1		1			
Age						
5- 9 years	6.913	< 0.01	7.112	<0.001	6.028	<0.001
10- 19 years	1		1		1	
No. siblings				0.708		
None	0.782	0.466	0.59	0.528		
1	1.53	0.704	1.027	0.737		
>1	1	0.299	1	1		
Oral health behavior						
Satisfactory	0.925	0.843	0.635	0.791		
Unsatisfactory	1		1			
DMFT and dmft						
0 (caries free)	3.851	0.005	1.225	0.789	2.72	0.03
> 0	1		1		1	
PUFA and pufa						
0	1.145	0.753	0.559	0.715		
> 0	1		1			
Untreated permanent and primary caries						
No	0.583	0.16	0.302	0.489		
Yes	1		1			

&Odds Ratio; ¥Odds Ratio Adjusted; §Hosmer and Lemeshow Test demonstrated p-value=0.158.

Discussion

In the present study, untreated caries were found to occur at very high levels in a population attending public schools in an isolated island region. Unfortunately, governmental financial resources for restorative dental treatment are not capable to include all oral demands specially [16,17] of those offshore population.

The present investigation suggests a significant association between dental caries and lower school academic performance, in agreement with previous studies [7,11,12,16,18-22], but it should be considered that data on the academic performance in different students were obtained by different methods, taking into account the diversity of cultural believes and public policies. Furthermore, in the present study, school performance data was extracted from an official municipality source, which could be considered an accurate method to achieve relatively comparable results as performed by previous studies [7,11,12,16,18,21,23].

The Brazilian Constitution of 1988 created a national public health system and implemented the Family Healthcare Strategy [24]. In this strategy, a health professional team approach the families in specific designated regions to establish a medical link with the inhabitants [25]. The National Oral Health Policy in Brazil was proposed to ensure promotion, prevention and rehabilitation of oral diseases in the general

population [26]. Thus, along the last nine years, an important education-preventive program has been established in such community and probably have had some impact in improving oral health among scholars. However, the last national oral health survey identified a striking inequity distribution of dental caries, particularly in underprivileged communities [27]. In this survey, 5-year-old children showed a mean dmft of 46.6%, while 12-year-old and 15-19-year-old showed 43.5% and 23.9% of caries-free individuals, respectively. The present study detected a reasonable high percentage of caries-free students in the permanent dentition (62.5%), but the prevalence of caries-free children in the primary dentition was considerable reduced (37.1%). This might be explained by the fact that permanent dentition are better impacted by oral school educational programs than primary teeth, as children are enrolled in primary schools generally only after 5 years of age and up to this age; thus, family habits are predominant.

Dental caries and the consequences of untreated carious teeth might influence academic achievements, diminishing schoolchildren's quality of life [12]. The current findings indicated a statistical significant association between "good" school performance and caries-free participants, but this result might also be associated with the demographics of this group. Families that are more concerned with their children's academic performance are probably also more general and oral health care aware and committed. School-based dental screening programs enable professionals to foster students with higher priority for dental caries [28] and this guideline has been recently adopted by the health professionals responsible for this community.

The PUFA/pufa index is useful for establishing priorities for dental care in schoolchildren [29,30]. A previous study in Brazil detected a prevalence of 23.7% of children scoring PUFA during assessments of the severity of clinical consequences of untreated dentine carious lesions in the primary dentition [31], a result similar to those found in the present study (24.3%). The prevalence of children scoring on PUFA/pufa was not correlated with school performance in the present study, contrary to what one might expect. This might have happened since we have used a threshold of at least PUFA/pufa=1 as an interest variable correlating with academic performance [15] and this might have leveraged the correlation since the prevalence of children scoring PUFA/pufa was very high among all children studied. Therefore, it is assumed that the high prevalence of schoolchildren with treatment needs and PUFA/pufa in the evaluated sample could indicate the community´s limitation in operative dental care assistance.

Regarding the type of school, full-time enrolled students presented a better oral health status compared with their peers in the part-time school. Such outcome might be due to the dietary choices and the fact that more systematic toothbrushing procedures are performed in the full-time school due to its broader hourly grid.

The oral health behavior in this population did not contribute to explain the oral health variables. This might have happened due to the subjective characteristic of self-reported measurements. Besides, it should be taken into account the great diversity of risk factors to which teeth are exposed, mainly in the first years of tooth eruption [32].

Regarding school absenteeism, it was possible to observe that mean missed school hours increased with the age of the students. Others obtained the same result, with the additional prevalence on female scholars [33]. While the present investigation included every reason for school absence, other surveys were based exclusively on dental circumstances [22,33]. The school absenteeism in the Pequenas Praias community may be considered extremely high, and could be explained by the fact that scholars depend on the meteorology/ocean conditions to arrive at school. Moreover, school absence could be a bias on academic result, as it seems plausible that schoolchildren who miss classes have less opportunities for education and,

consequently, are more likely to have poor school performance. Therefore, the consolidation of absenteeism and tests school results in one variable might represent the actually school performance of participants in the current study.

The present data are limited by the dental caries index used (DMFT/dmft), which do not enroll non-cavitated lesions, underscoring in some situations the real caries prevalence. A more accurate alternative to the DMFT/dmft index is the International Caries Detection and Assessment System (ICDAS) [34]. However, under the field conditions in which this study was performed, this could not be appropriately undertaken.

Another important limitation in generalizing the results refers to the inability to conduct the dental examination on the entire school population of the sample. A statistical difference was detected in scores of school results and school missed hours between scholars enrolled in the study and those not participating in the clinical examination. Most of scholars who did not participate in the study analyses belonged to the age range 10-19 years, group that presented the higher index of absenteeism. Yet, such gap could be responsible for causing interference in the final result, adding the fact that a considerable prevalence of caries-free individuals is expected among these age groups due to the oral health prevention program implanted along the last nine years in the community.

Another potential limitation concerns to this study design, as cross-sectional studies do not enable a cause-and-effect relationship. Besides, the timing of the snapshot is not guaranteed to be representative [35]. Thus, longitudinal studies are recommended to follow the dentition development and, consequently, chances in scholars oral health.

The results concerning the relationship between the student's oral health condition and their academic achievement, together with the prevalence of absenteeism in a community who deals with great difficult in access to a diversity of resources may contribute to public policy formulation to improve participation of the educational sector in long-term activities with the Family Healthcare Strategy. Currently, the Dental Family Health team are engaged in following the goals proposed by the WHO Global Oral Health for the new millennium and formulating regional strategies considering the political, socio-economic, cultural and legislative context of the community [36].

Conclusion

The present study showed a significant association between caries-free (permanent and primary dentition), dmft and good school academic performance controlled by age range. Besides that, students from the full-time school presented better oral health conditions and good school performance compared with those at the conventional part-time schools. The research implemented in this community suggests that improving schoolchildren's oral health by the increase of promotion and care activities may enhance the teaching-learning process, advocating conditions for healthy growth and development in society.

Authors' Contributions

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All authors declare that they contributed to critical review of intellectual content and approval of the final version to be published.

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None.

Conflict of Interest

The authors declare no conflicts of interest.

Data Availability

The data used to support the findings of this study can be made available upon request to the corresponding author.

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