

Association of Oral Health-Related Quality of Life with the Longevity of ART-Restorations in Children

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ABSTRACT

Objective: To evaluate the association of oral health-related quality of life (OHRQoL) with the longevity of ART-restorations in children after 18 months. **Material and Methods:** A longitudinal clinical study with 62 six- to seven-year-old children, both genders, 31 of whom underwent four weeks of oral health education strategy (OHES) followed by ART (G_{OHES+ART}) and the others only ART (G_{ART}). The Brazilian short-version of the Child Perceptions Questionnaire (16-CPQ₈₋₁₀) was used to evaluate the OHRQoL and the perception of change in oral health was assessed by a single question. Data was analyzed using Mann-Whitney, Wilcoxon and Friedman's tests. **Results:** After 18 months, G_{OHES+ART} reported a greater impairment on OHRQoL, mainly in oral symptoms domain ($p < 0.05$). In this period, greater impairment of oral symptoms was reported in children with failed restorations and with treatment considered to have a minor failure ($p < 0.05$). In inter-group analysis, the G_{OHES+ART}, with 2 to 4 restorations, Class I, of small size, located in the upper arch and with a smaller failure, reported more oral symptoms than the G_{ART}. **Conclusion:** In the long-term, children submitted to OHES followed by ART reported more oral symptoms. Factors such as number, class, size and location of the restorations need to be considered for the implementation of an efficient and effective oral health program, as well as for greater longevity of ART-restorations.

Keywords: Dental Caries; Child; Quality of Life; Dental Atraumatic Restorative Treatment.

Introduction

There is a consensus in the literature about measures of oral health-related quality of life (OHRQoL) being essential components in oral health surveys to determine treatment needs, clinical decision-making and to evaluate interventions, services and programs in public health services [1-3]. These assessments measure the functional and psychosocial impacts of oral diseases and are focused on supplementing clinical indicators, providing a comprehensive quantification of oral health of individuals and populations [4,5]. Cross-sectional studies have found an association between greater experience of dental caries and negative impacts on children's OHRQoL, such as dental pain, chewing difficulty, worry or frustration feelings and teeth related absence from school [1,6-9], which confirms the cross-sectional validity and reliability of these instruments. However, the longitudinal validity and reproducibility of measurements have been poorly studied in children with caries lesions [10].

Atraumatic restorative treatment (ART) comprises preventive and control measures for caries disease focusing on the concept of minimal intervention applicable in public health involving tissue removal decay using only manual instruments, usually without the use of anesthesia [11-14]. Minimal Intervention Dentistry (MID) for the management of dental caries has contributed to reducing the impact of dental caries on OHRQoL [14]. Although some studies have already demonstrated the effect of conventional dental caries treatment on improving OHRQoL in children [15,16], there is little evidence of the influence of ART on OHRQoL in the child population [7,9,17]. In Sousa et al. [18] study, including health educational strategies in the ART treatment plan was a determinant for the child's perception of improved oral health after restorative treatment.

The effectiveness of ART restorations has been evaluated based on three criteria [19]: modified Ryge criterion (United States Public Health Services – USPHS), FDI criterion, and ART restoration criteria. The ART restoration criterion was developed to ensure an easier and more reliable evaluation of restorations in the field. The fact that the same criterion is not always used turns out to be a problem, as it makes comparisons between studies difficult. However, a study of ART restorations that used both the USPHS and the ART restoration criteria stated that these are comparable [20].

Considering the benefits of the association between dental procedures and oral health educational strategies (OHES) for better cost-effectiveness [21,22], for better perception of oral health [18], and for stress modulation during ART steps for pediatric patients [23], it is important to assess the longevity of ART restorations after 18 months and their association with OHRQoL in children.

Material and Methods

Study Design and Ethical Clearance

This longitudinal clinical study is part of a wider research project submitted and approved by the Research Ethics Committee of the Piracicaba Dental School, University of Campinas – FOP-UNICAMP (protocol number 136/2014), and registered in ClinicalTrials.gov (CJK-2014-ART, registration date: January 28, 2016). The children and their parents/guardians signed the terms of assent and consent, respectively, in agreement with the research procedures.

Scenario

Schoolchildren aged six and seven years from the public schools in Piracicaba, Saltinho and Charqueada, SP, Brazil, were invited. The population of these municipalities ranges from 7,000 to 365,000 inhabitants, and the Human Development Index (HDI) between 0.74 and 0.79 [24]. The method of this study was based on the

recommendations of the SPIRIT protocol (Standard Protocol Items: Recommendations for Interventional Trials) [25]. The data was collected between July 2015 and December 2017.

Participants

The sample size was calculated based on the study by Paula et al. [7], which assessed the impact of ART on OHRQoL in schoolchildren using the Brazilian version of the Child Perceptions Questionnaire (CPQ₈₋₁₀) [26]. Considering the mean difference in the social well-being domain between children with (14.13±12.32) and without dental caries (5.20±5.13), the power of the test of 80%, confidence interval of 95 % and sample loss of 20% (correction factor of 1.226), the minimum amount needed in each group was 22 individuals (BioEstat 5.0, Mamirauá, Belém, PA, Brazil).

Inclusion criteria were children aged six and seven years, collaborative behavior, with at least one primary molar with dentin caries without painful symptoms, mobility and abscess; absence of caries in anterior teeth. Children who needed urgent treatment (pain of dental origin) and/or other dental procedures (e.g., extraction and endodontic treatment) were excluded from the study and were referred for treatment at FOP-UNICAMP dental clinic.

The sample consisted of 62 children of both genders, aged six and seven years old, equally distributed in two groups according to the protocol used: 31 children undergoing four weeks of OHES followed by ART (G_{OHES+ART}) and 31 only to ART (G_{ART}). The stratified random sampling was used to distribute the participants, i.e., each classroom was randomly assigned to each group (G_{OHES+ART} or G_{ART}). Moreover, the children who met the selection criteria for each class were underwent the same procedures to avoid sharing information between groups. Details about the sample distribution are shown in Figure 1.

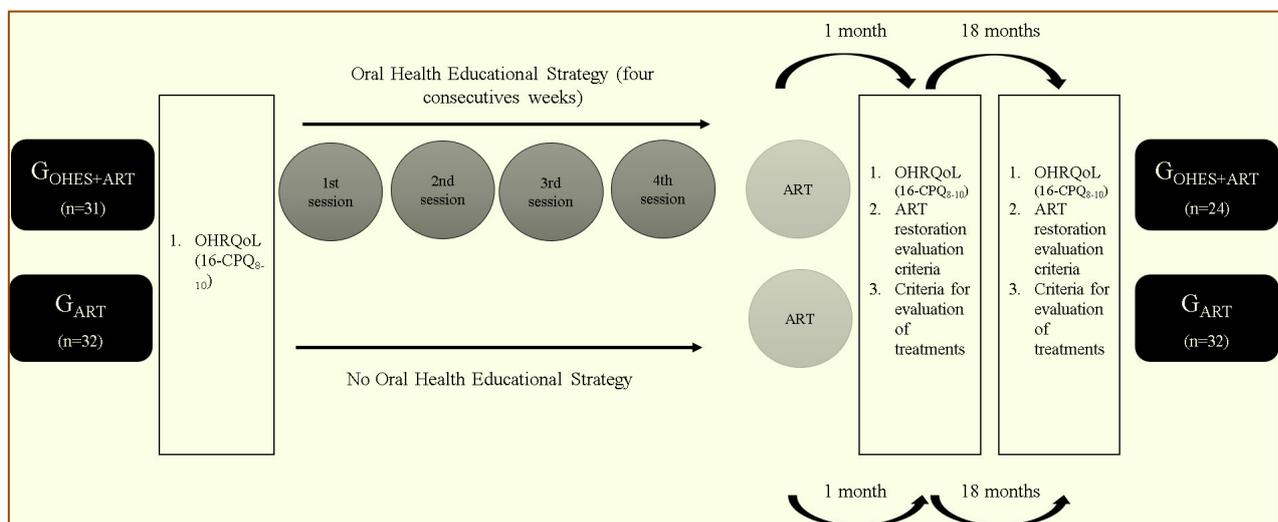


Figure 1. Flowchart of sample selection, allocation in groups, and description of the interventions (OHES: oral health educational strategy; ART: atraumatic restorative treatment).

The children were evaluated by a single examiner previously trained (JRSJ) through oral clinical examination using personal protective equipment (disposable gloves, cap and mask), mirror, WHO probe and gauze to verify the caries experience (number of decayed, lost and restored teeth through DMFT and dmft) [27] and ART restoration assessment [28]. Moreover, the presence of visible biofilm and gingivitis was evaluated on the upper incisors.

Educational Strategy in Oral Health

Students in GOHES+ART underwent four consecutive sessions (once a week, at school, by the same researcher): 1st session (visualization of the structures of the oral cavity: deciduous and permanent teeth, tongue, palate, and others); 2nd session (explanation on the etiological factors of dental caries – diet, microbiota and host – visualization of carious lesions using a mirror); 3rd session (oral hygiene instructions – modified Stillman technique and flossing – using models, supervised brushing); 4th session (explanation about the ART – indications and internships). The sessions were based on active learning methodology, interaction and reinforcement methodology. Subsequently, after these strategies, the GE+ART children were submitted to ART.

Atraumatic Restorative Treatment

ART was performed by a dentist (KGS), a specialist in Pediatric Dentistry, trained according to protocols developed for this approach [29]. Only manual instruments were used for opening and cleaning the primary molar cavities. The cavities were restored with high-viscosity glass ionomer cement (Ketac Molar Easymix®; 3M ESPE, Sumaré, São Paulo, SP, Brazil). ART was accomplished at school using school chairs and tables, which were adapted to simulate a dental chair next to the window with natural light. At this stage, the following exclusion criteria were considered: exfoliated and/or restored tooth after initial selection; inappropriate behavior and/or refusal to participate in the proposed procedures, pulp exposure during excavation (in these cases, the child was submitted to emergency treatment at the school itself and was referred to finish the treatment at the Pediatric Dentistry Clinic of FOP-UNICAMP).

All children were re-evaluated regarding OHRQoL, longevity of restorations and DMFT according to the following specifications:

Oral Health-Related Quality of Life

The Brazilian short-version of the Child Perceptions Questionnaire (16-CPQ₈₋₁₀) was applied, developed from the original 25-item Brazilian version [26,30]. A trained researcher (GFG) applied the questions through an interview with the child in a private room, asking about the frequency of oral diseases/changes impacts in four domains (four items per domain): oral symptoms, functional limitations, emotional well-being and social well-being. Answer options range from 0 (never) to 4 points (every day or almost every day). There were also two questions about the overall perception of oral health and general well-being, with response options ranging from 0 to 3 points for CPQ₈₋₁₀. The higher the score, the greater the impact of the oral condition on child's quality of life.

This information was obtained to calculate the child's perception of change with a 3-point Likert scale (very much improved – score 0, remains the same – score 1, much worse – 2). This criterion is a “gold standard” in the assessment of sensitivity to changes in OHRQoL measures, with the advantage of not being influenced by the individual's mood. Assessment intervals were at 1 month and at 18 months after ART restorations.

ART Restoration Evaluation Criteria

All examinations were performed by a trained researcher (JRSH), at the school, under natural light. The ART restoration evaluation criteria were used [28]: codes 0 or 1 were evaluated as successful, codes 2-7 were considered failures, and those with code nine were excluded from further analysis (Table 1). The location and size of the restorations were recorded according to Holmgren et al. [20]: restorations were classified as "small" if less than half of the surface in the mesiodistal and buccolingual direction was involved. Restorations exceeding these limits in any direction were classified as "large".

Table 1. ART Restoration evaluation criteria.

Code	Criterion
0	Present, satisfactory
1	Present, small cavity margin deficiency (< 0.5 mm)
2	Present, cavity margin deficiency (≥ 0.5mm)
3	Present, restoration fracture
4	Present, tooth fracture
5	Present, overfilled on the proximal margin (≥ 0.5mm)
6	Missing, almost all or the whole restoration was lost
7	Absent, another restorative treatment was performed
8	Absent, tooth is not present
9	Unable to diagnose
C	Carious lesion in dentin present (detected by the active part of the 0.5mm CPI probe)

ART: Atraumatic Restorative Treatment.

Criteria for Evaluation of Treatments

Treatments were classified as "successful" when they presented a satisfactory clinical condition (i.e., where there were no failures). Failures were classified into "minor" and "severe" (adapted from Innes et al. [31]). Minor defects were considered those in which there was a defect in the restoration/crown, but did not interfere with dental health. Serious failures were when there were signs or symptoms of irreversible damage to the dental pulp, such as a fistula, abscess, dental fracture or failures that could not be repaired (Table 2).

Table 2. Criteria for evaluating the treatment.

Outcome	Criterion
Success	Satisfactory restoration or crown, no need to intervene
	No symptoms of pulp pathology
	Exfoliated tooth
Minor Flaws	Secondary caries or new clinically detected caries lesions
	Crown features perforation
	Restoration fracture or need for adjustment
	Loss of restoration or tooth may be restored again
	Lost crown and tooth can be restored normally
Major Flaws	Reversible pulpitis, tooth can be treated without the need for pulpotomy or extraction
	Irreversible pulpitis or fistula or abscess, tooth needs pulpotomy, or extraction
	Lost restoration or crown but tooth is not able to be restored normally

Statistical Analysis

The collected data were analyzed using SPSS software (SPSS Inc., Chicago, IL, USA) and Sigma Stat (3.1 Sigma Stat Software Inc., Richmond, CA, USA) with a significance level of 5%. The asymmetric distribution of data was confirmed by the Shapiro-Wilk test. Comparisons of scores between the characteristics of restorations and CPQ in each group and between groups were performed using the Mann-Whitney test. Comparisons according to the evaluation criteria of restorations for each group and between groups in the same period were also performed using the Mann-Whitney test. Differences in CPQ between groups at different intervals were assessed using Friedman's or Wilcoxon tests, where appropriate.

Results

From the 62 children selected in the first phase of this study, in 2015, there was a loss of 12.9% of students who were no longer enrolled in schools. Thus, the G_{ART} comprised 32 children (♀=50.0%) and the G_{OHEs+ART} by 24 students (♀=58.3%). At baseline, all children of G_{ART} presented a DMFT score of 0, while two

of G_{OHES+ART} had scores of 1 and 3. In relation to dmft, 56.3% of G_{ART} presented scores 1-2, 28.1% score 3-4, and 15.6% score 5 or more. The respective frequency for G_{OHES+ART} were 70.8%, 25% and 20.8%, respectively. More than half of G_{ART} had at least one upper incisor with visible biofilm and/or gingivitis (56.3% and 56.3%), in contrast with 50% and 25% of G_{OHES+ART}, respectively.

At baseline, the 16-CPQ₈₋₁₀ total score was 5.5 (4.6) and ranged from 0.8 (1.3) for social well-being to 2.2 (1.6) for oral symptoms in the G_{ART}. After 18 months, the total score slightly increased to 5.6 (4.9) and ranged from 0.7 (0.9) to 2.4 (2.0) for the same domains. For the other G_{OHES+ART}, at baseline, the 16-CPQ₈₋₁₀ total score was 8.0 (5.2), and ranged from 1.2 (1.6) for social well-being to 3.3 (1.8) for oral symptoms. After 18 months, the total score slightly decreased to 7.5 (7.5) and ranged from 1.2 (1.9) for social well-being to 3.6 (2.4) for oral symptoms. There are no statistical differences in intra-groups between the moments. In the inter-group comparison, at baseline, G_{OHES+ART} reported more oral symptoms than G_{ART} (3.3±1.8 vs. 2.2±1.6; p=0.02, Wilcoxon test). The groups did not differ in 16-CPQ₈₋₁₀ scores after 18 months.

Table 3 shows the mean of the 16-CPQ₈₋₁₀ according to the characteristics of the restorations for each group after 18 months of ART. In the intra-group comparison, children with large-sized restorations (G_{ART}) and restorations located in the upper arch (G_{OHES+ART}) reported greater impact on functional limitations and oral symptoms, respectively. In the inter-group comparison, children from G_{OHES+ART} with 2 to 4 reported more oral symptoms than children with these same characteristics from G_{ART}.

Table 3. Mean (±SD) of the 16-CPQ₈₋₁₀ according to the characteristics of the restorations for each group (after 18 months).

Group	N	16-CPQ ₈₋₁₀				
		Total	OS	FL	EWB	SWB
G_{ART} (N=32, ♀=50.0%)						
Number						
1	21	5.5 (5.3)	2.4 (1.9)	1.4 (2.0)	1.1 (2.1)	0.6 (0.9)
2 to 4	9	4.9 (4.1)	1.8 (2.0)⁺	1.4 (1.7)	1.1 (1.5)	0.6 (0.7)
Type						
Class I	18	4.6 (4.6)	1.9 (1.8)⁺	1.3 (2.1)	1.0 (1.7)	0.4 (0.9)
Class II	12	6.4 (5.3)	2.7 (1.9)	1.6 (1.6)	1.3 (2.2)	0.8 (0.7)
Size						
Small	15	4.4 (4.9)	2.0 (1.9)⁺	0.9 (2.1)[*]	1.1 (1.8)	0.4 (0.9)
Large	15	6.3 (4.8)	2.4 (1.9)	1.9 (1.7)[*]	1.2 (2.0)	0.8 (0.8)
Place						
Upper arch	18	4.6 (4.5)⁺	1.8 (1.8)⁺⁺	1.4 (2.2)	0.9 (1.3)	0.4 (0.7)
Lower arch	12	6.5 (5.4)	2.8 (1.9)	1.3 (1.5)	1.5 (2.5)	0.9 (1.0)
G_{OHES+ART} (N=24, ♀=58.3%)						
Number						
1	16	7.2 (7.8)	3.1 (2.5)	1.4 (2.3)	1.4 (2.2)	1.2 (1.9)
2 to 4	8	7.8 (6.8)	4.4 (2.1)⁺	1.1 (1.7)	1.1 (2.3)	1.1 (2.0)
Type						
Class I	12	9.8 (7.8)	4.4 (2.5)⁺	1.8 (2.4)	1.9 (2.1)	1.7 (2.0)
Class II	12	5.3 (6.7)	2.8 (2.1)	0.9 (1.7)	0.8 (2.3)	0.8 (1.8)
Size						
Small	10	9.1 (7.0)	4.6 (2.5)⁺	1.4 (1.8)	1.9 (2.1)	1.2 (1.8)
Large	14	6.4 (7.8)	2.9 (2.2)	1.3 (2.3)	1.0 (2.3)	1.2 (2.0)
Place						
Upper arch	11	10.5 (8.1)^{*+*}	4.7 (2.0)^{*++}	1.7 (2.2)	2.4 (2.8)	1.6 (2.2)
Lower arch	13	5.0 (6.2)[*]	2.6 (2.4)[*]	1.0 (2.0)	0.5 (1.2)	0.8 (1.6)

CPQ: Child Perceptions Questionnaire; ART: Atraumatic Restorative Treatment; OHES: Educational Strategy in Oral Health; OS: Oral Symptoms; FL: Functional Limitations; EWB: Emotional Well-Being; SWB: Social Well-Being; Bold value means statistically significant difference; *p<0.05 (Mann-Whitney test); intra-group comparison; *p<0.05; ++p<0.001 (Mann-Whitney test); inter-group comparison.

Table 4 shows the mean of 16-CPQ₈₋₁₀ according to the evaluation criteria of restorations for each group after 18 months of ART. In the inter-group comparison, children from G_{OHES+ART} who had failed ART restorations and treatment with lesser failure reported more oral symptoms than children with the same characteristics as G_{ART}. There was no statistically significant difference in the intra-group comparison.

Table 4. Mean (±SD) of 16-CPQ₈₋₁₀ according to the evaluation criteria of restorations for each group (after 18 months).

Group	N	16-CPQ ₈₋₁₀				
		Total	OS	FL	EWB	SWB
G_{ART} (N=32, ♀=50.0%)						
ART						
Well succeeded	6	5.7 (4.0)	2.8 (1.7)	1.2 (1.5)	1.3 (1.8)	0.3 (0.5)
Flawed	13	4.1 (2.8)	1.5 (1.1)*	1.2 (1.5)	1.0 (1.2)	0.3 (0.6)
Excluded	11	6.6 (6.9)	2.6 (2.5)	1.7 (2.6)	1.2 (2.6)	1.1 (1.0)
Treatment						
Success	17	6.3 (5.9)	2.7 (2.2)	1.5 (2.2)	1.2 (2.3)	0.8 (1.0)
Minor Flaw	13	4.1 (2.8)	1.5 (1.1)*	1.2 (1.5)	1.0 (1.2)	0.3 (0.6)
Major Flaw	0	—	—	—	—	—
G_{OHES+ART} (N=24, ♀=58.3%)						
ART						
Well succeeded	2	—	—	—	—	—
Flawed	20	8.3 (7.9)	3.8 (2.6)*	1.6 (2.2)	1.7 (2.3)	1.3 (2.0)
Excluded	2	—	—	—	—	—
Treatment						
Success	3	—	—	—	—	—
Minor Flaw	16	9.7 (8.3)	4.3 (2.5)*	1.9 (2.4)	1.9 (2.5)	1.6 (2.1)
Major Flaw	5	3.2 (1.5)	2.4 (1.9)	0.4 (0.5)	0.4 (0.9)	0.0 (0.0)

CPQ: Child Perceptions Questionnaire; ART: Atraumatic Restorative Treatment; OHES: Educational Strategy in Oral Health; OS: Oral Symptoms; FL: Functional Limitations; EWB: Emotional Well-Being; SWB: Social Well-Being; *p<0.05 (Mann-Whitney test): inter-group comparison.

Table 5 compares the 16-CPQ₈₋₁₀ scores at 18 months with the previous moments for the G_{OHES+ART}. After 18 months of ART, children with 2 to 4 restorations, Class I type, small size and located in the upper arch reported more oral symptoms than 1 month after ART. At baseline, total scores for 16-CPQ₈₋₁₀ and oral symptoms were greater than at 18 months in children with restorations located in the lower arch and large size, respectively. Considering the restoration evaluation criteria, children with failed ART and treatment with minor failure reported more oral symptoms at 18 months than 1 month after ART.

Table 5. Comparison of 16-CPQ₈₋₁₀ scores at 18 months with previous moments (G_{OHES+ART}, N=24). Only significant results are shown.

Restorations Characteristics	Intervals	16-CPQ ₈₋₁₀				
		Total	OS	FL	EWB	SWB
Number						
2 to 4 (N=8)	1 month	-	1.4 (1.4)	-	-	-
	18 months	-	4.4 (2.1)	-	-	-
Type						
Class I (N=12)	1 month	4.1 (3.9)	1.8 (1.3)	-	-	-
	18 months	9.8 (7.8)	4.4 (2.5)	-	-	-
Size						
Small (N=10)	1 month	-	2.0 (1.2)	-	-	-
	18 months	-	4.6 (2.5)	-	-	-
Large (N=14)	Baseline	-	3.4 (1.8)	-	-	-
	18 months	-	2.9 (2.2)	-	-	-

Local						
Upper arch (N=11)	1 month	4.5 (4.2)	2.1 (1.2)	-	-	-
	18 months	10.5 (8.1)	4.7 (2.0)	-	-	-
Lower arch (N=13)	Baseline	9.2 (5.9)	-	-	-	-
	18 months	5.0 (6.2)	-	-	-	-
Rating Restoration Criteria						
ART						
Flaw (N=20)	1 month	-	1.9 (1.1)	-	-	-
	18 months	-	3.8 (2.6)	-	-	-
Treatment						
Minor Flaw (N=16)	1 month	-	1.8 (1.2)	-	-	-
	18 months	-	4.3 (2.5)	-	-	-

CPQ: Child Perceptions Questionnaire; ART: Atraumatic Restorative Treatment; OHES: Educational Strategy in Oral Health; OS: Oral Symptoms; FL: Functional Limitations; EWB: Emotional Well-Being; SWB: Social Well-Being; $p < 0.05$ (Friedman test): comparison between different moments for each criterion.

Discussion

In the comparison of OHRQoL self-perception according to ART characteristics and ART/treatment evaluation criteria, it was observed that children submitted to OHES prior to ART, with 2 to 4 Class I restorations, small and located in the arch higher, reported more oral symptoms than those with the same characteristics in the G_{ART} . This difference was also observed at baseline, with greater impairment on oral symptoms reported by $G_{OHES+ART}$ than G_{ART} . Maybe the experience of dental caries in permanent dentition in the former (DMFT 1-3 = 8.3%), not observed in the latter (DMFT=0), can explain these findings. It was hypothesized that children with greater dental caries experience would have higher impacts on their quality of life, suggesting they are likely to have experienced more oral pain, had difficulties with chewing, and others; showing an indirect effect of clinical signs on daily functioning via reported symptom status [32,33].

The above-mentioned results also suggest that subjective perceptions about OHRQoL may be associated with the environmental context in which children live, being influenced by educational strategies. In addition, the self-perception of OHRQoL is based on social, physical and emotional experiences [33] as a result of cognitive development [28], which entails different experiences in children of the same age group [13,26,32]. Thus, in this study, the OHES may have increased the children's sense of coherence [34], favoring a more accurate perception of their oral problems and symptoms, as observed by Sousa et al. [18].

Oral problems can cause pain, discomfort and functional limitations that affect the child's social life, diet, daily activities and well-being corroborating these studies [9,26,32,33,35,36], both groups reported a greater impact on oral symptoms 18 months after performing ART, in which most restorations were classified as flawed. Furthermore, it was observed that the greater the discomfort, the greater the report of functional limitation, as observed in G_{ART} children with large-sized restorations.

Oral symptoms can be influenced by anatomy due to the difference in bone density between the maxilla and mandible, confirmed in a recent study on optical differences between the mandible and the maxilla in the cervical-apical direction of the dental alveoli, using red light [37]. The maxilla attenuates a greater number of photons in the anterior, middle and posterior regions in relation to the mandible and the intensity of light distribution also differs between the bones, since the mandible is more isotropic compared to the maxilla [38]. Thus, the density of the maxilla being, on the other hand, smaller, the greater exposure of the maxillary nerve may explain the fact that children with an upper restoration reported more oral symptoms than those with an inferior restoration.

Short- and long-term improvements in oral symptoms are reflected on these children's dental condition [9]. The impact of ART on OHRQoL, especially in oral symptoms, was observed in short term after 1 month of

treatment, corroborating cross-sectional studies that show the positive impact of dental treatment [9,13,32]. The management of ART to control caries in elementary school children improves OHRQoL [38].

The longevity of the glass ionomer cement restoration may be compromised by its mechanical characteristics, such as low wear resistance and low flexural resistance [39], which may be one of the failure factors of the restoration and the treatment in this study being related to higher impact on quality of life' report after 18 months of ART compared to the 1st month.

The findings of this study should be considered in the context of its methodological strengths and weaknesses. This study grouped a sample with different characteristics regarding the caries lesions that should be restored, differences in number per child, size, location, and type of cavity, which produced a small amount of sample within each subgroup. During a longitudinal and clinical study, the difficulty of collecting a more exhaustively standardized sample within schools in a short and restricted time is presented.

According to the results found in the study, some clinical implications would be: the perception of quality of life in children depends on the information they receive previously, education in oral health is a fundamental pillar to improve the oral health of pediatric patients in addition to the treatment of the caries lesion itself. In addition, the type of cavity, location, size, and the number of caries lesions are important in the perception of quality of life-related to oral health in children.

Conclusion

Considering the population evaluated, after 18 months, there was higher impairment of OHRQoL, specifically in oral symptoms, in children submitted to OHES followed by ART compared to those submitted directly to ART. In addition, factors such as number, class, size and location of restorations need to be considered for the implementation of an efficient and effective program in oral health, as well as for greater longevity of ART restorations.

Authors' Contributions

JRSH		https://orcid.org/0000-0002-1226-2070	Conceptualization, Methodology and Investigation.
KGS		https://orcid.org/0000-0003-3784-9537	Conceptualization, Data Curation and Writing - Original Draft.
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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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References

- [1] Chaffee BW, Rodrigues PH, Kramer PF, Vítole MR, Feldens CA. Oral health-related quality-of-life scores differ by socioeconomic status and caries experience. *Community Dent Oral Epidemiol* 2017; 45(3):216-24. <https://doi.org/10.1111/cdoe.12279>
- [2] Mijan MC, Leal SC, Bronkhorst EM, Frenckend JE. Children's Oral Health-related Quality of Life (OHRQoL) three years after implementation of treatment protocols for managing cavitated carious dentine lesions. *Oral Health Prev Dent* 2019; 17(1):83-9. <https://doi.org/10.3290/j.ohpd.a41984>
- [3] Rollon-Ugalde V, Coello-Suanzes JA, Lopez-Jimenez AM, Herce-Lopez J, Toledano-Valero P, Montero-Martin J, et al. Oral health-related quality of life after dental treatment in patients with intellectual disability. *Med Oral Patol Oral Cir Bucal* 2020; 25(5):e576-e583. <https://doi.org/10.4317/medoral.23549>
- [4] Antunes LA, Andrade MR, Leão AT, Maia LC, Luiz RR. Systematic review: change in the quality of life of children and adolescents younger than 14 years old after oral health interventions: a systematic review. *Pediatr Dent* 2013; 35(1):37-42.
- [5] Kragt L, Dharmo B, Wolvius EB, Ongkosuwito EM. The impact of malocclusions on oral health-related quality of life in children - a systematic review and meta-analysis. *Clin Oral Investig* 2016; 20(8):1881-94. <https://doi.org/10.1007/s00784-015-1681-3>
- [6] Mashoto KO, Astrøm AN, Skeie MS, Masalu JR. Changes in the quality of life of Tanzanian school children after treatment interventions using the Child-OIDP. *Eur J Oral Sci* 2010; 118(6):626-34. <https://doi.org/10.1111/j.1600-0722.2010.00776.x>
- [7] Paula JS, Tôrres LH, Ambrosano GM, Mialhe FL. Association between oral health-related quality of life and atraumatic restorative treatment in school children: an exploratory study. *Indian J Dent Res* 2012; 23(6):738-41. <https://doi.org/10.4103/0970-9290.111249>
- [8] Leal SC, Bronkhorst EM, Fan M, Frencken JE. Untreated cavitated dentine lesions: impact on children's quality of life. *Caries Res* 2012; 46(2):102-6. <https://doi.org/10.1159/000336387>
- [9] Leal SC, Bronkhorst EM, Fan M, Frencken JE. Effect of different protocols for treating cavities in primary molars on the quality of life of children in Brazil - 1 year follow-up. *Int Dent J* 2013; 63(6):329-35. <https://doi.org/10.1111/idj.12054>
- [10] Gaynor WN, Thomson WN. Changes in young children's OHRQoL after dental treatment under general anaesthesia. *Int J Paediatr Dent* 2012; 22(4):258-64. <https://doi.org/10.1111/j.1365-263X.2011.01190.x>
- [11] Calache H, Hopcraft MS, Martin JM. Minimum intervention dentistry--a new horizon in public oral health care. *Aust Dent J* 2013; 58:17-25. <https://doi.org/10.1111/adj.12046>
- [12] Estupiñán-Day S, Tellez M, Kaur S, Milner T, Solari A. Managing dental caries with atraumatic restorative treatment in children: successful experience in three Latin American countries. *Rev Panam Salud Publica* 2013; 33(4):237-43. <https://doi.org/10.1590/s1020-49892013000400001>
- [13] Arrow P, Klobas E. Minimum intervention dentistry approach to managing early childhood caries: a randomized control trial. *Community Dent Oral Epidemiol* 2015; 43(6):511-20. <https://doi.org/10.1111/cdoe.12176>
- [14] Dorri M, Martinez-Zapata MJ, Walsh T, Marinho VC, Sheiham A, Zaror C. Atraumatic restorative treatment versus conventional restorative treatment for managing dental caries. *Cochrane Database Syst Rev* 2017; 12(12):CD008072. <https://doi.org/10.1002/14651858.CD008072.pub2>
- [15] Abanto J, Paiva SM, Sheiham A, Tsakos G, Mendes FM, Cordeschi T, et al. Changes in preschool children's OHRQoL after treatment of dental caries: responsiveness of the B-ECOHIS. *Int J Paediatr Dent* 2016; 26(4):259-65. <https://doi.org/10.1111/ipd.12192>
- [16] Paula JS, Sarracini KL, Ambrosano GM, Pereira AC, Meneghim MC, Mialhe FL. Impact of a dental care program on the quality of life of children with and without caries. *Braz Oral Res* 2016; 30(1):e139. <https://doi.org/10.1590/1807-3107BOR-2016.vol30.0139>
- [17] Jiang M, Chun M, Wong M, Chu CH, Dai L, Man EC. Effects of restoring SDF-treated and untreated dentine caries lesions on parental satisfaction and oral health related quality of life of preschool children. *J Dent* 2019; 88:103171. <https://doi.org/10.1016/j.jdent.2019.07.009>
- [18] Sousa KG, Gavião MBD, Castelo PM, Huamani JRS, Freitas CN, Mialhe FL, et al. Effect of educational strategy combined with ART on oral health-related quality of life: a controlled clinical trial. *Braz Oral Res* 2021; 35:e136. <https://doi.org/10.1590/1807-3107bor-2021.vol35.0136>
- [19] Zanata RL, Fagundes TC, Freitas MC, Lauris JR, Navarro MF. Ten-year survival of ART restorations in permanent posterior teeth. *Clin Oral Investig* 2011; 15(2):265-71. <https://doi.org/10.1007/s00784-009-0378-x>
- [20] Holmgren CJ, Lo ECM, Hu DY, Wan HC. ART restorations and sealants placed in Chinese school children: results after three years. *Community Dent Oral Epidemiol* 2000; 28(4):314-20. <https://doi.org/10.1034/j.1600-0528.2000.280410.x>
- [21] Plutzer K, Spencer AJ. Efficacy of an oral health promotion intervention in the prevention of early childhood caries. *Community Dent Oral Epidemiol* 2008; 36(4):335-46. <https://doi.org/10.1111/j.1600-0528.2007.00414.x>

- [22] Alsumait A, ElSalhy M, Amin M. Long-term effects of school-based oral health program on oral health knowledge and practices and oral health-related quality of life. *Med Princ Pract* 2015; 24(4):362-8. <https://doi.org/10.1159/000430096>
- [23] Salas Huamani JR, Barbosa TS, de Freitas CN, Sousa KG, Gavião MBD, Leal SC, et al. Assessment of anxiety and stress markers in children submitted to educational strategies and ART-restoration: a randomized clinical trial. *Arch Oral Biol* 2019; 97:191-7. <https://doi.org/10.1016/j.archoralbio.2018.10.032>
- [24] Programa das Nações Unidas para o Desenvolvimento. Índice de Desenvolvimento Humano Municipal Brasileiro. 2013. – Brasília: PNUD, IPEA, FJP, 2013. 96 p. Available from: <https://www.br.undp.org/> [Accessed on December 18, 2021]. [In Portuguese].
- [25] Chan AW, Tetzlaff JM, Gøtzsche PC, Altman DG, Mann H, Berlin JA, et al. SPIRIT 2013 explanation and elaboration: guidance for protocols of clinical trials. *BMJ* 2013; 346:e7586. <https://doi.org/10.1136/bmj.e7586>
- [26] Barbosa TS, Tureli MC, Gavião MB. Validity and reliability of the Child Perceptions Questionnaires applied in Brazilian children. *BMC Oral Health* 2009; 9:13. <https://doi.org/10.1186/1472-6831-9-13>
- [27] World Health Organization. Oral Health Surveys: Basic Methods. Geneva: World Health Organization; 1997.
- [28] Taifour D, Frencken JE, Beiruti N, van't Hof MA, Truin GJ, Van Palenstein-Heldermann W. Comparison between restorations in the permanent dentition produced by hand and rotary instrumentation - survival after 3 years. *Community Dent Oral Epidemiol* 2003; 31(2):122-8. <https://doi.org/10.1034/j.1600-0528.2003.00027.x>
- [29] Frencken JE, Holmgren CJ. Caries management through the Atraumatic Restorative Treatment (ART) approach and glass-ionomers: update 2013. *Braz Oral Res* 2014; 28:5-8. <https://doi.org/10.1590/S1806-83242013000600001>
- [30] Barbosa TS, Vicentin MD, Gavião MB. Quality of life and oral health in children - Part I: Brazilian version of the Child Perceptions Questionnaire 8-10. *Cien Saude Colet* 2011; 16(10):4077-85. <https://doi.org/10.1590/s1413-81232011001100013> [In Portuguese].
- [31] Innes NP, Evans DJ, Stirrups DR. The Hall Technique; a randomized controlled clinical trial of a novel method of managing carious primary molars in general dental practice: acceptability of the technique and outcomes at 23 months. *BMC Oral Health* 2007; 7:18. <https://doi.org/10.1186/1472-6831-7-18>
- [32] Barbosa TS, Gavião MB. Oral health-related quality of life in children: part II. Effects of clinical oral health status. A systematic review. *Int J Dent Hyg* 2008; 6(2):100-7. <https://doi.org/10.1111/j.1601-5037.2008.00293.x>
- [33] Genderson MW, Sischo L, Markowitz K, Fine D, Broder HL. An overview of children's oral health-related quality of life assessment: from scale development to measuring outcomes. *Caries Res* 2013; 47:13-21. <https://doi.org/10.1159/000351693>
- [34] Nammontri O, Robinson PG, Baker SR. Enhancing oral health via sense of coherence: a cluster-randomized trial. *J Dent Res* 2013; 92(1):26-31. <https://doi.org/10.1177/0022034512459757>
- [35] BaniHani A, Deery C, Toumba J, Munyombwe T, Duggal M. The impact of dental caries and its treatment by conventional or biological approaches on the oral health-related quality of life of children and carers. *Int J Paediatr Dent* 2018; 28(2):266-76. <https://doi.org/10.1111/ipd.12350>
- [36] Fernandes IB, Pereira TS, Souza DS, Ramos-Jorge J, Marques LS, Ramos-Jorge ML. Severity of dental caries and quality of life for toddlers and their families. *Pediatr Dent* 2017; 39(2):118-23.
- [37] Guiselini MJ, Deana AM, da Silva DFT, Koshiji NH, Mesquita-Ferrari RA, do Vale KL, et al. Pilot study on laser propagation in maxillary and mandibular bone: Grey level image analysis for optical measurements. *Photodiagnosis Photodyn Ther* 2017; 18:226-31. <https://doi.org/10.1016/j.pdpdt.2017.03.013>
- [38] Arrow P, Forrest H. Atraumatic restorative treatments improve child oral health-related quality of life: a noninferiority randomized controlled trial. *Community Dent Oral Epidemiol* 2020; 48(4):349-56. <https://doi.org/10.1111/cdoe.12539>
- [39] Bonifácio CC, Werner A, Kleverlann CJ. Coating glass-ionomer cements with a nanofilled resin. *Acta Odontol Scand* 2012; 70(6):471-7. <https://doi.org/10.3109/00016357.2011.639307>