







Reproducibility of SOHO-5 applied to 5-year-old students from public schools in a region from Paraíba sertão area

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Aim: This paper aimed to evaluate the reproducibility of the Scale Oral Health Outcomes for Five-Year-Old Children (SOHO-5) applied to public school students in a *sertão* area in the Paraíba. **Methods:** The study population consisted of the census of all children in the city with a 5-year-old child (59 students) who underwent a clinical examination based on World Health Organization criteria for dental care (dmft) and application of an oral health-related questionnaire quality of life (SOHO-5). This process was repeated 30 and 60 days after the initial test under the same application conditions for two calibrated examiners. To assess the reproducibility of the SOHO-5 instrument, the concordance correlation coefficient (ρ_c) was used and a Bland-Altman concordance analysis was performed to assess the variability (limit of concordance) existing between the time points of questionnaire administrations. **Results:** For the study scenario, there was no agreement between students' answers regarding their quality of life, as indicated by low values of the concordance coefficient. Furthermore, the 95% confidence intervals of these measures show that these values are not significant because the intervals in the $t_0 \times t_2$ (-0.11) and $t_1 \times t_2$ (-0.04) scenarios have "zero", while the lower bound for the $t_0 \times t_1$ scenario is 0.29. **Conclusions:** Therefore, there was no agreement between the standard response of 5-year-old children at three points in time when the questionnaire was administered.

Keywords: Dentistry. Oral health. Quality of life. Reproducibility of results.



Introduction

Dental caries is the disease resulting from an ecological shift within the dental biofilm, from a balanced population of microorganisms to an acid-forming, acidic and cariogenic microbial population, developed and maintained by the frequent consumption of fermentable carbohydrates from the diet¹⁻³.

And this cause a negative impact on the children oral health-related quality of life (OHRQoL)⁴ because untreated caries can cause limitation in the people daily for taking pains, and dental lost which contribute to the generation of biopsychosocial changes that may affect the quality of life of individuals because it affects weight gain, growth, and quality of life, as well as the cognitive development of preschool children^{5,6}.

The evaluation of OHRQoL in children reflects the self-perception about their oral health and thus can get excellent communication among patients, parents, and dental team⁷. The use of questionnaires in epidemiological studies has permitted a broader knowledge about adverse oral conditions that affect the quality of life. Thus, they can be valuable allies for the development of public health policies and strategies of prevention and treatment. However, most of the information on the impact of oral health on the quality of life of children younger the 8-year-old is based on parental reports⁸.

The Scale of Oral Health Outcomes for 5-year-old Children (SOHO-5), developed at United Kingdom for Tsakos et al.⁸ has demonstrated concrete evidence which children also can relate valid information and reliable of their own OHRQoL^{8,9}. Initially, this instrument had been validated only in English language, being adapted, tested and validated in Brazil to be applied to 5 and 6 years children by Abanto et al.⁹

Reproducibility tests are essential to ensure the consistency and reliability of quality of life questionnaires related to oral health. These tests ensure that results remain stable and reproducible over time or when performed by different reviewers, without significant variation. This is crucial for questionnaire validation as it allows for reliable comparison and use of the data in longitudinal studies and across different populations. Without these tests, data interpretation may be compromised, directly affecting the quality and applicability of the results¹⁰.

Therefore, this research proposed to evaluated the reproducibility of SOHO-5 applied to 5-year-old students from a public school in a small municipality with a relatively low Human Development Index (HDI), since most of the validated and applied OHRQoL questionnaires in Brazil, such as SOHO-5 were evaluated in southeast region, in a completely different social and cultural context than northeast region.

Methods

This study was approved in the Research Ethics Committee Involving Human Beings of the Health Sciences Center of the Federal University of Paraíba according to the guidelines and regulations for research involving human subjects and in compliance with resolution 466/2012 of the National Health Council of Health Ministry, Brasília-DF¹¹, CAEE: 33087414.9.0000.5188.

This is a short-term cohort study based on the collection instruments used in the project: Effectiveness of oral health promotion actions in high-risk social populations - prospective interventional cohort study for 5-year-old children¹¹.

It was selected for convenience for this research the Santa Cruz city, located in *sertão* area of Paraíba, in the Sousa microregion, which population is composed of 5,947 inhabitants and the Basic Education Development Index (BEDI) of 5.3. The local economy is predominantly agricultural, with an emphasis on subsistence farming and cattle raising. The urbanization rate is low, and the HDI is below the national average¹².

The Sample Plan included the census of all students enrolled in the municipal network of this municipality aged five years, totaling sixty-six children. During the interval between the three clinical evaluations and the application of the questionnaires, five children were lost. At the end of the collection, fifty-nine children were counted. Initially, sociodemographic and behavioral profiles were drawn. Besides, some aspects of the reproducibility of the instrument to evaluate oral health-related quality of life – SOHO-5 are presented.

Initially, at baseline (t_0), it was done clinical exams about oral health conditions of the participants, followed by the application of socioeconomic questionnaire and OHRQoL validated in Brazil for Abanto et al.⁹. After the period of thirty days (t_1), these same participants were re-examined and subjected to a new application of the questionnaires. After another thirty days (t_2), the process was repeated. Between t_1 and t_2 , restorative treatment of carious lesions was performed.

The self-relate SOHO-5 version is structurally composed for seven questions, being that the explication of the responses may be facilitated by the use of a card with the design of 03 faces, but its use is only recommended if the child does not understand the questions asked by the interviewer.

The response of each item is given by 3-point Likert-scale: no=0; a little=1; a lot=2. The total score is calculated from some of the points of the response options. Thereby, the total score of the child self-report version can vary from 0 to 14, being higher scores indicating the worst quality of life.

All exams were done on the same day in which the questionnaire was applied. After 30 days, it was repeated the clinical exam and application of the OHRQoL for the same participants for two calibrated researches (Interexaminer concordance of 0.97 and Kappa coefficient of 0.82 with confidence index (CI) of 95%, I.L.=0.75 and S.L.=0.90) in school environment, with natural illumination, carried out in school desks and repetition of the same application conditions at both times of collection.

For the clinical exam, the criteria established by WHO for the registration of dental caries affected by decayed, missing, filled (caries index – dmft – and treatment necessity)¹³.

A descriptive analysis of the data was performed to trace the sociodemographic and behavioral profiles and the distribution of 5-year-old students according to their caries experience.

To evaluate the reproducibility of the SOHO-5 instrument, some strategies already used in the specialized literature were used. Initially, the concordance correlation coefficient (ρ_c) proposed by Lin¹⁴ was considered. This coefficient aims to detect any deviation from the line of agreement (line 45°). Values of ρ_c near to the unity are indicative of concordance. Additionally, a Bland and Altman concordance analysis was done to evaluate the variability existent between the moments of questionnaire applications (concordance limit)¹⁵.

Thereby the students were evaluated about their oral health-related quality of life in three distinct moments (t_0 , t_1 e t_2); the Lin concordance coefficient was estimated for scenario t_0 versus t_1 , t_0 versus t_2 and t_1 versus t_2 with respective confidence intervals of 95%.

Since the dental caries intervention was performed between intervals t_1 and t_2 , hypothesis testing will be conducted to compare the quality of life of individuals. It was a Wilcoxon paired-sample comparison test because the normality hypothesis of quality of life was rejected by the Shapiro-Wilks normality test ($p < 0.05$) and the U-Mann-Whitney test to assess the difference between quality of life score, which is taken into account for interventions.

Results

Data considered for analyses consist of a sample of fifty-nine five-year-old children from a public school in the city of Santa Cruz, Paraíba.

In Table 1 are summarized the socio-demographic profile of children considered in this study. For the sample of 59 children, 57.6% are male. Regarding family composition, only 11.9% of the cases are a single mother. As for education, only 1.7% is illiterate. Concerning the variables number of siblings and a total number of people at home, more than half of the individuals analyzed have up to two siblings and more than four people.

Table 2 presents the results of the behavioral profile of analyzed individuals. In this context, 91.5% of students have their toothbrush, and 93.2% make use of fluoride toothpaste. About the frequency of brushing, only 28.8% perform three daily brushes, and only 3.4% brush their teeth more than three times. The results of caries experience between t_0 and t_1 are shown in Table 3. The caries prevalence estimated in the sample evaluated was 39%. Besides, 98.3% of the children had filed teeth with no caries, and 5.1% showed one filled tooth. Concerning the indication of extraction, there is at least one indication in approximately 12% of the students.

Moreover, only 3.4% of the students have two teeth extracted. Figure 1 shows the distribution of frequencies of the number of caries lesions. Most of the individuals did not have any caries lesion and were verified students with more than four lesions. After t_1 , the 15 caries teeth were filled (65.21%).

Table 1. Sociodemographic profile of student of 5-year-old, Santa Cruz – PB.

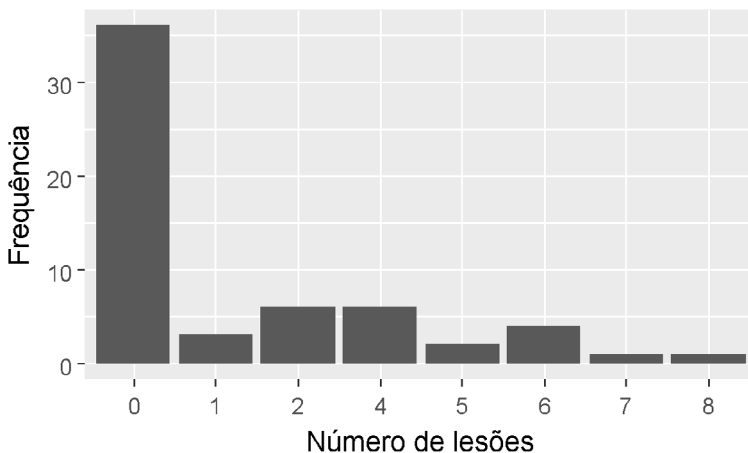
Variable	N	%
Gender		
Male	34	57,6
Female	25	42,4
Familiar composition		
Mother and father	52	88,1
Single mother	7	11,9
Number of siblings		
None	7	11,9
One sibling	25	42,4
Two siblings	22	37,3
Three siblings	3	5,1
More than three siblings	2	3,3
Education		
Illiterate	1	1,7
Incomplete elementary school	58	98,3
Number of people at home		
Two people	1	1,7
Three people	10	16,9
Four people	23	39
Five people	19	32,2
More than five people	6	10,2

Table 2. Behavioral profile of 5-year-old students. Santa Cruz – PB.

Variable	N	%
Own toothbrush		
Yes	54	91,5
No	5	8,5
Fluorite dental tooth		
Yes	55	93,2
No	4	6,8
Brushing frequency		
Once	36	61
Twice	4	6,8
Three times	17	28,8
More than three times	2	3,4

Table 3. Distribution of 5-year-old students according to caries experience. Santa Cruz – PB.

Variable	N	%
Decayed		
Yes	23	39
No	36	61
Filled and decayed		
Filled with no decayed	58	98,3
Three filled teeth and decayed	1	1,7
Filled		
No filled	56	94,9
One filled	3	5,1
Indication to extraction		
No indication	52	88,1
One indication	5	8,5
Two indications	2	3,4
Missing		
None	57	96,6
Two missing	2	3,4

**Figure 1.** Distribution of the number of carious lesions of 5-year-old students. Santa Cruz - PB.

The results are summarized in Table 4. For the investigate scenarios, there is no concordance between students' answers about their own quality of life, which can be observed for the low values of concordance coefficients. In addition, the 95% confidence intervals of these measures show that these values are not significant since the intervals contain zero for the scenarios $t_0 \times t_2$ e $t_1 \times t_2$, while the inferior limit for the scenario $t_0 \times t_1$ is near to zero. Moreover, the correlation measures and Cb give accuracy evidence and precision regarding the answers. Thus, the closer to the unit,

the more accurate the answers. For the SOHO-5, verified that there is low accuracy for the time scenarios considerate because the values of these analyses are far from one. Besides, comparison was done between baseline (t_0) and t_1 showed "better" results when compared to other scenarios.

Complementarily, and given the quantitative nature of the SOHO-5 score, Bland and Altman's¹⁵ agreement graphs were constructed. Similar to the agreement measure, graphs were constructed for the pairs of measures referring to the scenarios t_0 versus t_1 , t_0 versus t_2 and t_1 versus t_2 . Under the concordance hypothesis, points should be randomly distributed around zero within the 95% concordance limits. However, graphics to describe scenarios showed a nonrandom standard. In general, there is a clear relationship between the difference and the average of the measures, whereas the average of the measures increases, they tend to be less concordant. In all cases, there are a pair of observations out of the concordance limits intervals. Besides, the concordance limits of the graphics quite extensive, suggesting essential differences between measurements at different time points, suggesting an essential difference between different instants of time measure.

Table 4. SOHO-5 reproducibility measures. Santa Cruz-PB.

Measure	t_0-t_1	t_0-t_2	t_1-t_2
$\hat{\rho}_c$	0,29	-0,11	-0,04
IC de 95%	(0,08; 0,47)	(-0,22; 0,02)	(-0,21; 0,14)
$\hat{\sigma}$	1,42	3,27	2,31
\hat{u}	0,53	0,83	0,4
C_b	0,83	0,47	0,69
r	0,34	-0,23	-0,06

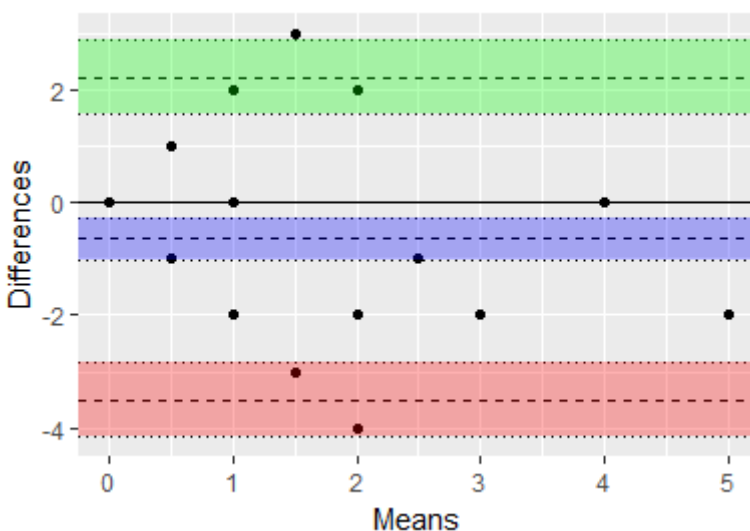


Figure 2. Bland-Altman plot for SOHO-5 of 5-year-old students between t_0 and t_1 intervals.

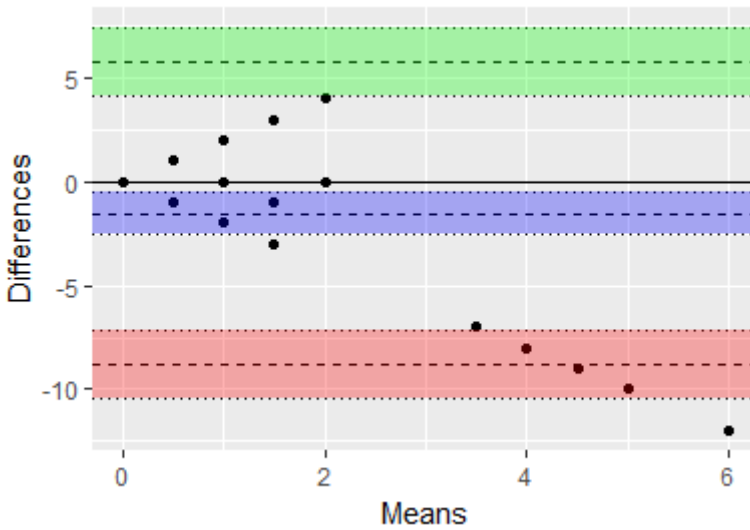


Figure 3. Bland-Altman plot for SOHO-5 of 5-year-old students between t_0 and t_2 intervals.

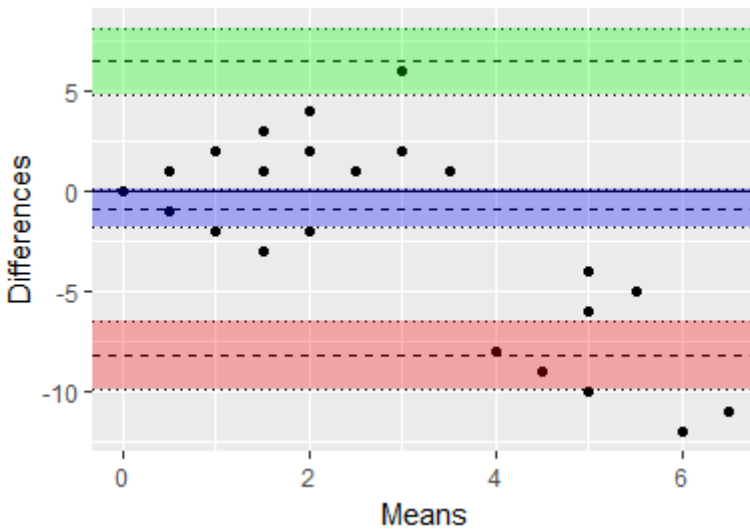


Figure 4. Bland-Altman plot for SOHO-5 of 5-year-old students between t_1 and t_2 intervals.

In Table 5 are presented some summary measures of SOHO-5 of students in of three instants of considered evaluation. Over the evaluation period, there was an increase in oral health-related quality of life, with a baseline estimate of 0.48 ± 1 , while in the last evaluation the average value was 2 ± 3.4 . In addition, it is possible to observe a reduction in variability relative to the mean value at time t_3 when compared to the baseline.

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Table 5. Descriptive measures for SOHO-5. Santa Cruz – PB.

Statistic	Period		
	t_0	t_1	t_2
Mean	0,48	1,12	2
Median	0	0	0
Minimum	0	0	0
Maximum	4	6	12
standard deviation	1	1,5	3,4

When evaluating interventions between time points t_1 and t_2 , hypothesis tests were performed to compare the quality of life of individuals at these time points, the result of Wilcoxon test indicated that there were no pieces of evidence to reject the hypothesis of equality of median score at these time instants, considering a significant level of 5% ($p=0.3395$). Also, it was evaluated if there were significant differences in quality of life score when compared to two types of interventions done (Topical fluoride application - mean: 1.96, standard deviation: 3.45, median: 0; Association of topical fluoride application and atraumatic restorative treatment - average: 2.18, standard deviation: 3.03, median: 1). In this case, it was done U-Mann-Whitney nonparametric test. The test result shows that was no difference in the quality of life median score when compared to these procedures at the 5% significance level ($p=0.3831$).

Discussion

Although all the sample of 5-year-old children regularly enrolled in the public-school system of the evaluated municipality was considered, the number is still well below the samples observed in previous studies that applied the same instrument. Ferreira et al.¹⁶ evaluated the total of 312 students, Fernandes et al.¹⁷ 121 5-year-olds, these two studies performed only one application of the questionnaires to respondents. At the same time, the paper of reproducibility and validation of instruments, such as Benedetti et al.¹⁸ and Sousa et al.¹⁹ used a sample size of 29 and 33 participants, respectively.

In relation to socioeconomic conditions described in Table 1, the prevalence of male gender was observed (57.6%), similar to verified by Abanto et al.²⁰ (52.3% 5-year-old boys) and oppose found by Abanto et al.²¹ with 49%, Ferreira et al.¹⁶ with 51.3% and Lawrence et al.²² with 49% of female participants. Concerning the family nucleus, most students (88.1) live with both parents and have only one sibling (42.4%) and live in residence with a total of 4 people (39.0% for five years). The city presents socio-demographic indicators typical of rural municipalities in the semi-arid northeastern

region of Brazil¹², with challenges related to access to basic services such as health-care and education, as well as infrastructure limitations.

Regarding the behavioral conditions evaluated (Table 2), the use of own toothbrush was 91.5% at five years, with a brushing percentage of 61% for the frequency 0 to 1 time for children of 5 years. This behavior can relate to parents have a worse perception of their child's oral health tend to brush less frequently. Additionally, younger children and those who have not visited a dentist also brush less frequently²³ and motor development on toothbrushing effectiveness has been observed in children aged ≥ 6 years old²⁴.

About caries experience (Table 1 and Figure 1), most part, 61% of students with 5 years did not show any caries lesion, result similar to found by Abanto et al.²¹, which the majority, 35.2% of 5-year-olds, had no caries experience, however, in the same age group and another study, Abanto et al.²⁰ found that 62.8% had caries experience. The Figure 1 also shows that a few individuals had the majority of lesions and that more than half did not require any intervention. Although 65.21% of the caries lesion are filled between t_1 and t_2 , the children were referred for continued dental care within the municipal public health service.

The dmft medium found in this study for the 5-year age group was 1.63, lower than the national average presented in epidemiological surveys, the the National Oral Health Survey (SB Brasil) 2010²⁵, which obtained a dmft of 2.43 at 5 years and specifically in the northeast region, the value was 2.89, and SB Brasil 2003²⁶, which verified a national dmft medium of 2.8 at 5 years and in the northeast region, the value of 3.21. This reduction is probably due to Brazil's public oral health policy, "Brasil Sorridente" and according to the preliminary data of SB Brasil 2023²⁷, 53.17% of children up to 5 years old did not have dental caries, but this last result shows more expressive in south and southeast regions.

This contrast between the national and Northeastern average with this study may be related to the improvement of access to public oral health services in recent years through programs implemented by the Ministry of Health, such as the HPS - Health Program at School that comes being worked in the last years in that municipality.

The maximum possible score for the SOHO is 14 points; according to Table 5, the median of the answers in the sample examined was low. However, an increase in the index was observed across the three intervals.

The reproducibility was tested by the concordance coefficient proposed by Lin¹⁴ for variability verification between three moments, each point in Likert-scale. Using Lin's coefficient, it was possible to numerically and graphically determine the agreement between the three scenarios and the reliability of a method, separately, by comparing repeated measures, but the values presented showed a low agreement (Table 4). This fact was ratified when the Bland and Altman¹⁵ method was applied, thus detecting deficiencies in the reproducibility of the measurements in the three intervals of the collection instrument.

The lack of agreement among participants' responses regarding quality of life at different time points indicates significant variability in children's perceptions of this

aspect. This result suggests that questionnaires administered to 5-year-old children may have limitations in terms of reproducibility and response stability, possibly due to the rapid cognitive development and constant shifts in perception characteristic of this age group. Low concordance also suggests that quality of life assessment tools need more rigorous methodological adaptation for this age to ensure greater accuracy and validity.

The presence of “zero” within the confidence intervals for the $t_0 \times t_2$ and $t_1 \times t_2$ scenarios supports the notion that concordance results are not statistically significant, highlighting response fragility and the potential influence of external variables such as school and home environments.

Oral health-related quality of life (OHRQoL) questionnaires can show significant improvement after dental caries interventions, but the quality of evidence is very low²⁸. This concordance limitation may be related to the attempt to rescue the memory effect between the application intervals of the questionnaires.

During the data collection period, some students reported, for example, not remembering the previous answers. Alternatively, in the second and third applications, the participants were more familiar with the questionnaires, or if new experiences occurred in this interval, a fact that may justify the alteration of the measures presented in Table 5. Standard quality of life instruments may not fully capture the dimensions of quality of life relevant to impoverished populations, such as survival, social status, community relations and family life, that are crucial but often missing from traditional QoL measures²⁹.

Although instrument validation studies indicate test-retest for a maximum of 14 days^{30,31}, this time is not yet a consensus. Many reproducibility and validity studies of questionnaires use different time intervals, Benedetti et al.¹⁸ used a 21-day interval between the test-retest, Sousa et al.¹⁹ used a 15-day interval, Lopes et al.³² and Santos et al.³³ advocated an interval of 30 days, the same period used in the present study.

As questionnaires as SOHO-5 work with self-perception of their participants about their entire life, thus, under the same conditions of applications and at the same public in an interval of one and two months, the instrument should obtain the same information.

However, the perception of the quality of life varies among individuals and the dynamic for each person³⁴. According to Fayers and Machin³⁵, quality of life instruments can be generic or specific. The generic ones evaluate the quality of life aspects and health state and can be used for patients regardless of the disease or condition, but also in healthy people, since they allow comparing the quality of life of people with the same disease, different diseases, or the general population. Nonetheless, they can fail in the sensibility to detect single and specific aspects of quality of life about the determinate disease. The specific ones can detect private of quality of life indeterminate disease and in relation to treatment effects, which can give some relevant information for patient management, but may present difficulty in the instrument's psychometric validation process due to the small number of items, as well as the ability to compare quality of life in different clinical conditions³⁶.

Abanto et al.⁹ consider dental caries as the oral condition that is most associated with the impact on preschoolers' quality of life. Hence, the fact that dental interventions occurred between the application interval of the questionnaires (t_1 and t_2) that could compromise the test performance in opposite directions, depending on the presence/resolution of dental caries, showed significant differences in the quality of life score.

Besides, the respondent burden and limited attention span are key issues when considering the quality of life questionnaires at this age⁶.

Therefore, although previous papers Abanto et al.⁹; Abanto et al.²⁰; Abanto et al.²¹ showed that SOHO-5 as a suitable instrument for OHRQoL measurement. However, the results of some studies on the impacts of the correlation between oral problems and quality of life are still quite controversial^{36,37}. The variability of methodologies employed in other studies, including the quality of life questionnaires, as well as the age groups studied and the application of the questionnaire intervals, limit direct comparisons with this research. Also, both the nature of the impact and the magnitude may vary according to the different cultural backgrounds that exist between countries and even within countries^{38,39}.

Therefore, although the absence of the other works reproduces the same conditions for the application of the questionnaire and performing a dental procedure before a new application, the importance of this study lies in highlighting the need for methodological revisions in research on children's quality of life. Therefore, studies have significant implications for evaluating public health and welfare interventions for this population.

Thus, it is necessary to develop more studies aiming at adapting the OHRQoL measurement instruments to the reality of the place where it is intended to be evaluated to better explore the individual perception of the impacts of oral problems on quality of life, extrapolating the results for more effective public health policies.

In conclusion, this study observed that despite having followed a whole instrument validation protocol (face, content and construct validation), both questionnaires, when applied in the test-retests to the same participants and under the same application conditions, showed alteration of the response standard.

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Conflict of interest

No potential conflict of interest relevant to this article was reported

Data availability

Datasets related to this article will be available upon request to the corresponding author.

Author Contribution

Marcos Alexandre Casimiro de Oliveira: Conceptualization, Application of the tests, Project administration, Writing - original draft, Writing - review & editing. **Ariana Vieira:** Application of the tests. **Raulison Vieira de Sousa:** Writing - review & editing. **Marijara Vieira de Sousa Oliveira:** Data curation, Formal analysis. **Alisson de Oliveira Silva:** Data curation, Formal analysis. **Fábio Correia Sampaio:** Methodology. All authors revised and approved the final version of the manuscript.

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