






# Can oral health have an impact on academic performance and school absenteeism? A systematic review and meta-analysis

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**Aim:** The study aimed to evaluate the association between oral health and academic performance and/or school absenteeism.

**Methods:** Electronic searches were performed of the PubMed, Web of Science, SCOPUS and LILACS/BVS databases. We included observational studies that evaluated the association between dental caries, tooth loss, dental pain or oral health status with school absenteeism or academic performance. The studies had to contain a representative sample of the population: schoolchildren, children or adolescents. After the removal of duplicates, the electronic searches produced 3,789 articles. Of these, 25 studies were included in the systematic review and 13 in the meta-analysis. **Results:** Considering all the studies evaluated in the meta-analysis, seven articles satisfied 100% of the Joanna Briggs Institute Critical Appraisal checklist, and six contained between 90% and 75% positive answers. The pooled effects showed that the chances of school absenteeism were 31% higher in subjects with dental caries (OR 1.31; 95%CI 1.12-1.54). Students with fair/poor dental health had a 50% higher chance of suffering poor academic performance (OR 1.50; 95%CI 1.22-1.84) and 34% higher chance of having problems at school (OR 1.34; 95%CI 1.06-1.70). Students with a history of toothache had a 3.7 higher chance of being absent from school (OR 6.65; 95%CI 1.60-8.32) and 71% higher chance of missing class due to toothache (OR 1.71; 95%CI 1.15-2.56). Subjects with a history of toothache had a 2.5 times higher chance of suffering poor academic performance (OR 2.58; 95% CI 2.04-3.27). **Conclusion:** Therefore, students with oral problems were more likely to take time off school and present inferior academic performance.

**Keywords:** Oral health. Academic performance. Absenteeism.

## Introduction

Oral health diseases are extremely prevalent in the worldwide population and are considered a public health issue<sup>1</sup>. Dental caries is the main oral condition affecting schoolchildren<sup>2,3</sup> and is the main reason for dental restoration failure<sup>4</sup>, tooth loss and the need for dental prostheses<sup>5,6</sup>. It is estimated that around 621 million children are affected by dental caries in the primary dentition<sup>7</sup>. Therefore, dental caries has an impact on the population's daily activities<sup>8-14</sup> and, consequently, has a major impact on quality of life<sup>15</sup>.

Recent studies have shown that some oral problems can impact academic activities in terms of absenteeism or even performance<sup>16,17</sup>. Absenteeism is commonly used as a synonym for missing school, with related factors comprising physical and mental health, family problems and strained relationships with classmates and teaching staff<sup>18</sup>. Academic performance can be negatively affected by absenteeism. An American study of children and adolescents, concerning missed classes due to dental appointments or oral problems in general, showed that more than 51 million hours a year were lost, and that the average number of missed hours increased with age<sup>19</sup>.

Oral health problems, such as dental caries, will result in pain<sup>20</sup> which, in turn, will influence students' well-being, ultimately interfering with school activities and classroom attendance<sup>16,17,21</sup>. The presence of students in social environments is essential for the development of skills and competencies envisaged for the 21<sup>st</sup> century: which go beyond cognitive development into the affective sphere. Of these, we should stress that empathy, qualified listening and teamwork can only be developed in social contexts since social interaction is one of the main approaches employed in psychological and cognitive development<sup>22</sup>. Moreover, Vygotsky's theory of proximal development, based on cognitive enhancement, is also dependent on social interaction<sup>23,24</sup>. So, frequent absenteeism can have an impact on individuals' cognitive and affective development.

Although some studies have associated oral health with academic performance and/or school absenteeism<sup>25,26</sup>, there are a number of conflicting issues, such as the definition of exposures and outcomes<sup>21</sup>. Accordingly, this study aimed to estimate the effect of oral health on academic performance and school absenteeism. The study hypothesizes that the occurrence of oral problems is associated with poor academic performance and more schooldays missed.

## Materials and Methods

This systematic review was conducted observing the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines<sup>27</sup> and was designed to answer the following questions: "What influence does school absenteeism have on oral problems?" and "Is oral health a factor in academic performance?". The study was registered in PROSPERO under reference number CRD42019110733.

The research question was structured following the PICO method:

- Participants/population: schoolchildren, children and adolescents;

- Intervention/exposure: dental caries, tooth loss, dental pain or poor oral health;
- Control/comparator: Individuals without dental caries, tooth loss, dental pain or having good oral health status
- Outcome: academic performance and school absenteeism.

Inclusion and exclusion criteria

The studies included in the review are original, observational studies that evaluated the association between dental caries, tooth loss, dental pain or self-reported oral health status and school absenteeism or academic performance. To be included in the review, the outcome of the study must include clinically measured dental caries, according to symptom (presence of toothache), or self-reported through the perception of oral health status. School absenteeism and academic performance must have been recorded either using data recorded by the school or through a self-report. The studies should contain a representative sample of the population, involving school-children, children, adolescents or university students. On the other hand, studies with convenience samples, literature reviews, comments or conference summaries were excluded. Studies in Portuguese, English and Spanish were accepted.

Search strategy

The electronic search for manuscripts was conducted on four different databases: BVS (Virtual Health Library), PubMed, Scopus and Web of Science. The research was carried out up to and including November 2022. The terms used in the search varied according to the database (Table 1). To describe exposure, the terms used were *dental caries*, *dental pain*, *toothache*, and *oral health*, and for the description of outcome, *absenteeism*, *school absenteeism*, *academic performance*, and *school performance* were considered.

Table 1. Description of search strategy

Database	Commands search
BVS	(tw:("Toothache" OR "dental pain" OR "Dental Caries" OR "Oral Health")) AND (tw:("Absenteeism" OR "Academic "Performance" OR "school performance"))
PubMed	"Toothache"[Mesh] OR "dental pain"[All Fields] OR "Dental Caries"[Mesh] OR "Oral Health"[Mesh] AND "Absenteeism"[Mesh] OR "Academic Performance"[Mesh] OR "school performance"[All Fields]
Scopus	(TITLE-ABS-KEY ("Toothache" OR "dental pain" OR "Dental Caries" OR "Oral Health") AND TITLE-ABS-KEY ("Absenteeism" OR "Academic Performance" OR "school performance" ) )
Web of Science	TS: ("Toothache" OR "dental pain" OR "Dental Caries" OR "Oral Health") AND TS: ("Absenteeism" OR "Academic Performance" OR "school performance")

Following the search, the articles were transferred to the EndNoteX8 reference software (Thomson Reuters, New York, NY, USA). First of all, duplicate articles were excluded. Then, the remaining titles and abstracts were read and selected by two separate reviewers (SAK and RD), and any differences between the reviewers were

discussed with a third reviewer (FSC) and resolved by consensus. For the analysis of full-text articles, the same list was screened by the same original reviewers, and articles were selected in accordance with the eligibility criteria.

### Critical appraisal

The Critical Appraisal Checklist described by the Joanna Briggs Institute<sup>28</sup> was used for a quality assessment of the studies included after a reading of the full texts. The checklist evaluates methodological aspects through questions answered as “YES”, “NO” or “UNCLEAR”. The same reviewers assessed each study independently. Because all selected studies were cross-sectional, the checklist for prevalence studies was adopted. The percentage of “yes” answers was used to compare the studies.

### Data extraction and Statistical analysis

The data were extracted and organized into a spreadsheet containing data on sample size, countries, continent, exposure, exposure instrument, outcome, outcome instrument, the measure of effect and its respective confidence interval, and methodological quality.

Subsequently, after obtaining the article data, in order to conduct the meta-analysis, crude and adjusted association measures (Odds Ratio) with respective 95% Confidence Intervals (95%CI) were recorded. When the measure of effect was not available, we calculated the odds ratio and 95% CI as per Borenstein et al.<sup>29</sup>. The prevalence ratio measures were converted to OR using the formula:  $PR = \text{odds ratio} / (1 - \text{risk}_0 + \text{risk}_0 \times \text{odds ratio})$ , where  $\text{risk}_0$  is the prevalence of the disease among non-exposed individuals<sup>30-33</sup>. The data were independently extracted by two reviewers (SAK and RD) using pre-piloted data extraction forms. In the event of disagreement, discussions were held to arrive at a consensus.

A meta-analysis was conducted to address review questions. When adjusted results were available, they were included, otherwise crude result estimates were employed. Combined results were presented as a pooled odds ratio (OR). The pooled odds ratio was estimated using fixed- and random-effect models. In the event of divergences (*Chi-square*  $p\text{-value} < 0.05$  or  $I^2 > 50\%$ ), the random-effect model was preferred<sup>34</sup>. In addition, sensitivity analyses were conducted to estimate and verify the influence of each study on the pooled results. A Funnel plot and Egger’s test were used to test for potential publication bias. Statistical analysis was performed using STATA 15.0 software (StataCorp, College Station, TX, USA).

## Results

The electronic searches revealed 4,092 studies. After the removal of duplicates, 3,792 articles were considered for a title and abstract screening. Fifty-eight were included for full-text evaluation and, of these, 33 were excluded (Table 2). Consequently, 25 studies satisfied the inclusion criteria for this systematic review and 13 studies were included in the meta-analysis (Figure 1). Table 3 summarizes the main characteristics of the studies included in the systematic review.

**Table 2.** Excluded articles and main reason for exclusion.

First Author; Year (#ref.)	Location	Reason of exclusion
AGAKU et al. <sup>55</sup> , 2015	USA	Exposure and outcome with inverted data
BAÑOS GARCIA et al. <sup>56</sup> , 2001	Cuba	Exposure and outcome were not evaluated
BERNABE et al. <sup>8</sup> , 2007	Peru	Association between outcome and exposure was not evaluated
BESSELIN et al. <sup>57</sup> , 2013	Laos	Outcome was not evaluated
BROWN et al. <sup>58</sup> , 2005	USA	Exposure and outcome were not evaluated
BUTANI et al. <sup>59</sup> , 2009	USA	Non-representative sample
COLARES and FEITOSA <sup>60</sup> , 2003	Brazil	Non-representative sample
DAVID et al. <sup>61</sup> , 2006	India	Exposure and outcome with inverted data
DE PAULA and MIALHE <sup>62</sup> , 2013	Brazil	Review article
DETTY and OZA-FRANK <sup>63</sup> , 2014	USA	Ecological study
EDELSTEIN et al. <sup>64</sup> , 2006	USA	Outcome was not evaluated
FEITOSA et al. <sup>65</sup> , 2005	Brazil	Exposure and outcome with inverted data
FREIRE and SHEIHAM <sup>66</sup> , 2008	Brazil	Exposure and outcome with inverted data
GARG et al. <sup>67</sup> , 2012	India	Non-representative sample
GHERUNPONG et al. <sup>68</sup> , 2006	Thailand	Exposure and outcome were not evaluated
GIFT et al. <sup>19</sup> , 1992	USA	Ecological study
HALBOUB et al. <sup>69</sup> , 2016	Yemen	Exposure was not evaluated
HONKALA et al. <sup>70</sup> , 2011	Finland	Exposure was not evaluated
JURGENSEN and PETERSEN <sup>71</sup> , 2011	Laos	Exposure and outcome were not evaluated
KUMAR et al. <sup>72</sup> , 2018	India	Outcome was not evaluated
LOGAN et al. <sup>73</sup> , 2008	USA	Exposure was not evaluated
MAHARANI et al. <sup>74</sup> , 2017	Indonesia	Non-representative sample
MITTAL et al. <sup>75</sup> , 2012	India	Outcome was not evaluated
MUIRHEAD and MARCENES <sup>76</sup> , 2004	UK	Ecological study
MUIRHEAD and LOCKER <sup>77</sup> , 2006	Canada	Ecological study
MURRAY et al. <sup>78</sup> , 2015	New Zealand	Outcome was not evaluated
NAAVAAL and KELEKAR <sup>79</sup> , 2018	USA	Outcome was not evaluated
NG <sup>80</sup> , 2011	USA	Article comment on another article
PAU et al. <sup>81</sup> , 2008	Pakistan	Association between outcome and exposure was not evaluated
PETERSEN et al. <sup>82</sup> , 2008	China	Exposure was not evaluated
PETRIDOU et al. <sup>83</sup> , 1996	Greece	Exposure and outcome with inverted data
POURAT and NICHOLSON <sup>84</sup> , 2009	USA	Descriptive study
SHAIKH et al. <sup>85</sup> , 2016	Saudi Arabia	Descriptive study

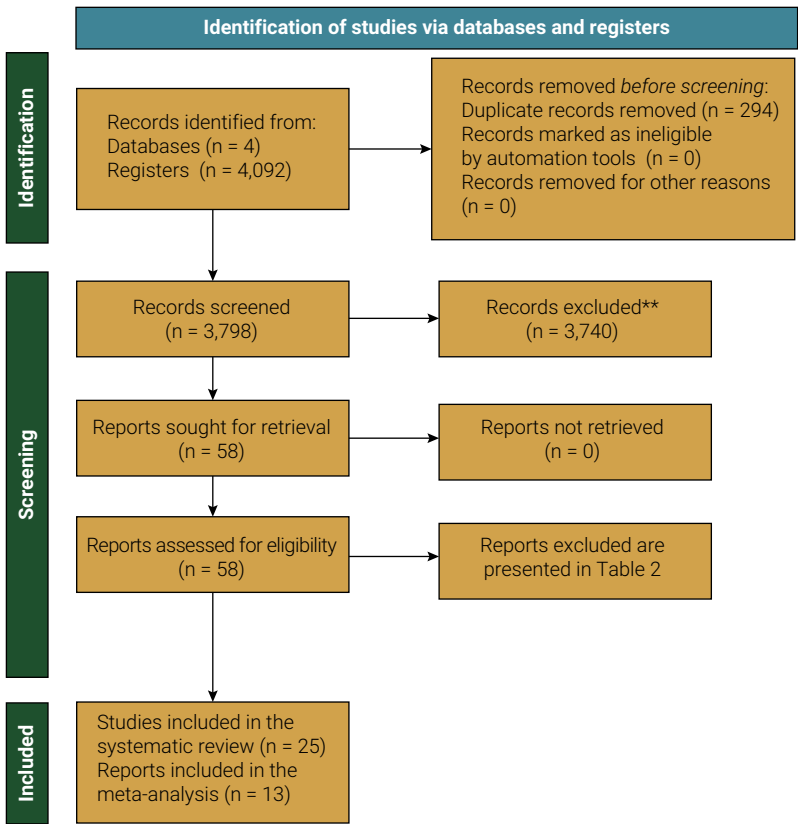


Figure 1. Article selection prisma flowchart.

Table 3. Characterization of included studies

First Author; Year (#ref.)	Sample (Age range)	Location	Oral problems definition	Exposure instrument	Absenteeism or school performance definition	Outcome instrument	Result	JBI critical appraisal
Studies not included in the meta-analysis								
ASTROM and OKULLO <sup>35</sup> , 2003	1146 (13-19)	Uganda	Missing teeth	DMFT	School performance	Questionnaire (OIDP)	2.0 OR	87,5%
BERNABE et al. <sup>40</sup> , 2007	805 (11-12)	Peru	Toothache	Questionnaire	Study performance	Questionnaire (Child-OIDP)	2.17 Mean	62,5%
BLUMENSHINE et al. <sup>16</sup> , 2008	2871 (0-17)	USA	Fair/poor dental	Questionnaire	Poor school performance	Questionnaire	2.34 OR	87,5%
DE PAULA et al., 2015 <sup>36</sup>	515 (12)	Brazil	Dental caries	DMFT	Not passing	School grades	2.84 OR	100%
DE PAULA et al., 2016 <sup>37</sup>	1149 (8-10)	Brazil	Dental caries	DMFT	Poor School performance	School grades	1.51 OR	100%
JURGENSEN and PETERSEN <sup>41</sup> , 2009	621 (12)	Laos	Dental caries	DMFT	School absenteeism	School data	3.0 Mean	100%
KAEWKAMNERDPONG and KRISDAPONG <sup>42</sup> , 2018	925 (11-16)	Thailand	Dental caries	DMFT	School performance	National standard examination	-11,04 beta	62,5%
NAIDOO et al. <sup>43</sup> , 2001	1025 (8-10)	South Africa	Toothache	Questionnaire	School absenteeism	Questionnaire	-	25%
PONGPICHIT et al. <sup>44</sup> , 2008	1158 (9-13)	Thailand	Toothache	Clinic exam	School absenteeism	School data	-	62,5%
MOHAMED et al. <sup>38</sup> , 2020	466 (7-8)	Bahrain	Dental caries	ICDAS	School performance	School data	-	100%
DARLEY et al. <sup>39</sup> , 2021	102,072 (13-17)	Brazil	Toothache	Questionnaire	School absenteeism	Questionnaire	1.35 OR	100%
MIALHE et al. <sup>45</sup> , 2022	385 (14-18)	Brazil	Toothache	Questionnaire	School performance	Questionnaire Self reported	-	100%
Studies included in the meta-analysis								
GOPALAN et al. <sup>46</sup> , 2018	2014 (2-15)	India	Dental caries	DMFT	School absenteeism	School data	1.34 OR	75%
GRADELLA et al. <sup>25</sup> , 2011	765 (2-4)	Brazil	Dental caries	DMFT	School absenteeism	Questionnaire	4.38 OR	100%
GUARNIZO-HERRENO and WEHBY <sup>53</sup> , 2012		USA						75%
	20314 (6-11)		Fair/poor dental health	Questionnaire	Miss school days	Questionnaire	1.20 OR	
								Continue

Continuation									
	12079 (12-14)	Fair/poor dental health	Questionnaire	Miss school days	Questionnaire	1.33 OR			
	14357 (15-17)	Fair/poor dental health	Questionnaire	Miss school days	Questionnaire	0.84 OR			
	20314 (6-11)	Fair/poor dental health	Questionnaire	Problem in school	Questionnaire	1.42 OR			
	12079 (12-14)	Fair/poor dental health	Questionnaire	Problem in school	Questionnaire	1.18 OR			
	14357 (15-17)	Fair/poor dental health	Questionnaire	Problem in school	Questionnaire	1.35 OR			
GUARNIZO-HERRENO et al. <sup>54</sup> , 2019	44735 (6-17)	Toothache	Questionnaire	School absenteeism	School data	1.72 OR	75%		
GUSKUMA et al. <sup>49</sup> , 2017	12	Toothache	Questionnaire	School absenteeism	School data	5.19 OR	100%		
JACKSON et al. <sup>17</sup> , 2011	2183 (0-18)	Fair/poor dental health	Questionnaire	Poor school performance	Questionnaire	1.62 OR	87.5%		
JIANG et al. <sup>50</sup> , 2005		China					100%		
	2662 (11;13;15)	Fair/poor dental health	Questionnaire	Poor school performance	Questionnaire	1.45 OR			
	2662 (11;13;15)	Toothache	Questionnaire	Poor school performance	Questionnaire	3.70 OR			
KARKI et al. <sup>47</sup> , 2019	1151 (5-15)	Dental caries	Untreated caries	School absenteeism	School data	1.11 OR	75%		
KRISDAPONG et al. <sup>51</sup> , 2013		Thailand					100%		
	1063 (12)	Toothache	Questionnaire	School absence due to toothache	Questionnaire	1.90 OR			
	811 (15)	Toothache	Questionnaire	School absence due to toothache	Questionnaire	1.50 OR			
NEVES et al. <sup>26</sup> , 2015	836 (3-5)	Dental Caries	DMTF	School absenteeism	Questionnaire	2.87 OR	100%		Continue



Continuation		Brazil					100%
PIOVESAN et al. <sup>21</sup> , 2012	312 (12)	Dental caries	DMFT	School absenteeism	School data	1.31 OR	100%
	312 (12)	Fair/poor dental health	Questionnaire	School absenteeism	School data	0.54 OR	
POURHASHEMI et al. <sup>48</sup> , 2015	300 (7-14)	Dental caries	Questionnaire	School absenteeism	Questionnaire	1.34 OR	75%
SEIRAWAN et al. <sup>52</sup> , 2012	USA						100%
	1495 (5-17)	Toothache	Questionnaire	School absenteeism	School data	5.70 OR	
	1495 (5-17)	Toothache	Questionnaire	Poor school performance	School data	2.48 OR	

Qualitative description of studies not included in the meta-analysis

Six studies were not included in the meta-analysis because they did not present exposure and/or outcome measures in accordance with the groups that were formed<sup>16, 35-39</sup>. Three presented results using means and regression coefficients<sup>40-42</sup> and three studies did not present the data required to calculate the measures of effect<sup>43-45</sup>.

Authors<sup>35,40</sup> have found that tooth loss and toothache have an impact on academic performance. Students with dental caries have an increased chance of having to repeat a year or suffering poor academic performance<sup>16,36-38,42</sup>. Thus, children who experienced toothache and higher levels of caries also tended to be absent from school more frequently than children who had no oral health problems<sup>39,41,43-45</sup>.

Description of the studies included in the meta-analysis

The thirteen studies included in the meta-analysis comprised a total sample of 105,159 children and teenagers, aged up to 18 years old. Four studies were conducted in Brazil, four in the United States and five in Asian countries. The studies that make up the meta-analysis were divided into seven groups according to exposure and outcome assessment. The results are displayed below and in Figure 2.

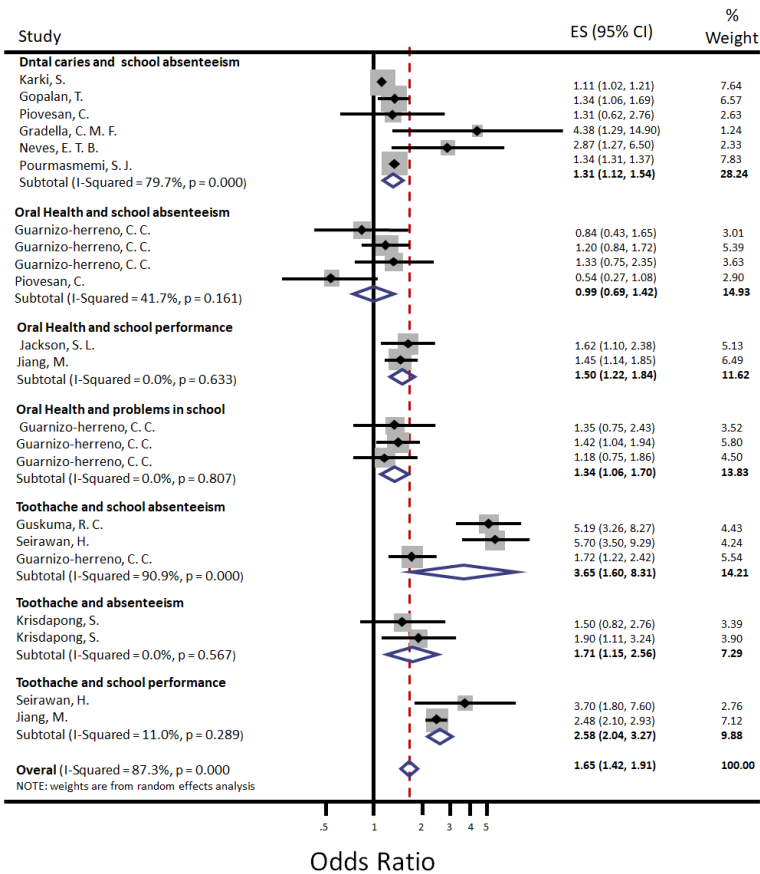


Figure 2. Meta-analysis results with description of odds ratios and respective 95% confidence intervals.

Dental caries and school absenteeism

The pooled effect<sup>21,25,26,46-48</sup> showed that students with dental caries had almost a 30% higher chance of missing classes than students without caries [(OR 1.31; 95%CI 1.12-1.54) I-squared=79.7%]. The funnel plot suggested publication bias, even though the Egger test (p=0.195) indicated an absence of publication bias (Figure 3). The omission of one study would modify the association between dental caries and school absenteeism<sup>26</sup> (Supplementary Figure 1A).

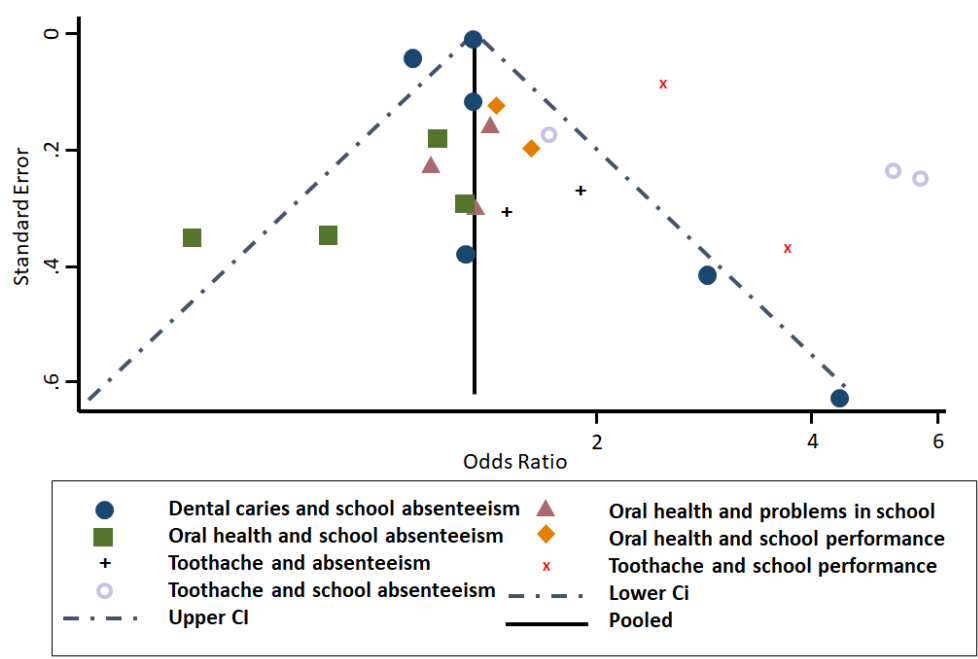


Figure 3. Funnel plot of publication bias.

Fair/poor dental health and school absenteeism

No association was observed regarding poor dental health and school absenteeism [(OR 0.99; 95% CI 0.69-1.42) I-squared=41.7%]. The funnel plot suggested publication bias, despite the Egger test (p=0.308) having indicated an absence of publication bias (Figure 3). In this group, the omission of any one study would not modify the lack of association (Supplementary Figure 1B).

Fair/poor dental health and poor academic performance

Poor self-perception of oral health had a 1.5 higher chance of resulting in worse academic performance than for those who reported better oral health [(OR 1.50; 95% CI 1.22-1.84) I-squared=0.0%]. The funnel plot suggested publication bias (Figure 3). It was not possible to perform a statistical test to verify publication bias because of

the small number of studies. The sensitivity analysis showed that the omission of one study would not modify the association (Supplementary Figure 1C).

### **Fair/poor dental health and problems in school**

Issues such as excessive shyness, low sociability/friendliness, feelings of worthlessness/inferiority and unhappiness, were reported. Students with poor self-perception of oral health had a 1.34 higher chance of having problems at school than students with better self-rated oral health [(OR 1.34, 95% CI 1.06-1.70 I-squared=0.0%)].

The next two study groups assessed both dental pain and school absenteeism. The difference between them is that, in the first group, the instrument for assessing the missing of classes does not specify if it was related to toothache, while in the second group this specification is mentioned.

### **Toothache and school absenteeism**

Students who reported having toothache presented an almost 3.7 higher chance of missing class than students who did not [(OR 3.65; 95%CI 1.60-8.32) I-squared=90.9%]. The funnel plot suggested publication bias. The sensitivity analysis showed that the omission of one study would not modify the association (Supplementary Figure 1D).

### **Toothache and absenteeism due to toothache**

Students who responded that they suffered from dental pain had a 71% higher chance of being absent from school compared to students without pain [(OR 1.71; 95% CI 1.15-2.56) I-squared=90.9%]. If the estimates (e.g., odds ratio) of dental pain and absenteeism in 12-year-old children were to be removed, there would be no significant association.

### **Toothache and poor school performance**

Students who reported suffering from toothache were twice as likely to exhibit poorer academic performance than students who did not [(OR 2.58; 95% CI 2.04 - 3.27) I-squared=11.0%]. The funnel plot suggested publication bias. The omission of one of the studies did not modify the association (Supplementary Figure 1E).

## **Quality assessment**

Taking into consideration all the studies evaluated in the meta-analysis, seven articles<sup>21,25,26,49-52</sup> satisfied 100% of the JBI Critical Appraisal checklist specific for prevalence studies, and just six produced results of between 90% and 75%<sup>17,46-48,53,54</sup> of positive answers on the checklist. This is important information as the included studies possessed high methodological quality and a low risk of bias.

In the evaluation of those studies not included in the meta-analysis, it was noted that six articles<sup>36-39,41,45</sup> satisfied 100% of the JBI Critical Appraisal checklist while the other six studies presented between 25% and 87.5%<sup>16,35,40,42-44</sup> positive answers on the checklists.

## Discussion

In general, our results revealed that students with oral health problems were more likely to miss school and suffer worse academic performance. The strongest associations found in the meta-analysis were related to dental pain, associated with both poor academic performance and increased school absenteeism. The possible explanations for these associations are related to the impact that dental pain has on the exercise of daily school activities, and absence from the classroom due to dental visits or to associated clinical conditions<sup>16,17,21,43,44</sup>.

It is worth noting the results of studies that evaluated toothache and school absenteeism in one Brazilian and one American article<sup>49,52</sup>. Participants were not questioned about absenteeism specifically due to toothache. However, in both studies, it was reported that the students were five times more likely to miss school than students who did not suffer from toothache. Due to the similarity of results, it is worth offering a reflection on the interventions applied to schoolchildren in these two countries<sup>49,52</sup>. It is possible to hypothesize that dental pain can, in some cases, result from the presence of dental caries increasing the chances of school absenteeism<sup>25,26,52</sup>. The degree of severity of the dental caries may influence the sensation of pain, making it impossible for the student to concentrate in the classroom and, consequently, interfering with his academic performance<sup>21,48,52</sup>, also preventing the student from attending class<sup>17,25,26,48</sup>.

Regarding oral diseases according to students' own perceptions, we have self-perception of oral health in relationship to school performance, problems in school, and school absenteeism<sup>17,21,50,53</sup>. Self-perception of oral health was not associated with school absenteeism, and this may be because this poor perception does not have sufficient impact to prevent attendance in the classroom<sup>21,53</sup>. However, self-perception of oral health was associated with both academic performance and problems at school<sup>17,50,53</sup>. This reinforces the fact that the child did not have to suffer from toothache, or necessarily have dental caries, but just that having a poorer self-perception of oral health can influence academic performance, exacerbate the school experience, or have a negative impact on the quality of life of the child or adolescent<sup>17,50,53</sup>, representing the global picture with regard to academic performance, which also includes social and cognitive skills.

Another essential factor for discussion is that, of the ten studies analyzed in the meta-analysis, five had adjusted effect measures, and all these studies controlled for demographic, social and economic variables<sup>17,25,26,51,53</sup>. Four adjusted the analysis for oral health variables<sup>17,26,51,53</sup>, and only one of them adjusted for variables related to children's psychological disorders<sup>53</sup>. The confounding adjustment probably contributes to a change in the effect measure, which cannot be assessed in this study through stratification due to the small number of studies included.

It is important to emphasize that meta-analysis is considered a robust source of evidence because it amplifies the statistical power and undertakes a quality assessment of the included studies because they are observed individually and the findings are subsequently compared. The studies included in our meta-analysis had a low risk of bias. However, some limitations of our study should be con-

sidered. Firstly, the visual evaluation of the funnel plot and statistical hypothesis tests are not usually recommended when there are fewer than ten studies in the meta-analysis, given its low power to detect possible publication bias. Secondly, this study noted a difficulty in grouping the studies, either because of the different methods of measuring the outcome or exposure investigated or the different ways of displaying the results obtained. Furthermore, all studies included in the meta-analysis used a cross-sectional design, precluding estimation of the long-term risk of oral problems, such as dental caries, tooth loss and toothache, to the academic performance of children and adolescents. We should advise that this systematic review has several peculiarities and, therefore, our results should be interpreted with caution. Moreover, it was not possible to explore factors potentially associated with heterogeneity between the studies, such as age grouping. Further studies with longitudinal designs should be performed to improve the quality of evidence observed in cross-sectional studies.

## Conclusion

Students with oral problems were more likely to miss school and demonstrate inferior academic performance. The results should be interpreted bearing in mind the limitations of the present study.

## Compliance with Ethical Standards

**Conflict of Interest:** no conflict of interest.

**Ethical approval:** not required.

**Informed consent:** not required.

**Financial:** none.

## Conflict of interests

The authors have no conflicts of interest to declare.

## Data availability

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

## Authors contribution

Sarah Arangurem Karam: Conception of the design, write the paper, participate of data collection and perform the literature review. Francine dos Santos Costa; Conception of the design, write the paper, participate of data collection and perform the literature review. Luiz Alexandre Chisini: Conception of the design and review of paper. Rodrigo Darley; Conception of the design, write the paper, participate of data collection and perform the literature review. Flávio Fernando Demarco: Conception of the design and review of paper. Marcos Britto Correa: Conception of the design and review of paper. All authors final approval of the version to be published.

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